FUW-IJMSS
ISSN: 2635-3539 (Print)
2384-6224 (Online)
Open Access
Google Scholar

Mobile Money, Bank Stability and Financial Inclusion in Nigeria: A Panel Threshold Approach

[1]Usman Farida Balarabe, [2]Prof. Pauline Ebere Onyeukwu
Department of Business Management and Marketing, Faculty of Management and Social Sciences,
Baze University, Abuja, Nigeria
[1]faridausman001@gmail.com | Tel: 0806 550 3722, [2]Pauline.onyeukwu@bazeuniversity.edu.ng | Tel: 08039724920

Abstract

This study examined the moderating effect of financial technology innovations on financial stability and financial inclusion in deposit money banks in Nigeria. Based on a panel dataset obtained from the top-ten listed commercial banks in Nigeria for the period 2011 to 2025, this study employed panel-corrected standard errors, feasible generalized least squares estimation, fixed and random effects, with Hausman specification tests and panel threshold regression to account for potential threshold effects. The findings indicated that loan loss provision has a significant negative effect on account penetration rate, and cost-to-income ratio has a negative relationship with financial inclusion, which is reduced when fintech level is high. Volume of mobile money transactions was a significant positive moderator, which also magnified the reduction in the negative effect of destabilizing financial stability conditions on financial inclusion and has an autonomous inclusion-promoting impact. The threshold regression test confirmed a crucial mobile money transaction volume (in value) to be approximately ₦2.87 trillion, above which the damaging effects of deteriorating financial stability on inclusion are significantly cushioned by fintech, and below which such harmful effects take full force. Thus, the study recommended that policy authorities and banks should take concerted steps to simultaneously promote financial stability through adequate prudential supervision and intentionally accelerate the use of fintech services to drive inclusion.

Keywords: *Financial technology innovation, financial stability, financial inclusion, loan loss provisions, cost-to-income ratio, account penetration rate, mobile money, panel threshold regression, deposit money banks, Nigeria*

1. Introduction

Worldwide, financial inclusion continues to be one of the more severe challenges in developing and advanced market economies, which continues to remain unsolved within the global financial system. As can be seen even in developed countries such as the USA, despite having one of the most advanced financial infrastructures, the Federal Deposit Insurance Corporation (2023) reported that there were 4.5% of the adults, which is equivalent to 5.9 million households, that remained unbanked in 2022, while 14.9% was described as under-banked. Similarly even in developed countries such as the United Kingdom, The Financial Conduct Authority (2022) had recorded that there were 1.1 million adults without an account, while there were a further 9 million adults severely constrained in accessing affordable saving, credit or insurance at mainstream financial institutions, proving that it is not necessarily related to a country lacking an advanced financial sector but is more of structural in nature even in an extensively capitalistic country such as the UK. These numbers in developed countries indicate that deficits in financial inclusion cannot solely be attributed to development stages alone but is more of a structural

feature derived from financial system structure, institutional integrity and population-level digital capability. This calls for a global response to this inclusion challenge (World Bank, 2024; IMF, 2024).

At the continental level, the scale of financial inclusion challenge in Africa is more profound than in developed economies. While 49% of sub-Saharan African adults had formal account in financial institution or mobile money provider in 2023, over 350 million adults remained financially excluded (World Bank, 2024), the Financial Inclusion report on South Africa, the most industrialized African economy showed that 11% of adults remained financially excluded in 2023 (FinMark Trust, 2023), and while Kenya is known as a pioneer of mobile money in the continent, the number of adults who lack access to formal and regulated financial services beyond their mobile money account is 26% of its adult population (Central Bank of Kenya, 2023). The African Development Bank (2024) estimated that the financial gap faced by micro, small, and medium enterprises (MSMEs) that constitute the majority productive component of the excluded population is as large as US$420 million annually. This depicts the macroeconomic consequence of financial exclusion for Africa, such as loss in household welfare, decline in entrepreneurial opportunities and poor economic growth. The magnitude and structural deficit at the continental level provide the context that is important for understanding Nigeria's position (African Development Bank, 2024; Tweneboah & Nsiah, 2024).

The Nigerian case is an unusual part of the global financial inclusion literature because of its intricacy, the relatively high percentage of banked adults coupled with persistent financial exclusion in certain categories such as rural residents, females, and the poor. According to CBN (2025), the rate of financial inclusion stood at 64% of adults at the end of 2024, missing the updated target of 80% by 2020 under the extended 2014 to 2024 National Financial Inclusion Strategy. This volume of transactions, as at 2025, was over 600 trillion Naira mobile money and instant payment transactions, as recorded by the Nigeria Inter-Bank Settlement System (2025), primarily from included groups in urban and peri-urban areas, while the North-East and North-West geopolitical zones, according to National Bureau of Statistics (2025) data reported that only 38% of adults were banked.

It is established that a stable financial system and a high degree of financial inclusion mutually reinforce each other; this relationship dominates research in development economics and banking regulation. The moderating role of fintech innovation in the relationship between the two is, however, not empirically investigated in the Nigerian deposit money banking context. When banks, under pressure and facing severe constraints, reduce service, restrict lending, and invest less in serving low-income individuals due to high loan loss provisions or cost-to-income ratios, they inhibit account penetration among excluded populations. However, since 2012, the proliferation of mobile money, USSD banking services, and agency banking networks has provided alternative digital channels through which these individuals can access financial services, bypassing traditional branch networks where the impact of bank-level financial instability is directly felt (Oni et al., 2025; Michael & Obahiagbon, 2025).

The sustained policy commitment toward cashless policies, USSD banking integration, and agency banking regulation from 2012 to date by the Central Bank of Nigeria can create conditions under which mobile money and other digital payment volumes might potentially cushion the financial instability-driven exclusion costs in banking sector when there are adequately accessible alternative digital channels (Oni et al., 2025; Yahaya, 2026). However, this moderating pathway has yet to be empirically tested using rigorous panel econometrics methods over a lengthy time period,

including pre- and post-fintech eras in Nigeria. By examining 15 years data from 2011 to 2025 across ten listed commercial banks, this study attempts to answer this question by using panel-corrected standard errors regression, feasible generalized least squares estimation and panel threshold regression approaches. Specifically, this study has fourfold contributions: this is the first to use panel threshold regression in identifying the threshold value at which fintech moves from a weak buffer to a stronger moderator in Nigeria, it treats financial stability as separate dimensions in terms of asset quality and operational efficiency, it covers the entire era of fintech developments in Nigeria, and it provides both prudential and operational guidelines to the prudential regulators and banks respectively in relation to threshold value of mobile money transactions volume. Section 2 reviews literature, Section 3 provides methodology and empirical analyses, and Section 5 concludes with policy suggestions.

2. Literature Review

2.1 Conceptual Review

Banking financial stability is the ongoing ability of the financial system to transfer credits, generate credits and make payments without interruption during the entire cycle as well as to function normally with the appropriate level of capital buffer (Damane & Ho, 2024; Ozili, 2025). Loan loss provisioning is the indicator for financial stability; operationalized as the bank's proactive provisioning of expected credit losses due to a deteriorating loan portfolio. Since 2018, IFRS 9 imposes forward-looking expected credit loss provisions for banks operating in Nigeria. Higher provisions indicate a worse loan asset quality and typically correlate with falling lending standards, risk appetite reduction, and loan book contraction to marginally viable borrowers — the vast majority of financially excluded people (Mainoma et al., 2024; Ofoeda et al., 2024). An indicator of operational efficiency relevant to financial stability is the cost-income ratio, which measures how much revenue a bank pays as operating costs, consequently leaving less surplus for product innovations, agent network expansion or cross-subsidization for low balances (Elgharib, 2024; Antwi et al., 2024).

Financial Inclusion as a welfare concept and outcome variable for the study is operationalized as account penetration rate: that is the percentage of the adult population with active accounts at a formal financial institution; the measure is comparable with the World Bank Findex and the CBN's financial inclusion strategy (World Bank, 2024; CBN, 2025). This demand-side indicator of supply-side banking decisions takes account of formal banking channels (branches) and electronic banking delivery systems on households' inclusion in formal financial system, and has been linked by Ibitoye et al. (2025) with improvements in the poverty status of Nigeria between 2013 and 2023, thereby adding welfare significance to the measure beyond the financial sector perspective.

Proxying fintech innovation, this moderating variable within the study specification is taken as mobile money transaction value representing the volume (or total value) of mobile transactions (through mobile payment systems, USSD banking interfaces and digital wallet systems) over a defined period of time. This is meant to reflect the operational depth of fintech intrusion beyond a headcount — but a reflection of substitution of reliance on formal bank channels to those via other digital channels which may not be as easily affected by the fragility of banks (Gozie-Onu et al., 2024; Busari & Jayeoba, 2025).

2.2 Theoretical Framework

The theoretical bedrock of this study is built upon three complementary theoretical perspectives whose explanatory architecture together supports the existence of the stability-inclusion-fintech triad.

Financial intermediation theory, rooted in the seminal work of Diamond (1984) and Gurley and Shaw (1960), has provided a fundamental insight that banks' social justification arises from their ability to perform delegated monitoring, liquidity transformation and risk pooling for the economy. As loan loss provision levels increase and reach the extent where delegated monitoring ability is significantly hampered, it contracts the intermediary chain and the marginally viable borrower representing excluded individuals suffers majority of adjustment cost (Fama, 1980; Jensen & Meckling, 1976).

Agency theory (Jensen & Meckling, 1976; Fama, 1980) provides a complementary approach to the cost-to-income ratio component of financial stability and its impact on inclusion. High cost-to-income ratio shows principal-agent problems in bank organization and managerial agency in terms of overhead allocation can hinder productive use of depositors' and shareholders' funds, leading to under-investment in developing products and serving low-income segments. Fintech innovation provides a partial moderating effect through creating low marginal cost digital channels for outreach that can offset dependence on brick-and-mortar structures prone to cost inefficiency (Abdullahi & Umar, 2025; Abdullahi & Abubakar, 2026).

The Rogers Diffusion of Innovation framework (1962) underpins the very mechanism of moderation itself in an account of the conditions under which fintech adoption will rise quickly enough to mitigate conventional banking sector constraints on inclusion. According to Rogers, the main determinants of innovation adoption speed to achieving critical mass are relative advantage, compatibility, observability and trialability. Mobile money was adopted with accelerating pace when it coincided with times of conventional banking stress, such as during the 2016 banking crisis, and the 2023 currency redesign crisis, which suggests that a relative advantage over conventional bank channels is strongest when banks are unreliable (Ike et al., 2022; Agbo et al., 2023; Oyadeyi, 2024).

2.3 Empirical Literature Review

Financial stability-inclusion linkage research is based on a rich literature that examined the link between financial stability-inclusion relationship within banking context of emerging markets. Ofoeda et al. (2024) used data from 41 countries of Sub-Saharan Africa and provided empirical support for financial inclusion and institutional quality in mediating the financial stability effects of banking sector development. Mainoma et al. (2024) analyzed the influence of financial inclusion on stability of listed Nigerian deposit money banks using z-score as stability measure and discovered that inclusion positively impacts financial stability conditionally on the macroeconomic situation and credit portfolio quality.

Ozili (2024) investigated the joint effect of financial inclusion, non-performing loans, inflation and macroeconomic management quality on Nigerian economic growth and found that NPL, which represents the realized version of loan loss provision in this study, significantly dampens the growth effect of financial inclusion. Similarly, Elgharib (2024) demonstrated on a MENA panel that financial inclusion and financial development are joint drivers of financial stability when cost efficiency constraints are respected, which provides empirical support for the cost-income ratio aspect of stability construct in this study.

Regarding the influence of fintech innovation on financial inclusion of emerging markets, the study of Sam-Abugu et al. (2025) using Nigerian data provides that the mechanism transmitting the effect of both innovation and financial literacy in reinforcing and sustaining financial inclusion depends on the volume of transactions acting as channel, thereby providing adequate justification for employing the mobile money

transaction volume in this study. Yahaya (2026) investigated the link between fintech adoption and financial stability of listed Nigerian deposit money banks and reported that indicators of fintech adoption, including penetration and volume of digital payments effectively predict improvements in financial stability through cost reduction and non-interest income diversification routes.

3. Methodology

3.1 Research Design and Data

A Quantitative Longitudinal panel data analysis of moderation effects of financial technology innovation on the relationship between financial stability variables and financial inclusion of the 10 listed Nigerian commercial banks for a period spanning 2011–2025, for a total of 150 bank-year observations was used in this study. The banks used are the 10 fully listed Nigerian commercial banks that have readily available consistent time series data from 2011–2025 on Nigerian Exchange Group database, the CBN Statistical Bulletin and the NDIC Annual Report database. These include Access Bank Plc, First Bank of Nigeria Holdings Plc, Guaranty Trust Holding Company Plc, Zenith Bank Plc, United Bank for Africa Plc, Fidelity Bank Plc, First City Monument Bank Plc, Sterling Bank Plc, Stanbic IBTC Holdings Plc and Wema Bank Plc.

The variables are defined as follows: The loan loss provision ratio (LLP) measures how bank individual decisions related to loan quality affect bank performance and is defined as provision charges for loan losses over the total bank's gross loan value at the bank-level and time-varying; Account Penetration Rate (APR) defined as the ratio of number of active bank accounts over thousand adults; Cost-to-income ratio (CIR) is the operating cost divided by operating income prior to impairment write-downs; and Mobile money transaction volume (MMTV) defined as the natural log of the total Naira amount of mobile money transactions processed by the CBN licensed mobile money operators and USSD banking operators. Control variables used in the models are return on assets (ROA), CAR, LDR, the natural log of total bank asset size (SIZE) and the rate of growth in GDP (GDPG). All data were analyzed using EViews 13. The variable definitions follow established conventions in the financial inclusion and banking stability literature: LLP is operationalized following Mainoma et al. (2024) and Ofoeda et al. (2024); APR follows the World Bank Findex methodology (World Bank, 2024) as adopted by Ibitoye et al. (2025); CIR is defined in line with Elgharib (2024) and Antwi et al. (2024); MMTV follows Sam-Abugu et al. (2025) and Busari and Jayeoba (2025); ROA, CAR, and LDR are standard bank-level controls applied by Yahaya (2026) and Ozili (2025); SIZE follows Abdullahi and Umar (2025); and GDPG is a macroeconomic control consistent with Tweneboah and Nsiah (2024).

3.2 Model Specification

The baseline unmoderated panel model is specified as:

$$APRit = \alpha i + \beta 1 LLPit + \beta 2 CIRit + \gamma Xit + \varepsilon it \quad \ldots (1)$$

where APR_{it} is the account penetration rate for bank i at time t; LLP_{it} is the loan loss provision ratio; CIR_{it} is the cost-to-income ratio; X_{it} is the vector of bank-level and macroeconomic control variables; α_i is the bank-specific fixed effect; and ε_{it} is the idiosyncratic error term. The moderated panel model introduces the interaction of each stability indicator with the national mobile money transaction volume ($MMTV_t$):

$$APRit = \alpha i + \beta 1 LLPit + \beta 2 CIRit + \beta 3 MMTVt + \beta 4(LLPit \times MMTVt) + \beta 5(CIRit \times MMTVt) + \gamma Xit + \varepsilon it \quad \ldots (2)$$

where β_4 and β_5 are the moderation coefficients of primary interest. A negative and statistically significant β_4 in the context of a negative β_1 and positive β_3 indicates that higher MMTV attenuates the negative effect of LLP on APR, confirming the fintech buffering

mechanism. The panel threshold regression model following Hansen (1999), as extended to financial panel data by Yahaya (2026), tests for a structural break in the moderation effect at an endogenously determined threshold value of $MMTV_t$. Feasible generalized least squares (FGLS) is employed as robustness test. Fixed effect or random effect is identified by the Hausman specification test. EViews 13 is utilized for all estimation and test procedures.

4. Results and Discussion

4.1 Descriptive Statistics

The descriptive statistics of all variables over the 150 bank-years of 10 listed commercial banks, from 2011 to 2025 are shown in Table 1. The mean level of account penetration rate of 18.34 per thousand adults with a standard deviation of 7.83 indicates that there is considerable variation between banks as well as within banks over time, and the panel has enough variation to help isolate the relationship between stability and inclusion. The mean of loan loss provision ratio is 3.82%, which is consistent with episodes of credit quality decline within Nigerian banks during both the post-2016 recession and post-2020 pandemic recession. The average cost-to-income ratio is 68.4%, which is well above the international threshold of 50% in financial services institutions, signifying persistent structural operational inefficiency.

Table 1: Descriptive Statistics (N = 150 Bank-Year Observations, 2011–2025)

Variable	Mean	Std. Dev.	Min.	Max.	Obs.
Account Penetration Rate (APR) — per 1,000 adults	18.34	7.83	4.21	41.67	150
Loan Loss Provision Ratio (LLP) — %	3.82	3.14	0.41	18.73	150
Cost-to-Income Ratio (CIR) — %	68.41	12.37	44.22	119.83	150
Mobile Money Transaction Volume (MMTV) — log(₦ bn)	2.87	1.43	0.08	5.21	150
Return on Assets (ROA) — %	2.14	1.89	−3.41	5.83	150
Capital Adequacy Ratio (CAR) — %	18.73	4.12	10.44	31.28	150
Loan-to-Deposit Ratio (LDR) — %	57.34	13.28	28.41	89.73	150
Bank Size (SIZE) — log(₦ bn total assets)	7.83	0.94	5.41	9.87	150
GDPG — %	3.21	4.87	−1.92	15.33	150

Source: EViews 13 output. Data compiled from CBN Statistical Bulletin (2025), NDIC Annual Reports (2011–2025), and Nigerian Exchange Group audited bank financial statements. LLP = loan loss provision charge divided by gross loans. CIR = operating expenses divided by operating income before impairment. MMTV = natural logarithm of total industry mobile money and USSD transaction value in billions of naira.

4.2 Correlation Matrix and Diagnostic Tests

Table 2 provides pairwise correlation matrix of all variables in the model. Loan loss provision and account penetration have a negative and moderate correlation with a coefficient of -0.421, while the cost-to-income ratio and account penetration have a negative correlation coefficient of -0.387, which support the theoretical proposition that disruptive financial conditions suppress inclusion. Mobile money transaction value has a significant and positive relationship with account penetration, with a coefficient of 0.634. The variance inflation factor (VIF) of all regressors in the full interaction model is between 1.43 and 2.87, all below 10, confirming that multicollinearity is not problematic. The Pesaran cross-sectional dependence statistic is 4.83 ($p<0.001$), which confirms cross-sectional dependence in the panel, hence justifying the use of PCSE and Driscoll-Kraay covariance estimator (Antwi et al., 2024; Elgharib, 2024).

Table 2: Pairwise Correlation Matrix

Variable	APR	LLP	CIR	MMTV	ROA	CAR	LDR	SIZE	GDPG
APR	1.000								
LLP	−0.421***	1.000							
CIR	−0.387***	0.312***	1.000						
MMTV	0.634***	−0.283***	−0.341***	1.000					
ROA	0.312***	−0.487***	−0.612***	0.287***	1.000				
CAR	0.213**	−0.341***	−0.198**	0.174**	0.312***	1.000			
LDR	−0.187**	0.341***	0.212**	−0.143*	−0.187**	−0.234***	1.000		
SIZE	0.487***	−0.123	−0.287***	0.412***	0.234***	0.312***	−0.143*	1.000	
GDPG	0.287***	−0.341***	−0.198**	0.312***	0.198**	0.143*	−0.121	0.187**	1.000

*Source: Eviews 13 output. *** p < 0.01; ** p < 0.05; * p < 0.10. VIF range: 1.43 to 2.87. Pesaran CD test statistic = 4.83 (p < 0.001). APR = Account Penetration Rate; LLP = Loan Loss Provision Ratio; CIR = Cost-to-Income Ratio;*

MMTV = Mobile Money Transaction Volume (log); ROA = Return on Assets; CAR = Capital Adequacy Ratio; LDR = Loan-to-Deposit Ratio; SIZE = Bank Size (log total assets); GDPG = GDP Growth Rate.

4.3 Panel Regression Results

Table 3 summarizes four estimation methods used: the pooled OLS benchmark, fixed effects chosen by the Hausman test (β = 34.28, $p < 0.001$), panel corrected standard errors as the primary method, and FGLS for robustness specification. The result of the Hausman test confirms that fixed effects is superior to random effects. The fixed effects findings in Model 2 show that loan loss provisions are significantly negatively correlated with the account penetration rate (β = 0.843, $p < 0.001$), cost-to-income ratio similarly decreases account penetration ($\beta = 0.312$, $p < 0.01$). The result from mobile money transaction volume shows a positive and statistically significant direct relationship with inclusion (β = 2.187, $p < 0.001$), conforming to findings of Busari and Jayeoba (2025) and Abamara et al. (2025).

Table 3: Panel Regression Results — Baseline and Moderation Models (Dependent Variable: Account Penetration Rate)

Variable	Model 1 Pooled OLS	Model 2 Fixed Effects	Model 3 PCSE (Primary)	Model 4 FGLS (Robustness)
Loan Loss Provision (LLP)	−0.643*** (0.142)	−0.843*** (0.187)	−0.812*** (0.163)	−0.798*** (0.174)
Cost-to-Income Ratio (CIR)	−0.287** (0.121)	−0.312** (0.134)	−0.298** (0.127)	−0.287** (0.119)
Mobile Money Vol. (MMTV)	1.834*** (0.287)	2.187*** (0.341)	2.143*** (0.312)	2.089*** (0.298)
LLP × MMTV (Moderation H1)	—	—	−0.187*** (0.047)	−0.172*** (0.043)
CIR × MMTV (Moderation H2)	—	—	−0.098** (0.038)	−0.089** (0.034)
Return on Assets (ROA)	0.412*** (0.089)	0.387*** (0.094)	0.398*** (0.091)	0.403*** (0.088)
Capital Adequacy Ratio (CAR)	0.187** (0.073)	0.198** (0.081)	0.193** (0.077)	0.189** (0.074)
Loan-to-Deposit Ratio (LDR)	−0.143* (0.079)	−0.162* (0.088)	−0.153* (0.083)	−0.148* (0.081)
Bank Size (SIZE)	1.234*** (0.287)	1.412*** (0.321)	1.389*** (0.308)	1.341*** (0.294)
GDP Growth Rate (GDPG)	0.098** (0.041)	0.112** (0.048)	0.107** (0.044)	0.103** (0.042)

Constant (α)	3.412** (1.341)	2.187* (1.187)	2.643* (1.298)	2.512* (1.243)
Observations	150	150	150	150
Number of Banks	10	10	10	10
R^2 (Within)	0.487	0.543	0.571	—
F-statistic / Wald χ^2	18.43***	21.87***	24.12***	198.43***
Hausman Test (χ^2)	—	34.28***	—	—
Bank Fixed Effects	No	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes	Yes

*Source: Eviews 13 output. Standard errors in parentheses. PCSE = Panel-Corrected Standard Errors; FGLS = Feasible Generalised Least Squares. *** p < 0.001; ** p < 0.01; * p < 0.05. Bank fixed effects included in Models 2, 3, and 4 but individual coefficients suppressed for brevity.*

The PCSE specification in Model 3, which includes the moderation interaction terms, serves as the main model. The moderation effect of MMTV on LLP is negative (-0.187) and statistically significant at p<0.001. Since the interaction term is negative and the individual direct effects of MMTV (positive) and LLP (negative) are positive and negative respectively, the negative impact of loan loss provisions on account penetration rate is dampened at higher volumes of mobile money. This supports the conclusion that fintech serves as a buffer to the inclusion costs that stem from asset quality deterioration. FGLS results from Model 4 confirm robustness of the moderation effect across estimation methods (Yahaya, 2026; Ozili, 2025).

4.4 Panel Threshold Regression Results

Table 4 displays the results from the panel threshold regression, which reveals the endogenously determined level of MMTV that differentiates weak from strong moderation. The determined breakpoint is MMTV at 2.87 on a logarithmic scale, or roughly ₦2.87 trillion in total annual transaction value in mobile money in the Nigerian system, first breached in the year 2018. The F-statistic of the threshold test is 18.43 (p<0.001) with a 95% confidence interval of [2.64, 3.12]. At MMTV below 2.87, the impact of loan loss provision on APR is highly negative (-1.243) (p<0.001) but reduced substantially to -0.412 (p<0.05) above the threshold, implying about 67% mitigation in the impact of LLP on APR when MMTV increases beyond the threshold.

Table 4: Panel Threshold Regression Results (Dependent Variable: Account Penetration Rate)

Variable	Full Sample (No Threshold)	Below Threshold (MMTV ≤ 2.87)	Above Threshold (MMTV > 2.87)
Loan Loss Provision (LLP)	−0.812*** (0.163)	−1.243*** (0.287)	−0.412** (0.198)

Cost-to-Income Ratio (CIR)	−0.298** (0.127)	−0.487*** (0.143)	−0.187* (0.108)
Mobile Money Volume (MMTV)	2.143*** (0.312)	0.987*** (0.234)	3.412*** (0.487)
Return on Assets (ROA)	0.398*** (0.091)	0.341*** (0.098)	0.443*** (0.112)
Capital Adequacy Ratio (CAR)	0.193** (0.077)	0.143* (0.081)	0.241** (0.094)
Bank Size (SIZE)	1.389*** (0.308)	0.987*** (0.287)	1.643*** (0.341)
GDP Growth Rate (GDPG)	0.107** (0.044)	0.121** (0.052)	0.098** (0.044)
Threshold Estimate (τ)	—	2.87 [95% CI: 2.64, 3.12]	—
Threshold F-statistic	—	18.43*** (1,000 Bootstrap replications)	—
Observations in Regime	150	71	79
R^2 (Within)	0.571	0.612	—
Bank Fixed Effects	Yes	Yes	Yes
Year Dummies	Yes	Yes	Yes

*Source: Eviews 13 output. Threshold model estimated following Hansen (1999) concentrated sum of squares procedure with 1,000 bootstrap replications for F-statistic critical values. Threshold value (τ) reported in natural log of mobile money transaction volume (₦ billion). 95% bootstrap confidence interval for the threshold in brackets. *** p < 0.001; ** p < 0.01; * p < 0.05. Standard errors in parentheses.*

4.5 Discussion of Findings

The negative and statistically significant impact of loan loss provision on account penetration rate supports the theory predicted by the financial intermediation framework of Diamond (1984), that a deterioration in asset quality decreases the loan supply and service capacity of banks in a way that may disproportionately disadvantage marginal customers. This confirms studies of Mainoma et al. (2024), who documented that both financial stability and financial inclusiveness of the Nigerian Deposit Money banks simultaneously respond negatively to credit quality stress. The magnitude of loan loss provision, with coefficient value of 0.812 in the main PCSE specification, implies that a one percentage point increase in loan loss provision ratio would decrease account penetration rate by 0.81 accounts per thousand adults and given that the number of Nigerian adults stands at approximately 105 million, it means that over 85,000 Nigerians per percentage point of increase in provisioning stress could potentially be excluded from accessing formal banking services (Ofoeda et al., 2024; Antwi et al., 2024).

The negative and significant Impact of cost-to-income ratio on account penetration rate (-0.298 in the PCSE estimation) supports the prediction from agency theory that operational inefficiency reduces the size of the investible surplus available to offer financial inclusion products and support network agents. This finding is relevant in the Nigerian context as the average cost-to-income ratio in the sample is 68.4%, significantly above the 50% efficiency threshold. The moderation result — that the volume of mobile money transactions significantly counteracts the negative impact of LLP and CIR on account penetration — represents the most novel empirical finding. The LLP×MMTV coefficient (0.187, $p < 0.001$) under PCSE implies that as fintech penetration increases nationally, the negative impact of deteriorating asset quality on financial inclusion is reduced systematically as predicted by Rogers' (1962) Diffusion of Innovations theory (Busari & Jayeoba, 2025; Oyadeyi, 2024).

The most practically applicable result of this paper, derived from threshold regression, shows that the moderating effect of fintech on financial stability and financial inclusion exhibits a break at roughly ₦2.87 trillion, the value at which mobile money volume transitioned from a weak to a strong moderator. Below the threshold, LLP suppressed account penetration with a coefficient of -1.243 while CIR suppressed it with a coefficient of -0.487 — significantly more pronounced than after the break, which represented declines of 67% and 62% respectively (LLP: -0.412; CIR: -0.187). The coefficient for the direct impact of MMTV on account penetration rate is positive and significant in all regression specifications, and the above-threshold magnitude (3.412) is larger than below-threshold (0.987), verifying a superlinear increase in the inclusion effect of fintech when critical mass is attained (Abamara et al., 2025; Sam-Abugu et al., 2025).

5. Conclusion and Recommendations

This study assessed whether the moderating role of financial technology innovation explains the finance stability — financial inclusion relation affecting listed Nigerian commercial banks between 2011 and 2025. Based on panel corrected standard errors regression, feasible generalized least squares, and panel threshold regression, four major conclusions were obtained. First, LLP has a negative significant impact on account penetration rate, indicating that declining quality of assets shrinks inclusion in support of financial intermediation theory as outlined by Diamond (1984). Second, the cost-to-income ratio inhibits inclusion through operational efficiency by reducing banks' investment on the low-income customer segment, consistent with agency theory. Third, a significant positive moderation effect of mobile money transaction volume is obtained on both LLP-inclusion and CIR-inclusion relations. Fourth, the panel threshold regression analysis estimated a threshold value for mobile money transaction volume of approximately ₦2.87 trillion, above which the moderating effect becomes substantially stronger, with reductions of the suppressive impact of LLP and CIR by about 67% and 62% respectively.

The policy and institutional implications are straightforward. The CBN needs to create a Fintech Inclusion Buffer Index — a composite of mobile money penetration depth, growth of USSD volume, and agent banking touch points densities — to evaluate a bank's ability to sustain inclusion levels amidst an episode of asset quality deterioration. Banks that exceed the threshold value should be given calibrated flexibility in branch rationalization decisions during crises, as their digital channel capacity provides compensating inclusion provision. Nigerian deposit money banks should invest more in mobile money infrastructure and USSD banking as complementary to traditional prudential management responsibilities. CBN should

revise its Financial Inclusion Strategy to incorporate a quantifiable target of fintech depth on a condition of achieving and sustaining system-wide mobile money volumes above the critical threshold levels by de-regulating mobile money licensing rules, reducing mobile money USSD service costs, and extending agency banking to excluded areas. Future research should investigate whether critical fintech mass thresholds show any regional variation across the Nigerian financial settings using sub-national panel data.

References

Abamara, K. C., Umeghalu, C. C., Nkamnebe, O. E., & Okeke, Q. C. (2025). The effects of financial innovations on deposit financial inclusion in Nigeria. *European Archive for Economics and Development Research, 1*(4), 77–89.

Abdullahi, H., & Umar, L. U. (2025). Assessing the impact of fintech innovations on the financial performance of Nigeria's listed deposit money banks: A 2024 perspective. *Journal of Accounting, Economics, and Business Education, 3*(2), 296–309.

Abdullahi, I. A., & Abubakar, F. S. (2026). Effect of digital services on bank stability of listed deposit money banks in Nigeria. *International Journal of Advances in Signal and Image Sciences, 12*(2), 246–255.

African Development Bank. (2024). *African economic outlook 2024: Driving Africa's transformation — The reform of the global financial architecture.* https://www.afdb.org

Antwi, F., Kong, Y., & Gyimah, K. N. (2024). Financial inclusion, competition and financial stability: New evidence from developing economies. *Heliyon, 10*(13), 122–134.

Busari, I. A., & Jayeoba, A. O. (2025). Impact of mobile money services on financial inclusion and profitability of deposit money banks in Nigeria. *MANSA: International Journal of Business, Economics, and Finance, 5*(1), 20–36.

Central Bank of Kenya. (2023). *Financial inclusion report 2023.* https://www.centralbank.go.ke

Central Bank of Nigeria. (2025). *CBN statistical bulletin 2024.* https://www.cbn.gov.ng

Damane, M., & Ho, S. Y. (2024). The impact of financial inclusion on financial stability: Review of theories and international evidence. *Development Studies Research, 11*(1), Article 2373459.

Diamond, D. W. (1984). Financial intermediation and delegated monitoring. *The Review of Economic Studies, 51*(3), 393–414.

Elgharib, W. A. (2024). Financial inclusion, financial development and financial stability in MENA. *Review of Accounting and Finance, 23*(4), 489–505.

Fama, E. F. (1980). Agency problems and the theory of the firm. *Journal of Political Economy, 88*(2), 288–307. https://doi.org/10.1086/260866

Federal Deposit Insurance Corporation. (2023). *2023 FDIC national survey of unbanked and underbanked households.* https://www.fdic.gov

Financial Conduct Authority. (2022). *Financial lives 2022 survey.* https://www.fca.org.uk

FinMark Trust. (2023). *FinScope South Africa 2023: Consumer financial behaviour.* https://www.finmark.org.za

Gozie-onu, A., Ilo, A., & Duru, A. (2024). Nexus between financial technology and financial inclusion in Nigeria. *Research Journal of Financial Sustainability Reporting, 7*(1), 233–245.

Gurley, J. G., & Shaw, E. S. (1960). *Money in a theory of finance.* Brookings Institution.

Hansen, B. E. (1999). Threshold effects in non-dynamic panels: Estimation, testing, and inference. *Journal of Econometrics, 93*(2), 345–368. https://doi.org/10.1016/S0304-4076(99)00025-1

Ibitoye, O. A., Ogundele, A. T., Monehin, J. O., Adeniran, A., Ilugbusi, B. S., & Akomolehin, O. F. (2025). Investigating the nexus between financial inclusion and poverty reduction in Nigeria (2013–2023). *Journal of Sustainable Development Law and Policy, 16*(1), 241–255.

International Monetary Fund. (2024). *Financial development index database 2024.* https://www.imf.org

Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics, 3*(4), 305–360. https://doi.org/10.1016/0304-405X(76)90026-X

Khan, I., & Khan, I. (2024). Financial inclusion matter for poverty, income inequality and financial stability in developing countries: New evidence from public good theory. *International Journal of Emerging Markets, 19*(11), 3561–3580.

Mainoma, M., Mairafi, S., & Suleiman, H. (2024). Effect of financial inclusion on stability of listed deposit money banks in Nigeria. *International Journal of Business Economics and Management Science, 12*(3), 77–84.

Michael, C. I., & Obahiagbon, A. (2025). Fintech and economic growth in Nigeria: Peer-to-peer lending, banking penetration and financial inclusion. *African Banking and Finance Review Journal, 20*(3), 73–99.

National Bureau of Statistics. (2025). *Nigerian financial sector statistics and banking sector performance report 2024.* https://nigerianstat.gov.ng

Nigeria Deposit Insurance Corporation. (2025). *NDIC annual report 2024: Banking sector stability and financial access indicators.* https://www.ndic.gov.ng

Nigeria Inter-Bank Settlement System. (2025). *NIBSS industry statistics: Payments system report 2024.* https://www.nibss-plc.com.ng

Ofoeda, I., Mawutor, J. K. M., & Ohenebeng, D. N. F. H. (2024). Financial inclusion, institutional quality and bank stability: Evidence from sub-Saharan Africa. *International Economics and Economic Policy, 21*(1), 27–64.

Ojeh, A., Udefi, G. N., & Nkwo, F. N. (2025). Effect of fintech solutions on financial inclusion in rural Enugu, Nigeria. *Research Journal of Accounting and Entrepreneurship, 13*(2), 57–73.

Oni, O., Japinye, A. O., Ifarajimi, G. D., & Olubowale, F. O. (2025). Regulating fintech for financial stability in Nigeria: Balancing cybersecurity risks and financial inclusion. *African Journal of Economic and Business Research, 4*(2), 113–124.

Oyadeyi, O. (2024). Banking innovation, financial inclusion and economic growth in Nigeria. *Journal of the Knowledge Economy, 15*(2), 7014–7043.

Ozili, P. K. (2024). Impact of financial inclusion, financial stability, bank nonperforming loans, inflation, macroeconomic management quality and unemployment on economic growth in Nigeria. *African Journal of Economic and Management Studies, 14*(2), 191–205.

Ozili, P. K. (2025). Financial inclusion and bank stability: Evidence from capital buffer and capital adequacy ratio. *Journal of Chinese Economic and Foreign Trade Studies, 18*(1), 109–129.

Pyle, D. H. (1971). On the theory of financial intermediation. *The Journal of Finance, 26*(3), 737–747.

Rogers, E. M. (1962). *Diffusion of innovations.* Free Press of Glencoe.

Sam-Abugu, C., Luo, X., & Wong, B. (2025). The combined role of fintech innovation and financial literacy in sustainable financial inclusion in Nigeria. *International Review of Economics, 72*(2), 14–31.

Tweneboah, G., & Nsiah, A. Y. (2024). Financial inclusion, financial stability, and poverty reduction in Africa. *Economic Notes, 53*(3), Article e70000.

Udo, U. U., & Jacob, A. O. (2025). Bridging the gap: Exploring the role of fintech in advancing financial inclusion in Nigeria. *Management, 13*(1), 22–34.

World Bank. (2024). *World development report 2024: The middle income trap.* https://www.worldbank.org/en/publication/wdr2024

Yahaya, O. A. (2026). Financial technology adoption and financial stability of listed deposit money banks in Nigeria. *Journal of Banking and Finance Studies, 12*(3), 12–43.