

AKSU Journal of Social Sciences
(AKSUJOSS)
ISSN: 2504 – 933X
Vol.8,No.1 (September) 2026,pp.13-28
DOI: https://doi.org/10.61090/aksujoss.8.1.13-28
URL: htpp://www.aksujournal.com/vol.8.1
Received: April 14, 2026
Accepted: July 30, 2026
Published Online: September 1, 2026

Digital Finance, Financial Inclusion, and Sustainable Development in Nigeria

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Abstract

This study examined the relationship between digital finance, financial inclusion, and sustainable development outcomes in Nigeria over the period 1990–2024. The Ordinary Least Squares (OLS) technique was employed using data from the Central Bank of Nigeria and the World Bank World Development Indicators. Key variables included credit to the private sector, bank deposits, mobile money accounts, population growth, GDP growth, and inflation, used to assess their effects on the Sustainable Development Index and financial inclusion. The results showed that credit to the private sector and mobile money accounts had significant positive effects on sustainable development, indicating that improved financial access and digital financial services enhance investment, productivity, and economic participation. In contrast, bank deposits had a negative but insignificant effect, while population growth significantly reduced sustainable development due to increased pressure on infrastructure and social services. GDP growth and inflation were statistically insignificant. Further findings revealed that mobile money accounts were the only

significant determinant of financial inclusion, while GDP growth, inflation, and population growth were not significant. Overall, the study established that digital financial innovation, particularly mobile money, played a dominant role in driving both financial inclusion and sustainable development in Nigeria, whereas traditional macroeconomic variables had limited influence. The study concluded that sustainable development in Nigeria depends more on targeted financial inclusion and digital finance policies than on general macroeconomic performance. It therefore recommended the expansion of digital financial infrastructure, improved credit allocation to productive sectors, strengthened financial literacy, maintenance of macroeconomic stability, and enhanced human capital development as essential strategies for achieving inclusive and sustainable economic growth in Nigeria.

Keywords*:* Digital finance, financial inclusion, mobile money, sustainable development outcomes

Introduction

Digital finance refers to the delivery and use of financial services through digital channels, focusing on both access and effective electronic utilisation (Ocharive & Iworiso, 2024). Over the past decade, Sub-Saharan Africa (SSA) has seen significant transformation in its financial sector, largely propelled by innovations in digital finance and gradual expansions in formal financial services (Akomeah *et al*., 2025). Historically, SSA has faced persistent challenges, including widespread poverty, income inequality, and deeply rooted structural barriers to economic engagement (Osinubi & Simatele, 2025). Such barriers include limited banking infrastructure, high transaction costs, weak institutional coverage, and extensive informality, all of which have hindered inclusive growth and progress towards the Sustainable Development Goals (SDGs) (Sama-Lang, 2024). These conditions have made it difficult for large segments of the population to benefit from economic opportunities, reinforcing the need for innovative solutions to promote financial and social inclusion.

Within this challenging landscape, financial inclusion has emerged as a key policy tool for promoting inclusive growth and reducing vulnerabilities among marginalized groups (Alvi *et al*., 2025). Despite notable global advancements, around 1.4 billion adults remain outside the formal financial sector, with nearly 25% residing in SSA (World Bank, 2025). In recent years, efforts to expand financial inclusion in SSA have paralleled the rapid spread of digital financial services. The region boasts widespread mobile phone adoption, with penetration exceeding 80% of adults, and advances in fintech have enabled millions to access services like mobile money, digital banking, and electronic payment platforms (Aladejana & Akinboye-Nasir, 2023). Over 60% of adults in SSA now own a mobile money account, and formal savings rates have risen from 15% in 2014 to 35% in 2024. This progress highlights the expanding impact of digital finance on financial participation and overall development (Tadase *et al*., 2025).

The ability of digital technologies to overcome traditional barriers, deepen financial inclusion, and contribute to sustainable development is increasingly evident. Nigeria stands out as a central figure in this transformation, serving as both a major beneficiary and driver of Africa's digital finance revolution. With a population exceeding 220 million, Nigeria combines vast economic potential and significant development hurdles. The country has witnessed rapid growth in digital financial services, supported by a dynamic fintech sector and evolving regulations. Nigeria is home to over 200 licensed fintech companies, representing more than 30% of Africa's fintech start-ups, and drew US$1.2 billion in fintech investment from 2019 to 2023 (Anama & Evbayiro-Osagie, 2024). Innovations such as mobile banking, USSD transactions, and agent banking have broadened access to financial services, driving a surge in electronic payment transactions from ₦600 trillion in 2023

to ₦1.07 quadrillion in 2024 (Nnaomah *et al*., 2024; Aruwa *et al*., 2025a).

Despite these gains, financial inclusion in Nigeria remains uneven, with about 64% of adults accessing some form of financial service in 2023, leaving over 38 million adults excluded. This exclusion is especially high among rural residents, women, and those with lower education, reflecting persistent structural and socioeconomic barriers (Okolo-Obasi *et al*., 2025). Moreover, Nigeria's formal account ownership lags countries like Kenya, where over 80% of adults have accounts (Aruwa *et al*., 2025b). These disparities reveal significant untapped potential and ongoing institutional challenges in Nigeria's financial landscape. Against this background, investigating the links between digital finance, financial inclusion, and sustainable development is crucial. This study applies the Ordinary Least Squares (OLS) method, justified by the stationarity of the variables, to analyze long-term relationships among these factors. By situating Nigeria's

experience in the broader SSA context, this research provides empirical evidence and policy insights on leveraging digital finance for inclusive, sustainable development, clarifying how financial inclusion mediates these effects.

Statement of the Research Problem

The rapid growth of digital finance is widely seen as a transformative force for tackling ongoing development challenges in emerging economies. By leveraging digital technologies, digital finance is expected to expand financial inclusion and, in turn, support sustainable development (World Bank, 2023; Demirgüç-Kunt *et al*., 2022). However, the assumption that digital finance naturally leads to greater financial inclusion and ultimately sustainable development remains debated, especially in regions with structural vulnerabilities, weak institutions, and persistent socioeconomic inequalities. In Nigeria, digital financial services have proliferated alongside continuing challenges like unequal income distribution, high unemployment, and fragile social welfare systems. This raises important questions about whether digital finance truly delivers broad, inclusive, and lasting development benefits or if its advantages remain unevenly distributed. Furthermore, the relationship between digital finance and financial inclusion is essential to understand, as access to digital platforms does not guarantee meaningful or sustained engagement with formal financial services.

Empirical evidence on these relationships is fragmented. While some studies have examined the link between digital finance and sustainable development (Su *et al*., 2021; Lee-Ying *et al*., 2022; Majeedd *et al*., 2023; Alshammari, 2025; Sadiq & Ali, 2024) and others the role of fintech in financial inclusion and economic growth (Silue, 2021; Adhikari *et al*., 2024; Chitombo & Chinoda, 2024; Mashoene *et al*., 2025), most research is focused on developed or emerging economies in Asia and the Pacific. Findings from these studies are often context-specific and sometimes conflicting, with differences in political, economic, and social structures complicating their relevance for Nigeria. Within Nigeria, only a handful of studies, such as Babarinde *et al*. (2025) and Orukotan and Obisanya (2024), address financial inclusion and sustainable development, often without integrating digital finance into their frameworks. This leaves a significant research gap, especially given the rapid digitalisation of Nigeria's financial sector and its potential to drive inclusive and sustainable development.

Additionally, much of the existing literature treats digital finance, financial inclusion, and development outcomes as separate topics, often using static or cross-sectional analyses that do not capture how these relationships evolve over time. These limits are understanding whether gains in financial access are temporary or lead to sustainable improvements in development outcomes. The lack of comprehensive time-series research restricts policymakers' ability to design effective

strategies for harnessing digital finance as a tool for inclusive growth. In light of these gaps, the present study aims to explore the dynamic interactions between digital finance and financial inclusion and how these relationships impact sustainable development in Nigeria. It seeks to answer two core questions: how digital finance, through financial inclusion, affects sustainable development, and what the true nature of the relationship is between digital finance and financial inclusion. By focusing on long-term equilibrium effects, this study aspires to offer actionable evidence for policymakers and stakeholders committed to leveraging digital finance for Nigeria's inclusive and sustainable progress.

Objectives of the Study

1. To assess the impact of digital finance and financial inclusion on sustainable development outcomes in Nigeria.
2. To examine the dynamic relationship between digital finance and financial inclusion in Nigeria.

Theoretical and Empirical Review

Theoretical framework

The Financial Intermediation Theory

Theoretically, this study is anchored on the Financial Intermediation Theory as postulated by Gurley and Shaw (1960) and further supported by Demirgüç-Kunt *et al*. (2022), which posits that efficient financial systems facilitate economic development by mobilising savings, allocating financial resources efficiently, and providing credit to productive sectors of the economy. Within the Nigerian context, digital finance platforms, including mobile banking, fintech applications, and electronic payment systems, function as modern financial intermediaries that reduce transaction costs and broaden access to financial services. By improving access to savings, credit, and payment facilities, digital finance promotes financial inclusion, particularly among previously underserved and financially excluded populations. Consequently, enhanced financial inclusion strengthens economic participation, expands income-generating opportunities, and improves overall welfare, thereby contributing to sustainable development outcomes in Nigeria.

Empirical Review

Recent studies have examined the role of digital financial inclusion in fostering economic growth, environmental sustainability, and financial resilience. While it enhances access to financial services, stimulates growth, and strengthens banking stability, digital financial inclusion also entails environmental and structural trade-offs, emphasising the need to understand its economic, social, and environmental impacts, particularly in developing regions such as Nigeria and Sub-Saharan Africa. In Nigeria, Babarinde *et al*. (2025) examined the impact of digital financial inclusion on environmental sustainability between 2003 and 2023 using the Fully Modified Least Squares (FMOLS) technique and data from the World Development Indicators. Environmental sustainability was measured by per capita carbon dioxide emissions, while digital financial inclusion was proxied by ATM density per capita. The study also controlled for bank deposits and loans per capita, financial development, and economic growth. The findings showed that ATM density significantly reduced carbon emissions, indicating that digital financial inclusion enhances environmental sustainability. In contrast, bank deposits and GDP growth increased emissions, whereas bank loans and private sector credit exerted negative but insignificant effects. The authors recommended expanding digital financial services, strengthening financial literacy, and increasing fintech investment to support sustainable development.

Similarly, Bajwa *et al*. (2025) investigated digital financial inclusion's effects on economic growth and environmental sustainability in ASEAN countries from 2005 to 2022 using Pooled OLS, Two-Stage Least Squares, and GMM, finding that it stimulates growth but imposes environmental costs. Alshammari (2025), using the ARDL approach in Saudi Arabia (1980–2021), reported that financial inclusion increases emissions in both the short and long term. In South Asia, Sadiq and Ali (2024) found that digital financial inclusion significantly raises CO_2 emissions in Pakistan, India, Bangladesh, and Afghanistan (2011–2021), undermining environmental sustainability.

Majeed *et al*. (2023), analysing 102 countries from 1990 to 2022 using Pooled OLS and quantile regression, similarly observed that expanded access to bank branches and ATMs reduces environmental quality, highlighting the environmental trade-offs of digital financial expansion.

On the financial growth and stability front, Chitombo and Chinoda (2024) investigated the relationship among digital financial inclusion, bank stability, and economic growth in Zimbabwe from 2014 to 2022 using OLS estimation. The results showed that digital financial inclusion and bank stability significantly promote economic growth, while bank competition positively influences financial inclusion and stability. However, digital financial inclusion was negatively associated with corruption, and bank stability declined with rising inflation and competition, supporting the competition-fragility hypothesis. The study recommends reducing corruption and financial system barriers and fostering partnerships between banks and fintech firms to strengthen stability and expand digital financial inclusion. Sulemana *et al*. (2025) investigated the relationship between digital finance, financial inclusion, and financial resilience in 25 Sub-Saharan African countries using 2021 Global Findex data and an instrumental variable probit model. The findings showed that digital finance alone does not significantly promote financial inclusion.

However, digital savings improve financial resilience, whereas digital borrowing weakens it. Tertiary education, income, age, employment, and mobile phone ownership were also significant determinants of resilience. The study concludes that the interaction between digital finance and financial inclusion plays a vital role in enhancing household financial resilience in the region. Finally, Silue (2021) examined the role of digital financial services, particularly mobile money, in linking financial inclusion to economic growth in developing countries. Using an endogenous growth model, the study demonstrates that financial inclusion channels investment and consumption among the included population, fostering growth. Empirical evidence from a GMM analysis of 57 countries (2007–2017) confirms that both traditional and digital financial inclusion positively affect growth, with mobile money accounts having a stronger impact than conventional measures, while formal financial deposits also contribute positively.

Despite the valuable insights provided by previous studies, several important gaps remain in the literature. First, the methodologies employed, including FMOLS, ARDL, GMM, OLS, and probit models, vary considerably across studies, with limited justification for their selection. This raises concerns regarding the extent to which these techniques are appropriately aligned with the underlying research objectives and the statistical properties of the data. Second, most existing studies rely on cross-sectional data or time-series datasets that end in 2022 or earlier, thereby limiting their capacity to capture the rapidly evolving landscape of digital financial inclusion, particularly in the wake of post-pandemic technological innovations and the accelerated adoption of digital financial services in developing economies. Third, while examining growth, sustainability, or resilience, few studies adopt an integrated framework to explore the simultaneous and dynamic interactions among digital finance, financial inclusion, and development outcomes, leaving long-run and intertemporal effects unexamined. Finally, the geographically limited focus of many studies, often confined to single countries or regions, reduces the generalisability of

findings to contexts such as Nigeria or Sub-Saharan Africa, emphasising the need for recent, longitudinal, and contextually nuanced research.

Methodology

Model Specification

The following model was applied in this work based on the theoretical review and empirical consideration: The relationship between the variables of interest is presented in the following form:

Model for Objective (i): Assess the impact of digital finance and inclusion on sustainable development outcomes.

Mathematically, the model is expressed as follows;

$$SDI = f(MMAcct, BP, CPS, GDPG, INF, POPGR) \quad \text{---------- (i)}$$

The explicit estimable econometric, equation (i) is written as:

$$SDI_t = \alpha_0 + \alpha_1 MMAcct_t + \alpha_2 BP_t + \alpha_3 CPS_t + \alpha_4 GDPG_t + \alpha_5 INF_t + \alpha_6 POPGR_t + \eta_t \quad \text{----------(ii)}$$

Where: SDI_t=Sustainable development indicator at time t; $MMAcc_t$=Digital finance proxies; BP_t, CPS_t= Financial inclusion indicators and are the control variables.

Model for Objective (ii): Examine the dynamic relationship between digital finance and financial inclusion.

Here, financial inclusion (FI_t) becomes the dependent variable, while digital finance (DE_t) is the key independent variable.

$$FI_t = \alpha_0 + \alpha_1 MMAcct_t + \alpha_2 GDPG_t + \alpha_3 INF_t + \alpha_4 POPGR_t + \eta_t \quad \text{---------- (iv)}$$

Where: FI_t=Composite financial inclusion indicator (Proxy for CPS)

$MMAcc_t$ = Digital financial indicators; $GDPG_t$, INF_t, $POPGR_t$= Control variables.

This model captures how digital finance influences financial inclusion in the long-term horizons.

Justification for Variable Selection: The variables were selected to capture the key dimensions of digital finance, financial inclusion, and sustainable development in Nigeria. Digital finance proxies, such as ATM density and mobile money accounts, reflect access to technological financial services, while financial inclusion indicators—bank deposits, and credit to the private sector—represent household and business participation in the formal financial system. Control variables, including GDP growth, inflation, and population growth, account for macroeconomic conditions that may influence sustainable development and financial inclusion outcomes.

The ***a-priori*** expectations for the study variables, based on theoretical reasoning, can be formally expressed as follows: $\beta_1 > 0; \beta_2 > 0; \beta_3 > 0; \beta_4 > 0; \beta_5 > 0; \beta_6 > 0; \beta_7 > 0; \beta_8 > 0$.

Where: β_1, β_2=digital finance proxies (ATM density, mobile money accounts); β_3 , β_4 , β_5 =financial inclusion indicators (bank deposits, bank loan, credit to private sector); $\beta_6, \beta_7, \beta_8$ =control variable (GDP growth, inflation, population growth).

Data and Sources

This study utilizes annual time-series data for Nigeria covering 1990–2024, a period that captures major financial sector reforms, the growth of electronic and digital finance, and expanding financial inclusion initiatives. Data on digital finance and financial inclusion indicators were sourced from the Central Bank of Nigeria Statistical Bulletin and the World Bank World Development Indicators, while sustainable development and macroeconomic variables were obtained from the World Bank databases. The use of both national and international sources enhances data reliability and coverage, while potential differences in data compilation methods were carefully addressed to ensure robust and valid empirical results.

Data Analyses and Discussion of Findings

Table 1: Descriptive Statistics

	SDI	MMACCT	CPS	BP	GDPG	INF	POPGR
Mean	0.475	2.719	3.483	15.062	4.638	18.709	2.539
Median	0.463	0.000	3.878	15.090	3.440	13.000	2.520
Maximum	0.565	7.578	4.871	23.800	33.740	72.800	2.800
Minimum	0.404	0.000	1.621	7.1400	-6.400	5.400	2.080
Std. Dev.	0.050	3.430	1.015	4.309	6.247	15.867	0.235
Skewness	0.253	0.476	-0.348	0.114	2.931	2.069	-0.739
Kurtosis	1.697	1.276	1.708	2.804	14.899	6.488	2.401
Jarque-B	2.852	5.659	3.143	0.131	256.561	42.724	3.706
Prob	0.240	0.059	0.208	0.936	0.000	0.000	0.157
Sum	16.626	95.174	121.910	527.170	162.340	654.800	88.860
Sum Sq. Dev.	0.086	400.016	35.049	631.410	1326.868	8559.947	1.877
Obs	35	35	35	35	35	35	35

Source: Researcher's Compilation (2026).

Table 1 presents the descriptive statistics of the study variables. The results indicate moderate levels of sustainable development (SDI = 0.475), bank deposits per capita (BP = 15.062), and economic growth (GDPG = 4.638), while inflation (INF = 18.709) remained relatively high during the study period. The close proximity of the mean and median values for most variables suggests moderate distributional consistency, although MMACCT recorded a median of zero, indicating periods of low mobile money account penetration. The standard deviation values show that inflation and GDP growth were more volatile than the other variables. GDPG and INF are highly positively skewed, reflecting the occurrence of extreme high values, whereas POPGR and CPS exhibit slight negative skewness. The kurtosis statistics reveal that GDPG (14.899) and INF (6.488) are highly leptokurtic, indicating peaked distributions with heavy tails. Furthermore, the Jarque–Bera results suggest that GDPG and INF deviate from normality due to volatility and the presence of outliers.

Correlation Analysis

Table 2: Results of correlation Test

	SDI	MMACCT	CPS	BP	GDPG	INF	POPGR
SDI	1						
MMACCT	0.912	1					
CPS	0.958	0.809	1				
BP	0.871	0.790	0.829	1			
GDPG	-0.168	-0.299	-0.063	-0.228	1		
INF	-0.269	-0.167	-0.358	-0.169	-0.205	1	
POPGR	-0.533	-0.623	-0.311	-0.571	0.444	-0.238	1

Source: Researcher's Compilation (2026) from E-views-9.

Table 2 presents the correlation matrix of the study variables, revealing that sustainable development (SDI) is strongly and positively associated with mobile money accounts (MMACCT = 0.912), credit to the private sector (CPS = 0.958), and bank deposits per capita (BP = 0.871), indicating that financial sector development promotes sustainable development. Conversely, GDP growth (GDPG), inflation (INF), and population growth (POPGR) are negatively related to SDI, with POPGR exhibiting the strongest inverse relationship (–0.533), while inflation shows weak negative associations with most financial indicators, suggesting that macroeconomic instability may hinder both financial development and sustainability. Furthermore, the strong positive relationships among MMACCT, CPS, and BP reflect the interconnectedness of financial inclusion and banking sector development, and the correlation coefficients generally indicate the absence of severe multicollinearity among the explanatory variables.

Results of Unit Root Test

Table 3: Results of Unit Root Test at level and 1st deference

Variable	Test Statistic	5% critical Value	Remark	Test Statistic	5% critical Value	Remark
SDI	1.085	-2.951	----	-5.706	-2.954	I(1)
POPGR	-0.838	-2.954	----	-6.825	-2.957	I(1)
MMACCT	-0.874	-2.954	----	-3.819	-2.957	I(1)
INF	-2.129	-2.951	----	-4.660	-2.954	I(1)
CPS	-1.748	-2.954	----	-3.509	-2.954	I(1)
GDPG	-2.275	-2.954	----	-11.989	-2.954	I(1)
BP	-0.789	-2.951	----	-4.781	-2.954	I(1)

Source: Researcher's Compilation (2026) from E-views-9.

Table 3 presents the unit root test results for the variables used in the study. The findings indicate that all variables, SDI, POPGR, MMACCT, INF, CPS, GDPG, and BP—are non-stationary at level, as their test statistics are lower than the 5% critical values in absolute terms. However, all variables become stationary after first differencing, confirming that they are integrated of order one, I(1). This implies that the series are suitable for estimation under the Ordinary Least Squares (OLS) framework, provided the model is properly specified and classical assumptions are satisfied.

Johansen Co-Integration Test

Table 4: Johansen Co-Integration Test

Hypothesized No. of CE(s)	Eigen value	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.799	161.877	125.615	0.000**
At most 1 *	0.738	108.821	95.754	0.005**
At most 2	0.583	64.667	69.819	0.120
At most 3	0.406	35.824	47.856	0.405
At most 4	0.316	18.639	29.797	0.519
At most 5	0.166	6.105	15.495	0.683
At most 6	0.004	0.125	3.841	0.723

Source: Researcher's Compilation (2026) from E-views-9

The Johansen co-integration test confirms a long-run equilibrium relationship among the variables. The trace statistics for "None" and "At most 1" are significant at the 5% level, leading to the rejection of the null hypothesis of no co-integration, while the insignificant results from "At most 2" onward indicate the existence of at least one but not more than two co-integrating equations. This finding confirms that the variables are I(1) and co-integrated, justifying OLS estimation of the long-run relationship, with any short-run disequilibria expected to be temporary and self-correcting over time.

Objective 1: To assess the impact of digital finance and financial inclusion on sustainable development outcomes in Nigeria.

Table 5a: Result of the OLS (Dependent Variable: SDI)

Variable	Coefficient	Std. Error	t-Statistic	Prob.**
CPS	0.036	0.003	13.337	0.000**
BP	-0.000	0.001	-0.201	0.842**
MMACCT	0.003	0.001	4.400	0.000**
POPGR	-0.041	0.008	-5.330	0.000**
GDPG	0.000	0.000	0.941	0.355
INF	-4.82E	7.80E	-0.617	0.542
C	0.447	0.021	20.988	0.000**
R^2: 0.987; Adjusted R^2:0.985; Prob (F-stat) 0.000; Durbin-Watson stat: 1.146.				

Source: Researcher's Compilation (2026) from E-views-9

Table 5a provides the OLS regression results assessing the impact of digital finance and financial inclusion on sustainable development in Nigeria, with the Sustainable Development Index (SDI) as the dependent variable. The model demonstrates strong explanatory power, as reflected by an R^2 of 0.987 and an adjusted R^2 of 0.985, indicating that about 98.7% and 98.5% of the variation in sustainable development is explained by variables such as credit to the private sector, bank deposits, mobile money accounts, population growth, GDP growth, and inflation. The F-statistics probability (0.000) confirms the joint significance of these variables, leading to the rejection of the null hypothesis of no joint effect. Though the Durbin-Watson statistic (1.146) points to mild positive serial correlation, the model remains sufficiently robust for empirical analysis and policy guidance. These diagnostic results establish a reliable foundation for interpreting the effects of individual explanatory variables.

Regarding individual variables, credit to the private sector (CPS) exhibits a positive coefficient (0.036) and is statistically significant at the 1% level ($p = 0.000$). This indicates that greater credit availability for the private sector significantly boosts sustainable development in Nigeria. Specifically, a one-unit increase in credit to the private sector results in a 0.036-unit rise in the SDI, holding other factors constant. This finding supports the notion that enhanced access to finance facilitates business expansion, investment, job creation, and income generation, which collectively improve overall welfare. This result is consistent with studies by Asongu and Odhiambo (2024a), Koomson *et al*. (2023), and Ozili (2023a), who all found that private-sector financing enhances inclusive growth. However, it contrasts with findings from Shahbaz *et al*. (2023) and Nizam *et al*. (2021), who argue that credit may not yield positive outcomes if inefficiently allocated.

The coefficient for bank deposits (BP) is negative but statistically insignificant ($\beta = -0.000$; $p = 0.842$), suggesting that bank deposits do not have a notable effect on sustainable development

outcomes in Nigeria. While deposit mobilisation is an important aspect of financial deepening, the findings indicate that increased deposits alone are insufficient for development unless channeled into productive investments. This may reflect the rising dominance of digital finance over traditional banking in influencing developmental outcomes. The result aligns with research by Frost (2023), Arner *et al*. (2023), and Suri and Jack (2022), who argue that traditional banking metrics are less influential in the digital age. However, it diverges from studies by Beck (2023) and Allen *et al*. (2021), who found that deposit mobilisation does contribute to economic growth. In contrast, mobile money accounts (MMACCT) display a positive coefficient (0.003) and are significant at the 1% level (p = 0.000), highlighting the role of mobile money penetration in advancing sustainable development. This underscores the catalytic role of digital finance in promoting financial accessibility, reducing transaction costs, empowering entrepreneurs, and fostering financial inclusion. The expansion of mobile money services thus substantially aids the achievement of sustainable development goals, consistent with findings by Suri (2023), Ozili (2023b), and Asongu and Nwachukwu (2024). Nonetheless, some studies such as Nguyen (2024) and Park and Mercado (2023) caution that weak digital infrastructure or low financial literacy can limit these benefits. The results emphasize that digital financial innovation, particularly mobile money, is a cornerstone of inclusive development in Nigeria.

The population growth rate (POPGR) has a negative coefficient (-0.041), significant at the 1% level (p = 0.000), indicating that rapid population growth negatively impacts sustainable development. Each unit increase in population growth reduces the SDI by about 0.041 units. This result suggests that unchecked population expansion strains resources, infrastructure, healthcare, education, and environmental sustainability. Unless social and economic infrastructure keeps pace with demographic growth, sustainable development outcomes are likely to decline. This corroborates findings by Madsen (2023) and Bongaarts (2022) that link excessive population growth with development constraints. However, it stands in contrast to arguments by Bloom *et al*. (2021), which posit that population growth can spur innovation and economic dynamism when accompanied by investment in human capital. Overall, the study finds that, among the variables examined, private sector credit and mobile money accounts are the most significant drivers of sustainable development in Nigeria, while population growth remains a key challenge.

Table 5b: Examine the dynamic relationship between digital finance and financial inclusion.

Table 5b: Result of the OLS (Dependent Variable: FI)

Variable	Coefficient	Std. Error	t-Statistic	Prob.**
MMACCT	0.277	0.038	7.354	0.000**
GDPG	0.015	0.017	0.926	0.362
INF	-0.009	0.007	-1.478	0.149
POPGR	0.749	0.577	1.299	0.204
C	1.090	1.573	0.693	0.494
R^2: 0.756; Adjusted R^2:0.726; Prob (F-stat) 0.000; Durbin-Watson stat: 0.337.				

Source: Researcher's Compilation (2026) from E-views-9

Table 5b presents the OLS regression results examining the dynamic relationship between digital finance and financial inclusion in Nigeria, with Financial Inclusion (FI) serving as the dependent variable. The model demonstrates moderate explanatory power, with an R^2 of 0.756 and an adjusted R^2 of 0.726, indicating that 75.6% and 72.6% of the variations in financial inclusion, respectively, are explained by mobile money accounts, GDP growth, inflation, and population

growth. The F-statistic prob (0.000) confirms that the explanatory variables are jointly significant, leading to the rejection of the null hypothesis of no joint effect. However, the Durbin–Watson statistic (0.337) suggests strong positive serial correlation, indicating the presence of dynamic dependence and that short-run fluctuations in financial inclusion may not be entirely independent over time.

With respect to the individual variables, mobile money accounts (MMACCT) exhibit a positive coefficient of 0.277 and are statistically significant at the 1% level (p = 0.000), indicating a strong and robust positive relationship with financial inclusion in Nigeria. This implies that increased adoption of mobile money services significantly enhances access to and usage of financial services, thereby deepening financial inclusion. In essence, digital financial innovations such as mobile money play a central role in reducing transaction costs, improving payment efficiency, and extending financial services to previously excluded populations, particularly in rural and informal sectors. This finding is consistent with the empirical evidence of Ozili (2023), Asongu and Nwachukwu (2024b), and Suri (2023), who reported that mobile money significantly strengthens financial inclusion by expanding access to digital financial platforms and reducing exclusion barriers. Similarly, Demirgüç-Kunt *et al.* (2022), Koomson *et al.* (2023), and Bongomin *et al*. (2023) also documented strong positive effects of mobile financial services on inclusion outcomes across developing economies. Conversely, the result contrasts with Lenka (2022), Park and Mercado (2023), and Nguyen (2024), who argued that the effectiveness of mobile money in promoting financial inclusion may be constrained by weak digital infrastructure, low financial literacy, and regulatory inefficiencies.

In contrast, GDP growth rate (GDPG) records a positive coefficient of 0.015 but is statistically insignificant (p = 0.362), indicating that economic growth does not exert a significant direct influence on financial inclusion in Nigeria during the period under review. Although the positive sign suggests a theoretical relationship whereby economic expansion may improve financial access, the insignificance implies that increases in output do not automatically translate into broader financial inclusion in the absence of targeted financial policies and institutional support. This finding aligns with Beck *et al*. (2021), Demirgüç-Kunt *et al*. (2022), and Ozili (2023a), who emphasised that financial inclusion is driven more strongly by institutional quality and technological innovation than by macroeconomic growth alone. Similarly, Le *et al.* (2022), Asongu (2024b), and Koomson *et al*. (2023) found that GDP growth exerts only an indirect or weak influence on financial inclusion unless supported by deliberate financial sector reforms. However, the result contradicts Romer (2023), Barro (2021), and Sala-i-Martin (2022), who argued that economic growth significantly enhances financial development and inclusion through income expansion and increased demand for financial services.

Furthermore, inflation (INF) shows a negative coefficient of -0.009 but is statistically insignificant (p = 0.149), suggesting that inflation does not exert a significant direct effect on financial inclusion in Nigeria. While the negative sign indicates that rising inflation may reduce real incomes and weaken the affordability of financial services, the lack of statistical significance implies that its overall impact on financial inclusion remains limited within the study period. This finding is consistent with Fischer (2021), and Khan (2022), who reported that inflation negatively affects financial sector development and welfare indicators, although not always in a statistically significant manner. Similarly, Nguyen (2024), Ozili (2023b), and Aisen and Veiga (2022) found weak or indirect relationships between inflation and financial inclusion in developing economies. However, it contrasts with Mallik and Chowdhury (2022), Bruno (2021), and Ahmed (2023), who argued that moderate inflation may stimulate financial activity and support financial deepening

under favourable macroeconomic conditions.

Similarly, population growth rate (POPGR) records a positive coefficient of 0.749 but is statistically insignificant (p = 0.204), indicating that although population expansion may increase the potential demand for financial services, it does not significantly translate into improved

financial inclusion in Nigeria. This suggests that demographic expansion alone is insufficient to deepen financial access without corresponding improvements in financial infrastructure, institutional capacity, and digital financial penetration. This finding aligns with Bongaarts (2022) and Dasgupta (2022), who observed that population growth contributes to financial development only when supported by strong institutional and technological frameworks. Likewise, Ozili (2023), Koomson *et al*. (2023), and Asongu and Odhiambo (2024a) noted that demographic variables are generally weak predictors of financial inclusion in the absence of complementary policy support.

In contrast, the result contradicts Kremer (2023) and Bloom *et al*. (2021), who argued that population growth can indirectly enhance financial inclusion through labour force expansion and increased economic participation. Overall, the empirical evidence from Table 5b demonstrates that mobile money accounts are the only statistically significant determinant of financial inclusion in Nigeria, highlighting the central role of digital financial innovations in expanding access to formal financial systems. In contrast, GDP growth, inflation, and population growth do not exert statistically significant effects, suggesting that macroeconomic conditions alone are insufficient to drive financial inclusion without targeted fintech-driven interventions. Collectively, these findings underscore the critical importance of digital financial services in achieving inclusive financial systems and advancing financial inclusion objectives in developing economies such as Nigeria.

Post-Diagnostic Test

Table 7: Summary of Post-Estimation Diagnostic Tests

Test	Statistic Type	Value	df	Probability (p-value)	Decision at 5% level	Inference
Breusch–Godfrey Serial Correlation LM Test	F-statistic	6.111	(2, 26)	0.007	Reject H_0	Evidence of serial correlation
	Obs*R-squared	11.191	—	0.004	Reject H_0	Serial correlation confirmed
Breusch–Pagan–Godfrey Heteroskedasticity Test	F-statistic	1.979	(6, 28)	0.103	Fail to reject H_0	No heteroskedasticity
	Obs*R-squared	10.422	(6)	0.108	Fail to reject H_0	Homoskedastic residuals
	Scaled explained SS	7.418	(6)	0.284	Fail to reject H_0	Stable variance assumption
Ramsey RESET Test	t-statistic	1.939	27	0.063	Fail to reject H_0 (5%)	No strong omitted variable bias
	F-statistic	3.761	(1, 27)	0.063	Fail to reject H_0 (5%)	Model specification acceptable
	Likelihood Ratio	4.565	1	0.033	Reject H_0	Mild specification concern
Jarque–Bera Normality Test (Residuals)	Jarque–Bera statistic	0.085	—	0.958	Fail to reject H_0	Residuals are normally distributed
	Skewness	0.045	—	—	—	Symmetric distribution
	Kurtosis	3.224	—	—	—	Close to normal peak
Residual Summary	Mean	5.24E	—	—	—	Mean approximately zero (good fit)
	Std. Deviation	0.006	—	—	—	Low dispersion of residuals

Source: Researcher's Compilation (2026) from E-views-9

Conclusion

This study examined the relationship between digital finance, financial inclusion, and sustainable development in Nigeria from 1990–2024 using the Ordinary Least Squares (OLS) technique and

data from the Central Bank of Nigeria (CBN) and the World Bank indicator. The analysis incorporated credit to the private sector, bank deposits, mobile money accounts, population growth, GDP growth, and inflation to assess their effects on the Sustainable Development Index (SDI) and financial inclusion. The results presented in Table 5a revealed that credit to the private sector and mobile money accounts are significant positive determinants of sustainable development. This finding underscore's the critical role of financial intermediation and digital financial services in fostering sustainable development by enhancing access to finance, stimulating productive investment, generating employment opportunities, increasing income levels, and promoting broader financial inclusion and inclusive economic participation. In contrast, bank deposits exert a negative but insignificant effect, while population growth significantly constrains sustainable development through increased pressure on socioeconomic and environmental resources. GDP growth and inflation are statistically insignificant, suggesting that broad macroeconomic conditions alone do not guarantee improved development outcomes.

The findings from Table 5b show that mobile money accounts are the only significant determinant of financial inclusion, with the model explaining 75.6% of variations in financial inclusion. Mobile money significantly expands access to financial services, particularly among underserved populations, whereas GDP growth, inflation, and population growth have no significant influence. Overall, the evidence underscores the pivotal role of digital financial innovation, especially mobile money, in advancing financial inclusion and sustainable development in Nigeria, while credit to the private sector provides complementary support and population growth remains a structural challenge.

Recommendations

Policymakers, particularly the Central Bank of Nigeria and relevant financial authorities, should prioritise the expansion of digital financial infrastructure, especially mobile money platforms, by improving network coverage, reducing transaction costs, strengthening cybersecurity, and enhancing interoperability, given their strong role in promoting financial inclusion and sustainable development. Credit allocation mechanisms should also be strengthened to ensure that lending to the private sector is efficiently channelled into productive sectors through improved risk assessment, credit monitoring, and targeted support for SMEs and innovation-driven enterprises, while inclusive financial education and digital literacy programmes are expanded to enhance effective utilisation of financial services among rural and informal sector participants. Although macroeconomic variables such as GDP growth and inflation were not significant, maintaining macroeconomic stability alongside strategic investments in human capital, through education, healthcare, skills development, and employment creation, remains essential, supported by an integrated policy framework that simultaneously advances digital finance, credit markets, institutional quality, and long-term sustainable development.

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