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Financial literacy as a moderator in the nexus between fintech adoption and financial inclusion

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Abstract
World Bank reports indicate that over half of the global adult population remains excluded from formal financial services, with the challenge being most pronounced in less developed economies where about 60% lack access to basic financial facilities. In Nigeria, although 64% of adults reportedly use banking services, the remaining 36% who are financially excluded remain a significant concern. Previous studies on the link between financial technology (FinTech) and financial inclusion have yielded mixed results, with evidence suggesting that financial literacy may play a moderating role in this relationship. This study examines the moderating effect of financial literacy on the relationship between financial technology and financial inclusion in Nigeria. Data were collected from 302 respondents out of 1,460 registered SMEs in the Federal Capital Territory (FCT), Abuja. Descriptive and correlation analyses were conducted, followed by structural equation modeling using Smart PLS for deeper insights. The results reveal that both financial technology and financial literacy significantly enhance financial inclusion among SME owners, with financial literacy further strengthening the impact of FinTech on inclusion. Based on these findings, the study recommends that policymakers and financial institutions design FinTech solutions tailored to the needs of SMEs while implementing financial literacy initiatives. Such measures will ensure that entrepreneurs maximize the benefits of digital financial innovations and contribute to inclusive financial participation.

Keywords: Financial literacy, financial technology, financial inclusion, SMEs owners.

1. Introduction

In recent years, financial inclusion has gained global attention as a critical instrument for reducing poverty and fostering economic growth. It is now widely acknowledged by policymakers, economists, and governments as central to realizing sustainable development goals (Monye, 2023; Oyadeyi, 2023; Marcellus, 2022). The World Bank (2020) reports that significant progress has been made worldwide, with about 1.2 billion adults gaining access to financial accounts since 2011. However, approximately 1.7 billion people, particularly those in rural and low-income communities, still lack access to formal financial services, with women in developing nations being the most excluded (Ahmad, et al., 2023).

Sub-Saharan Africa has experienced remarkable improvements in financial account ownership, largely driven by mobile money services. Between 2011 and 2021, account ownership in the region rose from 23% to 55%, surpassing the global average growth rate. Despite this progress, the region still lags behind globally, with Nigeria making up a significant proportion of the unbanked population (Majorie & Gerhard, 2022).

The World Bank Group (2021) further noted that while 70% of Africans have access to mobile internet, only about 25% actively use it, indicating a wide digital divide and underutilization of available infrastructure.

In Nigeria, mobile technology has emerged as a key driver of financial inclusion, particularly through mobile payments and person-to-person transfers. These innovations have broadened participation in commerce across both included and excluded populations (Central Bank of Nigeria, 2021). The Nigerian Inter-Bank Settlement System (NIBSS, 2024) reported that electronic transactions reached ₦600 trillion in 2023, representing a 55% increase from ₦387 trillion in 2022. This rapid transition from cash to digital payments has been fueled by mobile banking applications, USSD platforms, and even temporary cash shortages (NIBSS, 2023).

Nevertheless, adoption remains constrained by several barriers, including weak infrastructure, low levels of digital and financial literacy, high transaction costs, security risks, cultural resistance, lack of awareness, and complex system designs (Omotosho, 2021; Osirim et al., 2023). These obstacles demonstrated the need for consistent efforts to expand access to affordable financial services and promote inclusive economic growth (Tok & Heng, 2022). Despite widespread mobile phone ownership, only about 30% of Nigerian adults maintain formal bank accounts. Consequently, financial inclusion has become a top priority, with the Central Bank of Nigeria spearheading strategies to leverage digital innovations for underserved communities (Arotile, 2022; Oyadeyi, 2023).

Although financial technology (FinTech) and digital payment systems have significantly transformed Nigeria's financial sector thereby stimulating economic activity and contributing to GDP growth, the challenge of ensuring inclusive financial participation remains. The expansion of point-of-sale devices, mobile banking, and electronic payments demonstrates FinTech's transformative capacity, but issues such as limited financial literacy, uneven adoption, and accessibility gaps continue to restrict participation in the formal financial system (CBN, 2021; NIBSS, 2022). Digital finance has played a vital role in reducing the number of unbanked individuals by offering more accessible savings, credit, and insurance services, especially in developing economies (Nyamongo & Ndirangu, 2013; McKee, et al., 2015). As financial institutions continue to innovate and provide customer-focused solutions (Hadad, 2024; Oyadeyi, 2023), Nigeria's prospects of closing its financial inclusion gap are becoming more attainable.

Although a substantial body of studies in the literature have examined the link between financial technology (FinTech) and financial inclusion (e.g., David et al., 2022; Giaretta & Chesini, 2021; Benson, 2021; Akinosun, 2021; Akaba, 2020; Adegoke, 2021; Klus et al., 2019; Klapper & Popovic, 2019; Collon, 2018; Abdurahim & Ben, 2018; Alemam, 2018; Adepetun, 2017), much of the evidence originates from developed economies and presents mixed and in conclusive findings. While some studies confirm a strong and positive influence of FinTech on expanding financial inclusion, others (e.g., Abedeen, et al., 2024; Ashraf, Hafeez & Sajid, 2022; Syauqi, Suryani & Nugraha, 2023; Tidjani & Madouri, 2024) report weaker or even negative outcomes, implying that contextual conditions may shape the relationship. Emerging studies (Widiyatmoko et al., 2024; Islam & Khan, 2024) suggest financial literacy as a critical moderating factor, since the ability to understand and apply financial knowledge is essential for maximizing the advantages of FinTech solutions. By equipping individuals to use digital

platforms effectively, make sound financial decisions, and manage potential risks, financial literacy strengthens the contribution of FinTech to inclusive finance. Consequently, this study investigates the moderating role of financial literacy in the relationship between FinTech adoption and financial inclusion in Nigeria and proposes three hypotheses to address this gap.

$H0_1$ Financial technology has no significant effect on financial inclusion among SMEs in FCT, Abuja.

$H0_2$ Financial literacy has no significant effect on financial inclusion among SMEs in FCT, Abuja.

$H0_3$ Financial literacy does not significantly moderate the relationship between financial technology and financial inclusion among SMEs in FCT, Abuja.

2. Literature Review

Concept of Financial Inclusion

Sarma (2008) defines financial inclusion as more than just providing access to financial services; it involves the consistent and meaningful participation of all economic actors within the formal financial system. Similarly, Mubiru (2012) links financial inclusion to social inclusion, highlighting its capacity to empower individuals to both contribute to and benefit from economic progress. In the same vein, Amidžić, et al., (2014) emphasize that accessibility, affordability, and usability of financial products, such as savings, credit, and insurance are fundamental dimensions of inclusion. The overarching goal is to integrate people into the formal financial structure, reducing reliance on informal lending channels while enhancing financial security. The World Bank (2019) distinguishes between voluntary and involuntary financial exclusion, pointing out that utilization of services is shaped by socio-economic and cultural contexts. Parc and Mercardo (2015) argue that addressing involuntary exclusion requires targeted measures, as it often arises from market inefficiencies and regulatory hurdles. Rural populations are particularly vulnerable due to weak banking infrastructure and low levels of financial literacy (Hussaini & Chibuzo, 2018), while rigid product designs and stringent regulations exacerbate the problem (Dashi, et al., 2013). Honohan (2008) further notes that factors such as mobile phone penetration and institutional effectiveness improve access, whereas overreliance on foreign aid and demographic pressures hinder it.

Measuring financial inclusion and its impact on development remains challenging. Frameworks proposed by Amidžić et al. (2014) and Honohan (2008) incorporate indicators like demographic coverage, service utilization, and institutional capacity. Levine (2005) reinforces the close connection between financial inclusion and financial development, arguing that efficient financial systems promote economic growth by lowering transaction costs and minimizing risk. The expansion of digital financial inclusion signals a new era, driven largely by innovations in mobile banking and financial technology (FinTech). These advancements have closed traditional service gaps, extending financial access to underserved and remote groups (Sahay et al., 2020). Between 2014 and 2017, digital solutions significantly boosted inclusion even in areas where conventional banking growth had stalled (World Bank, 2018). Evidence from Fuster et al. (2019) and Tang (2019) suggests that FinTech acts as a complement rather than a substitute for traditional banking, though its full capacity to deepen financial inclusion is yet to be fully realized.

2.1 Problems of Financial Inclusion in Nigeria

The challenge of financial inclusion remains a major global concern, with less

than half of the world's adult population able to access formal financial services; a pattern that is also evident in Nigeria despite decades of financial sector reforms (Hafeez & Sajid, 2022). Although these reforms have supported sectoral growth, they have not adequately catered to the needs of vulnerable groups, thereby limiting improvements in the country's Human Development Index (HDI) and slowing broader economic development. Rural communities and sections of the working class face notable barriers to financial access, largely due to low levels of financial literacy. This underscores the importance of awareness campaigns, simplified service delivery systems, and financial education programs (CBN, 2017). Furthermore, security challenges, particularly concerns about cybercrime, discourage many from engaging with formal financial services, highlighting the need for stronger cybersecurity measures and strategies to enhance public confidence.

Financial Technology

Financial technology (FinTech) has transformed the banking industry by enabling financial transactions beyond traditional bank branches through electronic platforms such as mobile devices, ATMs, point-of-sale terminals, and computers. These innovations support diverse services like fund transfers, bill payments, account opening, and account management, thereby improving accessibility and convenience for users. Scholars offer varying definitions: Babalola (2018) describes FinTech as the provision of banking services through digital platforms, whereas Abid and Noreen (2006) stress its dependence on information and communication technology to process transactions. Similarly, the Basel Committee on Banking Supervision (2003) equates FinTech with e-business in the banking sector, highlighting its transformative influence. While technologies such as ATMs, internet banking, and mobile services have long existed, the rise of the internet has expanded FinTech's scope, reshaping the interaction between banks and customers (Moddibo, 2018). By integrating communication and telecommunication tools, FinTech simplifies financial operations and enhances service delivery.

Mobile devices serve as the dominant channel for digital access in developing nations (African Union, 2020; Federal Ministry of Communications and Digital Economy, 2019). Nigeria, for instance, records an internet penetration rate of 61.4%, primarily via mobile phones (Federal Ministry of Communications and Digital Economy, 2019). Across Africa, e-commerce is growing at 25.8%, outpacing the global rate of 16.8%. Within Nigeria, the e-commerce sector expands by about 25% annually, with a market value surpassing ₦255 billion (Olaleye et al., 2018). This rapid growth fuels the widespread adoption of mobile applications for banking, shopping, and other services, as consumers increasingly demand convenient online transaction options.

In addition, FinTech plays a central role in the Central Bank of Nigeria's cashless policy, which introduces charges on daily withdrawals exceeding ₦500,000 for individuals and ₦3,000,000 for corporate organizations. The policy promotes digital payment channels such as ATMs, POS devices, online banking, and mobile applications, supported by indigenous innovations (Putrevu & Mertzanis, 2024). Although cash remains in use, the initiative seeks to reduce its dominance, improve payment efficiency, and encourage broader adoption of digital financial solutions, fostering a more inclusive, technology-driven banking landscape in Nigeria (Tribune, 2022; Anaeto, 2022).

2.2 Empirical Review

Empirical studies on the role of financial technology (FinTech) in promoting financial inclusion and SME growth reveal mixed outcomes across contexts. Evidence from Indonesia, such as Syauqi, et al., (2024) and Nurohman, et al., (2024), demonstrates that FinTech adoption significantly enhances SMEs' access to financial services, operational information, and regulatory safeguards, fostering trust and sustainability. However, findings from Abedeen, et al., (2024), Ashraf, et al (2022), and Tidjani and Madouri (2024) show weak or negative effects in regions with poor infrastructure, low user confidence, and weak regulatory support. Collectively, these results emphasize that while FinTech has strong potential to drive inclusion and SME performance, its impact is largely shaped by local conditions such as digital infrastructure, regulatory frameworks, and financial literacy. Therefore, context-specific interventions are crucial to unlock FinTech's transformative potential.

Moderating Role of Financial Literacy

A moderator is a variable; either qualitative or quantitative, that influences the strength or direction of the relationship between an independent (predictor) variable and a dependent (outcome) variable (Baron & Kenny, 1986). Such variables are typically introduced when the relationship between predictor and outcome appears inconsistent or weaker than expected. In this study, financial literacy is treated as a moderating variable because prior research on the effect of financial technology (FinTech) on financial inclusion has yielded mixed findings. While some studies highlight a strong positive effect (e.g., David et al., 2022; Giaretta & Chesini, 2021; Benson, 2021; Akinosun, 2021; Akaba, 2020; Adegoke, 2021), others report weak or even negative associations (e.g., Abedeen, et al, 2024; Ashraf, et al, 2022; Syauqi, et al, 2023; Tidjani & Madouri, 2024). Financial literacy strengthens FinTech's role in fostering inclusion by enhancing users' understanding, trust, and effective adoption of digital tools. It refers to the ability to comprehend and apply financial concepts such as money management and investment (Lusardi & Mitchell, 2014). For SME owners, this competence is crucial in maximizing the benefits of FinTech solutions like mobile banking, digital payments, and online lending. Without it, they may face difficulties in effective usage, while also being vulnerable to risks such as fraud and cyberattacks that discourage adoption. Empirical evidence by Beck et al. (2018) further shows that SMEs with stronger financial literacy are better equipped to navigate digital financial systems, enabling them to leverage FinTech more effectively for business growth.

Theoretical Framework

The Technology Acceptance Model (TAM), introduced by Davis (1986), serves as a framework for understanding how individuals adopt and use new technologies (Monyoncho, 2018). The model highlights two central constructs: Perceived Ease of Use (PEOU), the extent to which a person believes that using a system will be free of effort, and Perceived Usefulness (PU), the belief that the system will enhance performance (Mojtahed, et al., 2011). These perceptions influence users' behavioral intentions, which ultimately determine actual technology adoption. TAM therefore emphasizes that both simplicity and functionality play a vital role in shaping acceptance (Lim & Ting, 2012).

Building on the Theory of Reasoned Action, TAM has broad applicability across various technologies and user groups, making it a valuable predictive model for examining technology acceptance and consumer attitudes toward

innovation (Lule, et al., 2012). Its significance is particularly evident in the realm of digital financial services, where user acceptance underpins progress in financial inclusion. In settings like Nigeria, where unique barriers to adoption exist, TAM provides insights into the critical factors that shape technology uptake (Lim & Ting, 2012; Monyoncho, 2018).

3. Methodology

This study adopted a quantitative survey research design, relying on a structured questionnaire as the main tool for data collection. From a population of 1,460 registered SMEs in the Federal Capital Territory (FCT), Abuja, a sample size of 302 respondents was determined using Krejcie and Morgan's (1970) sampling table. The SMEs were selected through cluster sampling, and the questionnaires were administered to owner-managers of the identified businesses. Out of the 302 questionnaires distributed, 300 were successfully retrieved and deemed valid for analysis. The data were processed using descriptive statistics and correlation analysis, while further examination was carried out through structural equation modeling (SEM) with the aid of Smart PLS software.

4. Result and Findings

Measurement Model

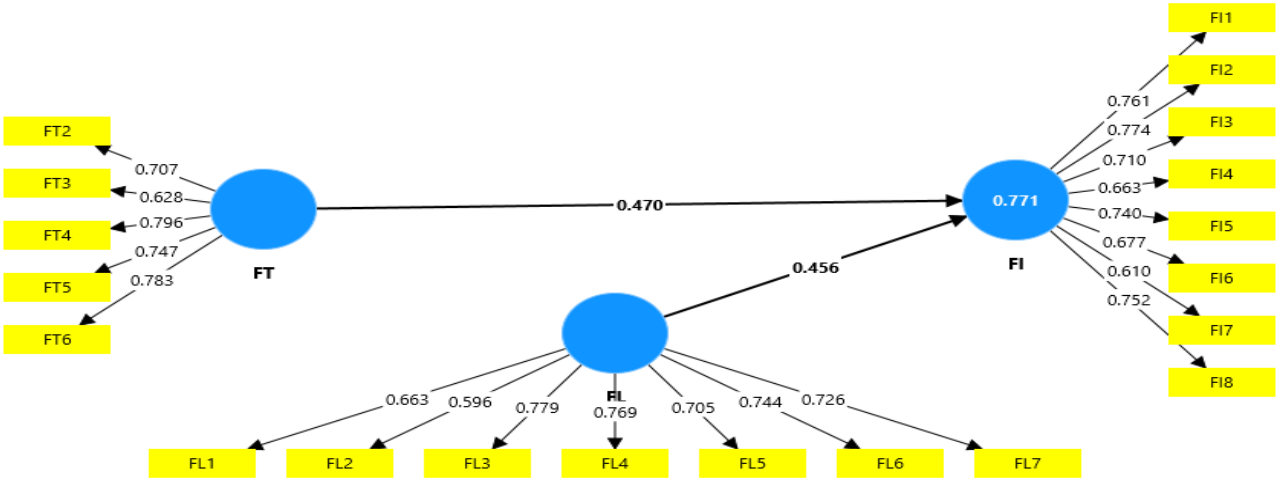

Figure 1: Measurement model

Figure 1 illustrates the structure of the measurement model output for the direct relationship. In the diagram, the independent variables; FinTech and financial literacy, are represented alongside their respective indicators, both pointing toward the dependent variable, financial inclusion. The details of the discriminant validity are presented in Tables 1 and 2. To establish discriminant validity, the study applied the Fornell and Larcker criterion, which requires that the square root of the AVE exceed the correlation with other variables in the model, as well as the Heterotrait-Monotrait Ratio (HTMT) method. These results are reported in Tables 1 and 2.

Table 1: Discriminant validity – Fornell larker approach

	Fin Inclusion	Fin Tech	Fin Literacy
Fin Inclusion	**0.839**		
Fin Tech	0.831	**0.797**	
Fin Literacy	0.834	0.734	**0.714**

The square roots of AVE are presented in bold font on the diagonal, and it can be

observed that the values are greater than the correlations among the constructs, thus this criterion is satisfied.

Table 2: Discriminant Validity- Heterotrait-Monotrait Ratio (HTMT)

	Fin Inclusion	Fin Tech	Fin Literacy
Fin Inclusion	0.300		
Fin Tech	0.233	0.882	
Fin Literacy	0.256	0.760	0.800

Source: SmartPLS 4, 2025

According to Henseler et al. (2015), HTMT values exceeding 0.90 may signal issues with discriminant validity. However, as presented in Table 2, all inter-construct correlations were found to be below the HTMT thresholds of 0.85, 0.90, and the HTMT inference benchmarks. This outcome demonstrates that discriminant validity was successfully achieved, supported by both conventional and advanced evaluation techniques.

Structural Model

The second part of the model is the structural model or inner model, Hair et' al. (2013) identified four key criteria for assessing the structural model in PLS-SEM.

Test of Hypotheses

The study examines the role of financial literacy on the relationship between financial technology and financial inclusion among SMEs owners in Nigeria. The interpretation and summary of the result is presented in Table 3.

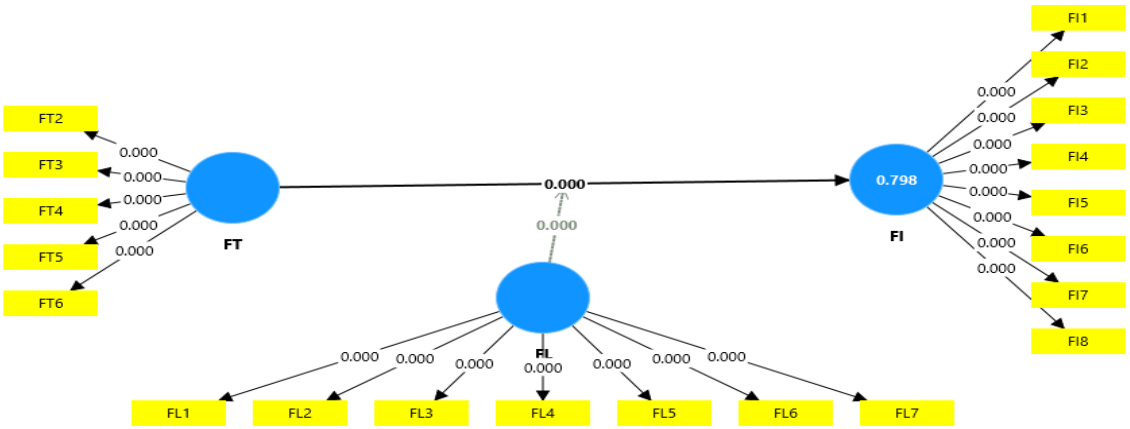

Figure 2: *Structural model for both direct and indirect relationships*

Figure 2 depicted the structural model of the study with moderating effect. It was noted that financial literacy showed a possible moderating effect on the direct relationships.

Table 3: *Path coefficient with moderation*

Hyp	Relationship	Beta value	Std error	T stat	P values	Decision
$H0_1$	FT -> FI	0.362	0.045	8.065	0.000	Rejected
$H0_2$	FL ->FI	0.344	0.046	7.394	0.000	Accepted
$H0_3$	FL x FT -> FI	0.196	0.18	5.477	0.041	Rejected

*****P value <0.01, **P value<0.05 * P-value<0.1**

From the results presented in Table 3 on the direct relationship, financial technology was found to exert a positive and significant influence on financial inclusion among SME owners (β = 0.362, t-value = 8.065, p-value = 0.000). This implies that a one-unit increase in

financial technology adoption enhances financial inclusion by 36.2%. Consequently, the first hypothesis (H01), which posited that financial technology does not significantly affect financial inclusion among SME owners in FCT, Abuja, is rejected. Similarly, financial literacy demonstrated a positive and significant impact on financial inclusion ($\beta = 0.344$, t-value = 7.394, p-value = 0.000), meaning that a one-unit increase in financial literacy results in a 34.4% improvement in financial inclusion. This leads to the rejection of the second hypothesis (H02), which assumed no significant effect of financial literacy on financial inclusion. At the moderation stage, the findings reveal that financial literacy significantly moderates the relationship between financial technology and financial inclusion ($\beta = 0.196$, t-value = 5.477, $p = 0.041$). This indicates that a one-unit increase in the interaction of financial literacy with financial technology yields a 19.6% increase in financial inclusion. Hence, the third hypothesis (H03), which stated that financial literacy does not moderate this relationship, is also rejected.

Theoretical Implications

This research advances the theoretical perspective on financial inclusion by introducing financial literacy as a moderating factor in the link between financial technology and financial inclusion. The results emphasize that financial literacy plays a crucial role in strengthening the impact of financial technology solutions, aligning with the resource-based view theory, which indicates the value of internal capabilities in driving improved outcomes. Furthermore, the study enriches existing literature on financial inclusion by showing that financial literacy not only has a direct positive influence on financial inclusion but also enhances the benefits derived from adopting FinTech.

Managerial Implications

For practitioners, the results show the importance of simultaneously advancing financial technology adoption and enhancing financial literacy among SME owners. Policymakers and financial institutions are encouraged to develop accessible, user-friendly FinTech solutions while providing financial literacy initiatives specifically designed to meet the needs of SMEs.

5. Conclusion and Recommendation

The study concludes that both financial technology and financial literacy are critical drivers of financial inclusion among SME owners in the Federal Capital Territory, Abuja, with financial technology enhancing access to financial services and financial literacy exerting both direct and moderating effects that strengthen this relationship. Building on these insights, it is recommended that policymakers and financial institutions promote the adoption of FinTech solutions designed to address the specific needs of SMEs while simultaneously implementing targeted financial literacy initiatives to equip entrepreneurs with the necessary skills to maximize these tools. Collaborative partnerships between government agencies, financial institutions, and educational bodies will be essential in expanding access to digital financial services, thereby fostering sustainable financial empowerment and inclusive growth for SME owners.

Suggestion for future research

Future research on the role of financial literacy in the relationship between financial technology and financial inclusion among SMEs in Nigeria could examine regional and sector-specific differences to account for contextual variations. Scholars may also integrate behavioral dimensions such as trust, risk perception, and digital literacy as additional moderating factors. Furthermore, longitudinal studies could

provide insights into the long-term effects of financial literacy programs, while gender-focused investigations may reveal how financial literacy shapes the experiences and outcomes of women-owned SMEs.

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