ASYMMETRIC IMPACT OF FINANCIAL INNOVATION AND INCLUSIVENESS ON BANKING PERFORMANCE IN NIGERIA: A NON-LINEAR ARDL APPROACH

Hamisu Ali
Adamawa State University, Mubi,
Faculty of Social Sciences,
Department of Economics,
Adamawa State-Nigeria.
hamisu682@adsu.edu.ng

Mohammed Umar,
Federal University of Kashere,
Faculty of Social Sciences,
Department of Economics &
Development Studies,
Gombe State-Nigeria.

Shehu El-Rasheed,
Federal University of Kashere,
Faculty of Social Sciences,
Department of Economics &
Development Studies,
Gombe State-Nigeria.

Corresponding author:
Hamisu Ali
Adamawa State University, Mubi,
Faculty of Social Sciences,
Department of Economics,
Adamawa State-Nigeria.
hamisu682@adsu.edu.ng

ABSTRACT

The study examined the asymmetric impact of financial innovation and inclusiveness on banking performance in Nigeria, with the objective of investigating the asymmetric relationship between Point of Sale (POS) systems and mobile money on banking performance. Using quarterly data from 2012Q1 to 2022Q4, the study employed the Non-Linear Autoregressive Distributed Lag (NARDL) model, with data sourced from the Central Bank of Nigeria Statistical Bulletin and GlobalEconomy.com (2023). The NARDL results show that, in the long run, ATMs significantly improve banking performance, while POS systems have a weaker positive effect. In the short run, POS remains slightly beneficial, but mobile money negatively impacts performance due to inefficiencies and risks. Despite this, mobile money usage persists under CBN regulations. The Wald test indicates no asymmetry in technological effects, and the error correction term confirms a 34% quarterly adjustment toward equilibrium. Based on these findings, it is recommended that the Central Bank of Nigeria (CBN) encourage collaboration between banks, fintech companies, and regulators to build a secure and efficient digital financial system, and strengthen regulatory oversight and risk management for mobile money and POS systems to enhance banking performance.

Keywords: *Asymmetric, Banking performance, Financial Innovation, Inclusiveness, NARDL*

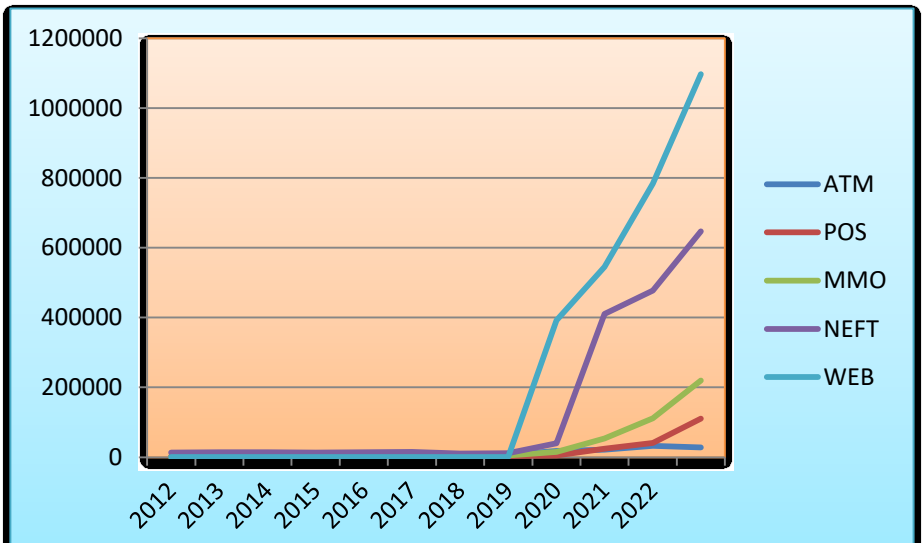
1.0 Introduction

Nigeria's financial innovation has significantly benefited from technology-driven instruments such as Automated Teller Machines (ATMs), Point of Sale (POS) systems, mobile phones, and internet platforms, which have improved transaction volumes, accessibility, and efficiency (Chibuez et al., 2013). ATMs provide flexibility by enabling transactions beyond traditional banking hours (Itah, 2014), while POS systems have reduced cash dependency in retail payments. Additionally, mobile and internet banking have fostered financial inclusion by enabling remote transactions. These advancements align with broader technological trends reshaping financial services globally, mirroring the transformation occurring in warehouse management through automation, robotics, and digital platforms like IoT, AI, and cloud computing (Smith, 2022; Jones, 2023; Brown, 2021).

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

These technologies have improved efficiency, accuracy, and productivity in warehouses, paralleling fintech's impact on financial services. Technological advancements in the financial sector, including AI, blockchain, and mobile banking, have driven innovation by enhancing operational efficiency, broadening financial inclusion, and reducing transaction costs (Gomber et al., 2017). Fintech solutions have enhanced payment systems and credit accessibility, which are reshaping global financial trends and forcing institutions to adopt emerging technologies (Arner et al., 2016). The rise of fintech startups is also challenging traditional banks to rethink their strategies and integrate advanced technologies to meet consumer expectations (Gharbi et al., 2022). The Central Bank of Nigeria (CBN) has supported this transformation through initiatives such as the Payment System Vision 2020, which aims to align Nigeria's financial infrastructure with global best practices (CBN, 2020). Moreover, cashless policies are promoting financial inclusion by reducing costs and improving banking services (Bayero, 2015; Ajayi, 2014). These developments demonstrate how financial innovation continues to play a pivotal role in driving Nigeria's economic growth.

Figure 1: The value of ATM, POS, MMO, NEFT and WEB in Nigeria



Note: Automated Teller Machine (ATM), Point of sale (POS), Mobile Money (MMO), National Electronic Fund Transfer (NEFT) and Web Electronic Banking (WEB)

Source: *Author's Computation, 2024*

As presented in Figure 1, the growth in transaction values (in ₦ billion) across five electronic payment channels in Nigeria ATM, NEFT, Mobile Money (MMO), POS, and WEB from 2012 to 2022. ATM and NEFT channels experienced the highest usage, with ATM transactions rising sharply from ₦100 billion in 2012 to over ₦1,100 billion (₦1.1 trillion) in 2022, while NEFT grew steadily to around ₦650 billion. Mobile Money (MMO) and POS showed significant growth, particularly after 2018, reaching

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

approximately ₦220 billion and ₦120 billion respectively by 2022, reflecting increasing adoption of mobile-based and retail payment systems. WEB transactions, though growing, remained the least utilized, rising modestly to about ₦30 billion in 2022. The sharp uptick across all platforms around 2019 suggests accelerated digital payment adoption, possibly influenced by fintech expansion and pandemic-related shifts in consumer behavior.

The rapid growth of financial technology (Fintech) and digital banking in Nigeria has enhanced convenience and accessibility but also introduced challenges that affect banking performance, such as regulatory gaps in consumer protection and data security (Ridwan & Joseph, 2021). Infrastructural disparities, especially in rural areas, contribute to financial exclusion due to limited access to necessary technology (NIBSS, 2020), while low financial and digital literacy among some groups further hinders the effective use of financial services (Ridwan & Joseph, 2021; Kass-Hanna et al., 2022). In Sub-Saharan Africa, persistent issues like consumer protection, data privacy, and systemic stability remain critical as the fast pace of fintech adoption often outpaces regulatory responses, exposing users to risks like fraud and cyber threats (Beck et al., 2020). Moreover, delays in regulating digital innovations such as blockchain and mobile payments can result in financial losses and security vulnerabilities, and digital inclusion efforts may unintentionally widen the gap due to poor infrastructure and digital skills (Demirgüç-Kunt et al., 2018). Unregulated digital lending has also raised concerns over systemic risks like over-indebtedness (Claessens et al., 2021), while unreliable infrastructure and low trust in financial institutions further discourage digital banking adoption (Akhisar et al., 2015). Additionally, technologies like NIBSS Instant Payments (NIP) and NEFT have, in some cases, negatively impacted banking performance, revealing the complexity of digital transformation. This study investigates the asymmetric relationship between point of sale and mobile money on banking performance in Nigeria. The paper is divided into five sections: Introduction, Literature Review, Methodology, Results and Discussions, and Conclusion and Recommendations.

2.0 Literature Review/Theoretical Framework

2.1 Conceptual Clarification

2.1.1 Financial Innovation

Financial innovation involves developing new financial instruments, payment methods, and technologies like blockchain and AI to address challenges and opportunities in the financial sector. It fosters financial inclusiveness by expanding services to underserved populations (Dabla-Norris et al., 2015) and drives economic growth by improving capital access and resource allocation. However, it can also introduce

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

systemic risks, necessitating robust regulatory frameworks (Acharya et al., 2017). Financial innovation responds to market conditions, technological advances, regulations, and consumer preferences (Dewatripont et al., 2020). It enhances efficiency, risk management, and financial accessibility (Demirgüç-Kunt et al., 2018; Bouri et al., 2020). Financial inclusion, emphasized by the World Bank (2017) and G20 (2016), facilitates access to credit, savings, and insurance (CGAP, 2011; Demirgüç-Kunt et al., 2016). Expanding financial access promotes investment, reduces poverty, and supports economic growth (Bruhn & Love, 2014).

2.1.2 Financial Inclusiveness

Financial inclusiveness, or financial inclusion, aims to provide accessible and affordable financial services to historically excluded individuals and communities (World Bank, 2021). It includes savings, loans, insurance, and electronic payments, ensuring all individuals can manage finances and invest (Demirgüç-Kunt et al., 2015). Beyond bank access, it addresses barriers like distance, documentation, and financial illiteracy while promoting trust and consumer protection (Hermes et al., 2020; CGAP, 2020). Policy initiatives, regulatory reforms, and technology, such as mobile banking, drive inclusiveness by expanding financial access (Suri & Jack, 2016).

2.1.3 Banking Performance

Banking performance evaluates efficiency, profitability, stability, and effectiveness using financial metrics like Return on Assets (ROA), Return on Equity (ROE), Net Interest Margin (NIM), and cost-to-income ratio, alongside non-financial factors such as customer satisfaction and regulatory compliance (Bhatti et al., 2020; Tiba & Mohammad, 2020). It assesses profitability, asset quality, liquidity, and innovation, ensuring bank sustainability and financial stability (Ozili & Outa, 2018). Key indicators include capital adequacy, risk management, and service quality (Gidigbi, 2017; Sanya & Olatunji, 2020). In developing economies like Nigeria, banking performance is crucial for financial inclusion and stability, influenced by technological advancements (Okafor et al., 2017; Osuigwe, 2022).

2.2 Theoretical Literature

Financial innovation and banking performance in Nigeria can be analyzed through multiple theoretical perspectives, with the Service-Led Growth Theory (Clark, 1940) serving as the overarching framework. This theory highlights the transition of economies towards service-driven growth, emphasizing how financial services contribute to employment, infrastructure expansion, and economic dynamism. Within this context, the Constraint-Induced Financial Innovation Theory (Silber, 1983) explains how Nigerian

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

banks innovate in response to regulatory and operational constraints, adopting technologies like AI and blockchain to enhance efficiency. The Theory of Consumption Value (Sheth et al., 1991) provides insights into consumer behavior, showing that the adoption of digital banking services is driven by functional, social, emotional, and conditional values. Meanwhile, the Innovation Diffusion Theory (Roger, 1995) illustrates how financial innovations spread within the banking sector, influenced by factors such as relative advantage, compatibility, and ease of use. Together, these theories provide a holistic view of how financial innovation and inclusiveness shape banking performance, reinforcing the role of financial services in driving economic growth, as posited by the Service-Led Growth Theory.

2.2.1 Theoretical Framework

The Service-Led Growth Theory (Clark, 1940) serves as the theoretical framework for assessing the asymmetric impact of financial innovation and inclusiveness on banking performance in Nigeria. This theory emphasizes the increasing significance of the service sector in economic growth as economies transition from agriculture and manufacturing to service-driven models. In the context of financial innovation, the banking sector plays a critical role in economic transformation by enhancing financial inclusion, efficiency, and accessibility. As financial innovations such as digital banking, mobile payments, and blockchain technology reshape banking operations, they drive service-led economic expansion by improving transaction speed, reducing costs, and increasing financial participation. Moreover, inclusiveness in banking services strengthens economic stability by integrating underserved populations into the formal financial system, further reinforcing the sector's contribution to overall economic growth. By adopting this theory, the study recognizes that financial innovation and inclusiveness are not merely technological advancements but fundamental drivers of service-sector expansion, employment generation, and economic development in Nigeria.

2.3 Empirical Literature

The relationship between financial innovation and financial stability has gained increasing attention, particularly following the 2008 global financial crisis. Various studies have explored different aspects of financial innovation, including cashless payment systems, digitalization, and agency banking, to assess their impact on financial performance and banking stability. Gorshkov (2022) examines cashless payment adoption in Russia, finding a J-curve exponential growth driven primarily by debit card transactions, with credit cards and e-money also contributing. Similarly, Kasri et al. (2022) analyze the impact of digitalization on financial stability in Indonesia using VECM and VAR models, introducing the Payment Penetration Ratio (PPR) as a measure of financial innovation. Their findings suggest a long-run

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

equilibrium relationship between digital payments and banking stability, with a unidirectional causality from digital payments to financial stability. Ashiru et al. (2023) investigate the effect of electronic payment channels on deposit money banks (DMBs) using the Granger causality test and ARDL model, identifying POS banking services as the most significant driver of bank performance due to the high transaction volume and value. While sharing similarities with this study, the present research extends the study period to Q4 2022, adopts a different methodology, and incorporates additional stability and financial innovation measures. Musa and Abubakar (2022) employ agency banking as a financial innovation metric and find a positive impact on the efficiency of DMBs in Nigeria.

In the same vein, Chukwunulu (2019) explores the role of financial innovations such as ATMs, mobile banking, internet banking, and POS terminals in Nigeria's economic growth, concluding that they have significant positive effects. While this aligns with the present study's focus on financial innovation and payment systems, this research introduces three advancements: it examines the link between financial innovation and financial system stability, incorporates both distinct electronic payment channels and aggregated financial innovation measures (payment system value as a GDP ratio), and employs the Dynamic Ordinary Least Squares (DOLS) method instead of the Generalized Method of Moments (GMM) used by Chukwunulu (2019), covers 2008–2017 with a limited sample of ten observations, which may lead to biased estimates, whereas this study spans 2010Q1–2022Q4, ensuring a robust dataset with over 30 observations for reliable statistical inference. Collectively, these studies underscore the crucial role of financial innovation in banking stability and economic performance, and this research builds on them with a more comprehensive approach, improved methodology, and a broader dataset to enhance result reliability.

The empirical literature on financial innovation, financial inclusion, and economic growth reveals diverse findings across different economies. Nsor-Ambala and Amewu (2023) examined the relationship between financial innovation and economic growth in Ghana using ARDL and NARDL models, finding no significant impact due to stringent regulations limiting fintech development. This challenges prior research suggesting a positive or negative impact and calls for policy reforms. Similarly, Jaimu and El-Rasheed (2024) explored the asymmetric effects of financial innovation and exchange rate fluctuations on money demand in Nigeria, highlighting that financial innovation significantly affects money demand, though its impact varies with exchange rate fluctuations, necessitating a policy approach that considers these asymmetries. Ibrahim and Sanusi (2022) analyzed the effect of Islamic financial inclusion and infrastructural quality on economic growth in Nigeria, revealing that Islamic finance fosters economic development by bridging infrastructural gaps. In a related study, Sani et al. (2024) investigated the link

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

between financial innovation and financial stability in Nigeria, showing a long-run equilibrium relationship when using disaggregated measures but not aggregated ones, implying that the level of granularity in measurement influences findings. Expanding the regional scope, Qamruzzaman and Wei (2019) analyzed the financial innovation-financial inclusion nexus in six South Asian countries, establishing a positive association and bidirectional causality, while Qamruzzaman (2021) extended this analysis to digital financial services, confirming their role in promoting economic growth in South Asia.

Earlier, Qamruzzaman and Jianguo (2018) had demonstrated that financial innovation enhances economic growth in Bangladesh, India, Pakistan, and Sri Lanka, affirming the feedback hypothesis. Collectively, these studies suggest that while financial innovation and inclusion are crucial for economic growth, their effectiveness depends on regulatory frameworks, market structures, and macroeconomic conditions, underscoring the need for context-specific policy interventions.

3.0 Methodology

This study utilized quarterly time series data for the period from 2012Q1 to 2022Q4, collected from the Central Bank Statistical Bulletin (CBN, 2023) and globaleconomy.com (2023). Banking performance (BP) was proxied by Return on Assets (ROA), while the key variables considered in the study include National Electronic Fund Transfer (NEFT), Automated Teller Machine (ATM), Point of Sale (POS), Web Banking Transactions (WEB), and Mobile Money (MMO). Following the studies of Toumi and Toumi (2019), Rahaman, Chen, and Jiang (2023), and Nsor-Ambala and Amewu (2022), this study adopts a similar model to establish the asymmetric relationship between the variables of interest. The Non-Linear Autoregressive Distributed Lags (NARDL) model, as established by Shin et al. (2014) and Pesaran et al. (2001), is employed for the analysis. This new series includes positive changes, which shall be denoted by $\Delta LnPOS_j^+$ and $\Delta LnMMO_j^+$ and negative changes to be denoted by$\Delta LnPOS_j^-$,$\Delta LnMMO_j^-$ for financial innovation and banking performance respectively. They are constructed as positive and negative partial sums as follows:

$$LnPOS_t^+ = \sum_{j=1}^{t} \Delta LnPOS_j^+ = \sum_{j=1}^{t} \max(\Delta LnPOS_j, 0) \quad (1)$$

$$LnPOS_t^- = \sum_{j=1}^{t} \Delta LnPOS_j^- = \sum_{j=1}^{t} \min(\Delta LnPOS_j, 0) \quad (2)$$

$$LnMMO_t^+ = \sum_{j=1}^{t} \Delta LnMMO_j^+ = \sum_{j=1}^{t} \max\left(\Delta LnMMO_j, 0\right) \quad (3)$$

$$LnMMO_t^- = \sum_{j=1}^{t} \Delta LnMMO_j^- = \sum_{j=1}^{t} \min\left(\Delta LnMMO_j, 0\right) \quad (4)$$

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

$\Delta LnPOS$ and $\Delta LnMMO$ are then replaced with$\Delta LnPOS^{+}_{t-i}$, $\Delta LnPOS^{-}_{t-i}$ and $\Delta LnMMO^{+}_{t-i}$, $\Delta LnMMO^{-}_{t-i}$ respectively as in equation (1, 2, 3 and 4) as linear ARDL model to form non-liner autoregressive distributed lags (NARDL) model. To discuss the asymmetric short run and long run dynamic cointegration among point of sale (POS) and mobile money banking (MMO), the positive and negative changes for the considered variables in the linear model as follows by the subsequent formulation as follows;

$$Ln\Delta BP_t = \alpha + \sum_{i=1}^{n1} b_i \Delta lnBP_{t-i} + \sum_{i=0}^{n2} c_i \Delta lnATM_{t-i} + \sum_{i=0}^{n3} d_i \Delta lnPOS^{-}{}_{t-i} + \sum_{i=0}^{n4} d_i \Delta lnPOS^{+}{}_{t-i} + \sum_{i=0}^{n5} e_i \Delta lnMMO^{+}_{t-i} + \sum_{i=0}^{n6} f_i \Delta lnMMO^{-}_{t-i} + \sum_{i=0}^{n7} g_i \Delta lnWEB_{t-i} + \sum_{i=0}^{n8} h_i \Delta lnNEFT_{t-i} + \theta_0 lnBP_{t-i} + \theta_1 lnATM_{t-i} + \theta_2 lnPOS^{-}{}_{t-i} + \theta_3 lnPOS^{+}{}_{t-i} + \theta_4 lnMMO^{-}{}_{t-i} + \theta_5 lnMMO^{+}{}_{t-i} + \theta_6 lnWEB_{t-i} + \theta_7 lnNEFT_{t-i} + \mu_t \quad (5)$$

The nonlinear ARDL (NARDL) model examines whether mobile money affects banking performance asymmetrically in the short-run, long-run, or both. Adjustment asymmetry is established if the lag orders of partial sum variables differ ($n_3 \neq n_4$), indicating that the response time to positive and negative shocks in banking performance varies. Short-run asymmetry exists if the estimates of e_i and f_i differ from g_i and h_i, while impact asymmetry is confirmed if the Wald test rejects the null hypothesis that $\sum e_i = \sum f_i$ and $\sum g_i = \sum h_i$. Long-run asymmetric effects are present if the normalized long-run estimates for positive and negative partial sums differ. Finally, the F-test is applied to determine whether asymmetric cointegration exists.

Table 1: Measurement of the variables

Variables	Definition	Measurements/Units	Source
BP	Banking Performance (*Proxy by Return of Assets (ROA)*	It is calculated by dividing net income by total assets and multiplying by 100.	The globaleconomy.com online (2023)
ATM	Automated Teller Machine	Measured as the value of ATM transaction in the country per annum for all the bank	Central Bank of Nigeria (CBN, 2023)
POS	Point of Sale	Measured as the value of POS transaction in the country per annum for all the bank	Central Bank of Nigeria (CBN, 2023)
NEFT	National Electronic Fund Transfer	The scale of measurement for electronic fund transfers can vary and may be expressed in terms of the volume and value of transactions.	Central Bank of Nigeria (CBN, 2023)
WEB	Web Banking Transaction	Measured as the value of banking transaction	Central Bank of Nigeria (CBN, 2023)
MMO	Mobile Money	Measured as the value of transaction through mobile money	Central Bank of Nigeria (CBN, 2023)

Source: *Author's Computation, 2024*

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

4.0 Results and Discussion

Descriptive Statistics Result

Table 2: Descriptive Statistics

	BP	ATM	POS	WEB	MMO	NEFT
Mean	5.180909	31.18262	29.59886	29.03012	29.88756	32.42163
Median	2.140000	29.50476	28.66289	26.89317	29.25652	30.85516
Maximum	20.93000	35.72198	35.95064	38.90017	36.94682	38.40448
Minimum	1.330000	28.31664	24.60404	24.17539	24.17355	30.20265
Std. Dev.	7.036509	2.837588	3.845017	4.681022	4.122531	2.627185
Skewness	1.654426	0.569911	0.464537	0.725922	0.405596	0.983328
Kurtosis	3.784024	1.517273	1.753859	2.367333	1.919688	2.918069
Jarque-Bera	21.19920	6.412399	4.429419	4.598215	3.346026	7.103162
Probability	0.000025	0.040510	0.109185	0.100348	0.187681	0.028679
Sum	227.9600	1372.035	1302.350	1277.325	1315.053	1426.552
Sum Sq. Dev.	2129.036	346.2319	635.7187	942.2144	730.7961	296.7903
Observations	44	44	44	44	44	44

Source: *Author computation (2024)*

The descriptive statistics in Table 2 provide an overview of financial variables: banking performance, automated teller machine transactions, point of sale transactions, web electronic banking transactions, mobile money, and national electronic fund transfer transactions. All the variables exhibit varying degrees of skewness and kurtosis. Banking performance shows significant variability and non-normality, as confirmed by the Jarque-Bera test. ATM and POS transactions display moderate dispersion, with slight positive skewness and lighter tails, indicating mild deviations from normality. Web electronic banking transactions and mobile money transactions exhibit relatively high variability but maintain near-normality. National electronic fund transfer transactions have low variability and a moderately peaked distribution, with the Jarque-Bera test suggesting slight deviation from normality.

Table 3: Unit Root Test Results

	ADF			PP		
Variables	**Level**	**1st Diff.**	**Status**	**Level**	**1st Diff.**	**Status**
BP	-2.6013**	-2.6657*	I(0)	-2.7482***	-6.5456***	I(0)
ATM	-0.8579	-6.0941***	I(1)	-1.2814	-6.4418***	I(1)
POS	-0.8897	-5.7190***	I(1)	-1.0542	-6.5417***	I(1)
WEB	-0.3081	-6.6470***	I(1)	-0.2367	-6.6641***	I(1)
MMO	-0.7878	-6.6791***	I(1)	-0.7467	-6.6978***	I(1)
NEFT	-0.7546	-6.4898***	I(1)	-0.7750	-6.4898***	I(1)

Note: (*) significance at 10%, (**) significance at 5% and (***) significance at 1% respectively (2023)
Source: Author computation (2024)

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

The results reported in Table 3 indicate that both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were conducted to examine the stationarity of the data series. Since the bounds test requires that variables be either integrated at I(0), I(1), or a combination of both, checking for stationarity is essential to ensure unbiased estimation. The findings reveal that Automated Teller Machine transactions, Point of Sale transactions, Web Electronic Banking transactions, Mobile Money transactions, and National Electronic Fund Transfer transactions are all stationary at first difference I(1), while Banking Performance is stationary at level I(0) in both the ADF and PP tests. Given these stationarity properties, the appropriate estimation technique for this study is the Autoregressive Distributed Lag (ARDL) model.

Table 4: Bound F-Test Cointegration

Test Statistics	**Value**	**K**
F-Statistic	11.28080	6
	Critical Value Bounds	
Significance	**1(0) Bound**	**1(1) Bound**
10%	1.99	2.94
5%	2.27	3.28
1%	2.88	3.99

Source: Author computation (2024)

The empirical results of the bound test, presented in Table 4 for cointegration, assess whether a long-term equilibrium relationship exists between the variables being analyzed. The calculated F-statistic is 11.28080, which is compared against the critical value bounds at various significance levels (10%, 5%, and 1%). Since the F-statistic (11.28080) exceeds the upper critical value bound at all significance levels, there is strong evidence of cointegration between banking performance, automated teller machine, point of sale, web electronic banking, mobile money, and national electronic fund transfer. This finding confirms the presence of a long-term equilibrium relationship among the analyzed variables.

Table 5: Long-run Results of Non-linear NARDL

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
LATM	0.004477	0.001841	2.432082	0.0204***
LPOS_POS	0.004865	0.003265	1.490139	0.1454
LPOS_NEG	-0.000364	0.036220	-0.010053	0.9920
LWEB	0.001947	0.001598	1.218435	0.2314
LMMO_POS	-0.010021	0.003134	-3.197333	0.0030***
LMMO_NEG	-0.006543	0.044916	-0.145671	0.8850
LNEFT	-0.001234	0.001594	-0.774237	0.4441
C	13.376114	0.044126	303.133791	0.0000***

Note. (*) significance at 10%, (**) significance at 5% and (***) significance at 1% respectively
Source: Author computation (2024)

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

The long-run results from the Non-Linear Autoregressive Distributed Lag (NARDL) model in Table 5 highlight the asymmetric relationship between technological factors Automated Teller Machines (ATMs) and Point of Sale (POS) systems and banking performance in Nigeria. ATMs show a strong positive and statistically significant impact, with a 0.45% improvement in banking performance linked to increased ATM usage. This underscores their role in enhancing transaction efficiency, financial accessibility, and customer convenience, particularly in underserved areas. The findings align with previous studies (Mohammed et al., 2024; Adebayo et al., 2024) and emphasize ATMs' importance in modernizing Nigeria's banking sector. Conversely, POS systems also exhibit a positive relationship with banking performance, albeit with weaker statistical significance 10 per cent. While POS adoption supports financial inclusion and reduces cash dependency, challenges such as infrastructure limitations and slow rural adoption may contribute to its relatively lower impact. Overall, both technologies play crucial roles in strengthening Nigeria's banking infrastructure. Their expansion, alongside regulatory support, is vital for maximizing their benefits, ensuring seamless integration, and mitigating potential risks from other financial innovations like mobile money, which showed negative short-run effects on banking performance.

Table 6: Short run Results of Non-Linear ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LATM)	0.001351	0.001335	1.011738	0.3188
D(LPOS_POS)	0.003501	0.002000	1.750348	0.0891*
D(LPOS_NEG)	-0.038127	0.035801	-1.064961	0.2944
D(LWEB)	-0.000006	0.001067	-0.005763	0.9954
D(LMMO_POS)	-0.005454	0.001833	-2.975578	0.0054***
D(LMMO_NEG)	0.043514	0.044276	0.982803	0.3326
D(LNEFT)	0.000520	0.001137	0.457803	0.6500
CointEq(-1)	-0.343625	0.106348	-3.231133	0.0027***

Note: (*) significance at 10%, (**) significance at 5% and (***) significance at 1% respectively
Source: Author computation (2024)

The short-run results from the Non-Linear Autoregressive Distributed Lag (NARDL) model in Table 6 reveal that technological factors have varying effects on banking performance in Nigeria. Point of Sale (POS) systems have a marginally significant positive impact, with a 0.35% improvement in banking performance at the 10% significance level. This suggests that increased POS usage improves banking efficiency, particularly in underserved areas. However, mobile money has a negative effect, with a 0.86% decline in banking performance, indicating that operational challenges, such as fraud and competition with traditional banks, may undermine its benefits. The error correction term of -0.343625 suggests that about 34% of disequilibrium in banking performance is corrected annually, indicating the sector's ability to adjust over time. These findings align with studies by Adebayo et al. (2024), but contrast with the

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

conclusions of Qumruzzaman & Jianguo (2020) and Udoh et al. (2021). Overall, while POS systems contribute positively to banking performance, mobile money and electronic transfers require careful management to mitigate their negative impacts, ensuring the banking sector's resilience amid technological changes.

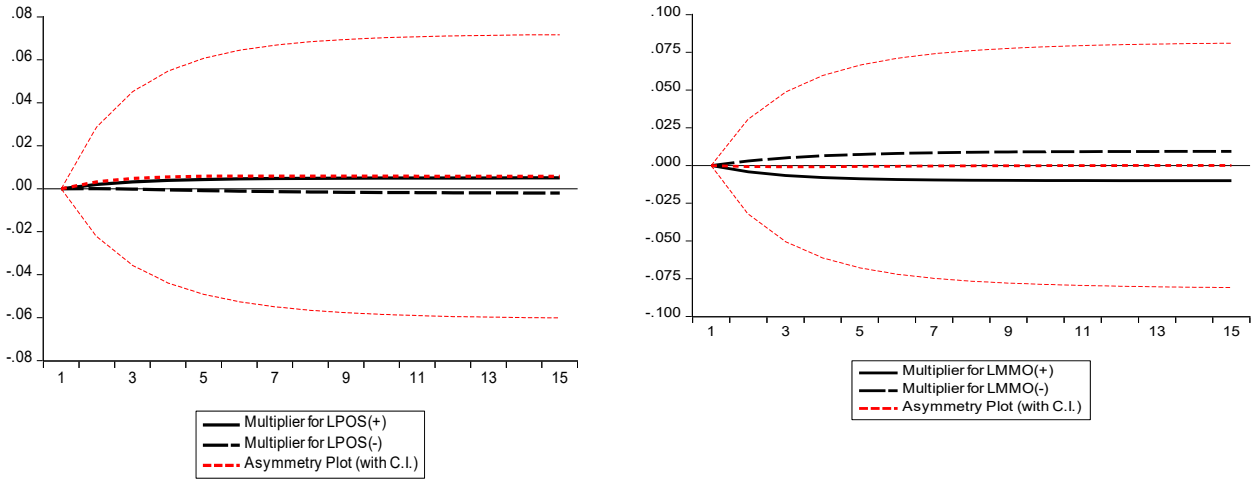
Table 7: Wald Test for Symmetric Impact

Test Statistic	Value	DF	Prob.
F-statistic	1.626	(1,34)	0.2108
Chi-square	1.626	1	0.2022

Source: Author computation (2024)

Table 7 presents the Wald Test for Symmetric Impact, which shows no statistically significant evidence to reject the null hypothesis of symmetry in the impacts on banking performance. The F-statistic of 1.626 and Chi-square statistic of 1.626, with p-values of 0.2108 and 0.2022, respectively, exceed the conventional significance threshold of 0.05. This suggests that positive and negative changes in variables like mobile money and point of sale systems have similar effects on banking performance, indicating a symmetric response. This finding aligns with studies by Citak et al. (2020) and Benlaria and Hamad (2022), but contrasts with the results of Toumi and Toumi (2019), whose findings may differ due to regional, economic, or banking system differences that could amplify asymmetric effects.

Figure 2: NARDL Multiplier Graph of Point of Sale and NARDL Multiplier Graph of Mobile Money



Source: Author Computation (2024)

Figure 2 illustrates the symmetric effects of positive and negative changes in Point of Sale usage on banking performance. The close alignment between the positive and negative change lines shows that

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

both have nearly identical impacts, with no significant asymmetry observed. The red dashed asymmetry plot remains within the confidence intervals throughout the time period, confirming that any differences between positive and negative changes are statistically insignificant. Over time, both effects stabilize around zero, suggesting that the impacts of Point of Sale usage changes are temporary and diminish in the long run. These findings imply that banking performance responds symmetrically to changes in Point of Sale usage, with no significant difference between positive and negative shocks in the short run. Similarly, the symmetric effects of positive and negative changes on banking performance, with the dashed line (positive changes) and solid line (negative changes) closely aligned. The red dashed asymmetry plot stays within the confidence intervals, confirming the statistical insignificance of any observed differences. Over time, both shock multipliers stabilize around zero, indicating that the effects dissipate in the long run. These results align with the Wald Test findings, reinforcing the conclusion that banking performance responds symmetrically to shocks, with balanced adjustments regardless of the direction of the change.

Table 8: Post-estimated Diagnostic Test of NARDL Result

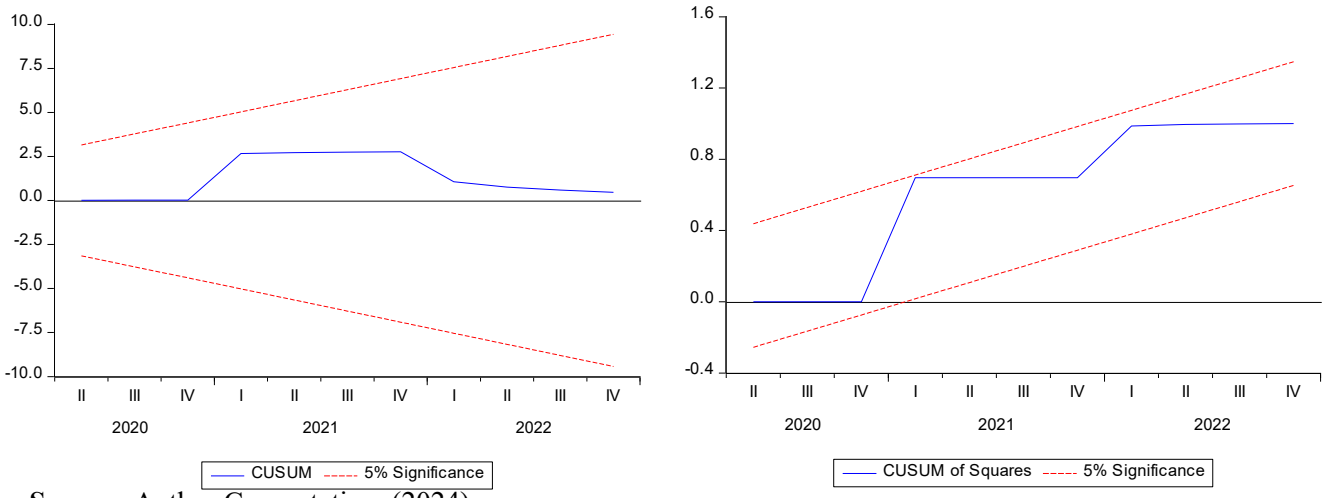
Test	**Coefficient**	**P-Value**
Serial Correlation LM Test	0.231791	0.7944
Residual Heteroskedasticity Test ARCH	0.614043	0.7356

Source: Author Computation (2024)

Table 8 presents the post-estimation diagnostic tests for the NARDL model, confirming its reliability and proper specification. The Serial Correlation Langarian Multiplier Test shows no evidence of serial correlation, with a test statistic of 0.231791 and a p-value of 0.7944, which is greater than the 0.05 significance level. Similarly, the Residual Heteroskedasticity Test (ARCH) yields a test statistic of 0.614043 and a p-value of 0.7356, indicating no heteroskedasticity. These results demonstrate that the residuals do not exhibit systematic patterns or non-constant variance, reinforcing the robustness of the NARDL model in analyzing the relationship between banking performance and various technological factors.

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

Figure 3: Cumulative Sum of Recursive Residuals of Cusum and Cusum of Square of NARDL



Source: Author Computation, (2024)

As depicted in Figure 3, the stability analysis of the model demonstrates that the coefficients and relationships within the model remain consistent over time. This consistency suggests that the model is robust and can be effectively utilized for forecasting and policy analysis.

5.0 Conclusion and Recommendations

The NARDL model results reveal a dynamic and revealing relationship between technological innovations and banking performance in Nigeria. In the long run, Automated Teller Machines (ATMs) significantly enhance banking performance, underscoring their role in promoting financial access, operational efficiency, and customer satisfaction, particularly in underserved areas. Point of Sale (POS) systems also show a positive impact, though with weaker statistical significance, suggesting that adoption and infrastructure gaps may limit their full potential. In the short run, while POS usage maintains a marginally positive effect, mobile money exhibits a negative impact on banking performance, likely due to operational inefficiencies, fraud risks, and competition with traditional banking services. However, it is important to note that mobile money and similar innovations are products of financial reforms adopted by the Central Bank of Nigeria (CBN), and despite their short-run drawbacks, no commercial bank can discontinue their use without regulatory approval from the CBN. The Wald test results indicate no significant asymmetry in the effects of technological changes, suggesting that both positive and negative shocks yield similar outcomes. Additionally, the error correction term confirms the sector's ability to adjust over time, and diagnostic tests validate the model's robustness with no evidence of serial correlation or heteroskedasticity. Based on the objective of investigating the asymmetric relationship between point of sale (POS) and mobile money (MMO) on banking performance in Nigeria, and guided by the Service-Led Growth Theory by (Clark, 1940), policymakers should strengthen regulatory oversight

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

and risk management for mobile money and POS systems to improve banking performance in Nigeria. This includes enhancing mobile money security and ensuring it complements traditional banking. The Central Bank of Nigeria (CBN) should also encourage collaboration between banks, fintech companies, and regulators to create a secure and efficient digital financial system.

References

Abubakar S., I., Aiyedogbon, J., & Obumneke, E. (2023). Nexus Between Financial Innovation and Financial Stability in Nigeria. *John and Obumneke, Ezie, Nexus Between Financial Innovation and Financial Stability in Nigeria (November 30, 2023)*.

Acharya, V. V., Engle III, R. F., & Pierret, D. J. (2017). Testing macroprudential stress tests: The risk of regulatory risk weights. *Journal of Monetary Economics, 85*(3), 39-57.

Adebayo, A. O., Henry, M. O., & Ali, M. A. (2024). The role of technological innovations in improving banking performance in Nigeria: A case study of ATMs and POS systems. *Journal of Banking and Financial Technology,* 12(3), 45-60.

Ajayi, L. B. (2014). Effect of cashless monetary policy on Nigerian banking industry: Issues, prospects & challenges. *International Journal of Business & Finance Management Research, 2(3),* 29-41.

Akhisar, I., Tunay, K., B. & Tunay, N. (2015). The Effects of innovations on bank performance: The case of electronic banking services. *Procedia - Social & Behavioral Sciences, 195*(2015), 369 – 375.

Arner, D. W., Barberis, J., & Buckey, R. P. (2016). FinTech, RegTech, and the reconceptualization of financial regulation. *Nw. J. Int'l L. & Bus.*, *37*, 371.

Ashiru, O., Balogun, G., & Paseda, O. (2023). Financial innovation and bank financial performance: Evidence from Nigerian deposit money banks. *Research in Globalization*, *6*, 100120.

Bayero, M., A. (2015). Effects of cashless economy policy on financial inclusion in Nigeria: An exploratory study. *Global Conference on Business & Social Science-2014, GCBSS-2014, 15th & 16th Decembe, Kuala Lumpur.172* (2015), 49 – 56.

Benlaria, H., & Hamad, A., J. H. (2022). Economic impact of renewable energy on sustainable development in Saudi Arabia. *International Journal of Energy Economics & Policy*, *12*(5), 311-318.

Bhatti, M. I., Jabeen, M., Hussain, M., & Yousaf, M. (2020). Financial performance of banking sector: A Study of Pakistan. *International Journal of Economics, Commerce & Management, 8*(6), 226-237.

Bouri, E., Gupta, R., Lau, C. K. M., & Roubaud, D. (2020). Cryptocurrency market reaction to monetary policy surprises: Evidence from bitcoin, ethereum, & ripple. *Journal of Behavioral & Experimental Finance, 28*(2020), 100396.

Brown, A. (2021). AI & Machine Learning in Warehouse Management: Optimizing Decision-Making & Predictive Analytics. *Technology in Logistics*, 3(1), 30-41.

Bruhn, M., & Love, I. (2014). The real impact of improved access to finance: Evidence from Mexico. *Journal of Finance, 69(12)*, 1347-1376.

CGAP. (2020). What is Financial Inclusion? Retrieved from https://www.cgap.org/research/what-financial-inclusion

Chibueze, Z., Maxwell, O., & Osondu, M. (2013). Electronic banking & bank performance in Nigeria. *West African Journal of Industrial & Academic Research, 6* (1), 171-187.

Chukwunulu, J. I. (2019). Effect of financial innovation on the Nigerian economy. *World Journal of Innovative Research*, *6*(5), 15-21.

Çıtak, F., Uslu, H., Batmaz, O., & Hoş, S. (2020). Do renewable energy & natural gas consumption mitigate CO 2 emissions in the USA? New insights from NARDL approach. *Environmental Science & Pollution Research*, 1-12.

Claessens, S., Cornelli, G., Gambacorta, L., Manaresi, F., & Shiina, Y. (2021). Do macroprudential policies affect non-bank financial intermediation?.

Clark, J. (1940). *The conditions of economic progress*. Macmillan.

Dabla-Norris, E., Gradstein, M., & Inchauste, G. (2015). What causes firms to hide output? The determinants of informality. *Review of Economics & Statistics, 97*(1), 281-293.

Demirgüç-Kunt, A., Klapper, L. F., Singer, D., & Oudheusden, P. (2016). *The global findex database 2014: Measuring financial inclusion around the world*. Retrieved from https://openknowledge.worldbank.org/entities/publication/f661fecd-3fc7- 5a45-886e-95d6b881e278

Demirguc-Kunt, A., Klapper, L., Singer, D., Ansar, S., & Hess, J. (2018). The global findex database 2017: Measuring financial inclusion & the fintech revolution.

Dewatripont, M., Ouvrard, A., & Sraer, D. (2020). Market innovation & the use of big data. *Annual Review of Economics, 12*,(4), 289-310.

Gharbi, I., Daoud, Y., & Kammoun, A. (2022). The Digitalization in the COVID-19 Era: A review, synthesis, & challenges–mitigating the impact of COVID-19 via Digitalization. *H&book of Research on Interdisciplinary Perspectives on the Threats & Impacts of P&emics,* 284-304.

Gidigbi, M. O. (2017). An assessment of the impact of banking reforms on economic growth and bank performance in Nigeria. *CBN Journal of Applied Statistics (JAS)*, *8*(2), 7.

Gomber, P., Koch, J. A., & Siering, M. (2017). Digital Finance and FinTech: current research and future research directions. *Journal of business economics*, *87*, 537-580.

Gorshkov, V. (2022). Cashless payment in emerging markets: The case of Russia. *Asia and the Global Economy*, *2*(1), 100033.

Hermes, N., Lensink, R., & Lutz, C. (2020). Financial inclusion & the role of microfinance Institutions. *The European Journal of Development Research, 32*(2), 351-376.

Ibrahim, S. S., & Sanusi, H. (2022). Testing the effect of Islamic financial inclusion, infrastructural quality on economic growth in Nigeria: New insight from bootstrap and non-linear ARDL. *MALIA: Journal of Islamic Banking and Finance*, *6*(2), 87-104.

Itah, A. J. (2014). Impact of cashless banking on banks' profitability (Evidence from Nigeria). *Asian Journal of Finance & Accounting, 6* (2), 362-376.

Jaimu, N. J., & El-Rasheed, S. (2024). Asymmetric Effects of Financial Innovation and Exchange Rate Changes on Money Demand in Nigeria. *Journal of Arid Zone Economy*, 75-84.

Jones, P., A. (2023). IoT & RFID Technology: Enhancing Tracking & Monitoring in Warehouses. *International Journal of Logistics Management*, 8(4), 112-125.

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

Kasri, R. A., & Chaerunnisa, S. R. (2022). The role of knowledge, trust, and religiosity in explaining the online cash waqf amongst Muslim millennials. *Journal of Islamic Marketing*, *13*(6), 1334-1350.

Kass-Hanna, J., Lyons, A. C., & Liu, F. (2022). Building financial resilience through financial and digital literacy in South Asia and Sub-Saharan Africa. *Emerging Markets Review*, *51*, 100846.

Mohammed, R. A., Ali, F. S., & Adebayo, O. A. (2024). Assessing the impact of automated teller machines (ATMs) and point of sale (POS) systems on banking performance in Nigeria. *International Journal of Financial Research, 15*(2), 32-49.

Musa, A., & Abubakar, H. (2022). Examining the Effect of Financial Innovation on Efficiency of Deposit Money Banks in Nigeria. *Available at SSRN 4003730*.

Nigeria Inter-Bank Settlement System. (2020). *Annual report: The future of payment systems in Nigeria*. Nigeria Inter-Bank Settlement System. https://www.nibss-plc.com.ng/reports/annual2020.

Nsor-Ambala, R., & Amewu, G. (2023). Linear & non-linear ARDL estimation of financial innovation & economic growth in Ghana. *Journal of Business & Socio-economic Development*, *3*(1), 36-49.

Nsor-Ambala, R., & Amewu, G. (2023). Linear and non-linear ARDL estimation of financial innovation and economic growth in Ghana. *Journal of Business and Socio-economic Development*, *3*(1), 36-49.

Okafor, I.G., Ezeaku, H.C., & Anyalechi, K., C. (2017). Does financial innovation drive growth? Empirical analysis of Nigerian case. *British Journal of Economics, management, & trade. 16(*3). 1-10.

Osuigwe, O. C., (2022), Financial innovation & economic growth in Nigeria. *International Journal of Innovative Social Sciences & Humanities Research 10*(2):36-51.

Ozili, P. K., & Outa, E., R. (2018). Bank loan loss provisions, investor protection, & the macroeconomy. *Research in International Business & Finance, 13,*(1) 413-434.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of applied econometrics*, *16*(3), 289-326.

Qamruzzaman, M. (2021). Nexus between financial innovations, remittances and credit performance: Evidence from augmented ARDL and nonlinear ARDL. *Investment Management & Financial Innovations*, *18*(3), 295.

Qamruzzaman, M., & Jianguo, W. (2018). Nexus between financial innovation and economic growth in South Asia: Evidence from ARDL and nonlinear ARDL approaches. *Financial innovation*, *4*(1), 1-19.

Qamruzzaman, M., & Jianguo, W. (2020). The asymmetric relationship between financial development, trade openness, foreign capital flows, & renewable energy consumption: Fresh evidence from panel NARDL investigation. *Renewable Energy*, *159*, 827-842.

Qamruzzaman, M., & Wei, J. (2019). Financial innovation and financial inclusion nexus in South Asian countries: Evidence from symmetric and asymmetric panel investigation. *International Journal of Financial Studies*, *7*(4), 61.

Rahaman, S. H., Chen, F., & Jiang, G. (2023). The asymmetric impact of renewable energy consumption on the economic growth of emerging South & East Asian countries: A NARDL approach. *Heliyon*, *9*(8).

Ridwan, D., & Joseph, T. E. (2021). Effect of bank charges on bank customer's savings & income in Nigeria. *Journal of Economics, Management & Trade, 27*(3), 1–11.

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

Sani, I. A., Aiyedogbon, J. O. C., & Ezie, O. (2024). Nexus between Financial Innovation and Financial Stability in Nigeria. *East African Scholars J Econ Bus Manag,* 7(9), 374-390.

Sanya, S., A. & Olatunji, O., R. (2020). Financial inclusion & financial performance of deposit money banks in Nigeria. *Cogent Economics & Finance, 8*(1), 1785560.

Sheth, J. N., Newman, B. I., & Gross, B. L. (1991). Why we buy what we buy: A theory of consumption values. *Journal of business research*, *22*(2), 159-170.

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration & dynamic multipliers in a nonlinear ARDL framework. *Festschrift in honor of Peter Schmidt: Econometric methods & applications*, 281-314.

Silber, W. L. (1983). The process of financial innovation. *The American Economic Review*, *73*(2), 89-95.

Smith, J. (2022). Automation & Robotics in Warehouses: Improving Efficiency & Productivity. *Journal of Warehouse Technology*, 15(2), 45-56.

Suri, T., & Jack, W. (2016). The long-run poverty & gender impacts of mobile money. *science, 354*(6317), 1288-1292.

Tiba, S., & Hajmohammad, S. (2020). Factors influencing the financial performance of banks: A Study of Jordanian Banks. *International Journal of Economics, Commerce & Management, 8*(6), 94-103.

Toumi, S., & Toumi, H. (2019). Asymmetric causality among renewable energy consumption, CO 2 emissions, & economic growth in KSA: evidence from a non-linear ARDL model. *Environmental Science & Pollution Research*, *26*, 16145-16156.

Udoh, B. E., Jack, A. E., Prince, A. I., Ekeowa, K. I. L., Ndubuaku, V., & Samuel, U. E. (2021). Financial deepening & economic growth in Nigeria: ARDL & NARDL techniques. *Universal Journal of Accounting & Finance*, *9*(4), 667-677.

World Bank. (2017). UFA 2020 Overview: universal financial access by 2020.http://www.worldbank.org/en/topic/financialinclusion/brief/achieving- universal-financial-access-by-2020

World Bank. (2020). *The role of digital financial inclusion in achieving the sustainable development goals*. Retrieved from https://www.worldbank.org/en/topic/financialinclusion/publication/the-role-of-digital-financial-inclusion-in-achieving-the-sustainable-development-goals