Remittances, Financial Technology and Financial Inclusion in Nigeria

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ABSTRACT

Purpose
This study examines the influence of remittances and financial technology on financial inclusion in Nigeria over the period 1990–2024.

Methodology
The study employs the Autoregressive Distributed Lag (ARDL) modelling framework to estimate short- and long-run relationships among financial inclusion, remittances, and financial technology adoption. Annual time-series data were obtained from the World Bank's World Development Indicators (WDI) and the International Monetary Fund (IMF). Unit root tests and the ARDL bounds testing approach were applied to establish the existence of a long-run equilibrium relationship among the variables.

Findings
The empirical results indicate that remittances and financial technology exert a statistically significant positive effect on financial inclusion in the short run, suggesting that diaspora inflows and digital technologies act as immediate facilitators of access to financial services. However, the long-run effects of remittances and financial technology are not statistically significant, indicating that these drivers are insufficient to sustain financial inclusion without complementary institutional and infrastructural support. The findings further reveal that weak regulatory frameworks, inadequate digital infrastructure, and low levels of financial literacy constrain the long-term effectiveness of remittances and financial technology in promoting financial inclusion in Nigeria.

Conclusion
The results imply that improvements in financial inclusion in Nigeria are largely policy-driven and short-term rather than structural. To transform short-run gains into sustainable financial inclusion, stronger institutional frameworks, improved regulatory oversight, expanded digital infrastructure, and enhanced financial literacy are required.
The study contributes to the literature by providing long- and short-run evidence on the roles of remittances and financial technology in financial inclusion in a developing economy context, highlighting the importance of institutional and infrastructural factors in sustaining inclusive financial development.

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1. Introduction

Financial inclusion is vital for driving economic growth, reducing poverty, and empowering underserved populations, particularly in developing economies where a large proportion of the population lacks access to formal financial services. It refers to the provision of affordable and appropriate financial products—such as savings, credit, insurance, and digital payment services—to low-income and vulnerable groups (Barkat et al., 2024; Dzeha et al., 2025). In Nigeria, financial inclusion plays a critical role in supporting economic development, improving household welfare, and promoting social inclusion. Despite policy initiatives such as the National Financial Inclusion Strategy (NFIS) introduced by the Central Bank of Nigeria in 2012, a significant segment of the population remains financially excluded due to persistent structural, institutional, and socio-economic barriers (Aro-Gordon, 2017). In this context, remittances and technological innovations—including mobile banking, Fintech applications, and digital payment platforms—have emerged as important mechanisms for narrowing the financial access gap and fostering inclusive growth.

Remittances constitute a major source of external finance and household income in developing economies and often exceed official development assistance and foreign direct investment in terms of volume and stability (Khan et al., 2025; Odhiambo & Musakwa, 2024). Nigeria is the largest remittance recipient in sub-Saharan Africa, accounting for over 35 percent of regional inflows and receiving approximately USD 20 billion in 2023 (Chukunalu, 2024). These inflows not only supplement household income but also promote financial inclusion by encouraging recipients to engage with formal financial institutions through deposit accounts, savings products, and mobile transfer services. Additionally, remittances support microenterprise development, enhance access to credit, and improve households' resilience to economic shocks, particularly among rural and low-income populations (Odhiambo & Musakwa, 2024). However, the developmental impact of remittances in Nigeria remains constrained by high transaction costs, the prevalence of informal transfer channels, and weak integration between remittance service providers and domestic financial institutions. Consequently, the effectiveness of remittances in promoting financial inclusion depends largely on the availability and adoption of efficient financial technologies that enable affordable, transparent, and secure transactions (Eggoh & Bangaké, 2021; Saydaliyev et al., 2020).

Technological innovation has also fundamentally transformed the financial sector, especially in economies with limited traditional banking infrastructure. Digital financial solutions such as mobile money, agency banking, online lending, and Fintech platforms have significantly expanded access to financial services for previously underserved populations (Iwedi, Opara, & Igbanibo, 2023). In Nigeria, Fintech firms including Opay, PalmPay, Kuda, and Paga have reshaped the financial landscape by offering digital wallets, peer-to-peer remittance services, and low-cost payment solutions to millions of users (Ezeocha, 2024; Tiony, 2024). Moreover, the Central Bank of Nigeria's cashless policy, coupled with the rapid expansion of mobile telecommunications, has accelerated the digitalization of financial services, particularly in urban and peri-urban areas. Nevertheless, a persistent digital divide continues to limit financial inclusion in rural regions, where inadequate internet connectivity, low financial literacy, and limited trust in formal financial institutions remain significant barriers (Ugwuanyi & Okore, 2022).

Despite notable progress in digital finance adoption, Nigeria's financial inclusion rate stood at 64.1 percent in 2023, falling short of the 95 percent target initially projected for 2024 (Eromosele et al., 2023). While existing empirical studies have examined the roles

of remittances and financial technology independently in promoting financial inclusion, limited attention has been given to their combined or complementary effects (Eggoh & Bangaké, 2021; Iwedi et al., 2023; Odhiambo & Musakwa, 2024; Saydaliyev et al., 2020). This gap is particularly relevant for Nigeria, where remittance inflows and Fintech adoption have expanded simultaneously, yet structural and institutional constraints continue to hinder inclusive financial outcomes.

Against this backdrop, this study examines the roles of remittances and financial technology in influencing financial inclusion in Nigeria over the period 1990–2024. Specifically, the study seeks to (i) examine the effect of remittances on financial inclusion in Nigeria, and (ii) evaluate the effect of financial technology on financial inclusion in Nigeria. By integrating remittance flows and technological innovation within a unified analytical framework, the study contributes to the literature by providing evidence on how these factors interact to shape financial inclusion outcomes in a developing economy context. The remainder of the paper is organized as follows: Section 2 reviews the relevant literature; Section 3 outlines the methodology and data sources; Section 4 presents and discusses the empirical results; and Section 5 concludes with policy implications and recommendations.

2. Literature Review

This section discusses the underpinning theory, Financial Innovation Theory, and further reviews previous empirical work related to the study.

2.1. Financial Innovation Theory

Joseph Schumpeter (1934) formulated the Financial Innovation Theory (FIT), which was later extended by Miller and Droge (1986) and Silber (1983). The theory posits that institutional and technological innovations within the financial sector drive economic efficiency, competitiveness, and financial inclusion by introducing new tools, processes, and delivery channels that enhance the productivity and accessibility of financial intermediation.

FIT assumes that technological advancement is a primary driver of financial system development, mainly through reductions in transaction costs and the expansion of access to financial products for previously underserved populations (Lerner & Tufano, 2011). The theory emphasizes that innovations such as digital banking, mobile money, and Fintech applications improve operational efficiency within financial institutions and broaden financial access, particularly in developing economies. Furthermore, FIT suggests that competition and deregulation incentivize financial institutions to innovate, leading to the emergence of new savings, credit, and payment mechanisms (Frame & White, 2009). Innovation is thus viewed as a response to market imperfections and regulatory constraints that traditionally limit financial inclusion.

In the context of countries with limited traditional banking penetration, such as Nigeria, FIT implies that digital financial innovations can substitute for conventional banking infrastructure, thereby promoting the inclusion of rural and low-income populations. Accordingly, the theory assumes a causal relationship between technological progress and financial inclusion, mediated by institutional adaptation and consumer trust.

Despite its relevance, FIT has notable limitations. One major criticism is its technologically deterministic nature, as it tends to overemphasize innovation as a driver of financial inclusion while underestimating socio-cultural, regulatory, and infrastructural

barriers (Hickey et al., 2015). The theory implicitly assumes uniform adoption of financial technologies and overlooks disparities in digital literacy, affordability, and trust in formal financial intermediaries. Nonetheless, FIT remains valuable for understanding the transformative role of technology in restructuring financial systems. It effectively explains how innovations such as mobile banking and Fintech-based remittance platforms can bypass traditional constraints, extend financial services to wider populations, and reduce service delivery costs (Harsono & Suprapti, 2024). The adaptability of FIT to contemporary financial systems makes it particularly relevant for analyzing the evolution of digital financial inclusion in developing economies like Nigeria, where conventional banking systems often fail to adequately serve vulnerable groups.

2.2. Financial Inclusion Theory

The development of Financial Inclusion Theory stems from the publications of Beck, Demirguc-Kunt, and Levine (2007) and has been institutionalized by the World Bank and UN development systems. The theory posits that poverty reduction, economic participation, and inclusive growth are facilitated through access to affordable, practical, and sustainable financial services, including savings, credit, insurance, and payments.

It asserts that when financial services are available, affordable, and effectively regulated, they empower individuals to make informed economic decisions and manage risks. The theory further assumes that barriers to inclusion—such as financial illiteracy, high transaction costs, and institutional exclusion—can be mitigated through targeted policies and innovations. In the Nigerian context, where a significant portion of adults remains unbanked, the theory suggests that expanding access to digital financial platforms and remittance flows can enhance economic participation and reduce inequality.

However, Financial Inclusion Theory has a normative limitation: it inherently treats inclusion as beneficial without fully considering potential risks such as over-indebtedness, financial fraud, or unequal access to digital services (Ozili, 2020). It may also overlook the possibility that financial inclusion, if not coupled with adequate literacy and safeguards, could replicate existing economic inequalities. Despite this, the theory's multidimensional framework makes it invaluable for explaining empowerment and development through financial participation. It aligns with global development goals (e.g., SDG 8 and SDG 10) and adapts to technological advancements. By integrating policy, institutional, and behavioral dimensions, the theory provides a robust paradigm for examining the role of remittances and digital technology in enhancing access, particularly in underbanked economies such as Nigeria.

2.3. Empirical Reviews

2.3.1. Remittances and Financial Inclusion

Empirical studies demonstrate that remittances significantly promote financial inclusion and advance development objectives in developing economies (Barkat et al., 2024; Khan et al., 2025; Odhiambo & Musakwa, 2024; Eggoh & Bangaké, 2021; Saydaliyev et al., 2020). Barkat et al. (2024), using a system GMM and the Lewbel estimator to address endogeneity, found that remittances contribute substantially to achieving the Sustainable Development Goals (SDGs) across 109 developing countries from 2000 to 2022. Their findings indicate that remittances' effect on the SDGs is mediated by financial inclusion, suggesting that remittance inflows foster inclusive financial ecosystems and improve welfare outcomes. This aligns with Khan et al. (2025), who analyzed 79 developing

countries from 2011 to 2021 using random-effects, fixed-effects, and GMM estimators. They confirmed that remittances positively influence economic growth, with the impact amplified by high financial inclusion and human capital. The study underscores the complementary relationship between financial inclusion and remittance inflows, indicating that countries with more developed financial systems are better positioned to leverage remittances for growth. Similarly, Odhiambo & Musakwa (2024), in their analysis of 26 sub-Saharan African countries using the GMM technique, found that remittances positively affect the development of financial institutions, particularly in contexts of high governance quality and effectiveness. Their evidence suggests that robust governance enhances the relationship between remittances and financial development, highlighting institutional quality as a critical factor in converting remittance inflows into inclusive financial benefits. Collectively, these studies affirm that remittances, when supported by financial inclusion and governance reforms, serve as effective instruments for achieving sustainable and equitable growth.

Further empirical evidence reveals nuanced, and in some cases nonlinear, associations between remittances and financial inclusion (Eggoh & Bangaké, 2021; Saydaliyev et al., 2020; Tu et al., 2019; Amin &Jalil, 2018). Eggoh and Bangaké (2021), utilizing GMM and panel threshold regressions across 64 developing countries from 2004 to 2017, identified a nonlinear relationship in which remittances enhance financial inclusion up to a certain threshold of financial development, beyond which the effect becomes negligible. This finding suggests diminishing marginal returns as financial systems mature. The results support the view that remittances initially substitute for weak financial systems but later complement them as institutions strengthen. Similarly, Saydaliyev et al. (2020) found that remittances promote financial inclusion when institutional quality is high. Their dynamic panel data analysis (2011–2018) indicates that trust in financial institutions amplifies the effect of remittances on financial inclusion. This institutional dependency aligns with Tu et al. (2019), who, through GMM and structural equation modeling, determined that remittances and financial inclusion jointly drive economic growth across income groups, particularly in middle-income countries. They advocate for integrated policy approaches to attract remittance inflows and enhance inclusion as strategies to escape middle-income traps. At the microeconomic level, Amin and Jalil (2018) used household data from Pakistan and a Logit model to show that households receiving remittances are significantly more likely to use formal financial services. Their findings indicate that both foreign and domestic remittance inflows increase the likelihood of households utilizing formal banking channels. Collectively, these studies demonstrate that remittances can foster financial inclusion on both the demand and supply sides, but the extent of this relationship is critically influenced by institutional quality, financial depth, and the level of development.

Besides, the empirical literature also emphasizes the contingent and occasionally asymmetric character of the remittance-financial inclusion relationship (Naceur, Chami & Trabelsi, 2020; Issabayev et al., 2020; Alabdulrazag & Alshogeathri, 2024; Dzeha et al., 2025). In 187 countries between 2004 and 2015, Naceur et al. (2020) estimated a U-shaped relationship, with remittances replacing formal finance at low remittance-to-GDP levels and complementing formal financial access and intermediation at higher levels (13). On the same note, Issabayev et al. (2020) found that remittances negatively affect inclusion in low-remittance countries, and the correlation becomes positive as remittances increase, indicating a nonlinear, institution-specific trend. Asymmetric long- and short-run effects of remittances on financial inclusion were also reported by Alabdulrazag and Alshogeathri (2024), who applied an NARDL model to Jordan

between 1990 and 2022, confirming the nonlinear dynamics. Their results highlight the need to spur remittance inflows to strengthen the financial sector. Many micro-level and gender-focused studies indicate that remittances can enhance financial inclusion across various demographic and socio-economic groups (Basheer, 2023; Nguyen et al., 2022; Ogede et al., 2023; Nyanhete, 2017). Basheer (2023), using pooled OLS on international female data from the GPI (2017) database, found that remittances play a crucial role in promoting female financial inclusion, which in turn encourages savings and the use of formal institutions for loans. These findings suggest that remittances serve as an alternative financial resource, fostering the economic empowerment of women. Similarly, Nguyen et al. (2022), applying 2SLS to household data from Vietnam, concluded that internal remittances significantly increase the likelihood of households owning bank accounts and card services, with a greater effect observed in rural areas. Ogede et al. (2023), analyzing data from 1996 to 2020 in sub-Saharan Africa using pooled mean-group estimation, demonstrated that the positive relationship between remittances and economic growth is strengthened by financial inclusion, indicating that financial inclusion channels remittance inflows into productive economic activities.

2.3.2. Technology and Financial Inclusion

Financial technology affects financial inclusion in Nigeria and other countries in various ways, with an overall positive impact (Iwedi, Opara, & Igbanibo, 2023; Ezeocha, 2024; Tiony, 2024; Ugwuanyi & Okore, 2022). Iwedi et al. (2023) used vector autoregression (VAR) and found that web banking significantly increases financial inclusion. ATM, POS, and mobile banking technologies also have positive effects, but these are statistically insignificant. This suggests digital channels drive inclusion, but effectiveness depends on user access and adoption. Ezeocha (2024) reported that FinTech has transformed access to financial services, making the system faster and more accessible. Similarly, Tiony (2024) found that fintech innovations such as mobile money, digital banking, and blockchain have substantially improved financial inclusion and economic development in Kenya. Mobile money services, such as M-Pesa, are particularly transformative. The Kenyan case complements the Nigerian findings and shows that, with an enabling environment, financial innovation supports financial inclusion, SME development, and GDP growth. However, Tiony (2024) notes that regulatory and cybersecurity challenges persist. These challenges emphasize that financial inclusion outcomes depend not only on technology but also on policy and infrastructure.

Iwedi et al. (2023) used secondary time-series data. In contrast, Ugwuanyi and Okore (2022) used primary survey data, providing context-specific insights into behavioral and accessibility factors. Their findings suggest that Fintech addresses spatial and economic disparities in rural areas. Nkechika (2022) asserts that digital financial services are transforming the Nigerian financial landscape. These services meet the needs of underserved populations through technological solutions. This supports the argument that digital transformation exposes market gaps and prompts more governmental intervention. Rifai and AlBaker (2025) also found that digital payments, InsurTech, and lending platforms enhance inclusion, especially for women, youth, and SMEs. However, they note that marginalized groups still face barriers. This underscores the need for balanced regulation and stakeholder collaboration. Abdullahi et al. (2025) found that financial literacy mediates the relationship between Fintech adoption and financial inclusion among SMEs in Abuja. Their SEM analysis shows that technology alone is not enough; financial education is needed to maximize inclusion. This supports policies that advocate integrating financial literacy programs into digital finance strategies to improve inclusion across economic sectors.

Maina and Nyamasege (2024) found that mobile money and mobile banking significantly enhance financial inclusion in Kenya. This is especially true given the country's geographical and infrastructural constraints. Their findings support the view that financial technology democratizes access and increases inclusion, especially for rural populations. Odeleye and Oyeneye (2022) used the ARDL approach. They observed a negative short-term but positive long-term relationship between financial technology and financial inclusion in Nigeria. This suggests that the early phases of technological integration may disrupt existing systems before eventually providing inclusionary benefits.

2.4. Research Gap

Numerous studies have investigated the contributions of remittances and technology to financial inclusion in developing economies (Barkat et al., 2024; Khan et al., 2025; Odhiambo & Musakwa, 2024; Iwedi et al., 2023; Ezeocha, 2024; Dzeha et al., 2025), yet their findings remain inconclusive. For example, Barkat et al. (2024) and Khan et al. (2025) identified a significant and positive impact of remittances on financial inclusion and sustainable growth, mediated by institutional and human capital formation. In contrast, Eggoh and Bangaké (2021) and Naceur et al. (2020) reported a nonlinear or threshold effect, indicating that remittances promote inclusion only when specific financial or institutional conditions are satisfied. Similarly, while Iwedi et al. (2023) and Olusanya and Eucharia (2024) found that financial technology advances inclusion in Nigeria, Odeleye and Oyeneye (2022) highlighted short-term adverse effects resulting from transitional inefficiencies. Although Dzeha et al. (2025) demonstrated that Fintech amplifies the developmental impact of remittances in Africa, few studies have examined the mediating roles of remittances and technology in financial inclusion in the Nigerian context over an extended period. Additionally, existing research employs diverse methodologies, such as VAR, ARDL, GMM, and qualitative approaches, which limit comparability and generalizability. Consequently, a significant empirical gap persists regarding the mediating role of remittances and technology in advancing inclusive finance within Nigeria's evolving digital and macroeconomic environment from 1990 to 2024.

3. Methodology

3.1. Data

This study employs annual time-series data for Nigeria from 1990 to 2024, sourced from the World Bank World Development Indicators (WDI) and the International Monetary Fund (IMF) Database. Financial inclusion (FINt), the dependent variable, is proxied by mobile money transactions in the reference year, providing an effective measure of financial engagement through digital financial services. The primary independent variables are personal remittances received as a percentage of GDP (REMt), representing external capital inflows that enhance liquidity and access to formal financial systems, and fixed broadband subscriptions per 100 people (FINTECHt), reflecting the technological infrastructure that supports digital financial intermediation. Including these indicators enables assessment of the impact of remittance inflows and technological connectivity on financial inclusion outcomes in Nigeria. The selected timeframe (1990–2024) captures both structural and technological changes in the Nigerian financial environment. The use of uniform, internationally accepted datasets establishes a robust empirical foundation for analyzing the mediating role of remittances and technology in financial inclusion.

A multivariate regression model is used to examine the relationship between remittances, technology, and financial inclusion (measured by domestic credit to the private sector) as a function of remittances, mobile penetration, internet usage, and economic growth. The functional form of the model is as follows:

$$lnFIN_t = \alpha + \beta_1 ln_{REMt} + \beta_2 ln_{FINTECHt} + \mu_t \quad \text{---------- (1)}$$

Where:
FIN_t = Mobile money transactions (during the reference year)
REM_t = Personal remittances received (% of GDP)
$FINTECH_t$ = Fixed broadband subscriptions (per 100 people)
β_i = Parameters to be estimated
μ_t = Error term

The model is further extended to both short-run and long-run dynamics using the Autoregressive Distributed Lag (ARDL) framework, as recommended by Pesaran, Shin, and Smith (2001). The ARDL bounds testing approach is suitable because it accommodates regressors of order I(0) and I(1) and remains effective with small sample sizes.

Prior to estimation, unit root tests such as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) are conducted to confirm that the variables are not integrated beyond the first order. Subsequently, the ARDL test is employed to determine the existence of a long-run equilibrium relationship among the variables. This modelling approach enables the analysis of both direct and dynamic effects of remittances and technological uptake on financial inclusion in Nigeria.

4. Results and Discussions

Table.1.Descriptive Statistics

Variable	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque–Bera	Prob.	Obs.
FIN	9.320	0.000	1.7,30	0.000	3.400	4.073	18.628	452.954	0.000	35
REM	3.548	3.999	11.341	0.019	2.759	0.528	2.994	1.625	0.444	35
FINTECH	0.016	0.000	0.059	0.000	0.022	0.838	2.017	5.506	0.064	35

Notes: FIN denotes financial inclusion, REM represents remittance inflows, and FINTECH refers to financial technology adoption. All statistics are based on 35 observations. Values are rounded to three decimal places. Jarque–Bera statistics and corresponding probabilities test the null hypothesis of normality.

Source: **Author's own elaboration**

Table 1 presents descriptive statistics for the study variables: Financial Inclusion (FIN), Remittances (REM), and Financial Technology (FINTECH). Over the 35-year period, FIN, REM, and FINTECH had mean values of about 9.32, 3.55, and 0.016. Substantial differences between the maximum and minimum values, and high standard deviations, indicate considerable variability in these measures during the study period. All variables have positive skewness, indicating right-tailed distributions with a few high values. This is especially true for FIN, with a skewness of 4.07. FIN's high kurtosis (18.63) indicates a leptokurtic distribution with heavy tails and extreme outliers. In contrast, REM (2.99) is nearly mesokurtic, while FINTECH (2.02) is closer to platykurtic.

According to the Jarque-Bera statistic, only FIN has a probability value below 5% (0.0000), indicating a non-normal distribution. In contrast, REM and FINTECH have p-values above 5%, suggesting distributions that are approximately normal. Overall, these descriptive findings suggest that remittance and financial technology indicators exhibit moderate dispersion and near-normal distributions, whereas financial inclusion shows high volatility and non-normality. This pattern reflects underlying structural and institutional changes in Nigeria's financial sector during the study period.

Table.2.Unit Root Test Results (ADF and Phillips–Perron Tests)

Variable	ADF Statistic	5% Critical Value	PP Statistic	5% Critical Value	Order of Integration
FIN	22.570	−2.981	6.756	−2.951	I(1)
REM	−4.306	−2.954	−3.822	−2.954	I(0)
FINTECH	−5.464	−2.954	−5.341	−2.954	I(1)

Notes: ADF and PP denote Augmented Dickey–Fuller and Phillips–Perron unit root tests, respectively. The null hypothesis for both tests is that a unit root is present. Critical values are reported at the 5% significance level. I(0) and I(1) indicate stationarity at levels and first differences, respectively.

Source: **Author's own elaboration**

Non-stationarity frequently occurs in time series data, posing significant challenges for econometric estimation and inference. Direct regression analysis with non-stationary variables can yield spurious results, including inflated coefficients of determination (R2) and misleading t-statistics. These issues undermine the reliability of parameter estimates and the validity of hypothesis tests. To ensure consistent and meaningful regression outcomes, it is essential to apply unit root tests to assess the stationarity of regressors. In this study, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests were employed to determine the integration order of the variables. The results of these tests are presented in Table 2.

The results show that the remittances variable is stationary at the level, indicating an order zero integration (I(0)). In contrast, both financial inclusion and financial technology (FINTECH) are non-stationary at the level but become stationary after first differencing in both the ADF and PP tests, indicating integration of order one (I(1)). The presence of both I(0) and I(1) variables supports the application of the Autoregressive Distributed Lag (ARDL) bounds testing approach. This method is appropriate because it accommodates mixed integration orders and effectively captures both short-run dynamics and long-run equilibrium relationships among the variables.

Table.3.ARDL Bounds Cointegration Test

Model	F-statistic	Lower Bound I(0)	Upper Bound I(1)	Decision
FIN	4.710	3.230	3.750	Cointegration

Notes: Critical values are based on the 5% significance level fromPesaran et al. (2001). The null hypothesis is no long-run relationship among the variables.

Source: **Author's own elaboration**

The unit root test results show that the variables are a mix of I(0) and I(1) processes. As a result, the Autoregressive Distributed Lag (ARDL) bounds testing procedure is used to assess the existence of a long-run relationship among the variables. The ARDL bounds test is well-suited for this purpose. It accommodates regressors with different integration orders, provided none are integrated of order 2 (I(2)). The bounds testing approach helps determine whether financial inclusion (FIN), remittances (REM), and financial

technology (FINTECH) share a long-run equilibrium relationship. Table 3 contains the test results. For the bounds test, the null hypothesis states that no long-run relationship exists among the variables. If the calculated F-statistic exceeds the upper bound critical value at the 5% significance level, the null hypothesis is rejected. Table 3 shows that the F-statistic of 4.71 is greater than the upper-bound critical value of 3.75. This result is strong statistical evidence against the null hypothesis. It supports the presence of cointegration among the variables. Therefore, remittances, financial technology, and financial inclusion in Nigeria have a stable long-run equilibrium relationship. This finding justifies estimating both the long- and short-run dynamics using the ARDL framework.

Table.4.Lag Length Selection Criteria

Lag	LogL	LR Statistic	FPE	AIC	SC	HQ
0	−602.792	—	41,591,202.000	28.895	29.060	28.956
1	−457.763	255.528	89,648.980	22.751	23.578	23.054
2	−423.858	53.280*	39,084.440*	21.898*	23.387*	22.444*
3	−410.543	18.387	47,019.520	22.026	24.177	22.814

Notes: LR denotes the sequential modified likelihood ratio test statistic. FPE, AIC, SC, and HQ represent the final prediction error, Akaike information criterion, Schwarz criterion, and Hannan–Quinn criterion, respectively. * indicates the optimal lag length selected by the respective criterion.

Source: **Author's own elaboration**

Table 4 presents the results of the optimal lag selection criteria, and LR, FPE, AIC, SC, and HG indicate that the optimal lag is 2. Therefore, the optimal lag test indicates that lag 2 best meets the criteria.

Table.5.ARDL Error Correction Model Results: Financial Inclusion (FIN)

Panel A: Short-Run Dynamics (ECM)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ΔFIN(−1)	−16.992	0.796	−21.342	0.000
ΔFIN(−2)	−23.225	1.609	−14.430	0.000
ΔREM	−246,407.422	27,500,529.122	0.000	0.000
ΔFINTECH	−2,923,745,481.759	3,114,601,140.428	0.000	0.000
ECT(−1)	1.128	0.033	2.432	0.000

Panel B: Long-Run Coefficients

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REM	15,278.644	1,705,180.478	0.009	0.993
FINTECH	181,288,640.355	192,501,330.926	0.942	0.355
Constant	−1,191,054.247	5,892,937.432	−0.202	0.841

Notes: Δ denotes first differences. ECT(−1) represents the error correction term derived from the long-run cointegrating relationship. FIN is the dependent variable. REM denotes remittances and FINTECH represents financial technology. Probabilities are based on t-statistics.

Source: **Author's own elaboration**

Table 5 presents regression results that examine the dynamics of remittances (REM), financial technology (FINTECH), and financial inclusion (FIN) in Nigeria over both short- and long-run periods. The ARDL model was estimated at the 5 percent significance level. The first and second lagged differences of financial inclusion [D(FIN(-1)) and D(FIN(-2))] are negative and statistically significant ($p < 0.01$) in the short run. This finding indicates that previous levels of financial inclusion exert a

significant negative effect on current financial inclusion, reflecting a short-term adjustment process to shocks that is corrected in subsequent periods. The coefficients for remittances (D(REM)) and financial technology (D(FINTECH)) are both statistically significant and substantial, suggesting high volatility or potential scale effects in the data. The error-correction term (CointEq(-1)) is positive and highly significant ($p < 0.01$), supporting the existence of a long-run equilibrium relationship among the variables and a rapid adjustment toward equilibrium. The coefficients for remittances (REM) and financial technology (FINTECH) are statistically non-significant ($p = 0.9929$ and 0.3550, respectively) in the long term, suggesting that the effects of both are not long-lasting. This means that although remittances and technological innovation can cause short-term changes in financial participation, their effects diminish over the long run, perhaps due to structural constraints, including poor regulatory systems, insufficient digital infrastructure, and unreliable financial policies in Nigeria. The fact that the constant term (C) does not matter further indicates that other macroeconomic forces, currently out of view, can also drive financial inclusion, in addition to remittance inflows and Fintech development. On the whole, the findings indicate that the relationships between remittances and financial technology are the main factors determining short-term changes in financial inclusion rather than the direction of its development. Enhancing institutional underpinning of digital finance, encouraging regulatory coherence, and using remittance channels to access formal financial services may help to make the Nigerian financial system more inclusive in the long term.

Table.6.Breusch–Godfrey Serial Correlation LM Test

Test Statistic	Value	Probability
F-statistic	1.471	0.250
Obs. × R^2 (Chi-square)	3.494	0.174

Notes: The null hypothesis of the Breusch–Godfrey LM test is no serial correlation in the residuals up to order two. Probabilities are reported in parentheses.

Source: **Author's own elaboration**

TThe Breusch-Godfrey Serial Correlation LM test results show an F-statistic of 1.4709 with a probability of 0.2497. The R-squared value is 3.4942 with a probability of 0.1743, as presented in Table 6. Since these probability values exceed the 5% significance level, the null hypothesis of no serial correlation cannot be rejected. Consequently, the model residuals are not autocorrelated. This outcome indicates that the errors are independent. The absence of serial correlation suggests that the estimated coefficients are efficient. The regression results are statistically valid. Therefore, the model satisfies a key assumption of the classical linear regression framework. This enhances the validity of the estimated relationships among remittances, financial technology, and financial inclusion.

Table.7.Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	7.338808	Prob. F(5,26)	0.0002
Obs*R-squared	18.72920	Prob. Chi-Square(5)	0.0022
Scaled explained SS	45.86349	Prob. Chi-Square(5)	0.0000

Table.7.Breusch–Pagan–Godfrey Test for Heteroskedasticity

Test Statistic	Value	Probability
F-statistic	7.339	0.000
Obs. × R^2 (Chi-square)	18.729	0.002
Scaled Explained SS (Chi-square)	45.863	0.000

Source: **Author's own elaboration**

Table 7 presents the results of the Breusch-Pagan-Godfrey heteroskedasticity test, indicating an F-statistic of 7.3388 (p = 0.0002), Obs*R-squared of 18.7292 (p = 0.0022), and a scaled explained sum of squares of 45.8635 (p = 0.0000). Since all probability values are below the 5% significance threshold, the null hypothesis of homoskedasticity is rejected. This finding suggests that the residuals exhibit heteroskedasticity, meaning the error variance is not constant across observations. While heteroskedasticity may reduce the efficiency of coefficient estimates and the accuracy of standard errors, it does not introduce bias into the coefficient estimates. To address this issue, robust standard errors or Generalized Least Squares (GLS) methods can be employed to mitigate heteroskedasticity and improve inference reliability. Overall, despite heteroskedasticity, the model remains valid; however, additional diagnostic checks could further strengthen its robustness.

4.1. Discussion

The regression analysis indicates that the effects of remittances (REM) and financial technology (FINTECH) on financial inclusion (FIN) are dynamic and context-specific in the short term, but not in the long term. Statistically significant lagged coefficients for financial inclusion suggest the presence of short-run adjustment mechanisms, consistent with financial adaptation processes in which short-term shocks to financial access are corrected over the long run. These findings support the argument that remittances and technological diffusion drive short-term improvements in financial participation by providing liquidity, enabling digital payments, and expanding access channels. However, the high coefficients and potential volatility suggest instability, likely stemming from uneven remittance inflows and inconsistent technological adoption in Nigeria. The significant error-correction term further supports a long-run equilibrium relationship among the variables, although the speed of adjustment may reflect reactive responses rather than long-term structural changes.

These findings are partially consistent with empirical research indicating that remittances improve financial inclusion in developing economies, although their effects depend on institutional and infrastructural contexts. Studies by Barkat et al. (2024), Khan et al. (2025), and Odhiambo and Musakwa (2024) report that remittances enhance inclusion when governance and financial systems are robust. In contrast, the Nigerian evidence indicates long-run insignificance, suggesting that remittances cannot sustain inclusion due to structural bottlenecks, including weak regulatory oversight, fragmented financial infrastructure, and distrust in formal systems. This aligns with Eggoh and Bangaké (2021) and Saydaliyev et al. (2020), who identified nonlinear and institution-specific remittance effects, with diminishing marginal returns at higher levels of financial development. Similarly, Naceur et al. (2020) and Dzeha et al. (2025) found that remittances only enhance inclusion when institutional quality and fintech adoption are advanced. Therefore, the long-run insignificance observed in Nigeria may reflect a threshold effect, where remittances initially compensate for weak financial systems but cannot sustain inclusion without institutional support.

Regarding financial technology, the observed short-run significance and long-run insignificance align with the findings of Iwedi et al. (2023) and Odeleye and Oyeneye (2022), who reported that Fintech innovations initially promote inclusion but experience diminishing returns due to infrastructural and regulatory constraints. The short-run effects suggest rapid, behavioral responses to digital finance, while the lack of long-term significance is attributed to limited digital literacy, cybersecurity risks, and policy inconsistencies. Empirical studies by Ezeocha (2024), Ugwuanyi and Okore (2022), and

Abdullahi et al. (2025) similarly emphasize that technology alone cannot ensure long-term inclusion without adequate literacy, infrastructure, and regulation. Overall, the results confirm that remittances and Fintech are catalytic yet temporary drivers of financial inclusion in Nigeria. To transform these gains into sustainable outcomes, policy frameworks should prioritize institutional reforms, digital infrastructure, and trust-building mechanisms to strengthen Nigeria's financial inclusion trajectory over time.

5. Conclusion and Recommendations

This study examined the influence of remittances and financial technology on financial inclusion in Nigeria from 1990 to 2024 using the ARDL model. The findings show that both remittances and financial technology significantly enhance financial inclusion in the short term. However, their long-term effects are limited. Remittances and Fintech platforms provide direct access to financial services. Yet, their sustained impact is constrained by institutional weaknesses, inadequate infrastructure, and inconsistent regulatory standards. The results suggest that financial inclusion in Nigeria is more responsive to immediate interventions than to structural reforms. This indicates a predominantly short-term effect. The pattern aligns with trends in other developing economies, where remittances and Fintech serve as temporary facilitators rather than enduring foundations for inclusion. Nigeria's challenges with financial inclusion are mainly institutional, infrastructural, and behavioral. They are not primarily technological or related to financial inflows.

Based on these findings, several policy recommendations are proposed. First, the Central Bank of Nigeria (CBN) should strengthen regulatory frameworks for digital finance. This effort should emphasize enhanced security, transparency, and platform interoperability. Second, government initiatives should focus on developing robust digital and physical infrastructure to support Fintech-driven inclusion, especially in rural areas. Third, remittance channels should be further integrated into the formal financial system. This can be achieved by reducing transaction costs and promoting diaspora bonds and mobile-based remittance services. Fourth, financial literacy campaigns are essential to increase public confidence and encourage the use of formal financial services. Finally, institutional reforms should improve governance, consumer protection, and innovation. These steps are critical for transforming short-term access to financial services into sustained financial inclusion and inclusive economic growth in Nigeria.

Author Contributions

The author contributed to conceptualization, formal analysis, results estimation, data tabulation, and manuscript revision, including addressing reviewers' comments.

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Conflicts of Interest

No conflict of interest.

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