Payment Innovation Transactions and Risk-Adjusted Profitability of Deposit Money Banks in Nigeria

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ABSTRACT

The dynamic realm of financial services has experienced a notable increase in innovative payment transactions, which are altering the dynamics of the banking sector. In this context, this research investigates the intricate connection between payment innovation transactions and the risk-adjusted profitability of Deposit Money Banks (DMBs) in Nigeria. The motivation for this study stems from the increasing importance of payment innovations in modern banking, necessitating a comprehensive investigation into their impact on bank profitability within the Nigerian context. To address this research inquiry, a descriptive research design was employed, facilitating a systematic exploration of the topic. Secondary data spanning from 2013 to 2022 were meticulously collected from the annual financial reports of fourteen listed DMBs in Nigeria, resulting in a dataset of 140 observations. A panel analysis approach utilizing Dynamic Generalized Method of Moments (D-GMM) was adopted to rigorously evaluate the intricate relationship between payment innovations and risk-adjusted profitability. The empirical findings illuminate several key insights. Notably, ATM banking emerges as a pivotal player, wielding a positive coefficient of 0.7105 and a highly significant probability value of 0.0007 concerning its impact on Risk-Adjusted Net Interest Margin (RANIM). This finding underscores the substantial influence of ATM banking in augmenting the profitability metric of Nigerian DMBs, signifying its potential as a driver of enhanced financial performance. This study provides compelling evidence that payment innovation transactions, particularly through ATM banking, significantly influence the risk-adjusted profitability of DMBs in Nigeria. These findings hold implications for strategic decision-making within the banking industry, urging stakeholders to harness the power of payment innovations to optimize profitability. To this end, it is recommended that DMBs in Nigeria continue to invest in and leverage payment innovation channels, with a keen focus on ATM banking, to sustain and enhance their risk-adjusted profitability in a dynamically evolving financial landscape.

Keywords : *Payment Innovation, Risk-Adjusted Profitability, Deposit Money Banks, ATM Banking, Transactions.*

1. Introduction

Over the past few years, Nigeria's financial landscape has been witnessing a transformative phase, largely due to the rapid adoption of diverse payment innovations, such as ATM payment channels, mobile banking, internet banking, and point-of-sale systems. These cutting-edge advancements in technology have significantly revolutionised the way banking transactions are conducted, ushering in an era of unprecedented convenience and accessibility for bank customers across the country. The widespread adoption has brought about several positive outcomes for the financial sector. The payment innovation channels have substantially reduced the need for customers to physically visit bank branches for routine transactions, alleviating long queues and minimising waiting times. This increased efficiency has not only enhanced customer satisfaction but also provided both customers and bank staff with more time for personalised and value-added services.

According to World Economic Forum (WEF), (2023), out of the 7.81 billion people who live on the planet, 5.20 billion use mobile phones, and 4.66 billion utilize the Internet. The value of transactions made using modern payment channels was $886.9 billion in North America, $1055.8 billion in Europe, $1138.9 billion in Asia, $126.6 billion in Latin America, and $84.9 billion in the Middle East and Africa (MEA) between 2017 and 2021. Globally, $ 3421 billion in transactions totalling 67% of all payments were made via new payment channels.

Nkem and Akujinma (2017) revealed that in Nigeria, DMBs underwent an unforeseen transformation, influenced by advanced banking technology and global payment trends. This shift was propelled by cutting-edge financial technology and increased internet usage, leading

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to the emergence of digital banking. Consequently, Nigeria's banking sector has shifted its emphasis toward retail banking and the widespread adoption of e-banking channels, significantly enhancing financial inclusion.

This development increased the competitiveness among the players in the banking industry who took advantage of technological advancement to serve their customers better (Jegede, 2014). The regulation by the CBN on DMBs such as the use of a cashless policy later paved the way for the use of ATMs, mobile banking, internet banking, and POS banking (Sanni, et al 2020). The prominent electronic payment channels in Nigeria are ATMs banking, mobile banking internet and POS banking. ATM channel is the leading payment innovation in Nigeria (CBN, 2020). In 2019 alone, 840 billion transactions were carried out on the nation's ATM banking platform with a total value of N6.512 trillion (CBN, 2020). The mobile banking payment channel had 78% of the total digital payment in the country (Nigeria Inter-Bank Settlement System (NIBSS, 2021).

As Nigerian DMBs continue to embrace technological advancements, there is a pressing need to comprehensively evaluate the impact of various payment innovations on their risk-adjusted returns. Risk-adjusted returns are crucial metrics for assessing a bank's financial performance, considering both the achieved return on assets and the level of risk taken to attain those returns.

In light of this, scholars like Sanni, Salami & Uthman (2020) and Zoauri & Abdelmaleek (2020) advocate for the use of risk-adjusted profitability metrics to accurately assess bank performance in the technology-driven era, emphasising their preference over risk-neutral metrics.

This study stands out by addressing this research gap, aiming to explore the impact of payment innovation transactions on the risk-adjusted profitability of Deposit Money Banks in Nigeria as its primary objective.

2. Literature Review

2.1 Payment Innovation

Payment innovation encompasses the continuous enhancement and progression of payment methods and systems, aimed at enhancing the convenience, security, efficiency, and accessibility of financial transactions. Recent years have witnessed notable progress in this domain, primarily propelled by technological advancements and evolving consumer preferences.

The use of technological payment methods and devices, such as Automated Teller Machines (ATM), mobile banking supported by Unstructured Supplementary Service Data (USSD), electronic cheques (e.cheques), Point of Sales (POS) terminals, and more, plays a crucial role in enhancing accessibility for users and instilling trust in the banking sector. These innovations have been instrumental in transforming the way people manage their finances and conduct transactions. The prominent payment innovations in Nigeria are discussed below:

2.1.1 Automated Teller Machine (ATM) Payment Channel

ATM payment channel, a transformative innovation aimed at streamlining payment transactions in the banking industry. As noted by Ibekwe (2021), it leverages technology to provide customers with convenient and location-independent access to their funds. This advancement has been made possible by the integration of technology into financial services, as highlighted by Bingilar and Bariweni (2019). ATM banking not only reduces customers' waiting times and enhances service delivery but also contributes to cost reduction for Deposit Money Banks (DMBs) while generating additional revenue, according to Oke, Ologunwa, and Kolawole (2021).

In the 21st century, ATM banking has evolved significantly to cater to the evolving needs of customers. Modern ATMs, as emphasised by Ibekwe (2021), have expanded their functionality beyond cash withdrawals. They now facilitate cash and cheque deposits, fund transfers, balance inquiries, mini statement printing, and even the purchase of prepaid cards or postage stamps. Additionally, advanced security measures, such as PIN encryption, card skimming detection, biometric authentication, and real-time monitoring, have been incorporated to safeguard transactions and customer data (Zouari & Abdelmalek, 2020).

The impact of ATM banking extends beyond customer convenience and efficiency. As observed by Othman, Saad, and Ramli (2020), it has replaced labour-intensive paper-based payment systems, increasing productivity for banks during business hours. This is because ATMs can operate continuously, complementing the services provided by human tellers. Moreover, the introduction of cardless transactions and features like cash recycling and remote monitoring further enhance the utility and reliability of ATMs, ensuring they remain a vital component of modern banking.

2.1.2 Mobile/USSD Banking

Mobile banking, as defined by the Nigeria Inter-Bank Settlement System (NIBBS) (2021), revolutionises the way banking payment services are delivered through mobile phones, eliminating the need for an internet data network. It relies on Unstructured Supplementary Service Data (USSD) codes provided by network providers. Safdar et al. (2018) complement this definition by highlighting mobile banking's incorporation of payment system features, underlining its role in conducting various banking activities. According to Nazrul-Islam, Ysuuf, and Shuaibu (2022), the incorporation of mobile banking into the financial system is underscored as a significant financial

innovation, primarily aimed at promoting financial inclusion, particularly for underserved populations.

The advent of smartphones has further transformed mobile banking by introducing dedicated mobile banking applications, enabling customers to access a wide array of digital payment services on their mobile devices. While mobile banking does not facilitate direct cash withdrawals or deposits from mobile devices like ATMs, it offers the convenient option of transferring funds to other accounts as an alternative to traditional cash transactions. This combination of accessibility and digital functionality has made mobile banking a powerful tool for financial inclusion and modern banking convenience.

2.1.3 Internet banking/Web Payment Channel

Internet banking, often referred to as a web-payment channel or electronic banking (e-banking), is a significant innovation in the banking sector. Chen and Peng (2019) define it as the delivery of a various banking products to consumers via the internet, while Monyoncho (2015) sees it as online real-time traditional banking functions. Tamara, Manurung, and Rusmanto (2019) view it as a modern payment channel offering online banking functions, providing customers with accessibility, convenience, control, and confidence. With internet banking, customers can efficiently manage their accounts, monitor transactions in real-time, and make payments conveniently from anywhere at any time (Aurazo & Vega, 2021).

Moreover, internet banking not only reduces operational costs and enhances payment processes, aligning with cashless policies (Oke, Ologunwa, & Kolawole, 2021), but it also serves as a valuable source of customer data. Nwakoby, Sidi, and Ofobruku (2019) highlight its impact on cost reduction and payment efficiency, while Akintoye et al. (2022) emphasise the influence of customer-related factors and technological infrastructure on its adoption. Additionally, the perceived security and confidentiality of online transactions are pivotal in determining its acceptance. Internet banking empowers banks with valuable customer behavior data, enabling them to tailor their services, improve product offerings, and make data-driven decisions to enhance performance and profitability.

2.1.4 Point of Sales (POS) /Agency Banking

Point of Sales (POS) Banking, as described by Salami, Akande, and Alalade (2022), is a payment processing and financial transaction system that relies on portable electronic devices known as POS terminals. These terminals are designed to facilitate card payments at various retail locations. The POS payment channel, as highlighted by Ibekwe (2021), involves the use of debit cards for processing payments and withdrawals, leading to improved efficiency, accessibility, and reach, particularly in unbanked areas where POS-accredited agents can operate remotely. Customers also benefit from time and resource savings since they are not required to visit bank branches or ATMs. Agent banking, as defined by CBN (2021), complements this system by offering enhanced financial access, increased bank efficiency, and employment opportunities for agents. With the assistance of POS terminals operated by approved bank agents, users can easily make deposits and withdrawals, enhancing convenience and accessibility.

The deployment of POS terminals significantly impacts bank performance by expanding the reach of banking services and bringing them closer to customers. This approach enhances customer engagement and satisfaction, ultimately contributing to the overall performance and profitability of Deposit Money Banks (DMBs).

2.1.5 Risk-Adjusted Profitability Metrics

Profitability in banking is assessed through risk-neutral and risk-based approaches. Risk-Adjusted metrics are discussed as follows:

2.1.6 Risk-Adjusted Return on Equity (RAROE)

RAROE is a financial measure that offers a nuanced and holistic assessment of a bank's profitability, considering the associated risk in generating profits. Unlike traditional Return on Equity (ROE), which looks solely at the absolute return generated relative to shareholders' equity without considering the element of risk, RAROE incorporates risk considerations into the assessment. The calculation of RAROE involves factoring in the standard deviation of returns, which serves as an indicator of the variability or uncertainty in the returns generated by the bank over a specific period. This standard deviation reflects the level of risk that the bank is exposed to in its operations and investment activities.

The significance of RAROE lies in its ability to provide a more accurate and balanced assessment of a bank's performance. While traditional ROE measures raw profitability, it often overlooks the inherent risks and uncertainties that banks face in their day-to-day operations. These risks can include market volatility, credit risk, interest rate fluctuations, and various other factors that can impact a bank's financial stability and long-term sustainability. By adjusting ROE with its corresponding standard deviation, RAROE allows for a more comprehensive evaluation of a bank's profitability in relation to the level of risk it undertakes. This metric is particularly valuable for both investors and stakeholders in the banking industry as it assists in making more informed investment decisions and evaluating a bank's ability to generate returns while effectively managing risk. (Brahmana, Kontesa, & Gilbert, 2018). RAROE is calculated as :

$$RAROE = \frac{ROE}{\sigma ROE} \quad \text{... 2.1}$$

Where ROE is return on equity and σ is the standard deviation of the related ROE.

2.1.7 Risk-Adjusted Return on Assets (RAROA)

RAROA is a crucial financial gauge that quantifies the efficiency of a bank in using its assets to produce profits, all while accounting for the degree of investment risk associated with this profit-generation endeavour. Unlike the traditional Return on Assets (ROA), which assesses the absolute profitability of a company in relation to its total assets without considering the element of risk, RAROA tak es into account the inherent risks associated with the utilization of those assets.

While traditional ROA offers insights into raw profitability, it may not capture the challenges and uncertainties that banks face in their operations, such as market fluctuations, credit risk, or economic volatility. These factors can significantly impact a bank's ability to generate consistent and sustainable profits. In essence, RAROA provides a nuanced perspective on a bank's financial performance, taking into account the critical element of risk in the assessment.

$$RAROA = \frac{ROA}{\sigma ROA} \quad \ldots 2.2$$

2.1.8 Risk-Adjusted Net Interest Margin (RANIM)

RANIM is a fundamental financial measurement used to evaluate the profitability of banks by taking into account the equilibrium between interest income and interest expenses. This metric surpasses the traditional Net Interest Margin (NIM).

The calculation of RANIM involves scaling the NIM by its corresponding standard deviation (σNIM). The standard deviation, in this context, serves as a measure of the variability or uncertainty in the net interest margin. It quantifies the level of risk attached to the bank's interest income and expenses.

The significance of RANIM lies in its ability to provide a more holistic assessment of a bank's profitability while accounting for the inherent risk. It allows investors, stakeholders, and financial analysts to not only gauge how efficiently a bank manages its interest-related income and costs but also to evaluate the risk-adjusted performance.

By incorporating risk considerations into the calculation, RANIM enables investors to compare the risk profiles of different banks. This is particularly valuable in the financial industry, where the level of risk associated with a bank's interest income and expenses can vary significantly. RANIM assists in making more informed investment decisions by assessing whether the interest-related profits adequately compensate for the associated risk.

$$RANIM = \frac{NIM}{\sigma NIM} \quad \ldots 2.3$$

2.2 Theoretical Framework

Meta-theory was created by Khraisha and Arthur (2018) claimed that various flaws exist in earlier hypotheses, For instance, geographical distance used to be a significant factor in driving payment innovations in DMBs, but it now only has a little impact on financial operations. Khraisha and Arthur (2018) introduced four models to elucidate the process of payment innovation, drawing from the foundations laid by Poole and Van (1995).

The life-cycle theory of payment innovation is the first model and states that every new financial product has a start and an end. The life cycle theory of payment innovation suggests that every innovation faces four stages; introduction, growth, maturity and decline. The extent of adoption and diffusion of financial innovations can vary depending on factors such as market conditions, industry dynamics, technological advancements, regulatory environments, and customer preferences (Ibekwe, 2021). Understanding the life cycle of innovation can help financial institutions, policymakers, and researchers anticipate the stages of adoption and plan accordingly. It highlights the importance of monitoring emerging trends, assessing the potential impact of innovations, and proactively adapting strategies to stay competitive in a rapidly changing financial landscape.

The moment an idea is perceived is the first phase, and the product goes through several stages of improvement in order to remain relevant. ATM served as an example to illustrate the life-cycle innovation hypothesis. ATM technology was first developed outside of the financial industry (Arthur, 2017). The initial ATMs could only dispense cash; however, modern ATMs are capable of performing a variety of tasks (Oke, Ologunwa & Kolawole, 2021). In reality, the life cycle of innovations can be more complex, with periods of re-evaluation, reinvigoration, or transformation. Additionally, the theory does not provide a comprehensive understanding of the specific determinants that drive each stage of the life cycle. However, the life-cycle theory is still relevant to the determinants of payment innovation and bank performance as it highlights the importance of monitoring emerging trends and adapting strategies accordingly.

The economic theory of payment innovation studies how market forces and economic factors drive the development and adoption of financial innovations. It considers the motivations of financial institutions and investors in creating and using new financial products and services. Market forces, profit incentives, risk-return dynamics, information, technology, and regulations all shape financial innovations. This theory also examines how these innovations impact the risk-return trade-off and the overall risk profile of financial markets (Khraisha & Arthur, 2018).

The third theory, evolutionary theory, claims that innovation happens as a result of optimisation, which means that businesses encounter issues for which they look for solutions. The theory views financial innovation as a process of adaptation and selection in response to changing market conditions and competitive pressures. This theory draws upon principles from evolutionary biology to understand how innovations emerge, evolve, and persist in financial markets over time. In the evolutionary theory of innovation, market feedback is measured, in the form of customer preferences, profitability, performance metrics, or regulatory changes that shape the adaptation, modification, or abandonment of financial innovations.

The institutional theory of innovation focuses on the role of institutional factors in shaping innovation. According to this theory, innovation is not solely driven by market forces but is influenced by the broader institutional environment (Khraisha & Arthur, 2018; Ejike, 2019). Meta theory is a combination of four theories which have integrating features in explaining the factors determining payment innovation. The four theories show the relevance of institutional need to innovate such as profit-seeking motive and the acceptance of the system by the public.

2.3 Empirical Review

Gundogdu and Taskin (2017) undertook research exploring the impact of credit cards as a novel mode of payment on the Turkish banking system. Their study revealed a noteworthy and meaningful correlation between credit cards and the operational effectiveness of Turkish banks. The investigation employed three criteria to measure bank performance: Return on Assets (ROA), Return on Equity (ROE), and Net Interest Margin (NIM). Concurrently, they measured the extent of digital innovative payments through metrics such as credit card usage volume, ATM transactions, and internet banking activities. The outcomes of their analysis disclosed a negative association between the utilisation of credit card innovation measures and Return on Assets (ROA).

Safdar et al. (2018) conducted an empirical analysis in Pakistan to assess the impact of innovative payment methods on bank efficiency. They found that only web payments (internet banking) had a statistically significant and positive effect on efficiency, highlighting the importance of resource allocation and technological investment. Wanalo (2018) examined the impact of technological financial innovations on the financial performance of Kenyan banks, finding that financial innovation had a positive but insignificant impact on bank performance, suggesting a need for a more comprehensive approach. Chipeta and Muthinja (2018) assessed the influence of financial innovation on Kenyan banks' performance, using industry-adjusted profitability metrics and ATM and internet banking as proxies for financial innovation. Their findings revealed a significant role of financial innovation in determining financial performance.

Njogu (2019) showed that modern payment channels, including internet banking, had a positive relationship with bank performance in Kenya. Serge, Clovis, and Alain (2019) studied the impact of technology-driven innovation in Sub-Saharan African banks and found a correlation between the adoption of mobile money and bank performance, highlighting the importance of technological integration and regulatory support. Zouari and Abdelmalek (2020) introduced the concept of risk as a mediating factor in the relationship between payment innovation and bank performance, revealing that payment innovation did not significantly impact Tunisian banks' profitability. Tian et al. (2020) investigated the relationship between innovation and profitability in US banks, finding a positive correlation.

Tran (2021) explored the correlation between payment system operations and the performance of Vietnam's banking industry, revealing that mobile payment innovations significantly influenced bank performance. Rahayu, Mariska, and Garantjang (2022) examined the impact of e-payment innovation on the performance of Indonesian banks, finding that these innovations significantly affected the banks' soundness. Mohammed, Ibrahim, and Muritala (2022) found that mobile payment in Nigeria had a positive and significant impact on the return on assets of commercial banks, while Real-Time Gross Settlement (RTGS) had a non-significant and negative impact. Adiga et al. (2022) assessed the influence of financial technology on Nigeria's banking sector using the ARDL methodology, concluding that it had a negligible effect on bank performance. Nazrul-Islam, Ysuuf, and Shuaibu (2022) investigated the impact of Fintech on the service delivery of Nigerian banks, revealing a significant and positive impact of bank payment innovations on service delivery.

3.0 Methodology

This study employs secondary data to explore the connection between payment innovation transactions and their influence on the risk-adjusted profitability of deposit money banks (DMBs) in Nigeria. The study encompasses all twenty-four licensed DMBs in Nigeria as of 2023. The sample size comprises the fourteen DMBs listed on the stock exchange in 2023. Data for this study were obtained from both the annual financial reports of the chosen DMBs and the statistical bulletins published by the Central Bank of Nigeria, spanning the period from 2013 to 2022. The panel dynamic model initially specified by Muhammed et al. (2022), specified in equation 3.1 below is adopted for the purpose of achieving the stated objective. However, this model has been subject to modifications tailored to our specific context.

$$D(ROA_t) = \beta_{01} + \beta_{11}(\mathrm{ROA}_{t-1}) + \beta_{21}(\mathrm{RRTGS}_{t-1}) + \sum_{i-0}^{p} \alpha_{11}\mathrm{D}(\mathrm{ROA}_{t-1}) + \sum_{i-0}^{q} \alpha_{21}\mathrm{D}(\mathrm{RRTGS}_{t-1}) + \beta_{31}(\mathrm{VMP}_{t-1}) + \sum_{i-0}^{q} \alpha_{31}\mathrm{D}(\mathrm{VMP}_{t-1}) + \beta_{41}\mathrm{D}(\mathrm{POS}_{t-1}) + \sum_{i-0}^{q} \alpha_{41}\mathrm{D}(\mathrm{POS}_{t-1}) + \beta_{51}\mathrm{D}(\mathrm{VIP}_{t-1}) + \sum_{i-0}^{q} \alpha_{51}\mathrm{D}(\mathrm{VIP}_{t-1}) + \beta_{61}\mathrm{D}(\mathrm{BSC}_{t-1}) + \sum_{i-0}^{q} \alpha_{61}\mathrm{D}(\mathrm{BSC}_{t-1}) + \varepsilon i_t \quad \ldots 3.1$$

The modified models are therefore specified in equations 3.2 to 3.4. Notably, these modified models incorporate risk-adjusted profitability metrics as the dependent variables, which differs from the approach employed by Muhammed et al. (2022). The equations are formulated as follows:

$$\Delta\mathrm{InRAROE} = \mathrm{C_o} + \alpha_{\mathrm{i}}\,\mathrm{InRAROE}_{\mathrm{it-1}} + \beta\mathrm{i}\Delta\mathrm{InATMB}_{\mathrm{it}} + \gamma\mathrm{i}\Delta\mathrm{InMB}_{\mathrm{it}} + \partial\mathrm{i}\Delta\mathrm{In}IB_{\mathrm{it}} + \rho\mathrm{i}\Delta\mathrm{In}POS_{\mathrm{it}} + \delta\mathrm{i}\Delta\mathrm{CR}_{\mathrm{it}} + \theta\mathrm{i}\Delta\mathrm{AQ}_{\mathrm{it}} + \varphi\mathrm{i}\Delta\mathrm{BZ}_{\mathrm{it}} + \varepsilon_{\mathrm{t}} \quad \ldots 3.2$$

$$\Delta\mathrm{InRAROA} = \mathrm{C_o} + \alpha_{\mathrm{i}}\,\mathrm{InRAROE}_{\mathrm{it-1}} + \beta\mathrm{i}\Delta\mathrm{InATMB}_{\mathrm{it}} + \gamma\mathrm{i}\Delta\mathrm{InMB}_{\mathrm{it}} + \partial\mathrm{i}\Delta\mathrm{In}IB_{\mathrm{it}} + \rho\mathrm{i}\Delta\mathrm{In}POS_{\mathrm{it}} + \delta\mathrm{i}\Delta\mathrm{CR}_{\mathrm{it}} + \theta\mathrm{i}\Delta\mathrm{AQ}_{\mathrm{it}} + \varphi\mathrm{i}\Delta\mathrm{BZ}_{\mathrm{it}} + \varepsilon_{\mathrm{t}} \quad \ldots 3.3$$

$$\Delta\mathrm{InRAROA} = \mathrm{C_o} + \alpha_{\mathrm{i}}\,\mathrm{InRAROE}_{\mathrm{it-1}} + \beta\mathrm{i}\Delta\mathrm{InATMB}_{\mathrm{it}} + \gamma\mathrm{i}\Delta\mathrm{InMB}_{\mathrm{it}} + \partial\mathrm{i}\Delta\mathrm{In}IB_{\mathrm{it}} + \rho\mathrm{i}\Delta\mathrm{In}POS_{\mathrm{it}} + \delta\mathrm{i}\Delta\mathrm{CR}_{\mathrm{it}} + \theta\mathrm{i}\Delta\mathrm{AQ}_{\mathrm{it}} + \varphi\mathrm{i}\Delta\mathrm{BZ}_{\mathrm{it}} + \varepsilon_{\mathrm{t}} \quad \ldots 3.4$$

Dependent Variables
(3-measures of risk-adjusted profitability)

RAROA = *Risk-Adjusted Return on Assets*
RAROE = *Risk-Adjusted Return on Equity*
RANIM = *Risk-Adjusted Net Interest Margin*

Independent Variables
(4-measures of payment innovation)

ATMB = *ATM banking transactions*
MB = *Mobile banking transactions*
IB = *Internet banking transactions*
POS = *POS transactions*

Control Variables

BZ = *Bank Size*
CR = *Regulatory Capital*
AQ = *Asset Quality*
E_t = *Error Term*

Table 3.1 : *Measurements of Variables*

S/N	Dependent Variables	Description	Measurement	Sources of Data
1	Risk-Adjusted Return on Equity (RAROE)	RAROE is a financial metric that evaluates a company's ability to generate profits from shareholder equity, considering the level of risk associated with those profits.	Ratio of ROE to standard deviation of ROE over the sample period.	Annual Reports of the selected DMBs. (2013-2022)
2	Risk-Adjusted Return on Assets (RAROA)	RAROA is a financial ratio that evaluates a company's efficiency in generating profits from its total assets, considering the level of associated risk.	Ratio of ROA to standard deviation of ROA over the sample period.	Annual Reports of the selected DMBs. (2013-2022)
3	Risk-Adjusted Net Interest Margin (RANIM)	RANIM is a vital banking metric that evaluates a bank's profitability and risk exposure related to its core lending and investment activities.	Ratio of NIM to standard deviation of NIM over the sample period.	Annual Reports of the selected DMBs. (2013-2022).

S/N	Independent Variables	Description	Measurement	Sources of Data
4	ATM Banking	ATM banking is a convenient payment innovation allowing users to conduct various transactions using debit cards at ATMs, without needing to interact with bank staff directly.	Value of all payment transactions carried out on ATM channel in the period.	CBN Statistical Bulletins & Annual reports of NDIC (2013-2022)
5	Mobile Banking	A transformative innovation that uses basic mobile phones to offer essential banking services without the use of internet data.	Value of all payment transactions carried out on mobile payment channel in the period.	CBN Statistical Bulletins & Annual reports of NDIC. (2013-2022)
6	Internet Banking	It offers round-the-clock online payment reduces the necessity for in-person branch visits.	Value of all payment transactions carried out on web payment channel in the period.	CBN Statistical Bulletins & Annual reports of NDIC. (2013-2022).
7	POS Banking	Point of Sale (POS) is a digital payment innovation enabling customers to conduct transactions at POS terminals using various electronic methods.	Value of all payment transactions carried out on POS payment channel in the period.	CBN Statistical Bulletins & Annual reports of NDIC. (2013-2022).
S/N	**Control Variables**	**Description**	**Measurement**	**Sources of Data**
8	Bank size (BZ)	Bank size refers to a bank's scale.	It is measured by the banks' total assets.	Annual Reports of the selected DMBs. (2013-2022).
	Assets Quality (AQ)	pertains to the assessment of a bank's asset portfolio's general condition and risk level, with a specific focus on loans and investments.	This is typically quantified using the ratio of non-performing loans to the total assets of the bank.	Annual Reports of the selected DMBs (2013-2022).
	Regulatory Capital (CR)	It encompasses the regulations dictating the amount and nature of capital banks must maintain to safeguard financial stability and the interests of depositors.	This is quantified through the Capital Adequacy Ratio (CAR), calculated as the ratio of a bank's combined Tier 1 and Tier 2 capital to its risk-weighted assets.	Annual Reports of the selected DMBs (2013-2022).

***Source** : Authors' compilation (2023)*

4. Results and Discussion

Table 4.1: *Descriptive Statistics*

	RAROA (%)	RAROE (%)	RANIM (%)	ATMB N'Billion	MB N'Billion	IB N'Billion	POSB N'Billion	BZ N'Billion	CR (%)	AQ (%)
Mean	0.0155	0.1428	0.0381	7011.6	1788.7	124727	3598.7	7.3463	0.134	0.044
Median	0.0132	0.101	0.0394	5712.8	929.30	62061	1084.4	6.6580	0.1700	0.0310
Max	0.0644	5.6864	0.1246	21230	5179.0	545039	24455	9.9850.0	0.6400	0.3000
Min	-0.0968	-3.584	0.0007	1984.6	31.510	17582	48.02	4.9162	-2.1480	1.000
Std. Dev.	0.0198	0.6664	0.0220	5452.3	1876.7	153770	7062.6	1.3661	0.3099	0.0483
Skewnes	-1.7243	4.2635	0.8913	1.69923	0.9110	1.9874	2.5491	0.4944	-5.8338	2.721
Kurtosis	12.811	49.9226	5.7209	4.8969	2.2687	5.7602	7.7389	1.6449	40.327	11.342
Jarq.Bera	630.91	13267	61.725	88.363	22.484	136.59	282.61	16.414	8922.0	578.86
Prob.	0.0000	0.0000	0.0000	0.0000	0.0013	0.0000	0.000	0.00273	0.0000	0.00000
Observ.	140	140	140	140	140	140	140	140	140	140

Note : *RAROA: risks-adjusted return on assets; RAROE: risks-adjusted return on equity; RANIM: risks-adjusted net interest margin; ATMB: ATM banking transactions; MB: mobile banking transactions; IB: internet banking transactions; POSB: POS banking transactions; BZ: bank size; CR: regulatory capital; AQ: asset quality.*

Source: *Authors' computation (2023).*

The descriptive statistical results in Table 4.1 provide valuable insights into various financial and operational aspects of the 14 listed DMBs in Nigeria over the period from 2013 to 2022. The mean values represent the average values for each variable. For example, the average RAROA is approximately 0.0155%, while the median RAROA is slightly lower at 0.0132%. This suggests that there might be some variability in RAROA across the banks. The minimum and maximum values indicate the range of variation within each variable. For instance, the

Table 4.2 *: Correlation Matrix*

	RAROA	RAROE	RANIM	ATMB	MB	IB	POSB	BZ	CAR	AQ
RAROA	1.0000									
RAROE	0.2338	1.0000								
RANIM	-0.0315	-0.0461	1.0000							
ATMB	-0.0017	-0.0391	0.1666	1.0000						
MB	-0.0375	0.0139	0.1645	0.3049	1.0000					
IB	-0.0322	-0.0189	0.1524	0.2505	0.7972	1.0000				
POSB	-0.0248	-0.0191	0.1220	0.1839	0.7123	0.9573	1.0000			
BZ	-0.1417	0.0044	0.3471	0.0839	0.0943	0.0922	0.0771	1.0000		
CR	0.0835	0.2451	0.0162	-0.0533	-0.1745	-0.0904	-0.0657	-0.1436	1.0000	
AQ	-0.0372	0.0510	-0.0417	0.0199	-0.0928	-0.1344	-0.1178	-0.2587	0.1971	1.0000

Source: *Authors' computation (2023).*

maximum RAROE is 5.6864%, significantly higher than the minimum RAROE of -3.584%. This wide range suggests substantial variations in the profitability of these banks. The standard deviation measures the dispersion or variability of the data.

The Jarque-Bera test assesses the normality of the data distribution. A significant p-value (usually below 0.05) suggests that the data does not follow a normal distribution. In this case, most variables have very low p-values (close to 0), indicating that they do not follow a normal distribution. The number of observations shows the sample size, which is 140 in this case, for all variables. In conclusion, these descriptive statistics reveal that the 14 listed DMBs in Nigeria exhibit substantial variations in their financial and operational performance. Some variables, such as RAROE, show significant variability, and their distributions may not be normal. These findings emphasize the need for further statistical analysis and modeling to understand the factors driving these variations and their potential implications for the banking sector in Nigeria.

In Table 4.2, there is a moderate positive correlation (0.2338) between RAROA and RAROE, indicating that as RAROA increases, RAROE tends to increase, reflecting the interdependence of asset and equity profitability. RAROA has a weak negative correlation (-0.0315) with RANIM, suggesting a small inverse relationship, possibly due to banks focusing on interest income.

ATM banking transactions have a weak positive correlation (0.1666) with RANIM, possibly due to fee income generated, but the relationship is not strong.

Mobile banking transactions have a weak negative correlation (-0.0375) with both RAROA and RANIM, possibly due to lower-cost transactions. Internet banking transactions also have a weak negative correlation (-0.0322) with both RAROA and RANIM, similar to mobile banking.

POS banking transactions have a weak negative correlation (-0.0248) with both RAROA and RANIM, possibly due to card-based transactions generating lower interest income.

Bank size has a negative correlation (-0.1417) with both RAROA and RANIM, indicating larger banks may have slightly lower profitability due to increased competition and operational complexity. Regulatory capital (CR) has a

Table 4.3 *: Panel Unit Root Test Results*

Variables	Levin, Lin & Chu Test		ADF-Fisher x^2 Test	
	Level	First Difference	Level	First Difference
RAROA	-10.4812 (0.0000)	-44.8820 (0.0000)	61.4812 (0.0000)	139.979 (0.0000)
RAROE	-2.0920 (0.0182)	-15.3384 (0.0000)	39.8269 (0.0685)	129.182 (0.0000)
RANIM	3.5957 (0.9999)	-6.92131 (0.0000)	8.30024 (0.9999)	84.2983 (0.0000)
ATMB	-3.1615 (0.0008)	-12.0002 (0.0000)	24.5216 (0.0000)	-12.0027 (0.0000)
MB	-14.5658 (0.0000)	-25.2989 (0.0000)	111.098 (0.0000)	214.284 (0.0000)
IB	1.9998 (0.9772)	-13.7932 (0.0000)	3.8763 (1.0000)	103.157 (0.0000)
POSB	-21.2708 (0.0000)	-49.0025 (0.0000)	34.6287 (0.1809)	140.588 (0.0000)
BZ	3.5957 (0.9998)	-6.9213 (0.0000)	8.3002 (0.9999)	84.2983 (0.0000)
CR	-1.6465 (0.0498)	-9.6455 (0.0000)	28.9368 (0.4157)	110.541 (0.0000)
AQ	-1.0027 (0.1580)	-6.9426 (0.0000)	31.5056 (0.2951)	-6.9426 (0.0000)

Source: *Authors' computation (2023).*

positive correlation (0.2451) with RAROE, suggesting that higher CR leads to higher returns for shareholders. Asset quality has a weak positive correlation (0.1971) with capital adequacy ratio, indicating that better asset quality is associated with higher capital adequacy ratios.

4.3 Unit Root Tests

Table 4.3 results show significant findings in the Levin, Lin & Chu tests for RAROA, RAROE, RANIM, and ATM transactions. RAROA and RANIM shift from non-stationary to stationary after differencing, revealing long-term and short-term trends. RAROE and ATM transactions similarly display non-stationary to stationary transitions, indicating short-term and long-term influences.

In the first model, the regression analysis showed that the lagged dependent variable had a highly significant positive association with risk-adjusted return on assets (RAROA), with a p-value of 0.0000. This suggests a substantial impact of previous returns on the current RAROA. However, ATM banking transactions, mobile banking transactions, internet banking transactions, and

Table 4.4 : *Panel D-GMM Result*

Variables	Model 1: RAROA	Model 2: RAROE	Model 3: RANM
LAGS	0.2800 (0.0000)** [19.4149]	0.053 (0.2741) [1.0994]	-1.1819 (0.2904) [-1.0634]
ATMB	-0.2959 (0.5889) [-0.5422]	-0.0001 (0.9871) [-0.0162]	0.7105 (0.0007)** [3.5037]
MB	0.0000 (0.9749) [0.0315]	-0.0127 (0.1310) [-1.5222]	0.2917 (0.2041) [1.2793]
IB	0.00002 (0.9754) [0.0309]	-0.0004 (0.9869) [-0.0165]	-0.5264 (0.1643) [-1.4021]
POSB	-0.0981 (0.8047) [-0.2479]	-0.0117 (0.2381) [-0.0165]	-0.1286 (0.2274) [-1.2215]
BZ	-0.5683 (0.0000)** [-5.6980]	0.1579 (0.5630)** [0.5802]	-0.5339 (0.0019)** [-3.2004]
CR	-0.1109 (0.0851) [-1.7387]	0.0182 (0.0081)** [2.7003]	0.5894 (0.0000)** [11.8036]
AQ	-0.0060 (0.0000)** [-7.0209]	0.0009 (0.8000) [0.2653]	0.1460 (0.8855) [0.1444]
S-Statistics	11.0135	7.4381	9.7136
Prob(J-Stats.)	0.0880	0.2822	0.1364
Instrument	14	14	14
AR(1)	0.9922	0.3368	0.9942
AR(2)	0.9997	0.1868	0.0115
F-Statistics	282.9142(0.0000)	861.2647 (0.0000)	1.2644 (0.0000)

The value in ( ) and [ ] are the p-values and t-statistics respectively while the values outside the parentheses are the coefficients. (**) 5% level of significance.

Source : *Authors Computation, 2023.*

POS banking transactions were not statistically significant, with p-values of 0.5889, 0.9749, 0.9754, and 0.8047, respectively, indicating a lack of association with RAROA. Conversely, bank size had a highly significant negative relationship with RAROA, with a p-value of 0.0000, suggesting that larger banks tend to have lower RAROA. Regulatory capital exhibited a marginally significant negative relationship, with a p-value of 0.0851, while asset quality had a highly significant negative association with RAROA, with a p-value of 0.0000.

In summary, the findings suggest that prior RAROA performance, bank size, and asset quality exert a considerable influence on the current RAROA of deposit money banks in Nigeria. However, factors like ATM banking transactions, mobile banking transactions, internet banking transactions, and POS banking transactions do not exhibit a noteworthy connection with RAROA. The model effectively accounts for auto-correlation within the data, and the instruments employed in the model collectively hold significance.

In the second model, the analysis focuses on the relationship between various independent variables and the dependent variable of risk-adjusted return on equity. The coefficient of the lagged dependent variable is not statistically significant (p-value = 0.2741), suggesting no association between past risk-adjusted return on equity and current returns.

Similarly, the coefficients of ATM banking transactions, mobile banking transactions, internet banking transactions, and POS banking transactions are not statistically significant, with p-values of 0.9871, 0.1310, 0.9869, and 0.2381, respectively. This indicates a lack of association between these variables and risk-adjusted return on equity. The coefficient of bank size is also not statistically significant (p-value = 0.5630), suggesting no meaningful association between bank size and risk-adjusted return on equity.

The coefficient associated with regulatory capital exhibits statistical significance at a 5% level (p-value = 0.0081), signifying a positive association with risk-adjusted return on equity. This suggests that banks with greater regulatory capital tend to experience slightly higher risk-adjusted returns on equity, albeit with a relatively minor impact. In contrast, the coefficient linked to asset quality lacks statistical significance (p-value = 0.8000), and its proximity to zero implies that asset quality has no substantial influence on equity returns.

The J-statistic stands at 7.4381, yielding a p-value of 0.2822, which implies that there is insufficient evidence to reject the null hypothesis stating no serial correlation in the model. This suggests that the model effectively addresses the issue of serial correlation in the data. The AR(1) statistic registers at 0.3368, indicating a low level of auto-correlation, while the AR(2) statistic is 0.1868, signifying a relatively weak autocorrelation. Additionally, the F-statistic records a value of 861.2647 with a p-value of 0.0000, demonstrating that the instruments employed in the model hold joint significance.

In the third model, the primary focus centers on understanding the connection between several independent variables and the dependent variable, this is risk-adjusted net interest margin. The coefficient related to the lagged dependent variable is not statistically significant (p-value = 0.2904), indicating an absence of a link between past risk-adjusted net interest margin and the current net interest margin. In contrast, the coefficient linked to ATM banking transactions holds statistical significance at the 5% level (p-value = 0.0007), signifying a positive relationship with risk-adjusted net interest margin. This suggests that a higher number of ATM transactions is associated with increased risk-adjusted net interest margins.

Conversely, the coefficients associated with mobile banking transactions, internet banking transactions, and POS banking transactions lack statistical significance, indicating no discernible relationship with risk-adjusted net interest margin. The coefficient pertaining to bank size exhibits statistical significance at the 5% level (p-value = 0.0019), revealing an inverse relationship between bank size and risk-adjusted net interest margin. This implies that larger DMBs tend to have lower RANIM in Nigeria. On the other hand, the coefficient of regulatory capital demonstrates statistical significance at the 5% level (p-value = 0.0000), suggesting a positive relationship with RANIM. This indicates that banks with higher capital adequacy ratios tend to have higher risk-adjusted net interest margins. Notably, the coefficient associated with asset quality is not statistically significant, indicating no observable connection with risk-adjusted net interest margin.

5. Discussion of Findings

In the analysis of the first objective, the primary focus was to evaluate the effects of different payment innovation channels on RAROA. The findings indicated that ATM and POS banking had a negative impact on RAROA, but these effects were not statistically significant. Similarly, mobile banking and internet banking exhibited a positive relationship with RAROA, although they also lacked statistical significance. These findings are consistent with prior research by Gundogdu and Taskin (2017), Safdar et al. (2018), and Ibekwe (2021), which observed a positive yet insignificant impact of payment innovation on ROA. Furthermore, these results align with the conclusions of Nkem and Akujinma (2017) and Ejike (2019), which suggested a negative association between ATM banking and ROA.

It is worth noting that the use of RAROA as influenced by payment innovation is relatively uncommon in the literature, as highlighted by Zouari and Abdelmalek (2020). The studies by Sanni, Salami, and Uthman (2020) and Ahmad et al. (2016) emphasized the importance of risk-adjusted measures in evaluating bank performance, as they provide a more robust assessment of bank stability by considering risk levels.

However, the results show a negative and significant relationship between bank size and RAROA. Larger banks may face increased agency costs and monitoring challenges, leading to lower returns on assets. Conversely, a higher regulatory capital was positively associated with RAROA, reflecting a stronger capital base and enhanced risk management practices, resulting in improved profitability and higher returns on assets, as suggested by Sanni, Salami, and Uthman (2020).

The findings from the second model, which aimed to address the second objective, reveal a noteworthy similarity between the RAROA and RAROE indices. When assessing the impact of various payment innovation channels on RAROE, the results suggest a consistent trend with that observed for RAROA.

In particular, the analysis suggests that ATM banking, mobile banking, internet banking, and POS banking had a negative and statistically insignificant influence on risk-adjusted returns on equity, which is a gauge of a bank's profitability. This implies that the adoption and utilization of these payment innovation channels do not appear to have a significant impact on a bank's capacity to generate returns for its shareholders. These findings align with the notion that while these payment innovations may enhance convenience and accessibility for customers, their contribution to a bank's profitability (Wanalo, 2018; Chipeta & Muthinja, 2018; Adiga et al., 2022), as measured by RAROE, remains limited or inconsequential. However the findings of (Njogu, 2019; Tian et al., 2020; Tran, 2021; Mohammed, Ibrahin & Muritala, 2022).

Conversely, two essential variables, bank size and regulatory capital, demonstrated a noteworthy and positive influence on the examined profitability metric (RAROE). The positive association with larger banks implies that they are more capable of delivering higher risk-adjusted returns on equity, aligning with the economies of scale and scope concept, which suggests that larger banks have the capacity to generate more significant returns for their shareholders.

Furthermore, the favourable influence of regulatory capital indicates that banks with more substantial capital foundations and more effective risk management procedures are better prepared to achieve enhanced profitability, ultimately resulting in increased returns on equity. These findings underscore the significance of bank size and capital adequacy in shaping the financial performance and profitability of deposit money banks in Nigeria.

In the examination of the third objective, our primary concern was to investigate how various payment innovation channels influence Risk-Adjusted Net Interest Margin (RANIM). The outcomes of this analysis unveiled a distinct pattern in the impact of these payment innovations on RANIM. Among the examined payment innovation channels, only ATM banking exhibited a notable and statistically significant positive effect on RANIM. This suggests that an increase in ATM transactions is associated with higher Risk-Adjusted Net Interest Margins. The positive relationship with ATM banking may be attributed to the fee income generated by ATM transactions and the potential for enhanced customer engagement, which can lead to increased interest income.

Furthermore, the findings revealed a positive and statistically significant link between regulatory capital and RANIM. This suggests that banks with higher capital adequacy ratios tend to experience higher RANIM. This positive association highlights the critical role of maintaining a robust capital base and implementing effective risk management practices in strengthening RANIM. In summary, the analysis of the third objective underscores the substantial impact of ATM banking on positively affecting RANIM, while also emphasising the significance of regulatory capital in enhancing this profitability metric within Nigerian's DMBs.

6. Conclusion and Recommendations

Following an exhaustive examination of the empirical results, this research draws the conclusion that payment innovation, with a particular emphasis on the ATM banking payment channel, exerts a notable influence on the risk-adjusted profitability of DMBs in Nigeria. This study hereby recommends that the DMBs in Nigeria endeavour to explore the advantages of deeper integration of ATM banking into their operations as a means to improve Net Interest Margins. Additionally, banks should prioritise maintaining strong capital adequacy ratios and effective risk management practices to improve overall profitability. Further research and exploration into the evolving landscape of payment innovations and their impact on bank performance in Nigeria should also be encouraged to facilitate a deeper understanding of these dynamics.

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