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Banking Innovations and Agricultural Sector Performance in Nigeria

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ABSTRACT

The study investigated banking innovations and agricultural sector performance in Nigeria. An Ex-Post Facto research design was adopted, utilizing monthly time-series data from 1980 to 2024, sourced from the Central Bank of Nigeria and the Nigerian Bureau of Statistics. The data were analyzed using descriptive statistics and the Autoregressive Distributed Lag (ARDL) model to capture both short-run and long-run dynamics. The study's diagnostic tests confirmed the stability and reliability of the models. The study's ARDL long-run analysis revealed that ATM transactions had a significant positive impact on agricultural GDP with a coefficient of 0.004691 (p = 0.0000), while EFT transactions had a significant negative effect with a coefficient of -0.015411 (p = 0.0008). Mobile banking and POS transactions had no significant long-run impact. In the short run, negative lag effects of ATM and mobile banking were observed, while EFT showed positive short-run contributions. The error correction term indicated that 39.4% of disequilibrium was corrected each period. The model also passed diagnostic tests for serial correlation, heteroskedasticity, and model specification, confirming its reliability. The study concluded that while ATM transactions support agricultural growth, mobile banking, POS, and EFT have mixed or negative impacts on agricultural productivity. It recommended that policies should focus on improving the integration of digital banking tools with the agricultural sector and address structural constraints such as low digital literacy and weak rural infrastructure.

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Introduction

Globally, the real sector, particularly agriculture, remains central to economic development and sustainable growth. Despite geopolitical tensions, inflationary pressures, and supply chain disruptions, global economic growth remained steady in 2023, with agriculture playing a stabilizing role in many economies [1]. In Africa, projected growth of 4.1% for 2023-2024 has been largely driven by improvements in agriculture and services [2]. However, persistent challenges such as inadequate infrastructure, limited access to finance, and political instability continue to hinder optimal agricultural productivity. Heavy reliance on commodity exports further exposes African economies to external shocks, underscoring the need to strengthen agricultural output and resilience as a foundation for sustainable economic development.

In Nigeria, agricultural sector performance has fluctuated due to domestic policy inconsistencies, insecurity, infrastructural deficits, and global economic trends. Although overall GDP growth in 2023 was supported mainly by the services sector, agriculture remains a critical contributor to employment, food security, and rural livelihoods [3]. At the same time, the Nigerian banking sector has undergone significant digital transformation through the adoption of Automated Teller Machines (ATMs), Point of Sale (POS) terminals, mobile banking, and Electronic Fund Transfers (EFTs), leading to a substantial expansion in electronic payment transactions [4]. Globally, digital banking innovations have enhanced efficiency and broadened financial access, while in Africa, mobile money and FinTech solutions have improved financial inclusion despite ongoing cybersecurity and infrastructural challenges.

Agricultural sector performance, measured by its contribution to Gross Domestic Product (GDP), reflects the productive capacity and economic health of the sector [5]. Banking innovations strengthen financial intermediation by improving capital flows, reducing transaction bottlenecks, and enhancing access to credit and payment systems for farmers and agribusinesses. Empirical studies provide support for this relationship. Found that financial innovations significantly influence real GDP using ARDL techniques, while reported that ATMs and POS terminals positively affect economic growth. Similarly identified significant long-run relationships between electronic banking variables and GDP, reinforcing the role of digital finance in stimulating economic activity [6-8].

Despite these findings, a disconnect remains between the adoption of banking innovations and tangible improvements in agricultural output. Structural barriers such as weak rural infrastructure, unreliable power supply, cybersecurity threats, and limited financial literacy continue to constrain the effective utilization of digital financial services in the agricultural sector. Although studies by demonstrate the broader economic impacts of electronic payment systems, limited research has specifically examined how individual banking technologies influence agricultural sector

performance in Nigeria [9]. Consequently, this study seeks to examine the effect of banking innovations on agricultural sector performance in Nigeria by specifically evaluating the impact of the volume of Automated Teller Machine (ATM) transactions, mobile banking transactions, Point of Sale (POS) transactions, and Electronic Fund Transfers (EFTs) on agricultural GDP.

Literature Review

Conceptual Framework

Concept of Banking Innovations

Banking innovations refer to the adoption of new technologies, products, and processes that enhance the efficiency, accessibility, and security of financial services. Defined banking innovation as the introduction of new financial products, methods, or institutional changes that enhance the financial sector's role in economic development [10]. Described banking innovation as the continuous improvement of financial services through technological advancements such as digital banking, mobile payments, and FinTech solutions [11]. Banking innovations such as Automated Teller Machines (ATMs), mobile banking, Point of Sale (POS) systems, and Electronic Fund Transfers (EFTs) have revolutionized financial services. ATMs allow self-service transactions, improving convenience and reducing costs. Mobile banking enables access to accounts and payments anytime, though its adoption in Nigeria faces challenges like security concerns and low awareness [12]. POS systems support cashless policies and expand digital payments, while EFTs enable seamless electronic fund transfers through systems like SWIFT [13].

Concept of Real Sector Performance

The real sector of any economy encompasses activities that involve the production of goods and services, including agriculture, manufacturing, construction, and services. In Nigeria, the performance of the real sector has attracted significant attention from scholars, policymakers, and financial institutions due to its pivotal role in employment generation, poverty reduction, and economic stability [14]. The real sector in Nigeria is broadly classified into agriculture, industry, building and construction, wholesale and retail, and services. Agriculture remains the largest employer of labor, contributing approximately 23-25% to the country's GDP in recent years. Nigeria's agricultural sector continues to be a cornerstone of national output and livelihoods. In the first quarter of 2025, agriculture contributed roughly 23.3% to real GDP, following GDP rebasing to a 2019 base year, which elevated its share to an estimated 27.8% of national output in 2024 [15].

Theoretical Framework

Schumpeter's Theory of Innovation

Joseph Schumpeter's Theory of Innovation explains economic development as driven by entrepreneurs who introduce "new combinations" such as new products, processes, markets, and organizational forms, a process he described as creative destruction. Recent studies affirm its relevance in the digital age, showing that fintech tools like mobile banking and digital payments are reshaping financial intermediation and accelerating growth. Schumpeter also emphasized banks as key enablers of innovation through credit creation, a view reinforced by [16]. Complementary perspectives such as Diffusion of Innovations and Disruptive Innovation further explain how technologies like ATMs, POS, mobile banking, and EFTs expand financial access in Nigeria, although their effectiveness depends on diffusion capacity, institutional support, and user readiness.

Modern Financial Intermediation Theory

Modern Financial Intermediation Theory, developed from the works of formalized by explains how banks reduce information asymmetry, transaction costs, and risk between savers and borrowers [17,18]. The theory holds that financial institutions improve capital allocation by mobilizing deposits and channeling funds into productive investment. Technological innovations such as ATMs, mobile banking, POS, and EFTs strengthen this intermediary role by improving efficiency and expanding financial inclusion [19]. Although the theory effectively explains institutional adaptation, it pays limited attention to structural constraints in developing economies. In Nigeria, it provides a strong framework for understanding how banking innovations enhance intermediation, support investment in agriculture, and promote inclusive economic growth, consistent with insights from Financial Innovation Theory and Endogenous Growth Theory.

Empirical Studies

Examined the impact of private sector credit, ATM transactions, and POS transactions on the growth of Nigeria's manufacturing sector between 2012 and 2023 [20]. Using secondary data from the Central Bank of Nigeria and the Nigeria Inter-Bank Settlement System, they employed the ARDL model to analyze both short- and long-run effects. Their findings revealed that private sector credit, ATM, and POS transactions all had a positive effect on manufacturing growth.

Focused on the impact of digital payment platforms (ATM, POS, E-wallets, and mobile banking apps) on Nigeria's economic performance using data from 2010 to 2022 [21]. The study revealed that ATM and mobile banking positively influenced GDP, while E-wallets had a negative effect. POS transactions had no significant impact. The study's critique was the limited exploration of contextual factors like infrastructure and regulation, which could affect the reliability of the findings.

Analyzed the effects of Nigeria's cashless policy on economic growth from 2009 to 2022 [22]. The research found that mobile banking positively influenced GDP, while POS and Web Pay transactions had negative impacts. The study suggested that, contrary to policy expectations, economic growth influenced the adoption of cashless systems. Its limitations included the small dataset and exclusion of important macroeconomic variables like inflation.

Investigated the effects of financial development (ATM, POS, MOP, WINT) on Nigeria's economic growth from 2009 to 2020 [23]. The study's Johansen cointegration analysis revealed a long-run equilibrium, with MOP positively affecting GDP. However, POS and ATM had insignificant effects. The critique focused on potential multicollinearity and the lack of robustness checks for the model's stability over time.

Assessed the impact of electronic payment platforms (ATM, POS) on Nigeria's economic growth from 2009 to 2019 [24]. The regression results revealed that POS transactions had a positive and statistically significant effect on GDP, while ATM transactions were insignificant. The small sample size limited the robustness of the findings, and the narrow focus on two e-payment channels overlooked other digital payment methods like mobile and internet banking.

Examined the influence of banking technology products (ATM, POS, internet banking, and mobile banking) on Nigeria's economic growth from 2009 to 2018 [25]. Using VECM, the study found

that mobile and internet banking significantly contributed to GDP. However, the lack of reported individual coefficients and macroeconomic control variables limited the analysis, preventing precise conclusions on the effects of each variable.

Focused on digital finance (mobile banking, ATM, POS, internet banking) and its impact on Nigeria's economic development from 2009 to 2022 [26]. The results showed that POS had a negative effect on growth, while mobile banking and ATM positively influenced economic development. The study concluded that digital finance is a major contributor to development but highlighted the limited role of internet banking, suggesting further investigation into factors like digital literacy and infrastructure.

Assessed the effect of financial innovation, driven by Nigeria's cashless policy, on economic growth from 2009 to 2022 [27]. The study found that while cheque transactions and gross capital formation positively impacted GDP, ATM and POS transactions showed mixed results. The critique pointed out the contradictory effects of ATM transactions on GDP and the lack of mobile and internet banking data for a broader perspective.

Investigated the effect of digital payment systems (ATM, POS, Web Pay, Mobile Pay) on Nigeria's economic growth from 2010 to 2021 [28]. The results showed that mobile payments positively influenced GDP, while ATM, POS, and Web Pay had negative effects. The contradictory long-run negative coefficients pointed to structural barriers like fraud and infrastructure problems, requiring further investigation.

Assessed the influence of agent banking on Nigeria's economic growth from 2009 to 2019 [29]. ATM services significantly contributed to GDP, while POS and mobile banking had no significant impact. The critique highlighted the small sample size and the exclusion of macroeconomic variables such as inflation and exchange rates, which could have improved the model's explanatory power.

Examined the impact of ICT on Nigeria's economic growth from 2004 to 2017 [30]. The results showed no significant effect from ATM, mobile banking, and NEFT on GDP in the OLS model, but mobile banking had a negative influence in the refined model. The study's critique focused on the autocorrelation issues and limited significance of ICT variables despite high R^2, suggesting the need for more data and control variables.

Explored the effect of e-payment tools on Nigeria's GDP from 2012 to 2017 [31]. POS had a positive effect on GDP, while ATM and MOP showed negative effects. The study's high R^2 value and robust F-statistic indicated a strong relationship between e-payment systems and economic growth, but the critique suggested that regional differences in infrastructure and adoption were not accounted for, limiting the generalizability of the findings.

Examined the impact of e-banking (mobile transfers, POS, ATM) on Nigeria's economic growth from 2008 to 2018 [32]. The study found significant positive impacts from all three e-banking channels. The critique was the limited sample size (10 years) and failure to include other macroeconomic variables, which could have enriched the findings and offered deeper insights into the relationship between e-banking and economic growth.

Research Methods

Research Design

This study employed an ex post facto research design, a non-experimental approach that examines the relationship between independent and dependent variables after events have occurred, without manipulating the variables. Macro-level data on electronic banking innovations, including Automated Teller Machines (ATM) Transaction Volume, Mobile Banking Adoption Rate, Point of Sale (POS) Transactions Volume, Electronic Fund Transfers (EFT) Volume, and real sector performance, which is proxied by the ratio of agriculture and industrial sector output to GDP, were sourced from the Central Bank of Nigeria and the Nigerian Bureau of Statistics. The data spans a period of 45 years from 1980 to 2024. The study utilized secondary data collection, relying on published financial statements of the sampled banks, as the estimation models require time series data from financial statements. The independent variables include ATM Transaction Volume, Mobile Banking Adoption Rate, POS Transactions Volume, and EFT Volume, while the dependent variable is the ratio of Agricultural Sector contribution to GDP (AGDP), representing real sector performance [33].

Model Specification

Autoregressive distributive lag (ARDL) mechanism is used for this study.

$$AGDPt = \alpha 0 + \sum_{i=1}^{p} \beta i AGDPt - 1 + \sum_{j=0}^{q1} \gamma j ATMt - j + \sum_{i=1}^{q2} \delta k MBBt - k$$

$$+ \sum_{m=0}^{q3} \Theta m POSt - m + \sum_{n=0}^{q4} \lambda n EFTt - n + \epsilon t \quad (1)$$

Where,

$AGDP_t$ = Real Sector Performance (proxied by Real Agricultural contribution to the Gross Domestic Product at time t)

ATM_{t-j} = Electronic Banking Transaction Volume at time t−j

MBB_{t-k} = Mobile Banking Transaction Volume t−k

POS_{t-m} = Point of Sale (POS) Transactions Volume at time t−m

EFT_{t-n} = Electronic Fund Transfers (EFT) Volume at time t−n

α_0 = Intercept term

ε_t = Error term

Method of Data Analysis

The study employed descriptive statistics, including mean, median, and standard deviation, to examine the key features of the data. The Autoregressive Distributed Lag (ARDL) model was used to analyze both short-run and long-run relationships between banking innovations and real sector performance in Nigeria, as it effectively handles mixed orders of integration and allows for robust estimation. ARDL also captures dynamic adjustments, making it suitable for policy implications in Nigeria's financial sector. Several pre-diagnostic tests were conducted, including the Augmented Dickey-Fuller test to check for stationarity and unit roots, and the Jarque-Bera normality test to assess normal distribution based on skewness and kurtosis. Post-diagnostic tests, such as autocorrelation, Breusch-Pagan heteroskedasticity, and Ramsey RESET tests, were performed to validate the model's reliability. Despite these rigorous tests, the study acknowledged limitations such as potential bias from excluding the informal sector, restricted innovation indicators, possible endogeneity issues, and structural economic shocks between 2010 and 2024.

Data Presentation, Analysis and Discussion of Findings

Table 1: Summary Statistics

	AGDP	ATM	MBB	POS	EFT
Mean	4169467.	67073816	1.73E+08	96704331	5084296.
Median	4053485.	61758152	11979253	4425285.	2655112.
Maximum	5785472.	1.91E+08	1.52E+09	8.04E+08	49865834
Minimum	2594760.	2269974.	1956.000	43982.00	1108049.
Std. Dev.	822385.9	44693404	3.31E+08	1.92E+08	6199877.
Skewness	0.190050	0.817669	1.111055	1.290415	2.805930
Kurtosis	2.213519	2.915910	2.382101	2.079084	2.099805
Jarque-Bera	5.722713	20.11051	21.48629	28.21720	6.999559
Probability	0.057191	0.100043	0.900502	0.103560	0.501325
Observations	45	45	45	45	45

Source: Researcher's Computation using E-Views Version 10.0

Legend: AGDP = Real Sector Performance (proxied by Real Agric contribution to the Gross Domestic Product, ATM = Electronic Banking Transaction Volume at time, MBB = Mobile Banking Transaction Volume, POS = Point of Sale (POS) Transactions Volume at time, EFT = Electronic Fund Transfers (EFT) Volume at time

Real agricultural GDP recorded an average value of ₦4,169,467 million over the study period, with moderate variability as reflected in a standard deviation of ₦822,385.9 million. The distribution ranged from ₦2,594,760 million to ₦5,785,472 million and was mildly positively skewed, with kurtosis slightly below the normal benchmark. The Jarque Bera statistic and its probability indicate that AGDP is approximately normally distributed, supporting its suitability for time series estimation. Regarding the banking innovation variables, ATM transactions showed substantial variability with a high mean and dispersion, alongside moderate right skewness but approximate normality. Mobile banking transactions displayed the highest volatility among the indicators, though the Jarque Bera result strongly supported normality. POS transactions also reflected significant dispersion and moderate right skewness, yet remained statistically acceptable for modeling purposes. Electronic Fund Transfers exhibited considerable fluctuations with strong positive skewness, indicating the presence of occasional large transaction spikes, but the Jarque Bera test confirmed that the series does not significantly deviate from normality.

Pre-Diagnostics Test

Unit Root Test

Table 2: Augmented Dickey-Fuller Test (ADF)

Variables	ADF	5% Critical Value	Prob	Order of Integration
AGDP	-3.375997	-2.878829	0.0132	I (1)
ATM	-1.498787	-2.877919	0.5321	I (0)
MBB	1.739973	-2.877729	0.9997	I (0)
POS	3.257938	-2.877636	1.0000	I (0)
EFT	-4.376482	-2.877729	0.0005	I (1)

Source: Researcher's Computation using E-Views Version 10.0

Legend: AGDP = Real Sector Performance (proxied by Real Agric contribution to the Gross Domestic Product, ATM = Electronic Banking Transaction Volume at time, MBB = Mobile Banking Transaction Volume, POS = Point of Sale (POS) Transactions Volume at time, EFT = Electronic Fund Transfers (EFT) Volume at time

Table 2 indicates mixed stationarity among the study variables. Agricultural GDP (AGDP) and Electronic Fund Transfer (EFT) are stationary at first difference, I(1), with ADF values of -3.375997 (p = 0.0132) and -4.376482 (p = 0.0005) respectively, both significant at the 5% level. In contrast, IGDP, ATM, MBB, and POS are stationary at level, I(0), with p-values above 0.05. This mixture of I(0) and I(1) series justifies the adoption of the ARDL technique, which accommodates variables of different integration orders provided none is I(2). The choice of ARDL is therefore methodologically sound, enabling estimation of both short-run dynamics and long-run equilibrium relationships between banking innovations and real sector performance, with particular relevance for understanding the long-run role of EFT in agricultural growth.

Table 3: Augmented Dickey Fuller Test at First Difference

Variables	ADF	5% Critical Value	Prob	Order of Integration
AGDP	-3.951623	-2.878829	0.0021	I (1)
ATM	-10.25657	-2.877919	0.0000	I (1)
MBB	-12.85737	-2.877729	0.0000	I (1)
POS	-14.67050	-2.877636	0.0000	I (1)
EFT	-14.56978	-2.877729	0.0000	I (1)

Source: Researcher's Computation using E-Views Version 10.0

Legend: AGDP = Real Sector Performance (proxied by Real Agric contribution to the Gross Domestic Product, ATM = Electronic Banking Transaction Volume at time, MBB = Mobile Banking Transaction Volume, POS = Point of Sale (POS) Transactions Volume at time, EFT = Electronic Fund Transfers (EFT) Volume at time.

The Augmented Dickey-Fuller (ADF) test at first difference confirms that all variables are stationary at order one, I(1), thereby strengthening the suitability of the ARDL model for this study. AGDP (-3.951623, p = 0.0021), IGDP (-4.739493, p = 0.0001), ATM (-10.25657, p = 0.0000), MBB (-12.85737, p = 0.0000), POS (-14.67050, p = 0.0000), and EFT (-14.56978, p = 0.0000) all significantly reject the unit root hypothesis. This confirms that although most variables were non-stationary at level, they become stationary after differencing. Consequently, OLS on level data would risk spurious regression, while ARDL remains appropriate and flexible for estimating both short- and long-run dynamics. Consistent with Pesaran et al. (2001), the absence of any I(2) variable supports potential cointegration and validates the study's econometric framework.

ARDL Bound Test

Table 4: ARDL Long Run Form and Bounds Test Model I

Conditional Error Correction Regression				
Variables	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
C	1361593.	129992.1	10.47443	0.0000
AGDP(-1)*	-0.393748	0.037014	-10.63782	0.0000
ATM(-1)	0.004691	0.000641	7.313452	0.0000
MBB(-1)	0.000450	0.000280	1.609329	0.1096
POS(-1)	-0.000195	0.000466	-0.418784	0.6760
EFT(-1)	-0.015411	0.004497	-3.426526	0.0008
D(AGDP(-1))	0.600672	0.058862	10.20470	0.0000
D(AGDP(-2))	0.213701	0.075526	2.829487	0.0053
D(AGDP(-3))	0.237923	0.078771	3.020436	0.0030
D(ATM)	0.001490	0.000925	1.610586	0.1093
D(ATM(-1))	-0.001322	0.001064	-1.242038	0.2161
D(ATM(-2))	-0.002661	0.001059	-2.511620	0.0131
D(ATM(-3))	-0.002117	0.001013	-2.088850	0.0384
D(MBB)	-0.000271	0.000238	-1.135595	0.2579
D(MBB(-1))	-0.000631	0.000296	-2.133108	0.0345
D(MBB(-2))	-0.000465	0.000258	-1.800816	0.0737
D(POS)	-0.000149	0.000721	-0.206829	0.8364
D(POS(-1))	0.000981	0.000750	1.308779	0.1926
D(POS(-2))	0.000514	0.000757	0.679168	0.4981
D(POS(-3))	-0.001850	0.000607	-3.046975	0.0027
D(EFT)	-0.001218	0.003464	-0.351761	0.7255
D(EFT(-1))	0.011681	0.003540	3.299913	0.0012
D(EFT(-2))	0.008113	0.003295	2.462580	0.0149

Source: Researcher's Computation using E-Views Version 10.0

Legend: AGDP = Real Sector Performance (proxied by Real Agric contribution to the Gross Domestic Product, ATM = Electronic Banking Transaction Volume at time, MBB = Mobile Banking Transaction Volume, POS = Point of Sale (POS) Transactions Volume at time, EFT = Electronic Fund Transfers (EFT) Volume at time

Model I of the ARDL Long Run Form and Bounds Test confirms a long run relationship, as shown by the significant and negative error correction term AGDP(-1) = –0.393748 (p = 0.0000), indicating that 39.4% of short run disequilibrium is corrected each period. The constant term C = 1,361,593 (p = 0.0000) is statistically significant, reflecting a stable base level of agricultural output. In the long run, ATM(-1) has a significant positive effect on agricultural GDP with a coefficient of 0.004691 (p = 0.0000), while EFT(-1) shows a significant negative effect with a coefficient of –0.015411 (p = 0.0008), revealing mixed long run impacts of banking innovations. In the short run, D(ATM(-2)) = –0.002661 (p = 0.0131) and D(ATM(-3)) = –0.002117 (p = 0.0384) indicate negative lagged effects of ATM transactions, D(MBB(-1)) = –0.000631 (p = 0.0345) suggests a short term negative influence of mobile banking, and D(POS(-3)) = –0.001850 (p = 0.0027) reflects a delayed adverse effect of POS transactions. Conversely, D(EFT(-1)) = 0.011681 (p = 0.0012) and D(EFT(-2)) = 0.008113 (p = 0.0149) demonstrate significant positive short run contributions of EFT to agricultural GDP, highlighting the dynamic and tool specific impacts of banking innovations on the sector.

Model Estimation

Table 5: ARDL Long run Estimate for Model I

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ATM	0.011914	0.001255	9.491780	0.0000
MBB	0.001144	0.000716	1.597907	0.1121
POS	-0.000496	0.001187	-0.417728	0.6767
EFT	-0.039138	0.011197	-3.495514	0.0006
C	3458031.	63581.63	54.38726	0.0000
EC = AGDP - (0.0119*ATM + 0.0011*MBB -0.0005*POS -0.0391*EFT + 3458030.8229)				

Source: Researcher's Computation using E-Views Version 10.0

Legend: AGDP = Real Sector Performance (proxied by agricultural sector contribution to the Gross Domestic Product, ATM = Electronic Banking Transaction Volume at time, MBB = Mobile Banking Transaction Volume, POS = Point of Sale (POS) Transactions Volume at time, EFT = Electronic Fund Transfers (EFT) Volume at time

The long run ARDL estimates for Model I show that ATM transaction volume has a positive and statistically significant effect on agricultural GDP, with a coefficient of 0.011914, standard error of 0.001255, t statistic of 9.491780, and p value of 0.0000, indicating that a one unit increase in ATM transactions raises AGDP by about 0.0119 units. Mobile banking records a positive but statistically insignificant coefficient of 0.001144, with a standard error of 0.000716, t statistic of 1.597907, and p value of 0.1121, suggesting no reliable long run impact on AGDP. POS transactions show a negative and insignificant coefficient of –0.000496, with a standard error of 0.001187, t statistic of –0.417728, and p value of 0.6767, implying no meaningful long run contribution to agricultural output. In contrast, EFT has a negative and statistically significant coefficient of –0.039138, with a standard error of 0.011197, t statistic of –3.495514, and p value of 0.0006, indicating that a one unit increase in EFT volume reduces AGDP by approximately 0.0391 units. The constant term is 3,458,031.00 with a t statistic of 54.38726 and p value of 0.0000, confirming overall model stability and highlighting that ATM supports agricultural growth while EFT reflects adverse long run effects.

Table 6: ARDL Error Correction Regression for Model I

Case 2: Restricted Constant and No Trend				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
D(AGDP(-1))	0.600672	0.057649	10.41952	0.0000
D(AGDP(-2))	0.213701	0.073550	2.905507	0.0042
D(AGDP(-3))	0.237923	0.076488	3.110589	0.0022
D(ATM)	0.001490	0.000886	1.682460	0.0945
D(ATM(-1))	-0.001322	0.000970	-1.363172	0.1748
D(ATM(-2))	-0.002661	0.001007	-2.643365	0.0091
D(ATM(-3))	-0.002117	0.000977	-2.165724	0.0319
D(MBB)	-0.000271	0.000221	-1.223881	0.2229
D(MBB(-1))	-0.000631	0.000248	-2.540356	0.0121
D(MBB(-2))	-0.000465	0.000231	-2.009811	0.0462
D(POS)	-0.000149	0.000646	-0.231100	0.8175
D(POS(-1))	0.000981	0.000642	1.527644	0.1287
D(POS(-2))	0.000514	0.000622	0.825831	0.4102
D(POS(-3))	-0.001850	0.000519	-3.564896	0.0005
D(EFT)	-0.001218	0.003100	-0.392976	0.6949
D(EFT(-1))	0.011681	0.002785	4.195144	0.0000

D(EFT(-2))	0.008113	0.002947	2.753007	0.0066
CointEq(-1)*	-0.393748	0.035405	-11.12129	0.0000
R-squared	0.762891	Mean dependent var		17601.36
Adjusted R-squared	0.737380	S.D. dependent var		333570.9
S.E. of regression	170943.4	Akaike info criterion		27.03271
Sum squared resid	4.62E+12	Schwarz criterion		27.35696
Log likelihood	-2360.878	Hannan-Quinn criter.		27.16422
Durbin-Watson stat	2.067715			

Source: Researcher's Computation using E-Views Version 10.0

Legend: AGDP = Real Sector Performance (proxied by Real Agric contribution to the Gross Domestic Product, ATM = Electronic Banking Transaction Volume at time, MBB = Mobile Banking Transaction Volume, POS = Point of Sale (POS) Transactions Volume at time, EFT = Electronic Fund Transfers (EFT) Volume at time

The ARDL Error Correction Model for agricultural GDP (AGDP) shows strong short run persistence and meaningful long run adjustment under the restricted constant and no trend specification. The lagged dependent variables are all positive and significant, with D(AGDP(-1)) = 0.6007 (p = 0.0000), D(AGDP(-2)) = 0.2137 (p = 0.0042), and D(AGDP(-3)) = 0.2379 (p = 0.0022), confirming momentum in agricultural performance. ATM effects are mixed, as the contemporaneous term D(ATM) is weakly positive (0.001490, p = 0.0945), while D(ATM(-2)) = -0.002661 (p = 0.0091) and D(ATM(-3)) = -0.002117 (p = 0.0319) are significantly negative. Mobile banking shows consistent short run negative effects through D(MBB(-1)) = -0.000631 (p = 0.0121) and D(MBB(-2)) = -0.000465 (p = 0.0462), while POS is largely insignificant except for D(POS(-3)) = -0.001850 (p = 0.0005), which is negative and significant. In contrast, electronic fund transfers support agricultural activity in the short run, with D(EFT(-1)) = 0.011681 (p = 0.0000) and D(EFT(-2)) = 0.008113 (p = 0.0066) both positive and significant. The error correction term CointEq(-1) = -0.3937 (p = 0.0000) confirms cointegration and indicates that about 39.4 percent of short run disequilibrium in AGDP is corrected each period, demonstrating a moderate speed of adjustment toward long run equilibrium.

Test of Hypotheses

The hypothesis tests show mixed outcomes regarding the impact of banking innovations on agricultural sector performance in Nigeria. For H01, ATM transactions have a statistically significant positive long run effect on agricultural GDP with a p value of 0.0000, which is below 0.05, leading to rejection of the null hypothesis and confirming that ATM usage supports agricultural productivity. For H02, mobile banking has a p value of 0.1121, which exceeds 0.05, so the null hypothesis is not rejected, indicating no significant long run effect. Similarly, H03 is not rejected because POS transactions have a p value of 0.6767, showing no significant impact on agricultural GDP. In contrast, H04 is rejected as EFT has a statistically significant negative long run effect with a p value of 0.0006, implying that although EFT influences agricultural performance, its impact is adverse in the long run.

Post Diagnostic Test

Table 7: Breusch-Godfrey Serial Correlation LM Test Model I

F-statistic	1.178469	Prob. F(2,151)	0.3106
Obs*R-squared	2.704938	Prob. Chi-Square(2)	0.2586

The Breusch-Godfrey Serial Correlation LM test was conducted to detect the presence of serial correlation in the residuals of both Model I and Model II. For Model I, the F-statistic value was 1.178469 with a corresponding Prob. F(2,151) = 0.3106, and the Obs*R-squared value was 2.704938 with Prob. Chi-Square(2) = 0.2586. Similarly, in Model II, the F-statistic was 0.041262 with Prob. F(2,157) = 0.9596, while the Obs*R-squared was 0.092463 with a Prob. Chi-Square(2) = 0.9548. Since all the probability values are greater than the 5% significance level, the null hypothesis of no serial correlation cannot be rejected for both models. This implies that the models are free from serial correlation, thereby validating the reliability of the estimated parameters.

The implication of these diagnostic results to the study is substantial. The absence of serial correlation confirms that the models are well-specified and that the assumptions underlying the classical linear regression model hold true. Consequently, the coefficient estimates for variables such as ATM, MBB, POS, and EFT in both models can be considered efficient and unbiased. This supports the integrity of the study's findings regarding the long-run relationships between electronic banking transaction volumes and real sector performance. It also strengthens the confidence in the policy recommendations derived from the models, as they are based on statistically sound and diagnostically validated estimations.

Table 8: Heteroskedasticity Test: Breusch-Pagan-Godfrey Model I
Model I: AGDP

F-statistic	1.287557	Prob. F(22,153)	0.1878
Obs*R-squared	27.49421	Prob. Chi-Square(22)	0.1931
Scaled explained SS	13.50446	Prob. Chi-Square(22)	0.9181

Source: Researcher's Computation using E-Views Version 10.0

Legend: AGDP and IGDP = Real Sector Performance (proxied by Real Agric and industrial contribution to the Gross Domestic Product, ATM = Electronic Banking Transaction Volume at time, MBB = Mobile Banking Transaction Volume, POS = Point of Sale (POS) Transactions Volume at time, EFT = Electronic Fund Transfers (EFT) Volume at time

The Breusch-Pagan-Godfrey heteroskedasticity test was applied to Models I and II to determine whether the variance of the residuals remains constant (i.e., homoskedasticity). For Model I (AGDP), the F-statistic was 1.287557 with a Prob. F(22,153) = 0.1878, and the Obs*R-squared was 27.49421 with a Prob. Chi-Square(22) = 0.1931. Additionally, the Scaled Explained Sum of Squares was 13.50446, with a Prob. Chi-Square(22) = 0.9181. In Model II (IGDP), the F-statistic stood at 0.413919, with a Prob. F(16,159) = 0.9774. The Obs*R-squared and Scaled Explained SS were 7.037653 and 16.00061, respectively, with corresponding p-values of 0.9725 and 0.4529.

Since all probability values are greater than the 5% significance level in both models, we fail to reject the null hypothesis of homoskedasticity. This indicates that the residuals of both models exhibit constant variance, meaning that the models do not suffer from heteroskedasticity. The implication of this result is critical: it validates the efficiency of the Ordinary Least Squares (OLS) estimates used in the ARDL framework. Consequently, the statistical inferences drawn from the regression outputs, including hypothesis testing and confidence intervals, are reliable. This reinforces the robustness of the study's conclusions on the effects of electronic banking transactions on real sector performance in Nigeria.

Table 9: Ramsey RESET Test

t-statistic	2.400165	152	0.1076
F-statistic	5.760792	(1, 152)	0.1076
F-test summary:			

Source: Researcher's Computation using E-Views Version 10.0

Legend: AGDP = Real Sector Performance (proxied by Real Agric contribution to the Gross Domestic Product, ATM = Electronic Banking Transaction Volume at time, MBB = Mobile Banking Transaction Volume, POS = Point of Sale (POS) Transactions Volume at time, EFT = Electronic Fund Transfers (EFT) Volume at time.

The Ramsey RESET Test was conducted to examine the functional specification of the estimated models specifically, to detect whether the models suffer from omitted variable bias or incorrect functional form. For Model I (AGDP), the t-statistic was 2.400165 with 152 degrees of freedom and a corresponding probability of 0.1076. Similarly, the F-statistic was 5.760792 with a probability of 0.1076. For Model II (IGDP), the t-statistic was 0.761428 with a probability of 0.4475, and the F-statistic was 0.579773 with the same probability.

Since the p-values for both models are greater than the 5% significance level, we fail to reject the null hypothesis that the models are correctly specified. This indicates that there is no strong evidence of omitted variables or incorrect functional forms in either of the models. The implication for the study is that the ARDL models for both agricultural and industrial sector performance are well-specified and structurally sound. This further strengthens the credibility of the study's findings and supports the use of the models for policy recommendations concerning the effects of electronic banking on Nigeria's real sector output.

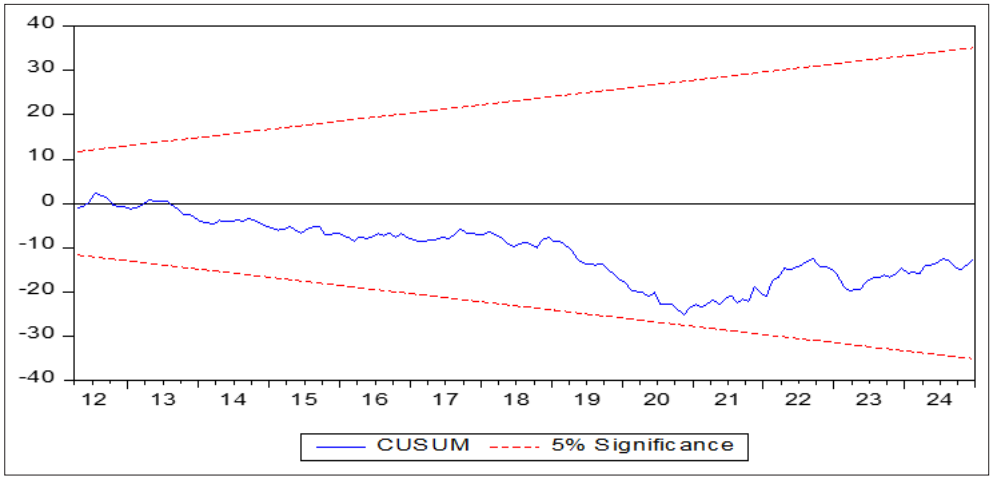

Figure 1: CUSUM Stability Test Model I

Figure 1 presents the CUSUM (Cumulative Sum) stability test for Model I, evaluating the structural stability of the estimated coefficients over the sample period. The blue line, representing the cumulative sum of recursive residuals, remains within the 5% significance

bounds (represented by the red dashed lines) throughout the evaluation period. This indicates that the parameters of Model I are stable over time, and there is no evidence of structural break or parameter instability. The stability of Model I confirms the reliability and robustness of the estimated long-run relationship between electronic banking indicators and agricultural sector performance. This strengthens the validity of the ARDL model's results and implies that the policy recommendations drawn from this model can be applied consistently over time.

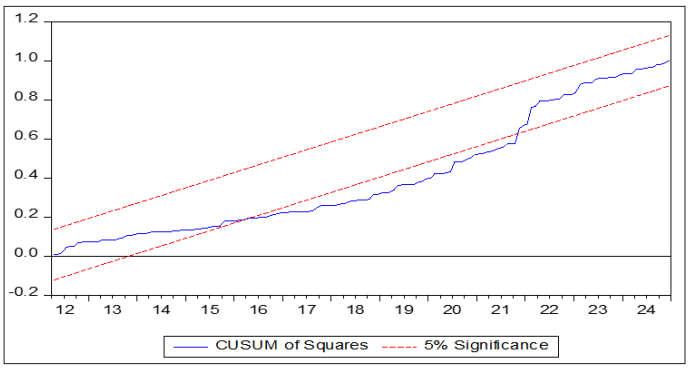

Figure 2: CUMSUM Squares Test Model I

Figure 2 presents the CUSUM of Squares test, which assesses the stability of the variance of the residuals (i.e., parameter constancy) in the regression model. The blue line, representing the cumulative sum of squared residuals, remains within the 5% significance bounds (dashed red lines) throughout the period analyzed. This result confirms that there is no evidence of heteroskedasticity or structural instability in the variance of the regression model. It reinforces the reliability and robustness of the estimated ARDL model, supporting its application in analyzing the relationship between electronic banking transactions and real sector performance over time.

Discussion of Result

The ARDL results for the study indicate that ATM transactions exert a positive and statistically significant long run effect on agricultural GDP, although the short run dynamics are weak and mixed. This suggests that the financial inclusion benefits of ATM deployment may take time to translate into measurable agricultural productivity gains. The finding is consistent with who documented a positive long run influence of ATM usage, and aligns with who emphasized that sustained access to formal financial channels enhances economic performance over time. However, the significant negative lag effects observed for ATM in the short run imply possible liquidity leakages or adjustment frictions within the agricultural sector, a complexity often overlooked in aggregate studies such as.

With respect to mobile banking, the Model I estimates reveal a positive but statistically insignificant long run relationship with agricultural GDP, accompanied by significant negative short run effects at various lags. This indicates that mobile banking has not yet matured into an effective financing channel for agricultural activities in Nigeria. The outcome contrasts with the broadly positive conclusions of whose aggregate GDP analyses suggested strong growth effects of digital banking. However, it partially agrees with who noted that the impact of digital finance tools depends heavily on usage patterns and sectoral integration. The evidence implies that structural constraints such as low digital literacy among farmers and weak rural targeting may be limiting the agricultural benefits of mobile banking platforms.

The POS transaction results further reinforce the sector specific nature of digital finance effects. In Model I, POS exhibits a negative and statistically insignificant long run coefficient, although a significant negative effect appears at the third lag. This delayed adverse impact supports the argument that POS infrastructure remains largely urban focused and weakly integrated into agricultural value chains. The finding is in line with, who also reported insignificant or negative POS effects on output. Similarly, the EFT results show a statistically significant negative long run effect on agricultural GDP, indicating potential structural displacement of financial flows away from the agricultural sector. This outcome supports the critical perspectives of while diverging from the generally positive macro level findings. Model I evidence demonstrates that banking innovations do not uniformly enhance agricultural performance and highlights the need for targeted, agriculture focused digital finance policies in Nigeria.

Conclusion and Recommendations

Conclusion

This study examined the impact of various electronic banking platforms on the agricultural sector in Nigeria using the ARDL framework. The findings highlight the uneven influence of digital financial services across sectors, with the agricultural sector benefiting most significantly from ATM usage. The positive long-term impact of ATM transactions is likely due to their role in improving liquidity in rural areas where farming is prevalent. However, mobile banking and POS transactions showed limited or negative effects on agricultural output, pointing to persistent barriers such as poor internet access, low digital literacy, and the informality of the agricultural sector. These results suggest that while digital financial services hold potential for agricultural development, their effectiveness is hindered by infrastructural challenges and a lack of targeted financial products for farmers. Therefore, the study emphasizes the need for policies focused on enhancing rural digital infrastructure, increasing digital literacy, and tailoring financial products to the specific needs of farmers. Additionally, the study recommends further investment in secure payment frameworks and digital systems to solidify short-term gains and promote sustained growth in the agricultural sector. This research underscores the importance of sector-specific interventions to ensure that the benefits of digital finance are equitably distributed across Nigeria's economy.

Recommendations

Based on the Study's Results, The Following Recommendations are Made.

- First, there should be targeted investments in strengthening rural internet connectivity and mobile network infrastructure to improve the accessibility and effectiveness of digital banking in the agricultural sector. This will help address the current barriers of poor internet access that prevent farmers from fully benefiting from mobile banking and POS systems.
- Second, comprehensive digital literacy programs should be implemented for farmers, especially in rural areas. These programs should focus on providing farmers with the skills needed to use digital financial services confidently, allowing them to effectively navigate mobile banking platforms and other digital payment systems.
- Third, financial products and services should be tailored to meet the unique needs of farmers. This includes designing affordable, accessible, and secure digital platforms that offer small loans, savings accounts, and insurance products specifically for agricultural activities, helping to improve agricultural productivity.

- Finally, efforts should be made to expand and enhance ATM networks in rural areas. Given the significant positive long-term impact of ATM transactions on agricultural GDP, increasing the availability of ATMs in rural regions would improve liquidity for farmers, making it easier for them to access cash for agricultural activities and promoting financial inclusion in these areas.

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