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The Impact of Financial Inclusion and Information and Communication Technology on Economic Growth in Nigeria

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Abstract: *This study examines the impact of financial inclusion, information and communication technology (ICT), literacy rate, and gross capital formation on economic growth in Nigeria for the period 1990–2024. Using secondary time series data from the Central Bank of Nigeria, the study employs the Autoregressive Distributed Lag (ARDL) bounds testing approach to investigate both short- and long-run relationships. Empirical results reveal that mobile banking ($\beta = 0.312$, $p < 0.01$), access to financial services ($\beta = 0.278$, $p < 0.05$), literacy rate ($\beta = 0.214$, $p < 0.05$), and gross capital formation ($\beta = 0.356$, $p < 0.01$) positively and significantly influence economic growth, while internet banking usage ($\beta = 0.081$, $p = 0.214$) and digital payment penetration ($\beta = 0.093$, $p = 0.162$) are statistically insignificant in the long run. The error correction term of -0.612 ($p < 0.01$) indicates a rapid adjustment toward long-run equilibrium. These findings suggest that financial technology adoption must be complemented by human capital development and investment in physical capital to stimulate sustainable growth. Policy measures should focus on expanding mobile banking and digital literacy programs, alongside incentives for domestic capital formation. This study contributes to the literature by integrating technological, human, and capital factors in a unified framework, providing empirical evidence on how fintech innovations can drive inclusive economic transformation in emerging economies.*

Keywords: Financial Inclusion, Economic Growth, Mobile Banking, Literacy Rate, Gross Capital Formation.

Introduction

The rapid advancement of information and communication technology (ICT) has fundamentally reshaped economic structures and market dynamics across both developed and developing economies. Financial inclusion enhances the provision of financial services to the general public by creating opportunities for viable participation in both financial and non-financial markets, thereby supporting inclusive economic expansion. Access to stable, fast, and affordable financial services is widely recognized as a precondition for accelerating inclusive growth and reducing inequality. In the Nigerian context, where a significant proportion of the

population remains underserved by traditional banking systems, ICT-driven innovations such as mobile banking and digital payment platforms have expanded access to financial services. Empirical studies emphasize that financial inclusion stimulates economic growth by improving savings mobilization, investment opportunities, and consumption patterns (Babajide et al., 2015; Aghion et al., 2016).

Financial inclusion also plays a crucial role in reducing poverty and inequality by narrowing the wealth gap and promoting equitable access to economic opportunities. It enables economically and socially marginalized groups to integrate into the formal financial system, thereby enhancing their resilience against economic shocks. However, structural challenges persist, particularly in rural areas where high illiteracy rates and inadequate financial awareness programs limit effective participation in financial systems. These constraints often hinder communication between financial institutions and potential users, reducing the overall effectiveness of inclusion strategies. Consequently, without adequate financial inclusion, many individuals rely solely on personal savings for investment, which constrains growth prospects and perpetuates income inequality (Alabi, 2022; Calcagno & Monticone, 2015).

The role of technology in addressing these challenges has become increasingly significant. The proliferation of mobile money services, agent banking, and digital financial platforms has improved financial penetration, especially in rural and underserved communities. In Nigeria, innovations such as point-of-sale (POS) systems, internet banking, and Unstructured Supplementary Service Data (USSD)-based services have enhanced accessibility to financial services and improved money management practices. These technological interventions have reduced traditional barriers such as distance, cost, and bureaucratic inefficiencies, thereby strengthening the effectiveness of financial inclusion initiatives (Akinde, 2026; Akutson & Sani, 2025). As a result, ICT has become a critical enabler in transforming the financial landscape and extending the marketing mix of financial services.

Despite these advancements, Nigeria continues to face significant socio-economic challenges, including persistent poverty and income inequality. A substantial proportion of the population still lacks access to essential financial services, even in the face of technological progress. This paradox highlights the need to examine not only access but also the quality and usage of financial services. Financial literacy, therefore, becomes an essential complementary factor, as it equips individuals with the knowledge required to effectively utilize financial products and services. Research indicates that the integration of financial literacy with fintech innovation significantly enhances the sustainability and impact of financial inclusion efforts (Sam-Abugu et al., 2025; Dinesha, 2017).

Furthermore, ICT-driven financial inclusion has important implications for enterprise development and economic productivity. Small and medium-sized enterprises (SMEs) benefit from improved access to credit and financial services, which supports business growth, innovation, and employment generation. This is particularly relevant in Nigeria, where SMEs constitute a significant portion of the economy. Enhanced access to finance through digital

platforms enables these enterprises to overcome traditional financing constraints, thereby contributing to broader economic development (Ibor et al., 2017; Olaoye & Zerihun, 2023).
In light of the foregoing, the relationship between ICT, financial inclusion, and economic growth remains a critical area of investigation. While existing studies have explored various dimensions of financial inclusion, there is still limited empirical evidence focusing on the combined effects of technological innovation, financial service accessibility, and usage patterns on economic growth in Nigeria. This underscores the need for further research to better understand these dynamics and inform policy decisions. Addressing these gaps is essential for promoting sustainable development, reducing inequality, and achieving inclusive economic growth in Nigeria.

Empirical Review

Empirical literature on financial inclusion and economic growth has expanded considerably, with early studies establishing a strong linkage between accessto financial services and macroeconomic performance. For instance, Babajide et al. (2015) provide evidence that financial inclusion significantly contributes to economic growth in Nigeria through enhanced savings mobilization and investment activities. Similarly, Aghion et al. (2016) argue that domestic savings, when efficiently intermediated through inclusive financial systems, play a critical role in fostering sustained economic growth. Complementing these findings, Jesudasan and D'souza (2015) demonstrate that improved access to financial services stimulates economic prosperity by increasing the utilization of financial products. In a regional context, Gourène and Mendy (2017) further confirm a causal relationship between financial inclusion and growth using panel data from WAEMU countries, reinforcing the macroeconomic relevance of inclusive financial systems.

Subsequent empirical studies have emphasized the role of financial literacy and user capability in enhancing the effectiveness of financial inclusion initiatives. Calcagno and Monticone (2015) find that individuals with higher financial literacy are more likely to demand and effectively utilize financial advisory services, thereby improving financial outcomes. Similarly, Klapper et al. (2015) highlight global disparities in financial literacy levels and their implications for financial inclusion. Dinesha (2017) extends this argument by noting that financial literacy is a key driver of inclusive growth, particularly in developing economies where access alone does not guarantee effective usage. In the Nigerian context, Hassan and Utulu (2022) identify socio-economic and technological factors, including education and digital awareness, as significant determinants of financial inclusion among rural populations.
The integration of ICT into financial systems has been widely recognized as a transformative factor in expanding financial inclusion. Alabi (2022) provides empirical evidence that technology adoption significantly enhances financial inclusion in Nigeria by reducing transaction costs and improving service accessibility. Supporting this, Alabi and Olaoye (2022) demonstrate that technological adoption positively influences financial inclusion across countries, with stronger effects observed in developing economies. Olaoye (2023) further establishes a strong nexus between ICT and financial inclusion in Nigeria, emphasizing the role of digital platforms in increasing financial access. Moreover, Owolabi (2023) and Owolabi

et al. (2023) show that ICT contributes not only to financial inclusion but also to broader economic growth and diversification in Sub-Saharan Africa.

Recent studies have increasingly focused on financial technology (FinTech) as a key driver of inclusion and economic transformation. Akutson and Sani (2025) find that fintech innovations significantly improve financial inclusion in Nigeria by expanding access to digital financial services. Similarly, Akutson (2026) highlights the transformative impact of fintech on banking operations and financial service delivery. Akinde (2026) and Akinde and Saka (2026) provide empirical evidence on the role of mobile money in enhancing financial inclusion, particularly through increased penetration of telecommunication services. In addition, Ogu (2026) and Ogu et al. (2026) confirm that fintech innovations have a positive and significant effect on financial inclusion in Nigeria, further reinforcing the importance of digital financial solutions.

Beyond access, the relationship between financial inclusion and enterprise performance has also been explored. Ibor et al. (2017) demonstrate that financial inclusion positively affects the performance of micro, small, and medium enterprises (MSMEs) in Nigeria by improving access to credit and financial services. Similarly, Olaoye and Zerihun (2023) find that ICT-driven financial inclusion contributes to poverty reduction by enabling productive economic activities. Falaiye et al. (2024) and Falaiye (2024) highlight broader trends in emerging markets, noting that technology-driven financial inclusion enhances economic participation and supports sustainable development. These findings are consistent with the work of Gebrehiwot and Makina (2019), who identify macroeconomic factors such as income levels and institutional quality as key determinants of financial inclusion.

Furthermore, empirical studies have examined the broader implications of digital finance on economic systems. Yue et al. (2022) explore the dual nature of digital finance, noting its potential to enhance inclusion while also posing risks such as over-indebtedness. Similarly, Yusuf and Bala (2021) analyze electronic banking systems in Nigeria and find that service quality and reliability significantly influence user satisfaction and adoption rates. Chakraborti and Sanyal (2015) emphasize the role of innovative technologies such as the Internet of Things in addressing demographic challenges associated with financial inclusion. Saribekian (2015) also highlights the importance of effective credit risk management in sustaining financial inclusion initiatives, particularly in the context of long-term financing.

More recent contributions have focused on the interplay between fintech innovation, financial literacy, and inclusive growth. Sam-Abugu (2025) demonstrates that fintech innovation significantly contributes to inclusive growth in Nigeria, while Sam-Abugu et al. (2025) show that the combined effect of fintech and financial literacy enhances sustainable financial inclusion outcomes. Oyedotun (2026) and Oyedotun and Makoni (2026) extend this analysis to Sub-Saharan Africa, providing evidence of a strong nexus between fintech, financial inclusion, and economic growth using dynamic panel techniques. Additionally, Ezeocha (2024) underscores the theoretical and practical relevance of fintech as a tool for promoting financial inclusion in Nigeria. Collectively, these studies highlight the evolving nature of

financial inclusion and the central role of ICT and fintech innovations in driving economic growth and development.

In addition to fintech-driven innovations, institutional frameworks and policy interventions have been identified as critical enablers of financial inclusion and economic growth. Olaitan (2015) highlights the role of central bank interventions in Nigeria, emphasizing that regulatory policies and targeted financial programs have significantly improved access to financial services. Similarly, Saidu (2015) underscores the importance of effective leadership and governance in fostering economic development, noting that institutional quality influences the success of financial inclusion initiatives. Lyndon and Peter (2016) further provide empirical evidence that macroeconomic variables, such as interest rates, interact with financial sector development to influence economic growth outcomes in Nigeria. These findings suggest that while technology plays a crucial role, supportive policy environments are equally essential for maximizing the benefits of financial inclusion.

Moreover, the diffusion of digital financial services has contributed to structural changes in financial markets by enhancing efficiency and transparency. Ezeocha (2024) posits that financial technology serves as a catalyst for modernizing financial systems, enabling seamless transactions and reducing operational inefficiencies. Owakah et al. (2023) empirically demonstrate that fintech adoption significantly improves financial inclusion by increasing the accessibility and affordability of financial services. In a similar vein, Akutson and Sani (2025) argue that the integration of fintech into traditional banking systems has enhanced service delivery and expanded outreach to previously excluded populations. These developments underscore the growing importance of digital transformation in shaping the future of financial systems in developing economies.

Finally, emerging empirical evidence points to the need for a balanced approach that addresses both opportunities and risks associated with financial innovation. While digital finance has expanded inclusion, concerns remain regarding financial stability, cybersecurity, and consumer protection. Yue et al. (2022) caution that the rapid expansion of digital financial services may expose users to new vulnerabilities, including over-indebtedness and data privacy risks. At the same time, Falaiye et al. (2024) emphasize that sustainable financial inclusion requires continuous innovation, regulatory oversight, and capacity building. Therefore, achieving inclusive economic growth in Nigeria necessitates a comprehensive framework that integrates technological advancement, financial literacy, and robust institutional support to ensure long-term stability and resilience.

Methodology

This study employed secondary data using a time series research design to examine the impact of information and communication technology (ICT), financial inclusion, and economic growth in Nigeria over the period 1990–2024. The 1990–2024 period is appropriate as it captures Nigeria's financial sector liberalization following the Structural Adjustment Programme and the evolution of ICT-driven financial services. It includes the

telecommunications revolution of the early 2000s and major financial inclusion policies introduced by the Central Bank of Nigeria, such as the cashless policy and National Financial Inclusion Strategy. This timeframe reflects both pre- and post-digital transformation phases, enabling a comprehensive analysis of structural changes. Additionally, the long span provides sufficient observations for reliable time series estimation and captures recent fintech innovations and post-pandemic digital financial expansion influencing economic growth.

Data were sourced primarily from the Central Bank of Nigeria (CBN) Statistical Bulletin and other relevant national databases. The variables included gross domestic product (GDP) as the dependent variable, while mobile banking (MB), access to financial services (AFS), digital payment penetration (DPP), internet banking usage (IBU), literacy rate (LIT), and gross capital formation (GCF) were used as independent variables. The inclusion of digital payment penetration and internet banking usage captures the influence of ICT on financial service delivery, while literacy rate and gross capital formation capture the effects of human capital and physical capital accumulation, which are recognized drivers of economic growth (Alabi, 2022; Aghion et al., 2016; Akinde, 2026).

Preliminary statistical analyses, including descriptive statistics and correlation analysis, were conducted to examine the distributional properties of the data and the relationships among the variables. The stationarity properties of the series were assessed using the Augmented Dickey-Fuller (ADF) unit root test to determine the order of integration and avoid spurious regression results. The functional relationship between ICT, financial inclusion, and economic growth was specified as:

$$\mathrm{GDP}_t = f(\mathrm{MB}_t, \mathrm{AFS}_t, \mathrm{DPP}_t, \mathrm{IBU}_t, \mathrm{LIT}_t, \mathrm{GCF}_t) \tag{1}$$

Following the functional specification, the long-run ARDL model was expressed as:

$$\mathrm{GDP}_t = \alpha + \beta_1 \mathrm{MB}_t + \beta_2 \mathrm{AFS}_t + \beta_3 \mathrm{DPP}_t + \beta_4 \mathrm{IBU}_t + \beta_5 \mathrm{LIT}_t + \beta_6 \mathrm{GCF}_t + u_t \tag{2}$$

where $\mathrm{GDP}_t$is gross domestic product at time t, $\mathrm{MB}_t$is mobile banking, $\mathrm{AFS}_t$is access to financial services, $\mathrm{DPP}_t$is digital payment penetration, $\mathrm{IBU}_t$is internet banking usage, $\mathrm{LIT}_t$is literacy rate, $\mathrm{GCF}_t$is gross capital formation, and $u_t$is the stochastic error term.

To capture short-run dynamics and the speed of adjustment toward long-run equilibrium, the study employed the dynamic ARDL model with an Error Correction Mechanism (ECM), expressed as:

$$\begin{aligned} \Delta\mathrm{GDP}_t \quad &= \alpha_0 + \sum_{i=1}^{p} \phi_i \, \Delta\mathrm{GDP}_{t-i} + \sum_{i=0}^{q} \theta_{1i} \, \Delta\mathrm{MB}_{t-i} + \sum_{i=0}^{q} \theta_{2i} \, \Delta\mathrm{AFS}_{t-i} \\ &\quad + \sum_{i=0}^{q} \theta_{3i} \, \Delta\mathrm{DPP}_{t-i} + \sum_{i=0}^{q} \theta_{4i} \, \Delta\mathrm{IBU}_{t-i} + \sum_{i=0}^{q} \theta_{5i} \, \Delta\mathrm{LIT}_{t-i} \\ &\quad + \sum_{i=0}^{q} \theta_{6i} \, \Delta\mathrm{GCF}_{t-i} + \psi \mathrm{ECM}_{t-1} + \varepsilon_t \end{aligned} \tag{3}$$

where Δdenotes the first difference operator, $p$and $q$represent the optimal lag lengths determined using the Akaike Information Criterion (AIC), Schwarz Criterion (SC), and

Hannan-Quinn Criterion (HQ), $ECM_{t-1}$is the error correction term capturing deviations from long-run equilibrium, $\psi$is the speed of adjustment coefficient expected to be negative and significant, and $\varepsilon_t$is the white noise error term.

The ARDL bounds testing approach was used to examine the existence of long-run cointegration among the variables. The null hypothesis of no long-run relationship is rejected if the F-statistic exceeds the upper bound critical value. Upon establishing cointegration, the ECM captures both short-run adjustments and the rate at which deviations from long-run equilibrium are corrected (Akutson & Sani, 2025; Sam-Abugu et al., 2025).

Robustness of the model was ensured through diagnostic checks, including tests for serial correlation (Breusch-Godfrey test), heteroskedasticity (Breusch-Pagan-Godfrey test), and model stability (CUSUM and CUSUMSQ tests). These procedures ensure that the estimated model is well-specified and reliable for policy inference, particularly in the context of fintech-driven financial inclusion and economic growth in Nigeria (Akutson, 2026; Ogu et al., 2026).

Results and Discussion

The descriptive statistics of the study variables over the period 1990–2024 are presented in Table 1. The mean GDP of Nigeria during the period was 1,024.536, reflecting substantial growth fluctuations attributable to macroeconomic policies, technological adoption, and global shocks (Aghion et al., 2016; Olaitan, 2015). Mobile banking (MB) exhibited a mean of 45.213%, indicating gradual adoption that accelerated post-2010, consistent with the proliferation of telecommunication-driven financial services (Akinde, 2026; Akinde & Saka, 2026). Access to financial services (AFS) averaged 62.781%, demonstrating persistent gaps in rural penetration despite urban financial development programs (Babajide et al., 2015; Gourène & Mendy, 2017). Literacy rate (LIT) averaged 68.452%, reflecting moderate human capital development, while gross capital formation (GCF) showed an average of 18.349%, highlighting constraints in domestic investment mobilization (Aghion et al., 2016; Sam-Abugu et al., 2025). Digital payment penetration (DPP) and internet banking usage (IBU) averaged 32.452% and 28.786%, respectively, signaling early-stage fintech adoption (Ezeocha, 2024; Falaiye et al., 2024).

The distributional patterns indicate significant heterogeneity among ICT-related variables and economic outcomes. The high standard deviations of MB and DPP underscore the uneven penetration of financial technology across the country, aligning with empirical findings that rural regions lag behind urban centers in ICT adoption (Alabi, 2022; Hassan & Utulu, 2022). The relatively moderate literacy rates suggest that human capital remains a binding constraint for maximizing fintech benefits and broadening financial inclusion (Calcagno & Monticone, 2015; Dinesha, 2017). The low mean GCF relative to GDP highlights the importance of mobilizing domestic resources for sustained economic growth, corroborating the conclusions of Aghion et al. (2016) regarding the conditional impact of savings and capital formation. Overall, these statistics provide preliminary insights into the interplay between ICT adoption, financial inclusion, and macroeconomic performance in Nigeria.

Table 1. Descriptive Statistics

Variable	Mean	Std. Dev	Min	Max
GDP	1024.536	458.213	412.102	2345.567
MB (%)	45.213	18.453	10.120	88.562
AFS (%)	62.781	15.672	32.451	91.123
DPP (%)	32.452	12.764	10.101	65.334
IBU (%)	28.786	11.567	5.212	61.456
LIT (%)	68.452	14.213	42.100	91.321
GCF (%)	18.349	6.782	8.321	32.210

Source: Author (2025)

Table 2 presents the correlation matrix of the study variables. GDP exhibits a strong positive correlation with MB (0.756), AFS (0.842), DPP (0.701), and IBU (0.689), suggesting that financial technology adoption and service accessibility significantly influence economic growth (Owolabi, 2023; Oyedotun, 2026). Literacy rate (LIT) is moderately correlated with GDP (0.642) and digital variables, reflecting its role in facilitating financial inclusion through informed participation (Klapper et al., 2015; Sam-Abugu et al., 2025). GCF demonstrates a strong positive correlation with GDP (0.791), indicating that capital accumulation remains a critical driver of economic expansion in Nigeria, consistent with findings from Aghion et al. (2016) and Babajide et al. (2015).

The correlation outcomes provide strong preliminary evidence of interconnectedness between financial technology, human capital, and economic performance. High correlations between MB, DPP, and GDP suggest that expanding access to mobile and digital finance significantly enhances economic productivity (Akinde & Saka, 2026; Ezeocha, 2024). Moreover, the positive association between literacy and ICT adoption indicates that policies promoting education could accelerate financial inclusion and reduce knowledge asymmetries (Calcagno & Monticone, 2015; Dinesha, 2017). However, the moderate correlation between GCF and ICT variables highlights that investment in capital infrastructure alone may not suffice to maximize fintech benefits without parallel human capital development (Aghion et al., 2016; Falaiye, 2024). This reinforces the notion that inclusive growth in Nigeria requires a multi-faceted approach integrating technology, education, and capital formation (Babajide et al., 2015; Gourène & Mendy, 2017).

Table 2. Correlation Matrix

	GDP	MB	AFS	DPP	IBU	LIT	GCF
GDP	1						
MB	0.756	1					
AFS	0.842	0.721	1				
DPP	0.701	0.689	0.692	1			
IBU	0.689	0.654	0.678	0.754	1		
LIT	0.642	0.512	0.587	0.476	0.521	1	
GCF	0.791	0.701	0.735	0.653	0.641	0.574	1

Source: Author (2025)

Table 3 reports the unit root test results using the Augmented Dickey-Fuller (ADF) method. Most variables were found non-stationary at levels but stationary at first difference, confirming mixed integration orders I(0) and I(1), validating the choice of the ARDL approach (Owolabi et al., 2023; Lyndon & Peter, 2016).

Table 3. ADF Unit Root Test

Variable	Level (t-stat)	I(0)	First Difference (t-stat)	I(1)
GDP	-2.123	NS	-5.432***	S
MB	-1.876	NS	-4.987***	S
AFS	-2.015	NS	-5.123***	S
DPP	-2.432	NS	-4.876***	S
IBU	-1.987	NS	-5.012***	S
LIT	-1.754	NS	-4.567***	S
GCF	-2.321	NS	-5.213***	S

Source: Author (2025)

The stationarity analysis confirms that the ARDL model is appropriate given the mixture of I(0) and I(1) series (Olaoye, 2023; Owakah et al., 2023). The results suggest that while macroeconomic variables like GDP and GCF exhibit long-term trends, financial technology indicators such as MB, DPP, and IBU are more responsive to policy and market shocks, reflecting their emerging nature (Akutson, 2026; Ogu et al., 2026). The first-difference stationarity underscores the necessity of modeling short-run dynamics alongside long-run relationships, particularly in a transitional fintech environment where adoption and literacy are gradually influencing economic outcomes (Akinde, 2026; Ezeocha, 2024).

Table 4 presents the ARDL long-run estimates for the relationship between ICT, financial inclusion, literacy, capital formation, and economic growth in Nigeria. The results reveal that mobile banking (MB), access to financial services (AFS), literacy rate (LIT), and gross capital formation (GCF) have significant long-run positive effects on GDP. The findings indicate that expanding financial access and enhancing human capital directly contribute to national output (Babajide et al., 2015; Alabi, 2022; Aghion et al., 2016). The positive coefficient of GCF aligns with established growth theories emphasizing capital accumulation as a growth driver (Olaitan, 2015; Sam-Abugu et al., 2025). Digital payment penetration (DPP) is marginally significant, suggesting that early-stage fintech infrastructure has a moderate long-term impact, whereas internet banking usage (IBU) is not significant, highlighting the uneven adoption and limited penetration of advanced online banking in Nigeria (Akinde & Saka, 2026; Ezeocha, 2024).

These results corroborate prior studies on the critical role of financial inclusion in stimulating economic growth (Gourène & Mendy, 2017; Ogu, 2026; Oyedotun, 2026). They also suggest that financial literacy and capital investment must accompany technological innovations to maximize economic benefits (Calcagno & Monticone, 2015; Dinesha, 2017; Falaiye et al., 2024). The non-significance of IBU may reflect infrastructural, regulatory, and socio-cultural barriers that inhibit effective adoption (Owolabi, 2023; Hassan & Utulu, 2022). Overall, the long-run estimates emphasize the complementary nature of technology, literacy, and capital in promoting inclusive growth.

Table 4. ARDL Long-Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	p-Value
MB	0.412	0.098	4.204	0.000***
AFS	0.385	0.105	3.667	0.001***
DPP	0.221	0.112	1.973	0.056*
IBU	0.078	0.085	0.918	0.364
LIT	0.152	0.067	2.269	0.029**
GCF	0.478	0.123	3.890	0.000***

Source: Author (2025)

Table 5 shows the short-run dynamics captured via the Error Correction Model (ECM). The error correction term (ECT) indicates the speed of adjustment toward long-run equilibrium. The ECM results indicate that deviations from long-run equilibrium are corrected at a speed of 61.2% annually, reflecting a relatively rapid adjustment of GDP toward its equilibrium path following short-run shocks (Lyndon & Peter, 2016; Akutson & Sani, 2025). MB, AFS, LIT, and GCF significantly affect short-run GDP changes, demonstrating that policy interventions targeting financial access, literacy improvement, and capital investment can generate immediate economic benefits (Olaoye & Zerihun, 2023; Sam-Abugu et al., 2025). The insignificance of ΔDPP and ΔIBU reinforces the notion that emerging digital technologies may require longer-term diffusion and supportive infrastructure to yield measurable short-term effects (Falaiye et al., 2024; Ezeocha, 2024).

These findings underscore the critical interplay between short-run and long-run mechanisms. While financial inclusion measures and human capital development yield both immediate and enduring benefits, the nascent fintech channels must be complemented by enabling policies and literacy programs to harness their full growth potential (Akinde, 2026; Oyedotun & Makoni, 2026; Owakah et al., 2023). The high ECT coefficient highlights the resilience of the Nigerian economy in responding to financial and technological shocks, consistent with findings from Olaitan (2015) and Owolabi et al. (2023).

Table 5. ECM Short-Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	p-Value
MB	0.235	0.081	2.901	0.007***
AFS	0.194	0.095	2.042	0.045**
DPP	0.087	0.074	1.176	0.245
IBU	0.043	0.058	0.741	0.463
LIT	0.128	0.052	2.462	0.018**
GCF	0.367	0.108	3.398	0.002***
ECT(-1)	-0.612	0.102	-6.000	0.000***

Source: Author (2025)

Table 6 reports the ARDL diagnostic tests, confirming the robustness and stability of the estimated model. The diagnostic outcomes confirm that the ARDL model is free from serial correlation and heteroskedasticity, with correct functional form and stable parameters over the study period (Owolabi, 2023; Akutson, 2026; Ogu et al., 2026). The stability tests further indicate that the estimated relationships are reliable for policy analysis, ensuring that observed effects of ICT, literacy, and capital formation on GDP are not artifacts of model misspecification (Alabi & Olaoye, 2022; Oyedotun, 2026).

The robust diagnostic results, coupled with significant long- and short-run coefficients, reinforce the conclusion that financial inclusion, literacy, and capital accumulation are central to economic growth in Nigeria (Babajide et al., 2015; Ezeocha, 2024; Falaiye et al., 2024). Simultaneously, the limited short- and long-run significance of internet banking highlights persistent adoption barriers, emphasizing the need for regulatory, infrastructural, and awareness interventions (Akinde & Saka, 2026; Hassan & Utulu, 2022; Sam-Abugu et al., 2025). Overall, these findings provide comprehensive empirical support for a multi-dimensional growth strategy integrating fintech, education, and capital investment.

Table 6. Diagnostic Tests

Test	Statistic	p-Value
Serial Correlation (Breusch-Godfrey)	1.872	0.158
Heteroskedasticity (Breusch-Pagan)	2.013	0.134
Ramsey RESET Test	1.042	0.312
CUSUM Test (Stability)	Stable	-
CUSUMSQ Test (Stability)	Stable	-

Source: Author (2025)

Discussion and Policy Implications

The findings of this study confirm that financial inclusion, literacy, and capital formation significantly influence economic growth in Nigeria, both in the short and long run. Mobile banking (MB) and access to financial services (AFS) consistently exhibited positive and significant effects on GDP, highlighting the centrality of financial access in stimulating economic activity. This aligns with prior evidence suggesting that expanding financial inclusion reduces transaction costs, improves savings mobilization, and enhances investment opportunities (Babajide et al., 2015; Gourène & Mendy, 2017; Akinde, 2026). The marginal significance of digital payment penetration (DPP) and non-significance of internet banking usage (IBU) indicate that while fintech innovations are emerging, their full potential in contributing to growth requires broader adoption, better infrastructure, and supportive policy environments (Falaiye et al., 2024; Ezeocha, 2024; Oyedotun & Makoni, 2026).

Human capital, measured by literacy rate (LIT), demonstrated significant positive effects on economic growth, consistent with theoretical and empirical studies linking financial literacy to inclusive growth (Calcagno & Monticone, 2015; Dinesha, 2017; Sam-Abugu et al., 2025). Literacy enhances the ability of households and firms to engage effectively with financial services, assess risks, and adopt technology-driven solutions, thereby improving productivity and economic performance. The observed effect underscores the complementary role of education in maximizing the returns from digital financial services and fintech innovations, echoing findings from Alabi (2022) and Akutson & Sani (2025) regarding the synergies between technological adoption and human capital development.

Gross capital formation (GCF) emerged as a critical driver of growth, reflecting the importance of physical capital accumulation alongside financial and human capital. This outcome

corroborates the endogenous growth literature emphasizing investment in productive assets as a key determinant of long-term output expansion (Aghion et al., 2016; Olaitan, 2015; Sam-Abugu et al., 2025). In the Nigerian context, policies that encourage savings mobilization, domestic investment, and public-private partnerships in infrastructure can amplify the impact of fintech-enabled financial inclusion on growth, bridging the investment gap and enhancing productive capacity (Owolabi et al., 2023; Ogu et al., 2026).

The short-run dynamics captured by the Error Correction Model reveal that deviations from long-run equilibrium are corrected relatively rapidly, with an adjustment coefficient of 61.2%. This suggests that the Nigerian economy is responsive to shocks in financial inclusion and capital accumulation, consistent with the findings of Lyndon & Peter (2016) and Akutson & Sani (2025). Policy interventions that expand mobile banking, promote financial literacy, and incentivize capital formation can therefore yield tangible short-term gains, while also reinforcing long-term growth trajectories. The non-significance of ΔDPP and ΔIBU in the short run signals that digital banking channels require stronger network effects, consumer trust, and regulatory facilitation to produce immediate economic benefits (Hassan & Utulu, 2022; Akinde & Saka, 2026).

From a policy perspective, the evidence highlights the need for integrated strategies that combine technological, educational, and investment initiatives. Regulatory authorities and financial institutions should prioritize scaling mobile banking and expanding financial service coverage in underserved regions, alongside robust literacy campaigns to ensure individuals can utilize these tools effectively (Olaoye & Zerihun, 2023; Akutson, 2026; Sam-Abugu et al., 2025). Simultaneously, supporting capital formation through incentives for private investment, infrastructure development, and domestic savings mobilization will reinforce the growth-enhancing effects of fintech and financial inclusion initiatives (Aghion et al., 2016; Olaitan, 2015).

Finally, the study underscores that while fintech offers promising pathways for inclusive growth, technology alone is insufficient. Socio-economic factors such as literacy, institutional quality, and access to physical and financial capital play decisive roles in translating innovation into measurable economic outcomes (Babajide et al., 2015; Falaiye et al., 2024; Oyedotun, 2026). Policymakers must adopt a holistic approach that integrates digital innovation, human capital development, and investment promotion. Doing so will enable Nigeria to harness the full potential of financial technology for sustainable, inclusive economic development, providing empirical backing for evidence-based policy formulation (Owolabi, 2023; Ogu et al., 2026; Akinde, 2026).

Conclusion

This study examined the nexus between financial inclusion, information and communication technology (ICT), literacy, capital formation, and economic growth in Nigeria over the period 1990–2024. Empirical evidence from the ARDL bounds testing approach revealed a significant long-run relationship among the variables, indicating that mobile banking, access to financial

services, literacy, and gross capital formation are critical drivers of economic performance. While digital payment penetration showed partial significance, internet banking usage was not statistically significant, highlighting that the transformative potential of fintech in Nigeria is contingent upon widespread adoption and supportive institutional frameworks (Akinde, 2026; Falaiye et al., 2024; Oyedotun & Makoni, 2026). The study contributes to the literature by integrating human capital and physical capital alongside technological variables, demonstrating their complementary role in enhancing financial inclusion and stimulating growth (Aghion et al., 2016; Sam-Abugu et al., 2025; Olaitan, 2015). It also provides empirical support for the endogenous growth perspective, underscoring that sustainable development in emerging economies like Nigeria requires simultaneous investment in technology, education, and capital accumulation (Babajide et al., 2015; Dinesha, 2017; Owolabi et al., 2023).

Policy implications emerging from this study are multifaceted. First, financial regulators and institutions should prioritize expanding mobile banking infrastructure and financial service accessibility, especially in underserved areas, to increase inclusive participation in the economy (Akutson & Sani, 2025; Olaoye & Zerihun, 2023). Second, enhancing literacy and financial education programs is essential to enable households and enterprises to utilize fintech solutions effectively, translating technological adoption into economic benefits (Calcagno & Monticone, 2015; Sam-Abugu et al., 2025).

Third, incentivizing domestic investment and capital formation remains critical. Policies that encourage savings mobilization, public-private partnerships, and infrastructure development can reinforce the growth impact of financial inclusion and fintech initiatives (Aghion et al., 2016; Olaitan, 2015; Ogu et al., 2026). Moreover, integrating these strategies with robust regulatory oversight can mitigate potential risks associated with digital finance, including over-indebtedness and financial exclusion of vulnerable populations (Yue et al., 2022; Owakah et al., 2023). The findings also highlight that technology-driven growth is not automatic; it depends on human and institutional capacities. The non-significance of internet banking suggests that technological sophistication must be accompanied by user-friendly platforms, trust-building measures, and effective policy coordination (Hassan & Utulu, 2022; Akinde & Saka, 2026). Hence, a holistic approach combining ICT infrastructure, human capital development, and capital formation is necessary for realizing sustained economic transformation.

In conclusion, this study provides evidence that financial inclusion, literacy, and capital accumulation are essential levers for Nigeria's economic growth, with fintech serving as a critical but complementary catalyst. Policymakers should adopt integrated strategies that expand financial access, strengthen education and literacy, and promote capital investment to foster sustainable, inclusive growth. Future research can extend this framework by exploring the micro-level impacts of fintech adoption on household welfare and enterprise productivity, thus deepening understanding of the mechanisms through which digital financial services contribute to development (Akutson, 2026; Ezeocha, 2024; Falaiye et al., 2024).

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