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Original Article

Driving Sustainable Growth: Exploring The Nexus Between Financial Innovation And Banking Sector Profitability In Nigeria

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ABSTRACT: *This paper investigates the effect of financial innovation on the profitability of the banking sector in Nigeria, with the new focus on the most popular mobile banking, digital payments, and blockchain technologies. It uses the data of 26 commercial banks available from the period of 2009 to 2024 to compare the profitability of them using return on assets ROA as the main measure. The data comes from the Central Bank of Nigeria CBN which contains digital innovations such as Web Pay, Mobile Pay, NIP, NEFT, Remita, and Central Pay. The results show that mobile banking and blockchain technologies have a more significant positive effect on profitability than the impact of digital payments which is different. The study urges strengthening mobile platforms, replacing the existing digital infrastructure with the new one, and implementing blockchain technologies.*

KEYWORDS: *Financial Innovation, Banking Sector Profitability, Mobile Banking Technologies, Digital Payment Systems, Blockchain Technologies.*

JEL CLASSIFICATION: *G21, G23, O16, O30, O32.*

1. INTRODUCTION

One of the major obligations of the banking sector is the contribution towards the sustainable progress of the entire economy. The banking sector in Nigeria has faced the bumps of time recently, one of which was the financial innovation. Simply, it is what consists of the term financial innovation i.e. the development of new financial products, services, and technologies to improve the productivity, accessibility, and competitiveness of financial markets (Rochet, 2018). This innovation can help banks make more money in the long run in a country like Nigeria, which faces economic problems such as inflation, changes in exchange rates, and limited access to finance. As banks continue to use innovative solutions like mobile banking technology, blockchain technology, and digital payment systems, they boost their operational efficiency, grow their customer base, and in the end, increase their profits (Arner et al. 2020).

Financial innovation and profitability in the banking sector are closely connected, and their interaction is often described as a mix of strategies such as better customer service, reduced operational costs, and bigger market availability. In Nigeria, these innovations are viewed as essential for sustainable growth, providing banks with new opportunities for generating revenue and managing risks (Nguyen & Tran, 2022). Additionally, advancements such as digital banking have not only helped tackle financial inclusion issues but have also enabled banks to reach new demographic segments, thereby increasing their profit margins (Ogunbiyi et al., 2020). However, while these innovations offer significant advantages, they also come with risks, including cybersecurity threats and regulatory hurdles, which can impact the overall profitability of banks (Alhassan et al., 2021). Therefore, understanding how financial innovation relates to banking sector profitability in Nigeria is crucial for policymakers and banking institutions that aim to promote economic growth while maintaining financial stability.

1.1 STATEMENT OF THE PROBLEM

While financial innovation has quickly gained traction in the Nigerian banking sector, there has been limited research on its direct impact on profitability. Innovations such as mobile banking, digital payment channels, and blockchain technology have transformed how banking operations are conducted, leading to increased access and customer satisfaction (Iwedi, 2023 and Iwedi, 2024). However, the existing literature does not adequately address how these innovations contribute to key profitability metrics like Return on Equity (ROE), Return on Assets (ROA), Net Interest Margin, and other financial ratios.

These issues are further complicated by challenges such as cybersecurity threats, high implementation costs, and the regulatory complexities that come with innovative financial solutions. Moreover, despite improvements in operational efficiency due to financial innovation (Iwedi, 2024), the inconsistent adoption of these technologies across different banks raises concerns about their scalability and long-term profitability impact.

This paper aims to address these gaps by examining the relationship between financial innovation and profitability in Nigerian banks. It will analyze how advancements in financial services affect revenue generation, operational efficiency, and overall performance, while also considering the challenges that may hinder their effectiveness in promoting sustainable growth.

1.2. OBJECTIVE OF THE STUDY

This paper's main goal is to explore the link between financial innovation and how profitable Nigerian banks are. It aims to grasp how new tech and financial products affect banks' ability to keep making money and grow. The study has these specific goals:

i. To check how mobile banking tech changes Nigerian banks', return on assets.
ii. To see how digital payment tech has an impact on Nigerian banks' return on assets.
iii. To look at how blockchain tech affects Nigerian banks' return on assets.

2. LITERATURE REVIEW

2.1. CONCEPTUAL REVIEW

2.1.1. FINANCIAL INNOVATION

Financial innovation therefore means the development and the use of new financial assets, technologies, products, and markets which are directed at improving the processes of financial inter-mediation and improving efficiency in the services being rendered (Tufano, 2003; Lerner & Tufano, 2011). This includes the development of new financial products like digital payment systems, insurance offerings, and derivatives, along with innovative approaches to distributing and pricing these services (Allan & Gale, 1994). Such innovations allow companies to navigate regulatory challenges, lower transaction costs, and improve the efficiency of capital intermediation (Kane, 1987).

In Nigeria, financial innovation has become essential for commercial banks striving to stay competitive. Technologies like mobile banking, point-of-sale systems, and online banking have transformed the banking industry, enabling banks to access a broader customer base, cut operational costs, and enhance overall efficiency (Okonkwo, Obinozie & Echekoba, 2015). The rapid growth of financial innovations has been primarily fueled by technological progress and increased globalization, which have altered the banking environment, making it more dynamic and attuned to market needs (Kumar, 2011).

2.1.2. MOBILE BANKING TECHNOLOGY

Mobile banking technology involves using mobile devices like smartphones and tablets to access and manage banking services and financial transactions. It provides a host of banking services including but not limited to checking account balances, funds transfer, payment of bills, applying for loans, and investments using mobile applications and mobile optimized websites. This technology relies on telecommunications networks (like 3G, 4G, and 5G) and secure digital platforms to facilitate real-time transactions, providing convenience, accessibility, and efficiency. It has a big role in improving financial accessibility at a time when most people in many countries, most especially the developing ones, still find it hard to access banking services.

In Nigeria the mobile banking operation involves several players which includes the mobile operators or the mobile service providers, the financial institutions for instance the banks, other technology companies other than the money banks, Fintechs, the regulatory authorities inclusive of the Central Bank of Nigeria (CBN) that plays a critical role in mobilizing, facilitating and protecting the mobile banking system from fraudsters (Ovia, 2021). Factors driving adoption include the potential for digital financial inclusion, lower transaction costs, and better accessibility through smartphones and affordable mobile data (Iwedi,et al 2023). However, challenges like cybersecurity risks, gaps in digital literacy, and infrastructural limitations prevent mobile banking from reaching its full potential (Iwedi, Kocha & Wike, 2022). Despite these obstacles, the growth of mobile banking, indicated by rising transaction volumes and mobile money accounts, highlights its crucial role in Nigeria's financial landscape (CBN, 2022).

2.1.3. DIGITAL PAYMENT TECHNOLOGY

Digital payment technology is about electronic systems that let people move money and make financial transactions using digital platforms. This includes things like mobile payments online banking digital wallets, and cryptocurrency (Ovia, 2021). These tools allow people to buy stuff and send money. They make things work better, cut down on the need for cash, and help more people use financial services in countries that are still developing (Iwedi, 2023 and Nwankwo, 2022). The main parts of this technology are encryption to keep things safe, cloud computing to handle lots of users, and mobile internet so people can connect. As more people

use smartphones and get online digital payments are growing. They use things like NFC and QR codes. But there are still problems to solve, like keeping everything secure from hackers teaching people how to use these tools, and dealing with changing rules.

2.1.4. BLOCKCHAIN TECHNOLOGY

Blockchain technology is a digital ledger system spread across many computers. It keeps track of transactions in a way that's secure, open, and unchangeable. The system groups each transaction into a "block" and connects it to the block before it making a chain. This setup makes sure that once someone records a transaction, no one can change or remove it (Zheng et al. 2017). Blockchain works without needing a central authority because the people in the network agree on which transactions are valid. Most people know about blockchain because of cryptocurrencies, but it's useful in other areas too (Zheng et al. 2017). For example, it can help manage supply chains, improve healthcare, and change how finance works.

2.1.5 BANKING SECTOR PROFITABILITY

Banking sector profitability refers to how well financial institutions, like commercial banks, can generate earnings in relation to their revenue, assets, or equity over a certain timeframe. This is normally done by focusing on such financial performance measures as Return on Assets (ROA), Return on Equity (ROE) and Net Interest Margin (NIM). The aforementioned metrics are important in determining the extent to which a bank achieves optimal utilization of resources, in making of its profits. Return on Assets (ROA) compares profit to assets to measure how effectively a bank employs assets in generating income whereby, the higher the ROA the better asset management (Molyneux & Thornton, 1992).

Ownership Equity Return or Return on Equity (ROE) quantifies how efficient a bank is with regards to generating value from the shareholders' self-invested funds. It plays the role of an important benchmark that expresses the bank's profitability and utility to the shareholders (Koch and MacDonald, 2000). Net Interest Margin (NIM) informs the extent to which the revenues from interest earned from loans and other securities less the costs of borrowing from depositors is earned on interest-earning assets (Saunders & Allen, 2002). Ex ante, the banking sector profitability depends on such factors as interest rates, operating efficiency, and legislation and competition (Berger, 1995; Demirgüç-Kunt & Huizinga, 2000). We understand profitability as the primary condition for maintaining bank stability, development, and shareholders' value creation.

2.2. THEORETICAL FRAMEWORK

Various established theories explaining the perspective of innovation in the financial systems and factors influencing banking profitability provide the theoretical framework for studying the link between financial innovation and the profitability of the Nigerian banking industry. Three major theories underpinning financial innovation and one key theory on banking sector profitability are presented below.

2.2.1. DIFFUSION OF INNOVATIONS THEORY

The 'Diffusion of innovations theory,' put forward by Everett Rogers in 1962, looks at how new ideas spread in cultures and organizations. This theory outlines five steps in the adoption process: knowledge, persuasion, decision, implementation, and confirmation. This concept proves useful when integrating financial breakthroughs like mobile banking and blockchain technology into banking operations. Rogers (1995) states that the spread of innovations has an impact on relative advantage fit with social norms, simplicity of use, ability to test, and visibility. These five elements together shape the speed of adoption but don't guarantee the same outcome in the diffusion process.

The theory highlights how innovations diffuse either at the sector or organization level. In the banking industry, changing customer needs and pressure for speedier service delivery have been the major influencing factors for the rapid expansion of electronic money transfers, use of ATMs, POS terminals, and mobile banking. For instance, mobile banking represents the application of a mobile communication technology from the telecommunication industry to the banking sector, which brings speed, accessibility, and convenience. Financial institutions that use these innovations have competitive advantages, as stated by Dearing and Cox (2018), who found that the early adopters enjoy increased efficiency and customer satisfaction.

Research work has also focused on the impacts of digital innovations on financial performance. Ghose and Maji (2022) concluded that internet banking intensity enhance the profitability of the Indian banks. From the perspective of customers, satisfaction remains the focus of most internet banking adoption issues, as indicated by Keskar and Pandey (2018). More recently, Rahi et al. (2021) revealed that user continuance in the context of internet banking is greatly determined by factors stemming from the theories of expectation-confirmation, self-determination, and commitment trust.

Competition, regulatory frameworks, and consumer demand have been the factors that shaped the adoption of digital payment systems and blockchain technology in Nigeria. The Central Bank of Nigeria has been leading the drive for financial inclusion with

the digital payments directive of 2012, among others, to the launch of the eNaira in 2021. These, together with the operationalization of the open banking regime in 2023, have improved service delivery and created competitive advantages for early adopters. Strategic investments by Nigerian banks in digital platforms have increased rural outreach, improved profitability, and sustained their centrality in the presence of competition from fintechs and mobile money platforms.

Blockchain adoption has also gained steam in Nigeria, with regulatory support in the form of a national blockchain policy in 2023 and the lifting of the cryptocurrency ban. The introduction of a Nigerian stablecoin and regulated blockchain-based assets has kept the banks on course, using these technologies to help spur economic growth. However, challenges persist in the ways of low adoption rates regarding the eNaira or interoperability-related issues. In sustaining profitability and competitiveness amidst an increasingly digital financial landscape, continuous policy refinement, advancement in technology, and cooperation with fintechs are critical (Tidd & Bessant, 2018).

2.2.2. TECHNOLOGY ACCEPTANCE MODEL (TAM)

The Technology Acceptance Model (TAM) developed by Davis in 1989, offers a solid theoretical base to understand how mobile banking, a major innovation, has gained acceptance in Nigeria's banking sector. This model, which stems from the Theory of Reasoned Action, examines the factors that lead to the use of technology. It suggests that two main factors perceived usefulness (PU) and perceived ease of use (PEOU) shape an individual's preference for a particular technology (Davis 1989).

In this context, perceived usefulness refers to how much a person believes mobile banking will improve their banking activities. For example, the ability to make transactions and access financial services at any time increases the perceived usefulness of mobile banking (Onakoya et al. 2022). On the other hand, perceived ease of use relates to how accessible a person thinks mobile banking technology is (Ndubuisi & Kabubo 2022). Features like a user-friendly interface simple navigation, and a gentle learning curve all contribute to higher acceptance rates.

Users' perceived usefulness and perceived ease of use are the constructs of TAM, diagnostics indicate that when using mobile banking, if the users have a positive attitude towards it, they tend to increase their intention to adopt or use the technology (Chukwuma & Ikpesu, 2021). Moreover, the adoption of mobile banking depends on system factors and social factors influence, perceived trust, perceived security, system features which indirectly determine perceived usefulness and perceived ease of use. TAM has been used to explain the fast growing adoption of mobile banking technology; see Adekunle & Salami, (2023). It also specifically underlines the role of the model and potential of designing systems that can be useful as well as easily accepted by consumers.

2.2.3. TRANSACTION COST THEORY

Transaction Cost Theory (TCT), proposed by Coase in 1937 and Williamson in 1975 highlighted that any economic transaction involves cost such as cost of searching, negotiating, policing, and auditing. In the banking sector, these costs appear as inefficiencies in service delivery, affecting areas like branch operations, loan processing, and payment settlements (Owolabi & Kola, 2016). Innovations such as mobile banking and blockchain technology help reduce these costs, enhancing profitability by streamlining operations.

Mobile banking serves as a prime example of TCT in action by cutting down on physical banking expenses. Customers benefit from saving time and money by accessing services like fund transfers and bill payments from anywhere. In Nigeria, where access to financial services in rural areas is often limited, mobile banking plays a crucial role in bridging this gap, increasing financial access and boosting bank profits through higher deposits and transaction volumes (Iya & Akinmoladun, 2020). This innovation also lowers overhead costs by minimizing the need for extensive branch operations, which aligns with TCT's emphasis on cost reduction.

Blockchain technology is transforming the banking landscape by decentralizing transaction processes, removing intermediaries, and decreasing delays and fees. In Nigeria, blockchain facilitates cross-border payments and trade finance, providing real-time, cost-effective solutions (Tchouassi, 2019). These advancements enhance banks' operational efficiency, attract new customers, and support profitability by reducing transaction costs and creating new revenue opportunities, such as smart contracts and cryptocurrency services.

By cutting costs, these technologies allow banks to concentrate on strategic investments, including product innovation and market expansion. For example, mobile banking promotes financial inclusion by reaching underserved communities, while blockchain guarantees secure and transparent transactions (Mazzucato, 2013). These innovations not only improve customer satisfaction and loyalty but also bolster banks' competitive edge in an ever-evolving financial landscape. TCT highlights the crucial role of financial

innovations in cutting costs and boosting profitability. For banks in Nigeria, adopting mobile banking and blockchain technologies is essential for staying competitive, promoting financial inclusion, and fostering overall economic growth (Gambo, 2020). These developments resonate with TCT's principles, equipping banks to succeed in a rapidly digitalizing market.

2.2.3 PROFITABILITY THEORY: THE STRUCTURE-CONDUCT-PERFORMANCE (SCP) PARADIGM

The SCP paradigm, introduced by Joe S. Bain in the 1950s, connects market structure, firm conduct, and performance. It illustrates how market conditions influence firm behavior, which in turn affects profitability and efficiency. This model, later enhanced by Scherer and Ross, continues to be an essential framework for industry analysis, including the banking sector (Bain, 1951). In Nigeria's banking landscape, SCP emphasizes how the market structure, characterized by a mix of large and small banks, promotes competition. Larger banks, with their advanced technology, often spearhead financial innovations, while smaller banks typically concentrate on niche markets (Bain, 1951). The regulatory framework, including initiatives like the Central Bank of Nigeria's (CBN) financial inclusion strategy, has spurred the adoption of technologies such as mobile banking, thereby broadening financial access in underserved areas.

The conduct of firms, which includes investments in digital banking, pricing strategies, and customer service, plays a crucial role in determining profitability. Nigerian banks that embrace innovations like mobile banking, blockchain, and online platforms can enhance efficiency, improve customer satisfaction, and lower transaction costs (Scherer & Ross, 1990). These approaches allow them to cater to increasing consumer demands and gain an edge over competitors. Performance in the SCP framework is assessed using metrics such as Return on Assets (ROA) and Net Interest Margin (NIM). Innovations help reduce costs, increase revenue, and optimize operations, leading to improved profitability. For example, mobile banking reduces the need for physical branches, cutting down on logistics and staffing expenses, while blockchain technology enhances the security and speed of transactions.
In Nigeria, the early adoption of digital innovations gives banks a competitive advantage, boosting their market share and profitability. On the other hand, those that are slower to adopt may find themselves losing relevance in a rapidly changing market. Combining SCP with theories like Diffusion of Innovations and Transaction Cost Theory highlights how financial innovations can create a competitive edge and drive profitability.

2.3 EMPIRICAL REVIEW

Exploratory findings indicate the existence of a correlation between the level of financial innovation and the level of profitability in the banking industry in Nigeria. Valverde Paso, and Fernández (2007) found that product and service innovations have a strong link to the regional gross domestic product, investment and gross savings in Spain. Beck et al. (2012) noted that outside money for financial innovation might lead to changes in economic growth volatility. Their paper looked at bank, industry, and country data from 32 developed countries from 1996 to 2006. It claimed that outside funding of innovations affects how much economic growth varies.

Idun and Aboagye (2014) studied how bank competition and financial innovation affect economic growth in Ghana. They found that financial innovation and economic growth had a negative link in the long run but a positive one in the short run. They also found proof of two-way Granger causality between financial innovation and economic growth. Mwinzi (2014) studied Kenya and showed that financial innovation depends on economic growth. He stressed the growth of some percentages of mobile transactions. This study aimed to explore the impact of financial innovation on economic growth, focusing on research conducted by Bara & Mudzingiri (2016) in Zimbabwe. They specifically examined the role of financial development in developing countries by utilizing Autoregressive Distributed Lag (ADL) bounds tests and Granger causality tests on Zimbabwean monetary time series data from 1780 to 2013. The findings indicate that the relationship between financial innovation and economic growth in Zimbabwe varies depending on the specific measures of financial innovation considered. This supports the notion that financial innovation represents a sustainable, long-term shift in economic development. Additionally, the study reveals that there is some degree of directional causality, particularly when the effects of financial development are taken into account.

Qamruzzaman and Jianguo (2017) utilized the ARDL & ECM bound testing approach to granger causality in order to determine whether or not there is a long run relationship between financial innovation and economic growth in Bangladesh. Additionally, they used real GDP per capita as a variable to measure economic growth whereas the level of financial innovation was measured by means of the domestic credit to the private sector and M2/M1 ratio. The results underlined that financial development and growth have a positive and significant long-run relationship. In addition, the causality tests exhibited that there exists unidirectional causality from financial innovation to growth which indicates that any shocks in innovation are likely to benefit Bangladesh's economic growth.

Scrutinizing the influence of financial innovation on the Economic growth of Nigeria, Ozurumba and Oyapema in 2019 used the Ordinary Least Square Method. Their analysis made use of NIBSS transaction figures, the volume of Automated Teller Machine

(ATM) transactions, and Agent Banking for the period spanning between 2012 and 2018. The implications from the regression analysis revealed that the amount of financial intermediation conducted through NIBSS and Agent Banking was positive but minimal with respect to the economic growth of Nigeria. However, transactions carried out through ATM's had an adverse effect which was statistically significant at 5% level.

The study by Chukwunulu was conducted in 2019 and it was dedicated to an investigation of the financial development function as well as the growth of the Nigerian economy. A dataset consisting of ATM, web, point of Sale (POS), and mobile payment transactions between the year 2008 and the year 2017. Due to the short study period, the study adopted the Generalized Methods of Moments (GMM) estimation method. Results showed that the four of the current recognized e-money transaction entities have positive implications in fostering Nigeria's GDP growth. This implies that financial innovation has enhanced the economic growth of Nigeria in the period under consideration 2008–2017, contrary to prevailing opinion by John (2019) who stated that ATM, mobile payment, and web based transactions' have a negative impact on the Nigeria's real GDP growth.

Qamruzzaman (2023) studies effect of financial innovation on financial inclusion ratio in a sample of 22 Arab countries for the period 2004 to 2020. In the present work, financial inclusion is measured by the amount of ATMs as well as the amount of depositors of the commercial banks; and financial innovation is the proportion of the broad money to the narrow money. To test the aforementioned relations, the research employs: LM, Pesaran and Shin W-statistics for cross sectional dependence; unit root tests; panel Granger causality tests; cointegration with NARDL and system GMM estimation. The result indicates also that there is a strong relationship between Financial Inclusion and financial innovation, the latter has been attributed as the more potent factor in bringing people in the non-formal financial system into inclusion.

In this paper, Rasheed et al. (2024) analyze the interdependence of financial innovation (FINV), green finance (GRF), and sustainability performance (SUSP). It reveals that through providing resources to support sustainable actions, there has been positivity in the improvement of FINV through the GRF, as a result increases the sustainable growth that has social responsibility, environmental, and economic targets. Misati et al., (2024) assess the effects of digital financial innovation, financial depth, and economic growth within the Kenyan context using co integration of the ARDL model. Based on their findings they show positive correlation between digital innovation, financial depth, internet and mobile services with huge effects on economic growth which is facilitated by financial depth.

In Nigeria, the existing literature points to methodological and proxy-related shortcomings. Numerous studies depend on static models and outdated proxies, which restrict understanding of the dynamic effects of financial innovation on profitability. This research addresses these issues by utilizing ARDL models, integrating modern proxies such as digital payments and blockchain, and broadening profitability metrics to more accurately evaluate the impact of innovation.

3. METHODOLOGY

The research design is quantitative and takes a cause-and-effect approach to explore how financial innovation impacts the profitability of banking sector in Nigeria. The study specifically examines mobile banking, digital payment technologies, and blockchain systems. It utilizes a time-series analysis of quarterly data spanning from 2009 to 2024 to assess the effects of these innovations over time. The analysis includes all 26 commercial banks, ensuring a thorough examination of the industry. Secondary data is gathered from Central Bank of Nigeria (CBN) publications, covering mobile banking technologies (like Web Pay and Mobile Pay), digital payment systems (such as NIP and NEFT), and blockchain technologies (including Remita and Central Pay). Return on Assets (ROA) is used as the dependent variable. To investigate causal relationships, econometric techniques are employed, including the Augmented Dickey-Fuller test, and ARDL model.

The model is defined in equation (3.1). It is important to note that this model was adapted and modified based on the research conducted by Ashiru et al. (2023).

$$\mathrm{ROA} = \mathrm{f}(\mathrm{WPY}, \mathrm{MPY}, \mathrm{NIP}, \mathrm{NEF}, \mathrm{RTA}, \mathrm{CPY})$$

$$\mathrm{ROA}_t = \alpha_0 + \beta_1 \mathrm{WPY}_{it} + \beta_2 \mathrm{MPY}_{it} + \beta_3 \mathrm{NIP}_{it} + \beta_4 \mathrm{NEF}_{it} + \beta_5 \mathrm{RTA}_{it} + \beta_6 \mathrm{CPY}_{it} + \varepsilon_{it} \qquad (3.1)$$

Based on equation (3.1), the ARDL was applied in equation (3.3). However, the implementation of the model relied on pre-test results that indicated the presence of different orders of integration across various series, which aligns with the findings of Pesaran, Shin, and Smith (2001). Thus, a general ARDL model can be expressed as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i Y_{t-i} + \sum_{j=0}^{q1} \gamma_{1j} X_{1,t-j} + \sum_{j=0}^{q2} \gamma_{2j} X_{2,t-j} + \cdots + \sum_{j=0}^{qk} \gamma_{kj} X_{k,t-j} + \varepsilon_t \qquad (3.2)$$

Equation (3.2) can be reformulated as follows:

$$ROA_t = \alpha_0 + \sum_{i=1}^{n} \beta_i MOBILE_t + \sum_{t=1}^{n} \beta_2 DIGIPAY_t + \sum_{t=1}^{n} \beta_3 BLOCKCHAIN_t + \sum_{l=1}^{n} \gamma_1 CAPRATIO_t + \varepsilon_t$$

Where
ROA_t is the Return on Asset of the banking sector in Nigeria at time t (dependent variable)
$MOBILE_t$ represents mobile banking technology adoption (Web Pay, Mobile Pay),
$DIGIPAY_t$ represents digital payment technologies (NIP, NEFT),
$BLOCKCHAIN_t$ represents blockchain technologies (Remita, Central Pay),
X_t denotes control variables, which is capital adequacy ratio (CAR)
α_0= Intercept term
β_1 β_2 β_3 = Coefficients for the respective independent variables
ε_t is the error term.

4. RESULTS AND DISCUSSIONS

4.1. UNIT ROOT TEST

TABLE 1 Augmented Dickey-Fuller Stationary Test

Variables	ADF Statistics	1%	5%	Prob
ROA	-8.138151	-3.548208	-2.912631	0.0000
WPY	-6.976319	-3.548208	-2.912631	0.0000
MPY	-5.030074	-3.565430	-2.919952	0.0001
NIP	-8.332077	-3.548208	-2.912631	0.0000
NEF	-8.103724	-3.548208	-2.912631	0.0000
RTA	-5.931285	-3.632900	-2.948404	0.0000
CPY	-5.838829	-3.632900	-2.948404	0.0000

Source: E-view 10 Output

The Augmented Dickey Fuller test is used to assess the stationarity of variables and detect the presence of a unit root. If the calculated test statistic falls below the negative critical value for the 1 percent or 5 percent significance level, the null hypothesis is rejected, indicating that the variables exhibit stationarity. For ROA, WPY, MPY, NIP, NEF, RTA and CPY, all the test statistics exceed the critical values with corresponding probability values, which are below 0.05, suggesting that all these variables are stationary. This suggests they reciprocate manageable standard deviation around a single typical value over some period of time and therefore are less likely to offer unpredictable or non-stationary data.

TABLE 2 Lag Order Selection Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-4278.589	NA	5.34e+97	244.8908	245.2019	244.9982
1	-4072.476	318.0027	7.13e+93	235.9129	238.4015	236.7720
2	-3928.654	164.3679*	4.52e+91*	230.4945*	235.1606*	232.1052*

Source: E-view 10 Output

Table 2 summarizes the findings of several lag selection methods. These criteria are essential for identifying the optimal number of lags to incorporate into a model to achieve the best fit and accuracy. According to the results, Lag 2 is the most suitable choice for this analysis, as it shows the lowest AIC (230.4945), SC (235.1606), and HQ (232.1052) values, along with the smallest FPE (4.52e+91). This suggests that using two lags yields the best model fit while avoiding unnecessary complexity.

4.2. ARDL BOUNDS TESTING FOR COINTEGRATION

TABLE 3 ARDL Bounds Technique for Cointegration Test

F-statistic	Freedom	Level of Significance	I(0) Bound	I(1) Bound	Remark
93.66047	6	10%	2.12	3.23	Cointegrated
		5%	2.45	3.61	
		2.5%	2.75	3.99	
		1%	3.15	4.43	

Source: E-view 10 Output

The method applied to check whether there exists a long-run relationship between the variables known as the ARDL Bounds Test. The single output derived from estimation is F-statistic (93.66047) used to compare with critical value I(0) at different significance levels and critical value I(1) for comparing upper bounds. Referring to the above computation, it can be observed, that the F-statistic (93.66047) goes above the upper bound (I(1)) at all the levels of significance. Since the values of F-statistic are greater than the respective upper bound I(1), we infer that H0 stating that there is no cointegration is untenable. This implies that there is a long-run coexistence between the dependent variable such as ROA and the independent variables such as WPY, MPY, NIP, NEF, RTA, CPY. This result means that Mobile-banking technology, digital payment technology, and blockchain have significance different positive associations with banking profitability in the long run.

4.3. ARDL ESTIMATES

TABLE 4 ARDL Short-Run

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
ROA(-1)	0.644505	0.054604	11.80335	0.0000
ROA(-2)	-0.162896	0.047893	-3.401232	0.0043
WPY	-0.002570	9.46E-05	-27.17623	0.0000
WPY(-1)	0.000522	8.98E-05	5.808162	0.0000
WPY(-2)	-0.001138	9.69E-05	-11.74417	0.0000
MPY	0.006677	0.000492	13.57535	0.0000
MPY(-1)	-0.001764	0.000456	-3.870923	0.0017
MPY(-2)	-0.000547	0.000381	-1.438222	0.1723
NIP	-0.000125	0.001882	-0.066595	0.9478
NIP(-1)	-0.016421	0.000915	-17.94284	0.0000
NIP(-2)	-0.010022	0.000797	-12.57334	0.0000
NEF	0.197079	0.028193	6.990467	0.0000
NEF(-1)	0.311992	0.015195	20.53221	0.0000
NEF(-2)	0.323943	0.016060	20.17026	0.0000
RTA	-0.102380	0.067077	-1.526308	0.1492
RTA(-1)	0.782163	0.033331	23.46642	0.0000
RTA(-2)	0.491082	0.034102	14.40033	0.0000
CPY	-3.959957	1.216756	-3.254520	0.0058
CPY(-1)	10.60221	0.654950	16.18783	0.0000
CPY(-2)	4.319242	0.530347	8.144176	0.0000
C	-1921070.	246178.7	-7.803559	0.0000
R-squared	0.999563	Mean dependent var		12722835
Adjusted R-squared	0.998938	S.D. dependent var		1536063.
S.E. of regression	50067.77	Akaike info criterion		24.76385
Sum squared resid	3.51E+10	Schwarz criterion		25.69706
Log likelihood	-412.3674	Hannan-Quinn criter.		25.08600
F-statistic	1599.413	Durbin-Watson stat		2.295328
Prob(F-statistic)	0.000000			

Source: E-view 10 Output
*Note: p-values and any subsequent tests do not account for model

The ARDL short-run model looks at the immediate impacts of various factors on Return on Assets (ROA). The findings indicate that ROA (-1) has a positive and significant coefficient (0.644505, p = 0.0000), which points to a persistence in profitability. In contrast, ROA (-2) shows a negative coefficient (-0.162896, p = 0.0043), suggesting a corrective adjustment from earlier profitability levels. When it comes to mobile banking, Web Pay (WPY) initially exerts a negative influence on profitability (-0.002570, p = 0.0000), but the first lag reveals a positive effect (0.000522, p = 0.0000), while the second lag turns negative (-0.001138, p = 0.0000). Mobile Pay (MPY) demonstrates a strong positive impact (0.006677, p = 0.0000), although the first lag shifts to a negative effect (-0.001764, p = 0.0017), and the second lag is not significant.

Digital payment systems present varied outcomes. NIP shows no immediate effect (-0.000125, p = 0.9478), but it has negative impacts in both the first (-0.016421, p = 0.0000) and second (-0.010022, p = 0.0000) lags, indicating inefficiencies over time. Conversely, NEF consistently adds positively to profitability, with significant effects across all periods (0.197079, p = 0.0000). Regarding blockchain technologies, RTA shows no immediate effect (-0.102380, p = 0.1492) but has positive lag effects

(0.782163, p = 0.0000 and 0.491082, p = 0.0000). CPY presents a negative immediate effect (-3.959957, p = 0.0058) but positive lag effects (10.60221, p = 0.0000 and 4.319242, p = 0.0000), indicating potential long-term benefits. The model demonstrates a strong fit with an R-squared of 0.999563, and the F-statistic of 1599.413 (p = 0.0000) confirms its significance. The Durbin-Watson statistic of 2.295328 suggests that there are no significant autocorrelation problems.

4.4. DIAGNOSTIC TEST

TABLE 5 Residual-Based Diagnostic Tests

Breusch-Godfrey Serial Correlation LM Test	
F – statistic	2.750182
P-Value	0.0859
Heteroskedasticity Test: Breusch-Pagan-Godfrey	
F – statistic	1.783407
P-Value	0.1142
Ramsey RESET Test	
F – statistic	4.580539
P-Value	0.0432
Jarque-Bera Test for Normality of Residual	
Jarque-Bera	17.98707
P-Value	0.000124

Source: E-view 10 Output

After completing the ARDL long-run and short-run estimations with the error correction mechanism, it was important to conduct residual-based diagnostic and stability tests. As detailed in Table 5, the tests included the Reusch-Godfrey Serial Correlation LM, Heteroskedasticity, Breusch-Pagan-Godfrey, Ramsey RESET, and Jarque-Bera tests for Normality of Residuals. The findings showed that the residuals were free from serial correlation, heteroscedasticity, and model misspecification, although there were some concerns regarding non-normality. This indicates that the estimations are generally robust and reliable for making inferences.

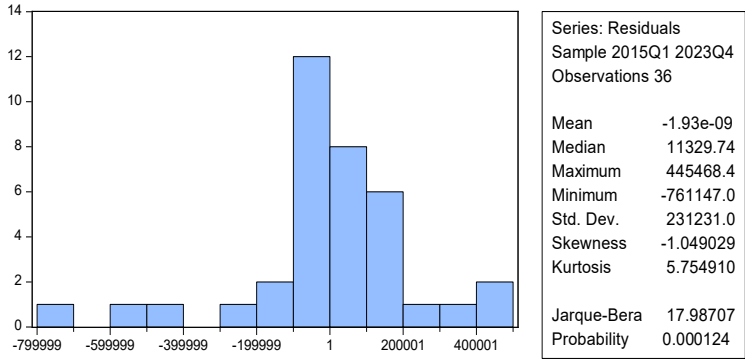

FIGURE 1 Bera Normality Test

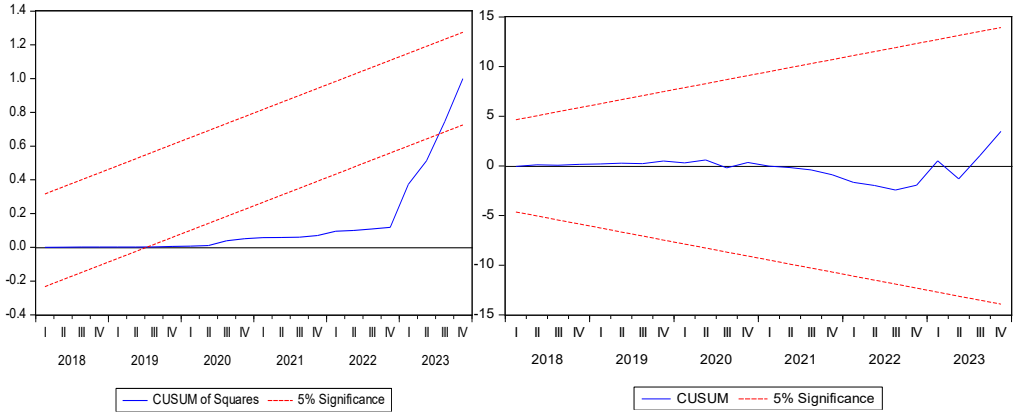

FIGURE 2 CUSUM and CUSUM of Squares

CUSUM and CUSUM of Squares graphs are used in assessing model stability. In the CUSUM Plot, blue line remains within the 5% significance most of the time indicating that the model is fairly healthy. That said, slight unpredictability from late year 2022 to mid-year 2023 is observed since the line is closer to the edges. In CUSUM of Squares Plot, the blue line crosses the 5% significance level at 2023, suggesting presence of structural shift in the model during this time. It may also mean changing signs of the relationships between the variables or change signs of the shocks in the model. In total, there is a gross stability of the model most of the time, although it exhibits a sign of structural instability towards the end of the time period under analysis.

5. CONCLUSION AND RECOMMENDATIONS

The financial innovation through mobile banking technologies, the digital payment system and blockchain technologies has been examined in this paper in relation to return on assets of the Nigerian banking sector. The findings reveal that while innovations like mobile payments and blockchain technologies positively influence profitability, their effects differ over time. Mobile banking technologies provide significant short-term advantages, whereas blockchain technologies yield substantial profitability contributions over a longer period. In contrast, some digital payment systems may initially incur costs or inefficiencies before resulting in positive outcomes. Overall, financial innovation is essential for fostering sustainable growth in Nigeria's banking sector. Consequently, the following recommendations were proposed:

First, banks should broaden their mobile payment platforms (e.g., MPY) and enhance transaction security and efficiency to optimize short-term profitability. Ongoing innovation in user-friendly mobile banking applications will boost adoption and profitability.

Second, banks need to tackle inefficiencies in systems like the Nigeria Interbank settlement system (NIP) by investing in infrastructure improvements and lowering transaction costs. Strengthening systems like NEF (National Electronic Funds Transfer), which consistently supports profitability, can enhance sustainable performance.

Third, considering the delayed yet significant impacts of blockchain technologies such as Remita (RTA) and Central Pay (CPY), banks should invest in blockchain infrastructure to tap into its long-term profitability potential. Effective integration and phased implementation will help reduce short-term costs while maximizing future benefits.

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