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Original Article

Financial Technology on Financial Inclusion in Nigeria

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Abstract: *This study examines the impact of financial technology (fintech) on financial inclusion in Nigeria over the period 2005–2025. It is anchored on the Innovation Diffusion Theory and the Technology Acceptance Model. Financial inclusion is proxied by account ownership, access to banking services and usage of financial products, while fintech development is measured by automated teller machines (ATM), point-of-sale (POS) systems, mobile money and electronic payment transactions. The study adopts a quantitative design using secondary time-series data from the Central Bank of Nigeria, the Nigeria Inter-Bank Settlement System, the World Bank and Enhancing Financial Innovation and Access. Since all the variables are integrated of order one, I(1), a single-equation Error Correction Model (ECM), estimated through the Engle–Granger two-step procedure, is employed to analyze the long-run and short-run relationships. The findings reveal that electronic payment transactions have a positive and statistically significant effect on financial inclusion in both the long run and the short run, while the effects of ATM, POS and mobile money transactions are not statistically significant. The error correction term is negative and significant, indicating that about 51.2% of any short-run disequilibrium is corrected within one year. The study concludes that fintech has played a crucial role in expanding financial access, but that digital illiteracy, infrastructural deficits and regulatory constraints limit its full potential. It recommends that policymakers strengthen regulatory frameworks, promote agent banking and invest in digital infrastructure to foster inclusive financial development in Nigeria.*

Keywords: *Electronic Payments, Error Correction Model, Financial Inclusion, Fintech, Mobile Money, Nigeria.*

I. INTRODUCTION

The financial sector has undergone profound transformation in recent decades, driven largely by advances in information and communication technology. These developments have given rise to financial technology (fintech), a broad term that encompasses innovative digital solutions designed to improve the delivery and accessibility of financial services. Fintech has reshaped traditional financial systems by enabling faster, more efficient, and cost-effective transactions through platforms such as mobile banking, electronic payments, digital lending, mobile money services, and agent banking. As digital technologies continue to evolve, fintech has emerged as a critical tool for promoting inclusive economic growth, particularly in developing economies where access to conventional banking services remains limited.

Financial inclusion can be defined as providing access to affordable financial products and services for all parts of society, particularly those on low incomes and without access to formal banking systems. Financial inclusion is generally regarded as an important factor in reducing poverty; improving people's ability to participate economically; and supporting long-term economic growth. When individuals or businesses can access formal financial services, they are able to safely deposit their money; obtain credit when required; manage risks associated with their business; pay bills efficiently; and engage in more active participation within the local economy. Unfortunately, despite the fact that financial inclusion plays such an essential role in improving people's lives, a large number of people in developing countries like Nigeria have historically been excluded from the formal financial system because of barriers including geographical isolation; high transaction costs; lack of adequate financial infrastructure; and low levels of financial education.

The Federal Republic of Nigeria, which is the largest economy and most populous country in Africa, has been making significant progress towards enhancing financial inclusion in recent years. Regulatory bodies within the country have implemented numerous policy initiatives and reforms to increase access to financial services and decrease the number of adults who do not have access to any form of formal financial service. Despite having made such advancements, financial exclusion remains a severe problem in Nigeria, particularly with respect to those living in rural areas, female populations, informal business owners/operators, and individuals with lower levels of income. Due to the continued existence of this issue, there is an ever-increasing requirement for innovative solutions that can overcome some of the restrictions typically placed upon traditional financial institutions.

The fast expansion of fintech has produced fresh avenues for providing financial services to those areas of the Nigerian population that were previously underserved. Fintech includes various forms of technology-driven financial service delivery, including but not limited to: mobile money platforms, point-of-sale (POS) terminal devices, Automated Teller Machine (ATM)

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systems, internet banking applications and other digital payment systems. Each of these forms of fintech has fundamentally changed how financial services are provided and used by customers. As such, each form of fintech has reduced the requirement of physical bank branch operations, lowered the cost of conducting transactions, improved the customer experience through convenience, and increased the overall operational efficiencies of completing financial transactions.

Although there has been significant expansion in the use of FinTech throughout Nigeria, there are still questions as to what degree the increased adoption of FinTech will translate into greater financial inclusion. Some studies indicate that FinTech improves access to financial services through eliminating traditional barriers; however, other studies suggest that limitations such as insufficient digital infrastructure, cybersecurity issues, uncertain regulatory environments, and lack of digital literacy may limit the impact of FinTech. The varying viewpoints regarding FinTech and financial inclusion highlight the need for empirical research on how FinTech development impacts financial inclusion within the Nigerian environment.

In contrast with what has occurred prior to this time, this research is designed to examine the effects of financial technology (fintech) on financial inclusion within Nigeria during the years 2005-2025. This research also addresses how several major indicators of financial technology ATM transactions, POS transactions, mobile money transactions, and electronic payments affect access to and use of formal financial services. The study is anchored on the Innovation Diffusion Theory and the Technology Acceptance Model, which explain why users adopt new financial technologies and therefore why greater use of fintech channels is expected to raise financial inclusion. To achieve the objective, the study employs a single-equation Error Correction Model (ECM), estimated through the Engle–Granger two-step procedure, to capture both short-run and long-run dynamics in the relationship between fintech development and financial inclusion. The ECM is appropriate because the unit root tests show that all the variables are integrated of the same order, I(1), so that a long-run relationship can be examined and the speed of adjustment to equilibrium estimated within one equation. The study does not require a system of equations, because it has a single dependent variable, financial inclusion, and does not model interaction or feedback among the variables, which is the purpose of the Vector Error Correction Model (VECM). The study employs the same methodology to examine short-run and long-run associations. Therefore, the results of the research will contribute to the expanding body of knowledge about digital finance and its relationship with inclusive development. It is anticipated that the findings of the study will offer significant insight into how policymakers, financial institutions, regulators, and other stakeholders can use fintech to promote broad-based financial inclusion and sustainable economic development in Nigeria.

II. LITERATURE REVIEW

A) Conceptual Review

FinTech is an area where technology-based approaches have been used to provide a wide variety of financial products and services. Some of these include: mobile banking, online banking, electronic payment options, digital loan processing, blockchain technology, mobile money service offerings, and agent banking. In general terms, the goal of all of these technologies is to increase efficiency in the delivery of financial services, lower the cost of transactions, and broaden the availability of financial services. There has been a significant transformation in the way that traditional banks operate as a result of the increased use of technology within the financial sector. New methods for providing financial services to consumers in both developed and developing countries have emerged as a result of this transformation (Arner, Barberis, & Buckley, 2016; Ozili, 2018).

FinTech is becoming a key tool to close the gap between those who have access to financial services and those who do not. FinTech provides consumers with the ability to save money, make payments, send/receive funds, and obtain loans through digital means rather than solely through the use of traditional banks. The growing number of people with mobile phones and access to the Internet has also contributed to a rapid increase in the adoption of FinTech throughout Africa, such as Nigeria (Demirgüç-Kunt et al., 2022; World Bank, 2022).

Financial inclusion is a term that defines how accessible and affordable financial products and services are for every individual in a society, especially those who fall into low-income categories or are under-represented. Financial inclusion includes providing access to savings accounts, credit options, insurance programs, and payment methods. The concept of financial inclusion has received worldwide recognition due to its potential to help alleviate poverty, empower individuals economically and create sustainable development (World Bank, 2022; United Nations, 2021).

The use of formal financial services increases the welfare of households, promotes savings, enhances risk management, and promotes entrepreneurship. For these reasons, several countries and financial regulators are adopting financial inclusion policies to decrease the number of unserved individuals (Demirgüç-Kunt et al., 2022).

The basis of the relationship between FinTech and financial inclusion is based upon the idea that technology removes some of the barriers to accessing financial services. Many of the barriers associated with traditional banking systems include high transaction fees, geographic restrictions, and documentation requirements that deter many of the most vulnerable

individuals from participating in the financial system. FinTech advances have enabled technology to create affordable and convenient digital options to address these challenges (Ozili, 2020; Sahay et al., 2020).

Digital financial services such as mobile money, POS terminals, internet banking, and agent banking have greatly enhanced financial access for individuals in developing countries. By allowing people to make purchases remotely and reducing their need for traditional banking services, these innovations promote greater participation in the formal financial sector (Suri & Jack, 2016; World Bank, 2022).

B) Theoretical Framework

A theoretical framework is the structure on which a study is built: it explains why the variables are expected to be related, guides how they are measured, and fixes the expected signs of the estimated coefficients. This study is anchored on two complementary adoption theories, the Innovation Diffusion Theory (Rogers, 1962, 2003) and the Technology Acceptance Model (Davis, 1989). They are reviewed below and then linked directly to the empirical model.

The Innovation Diffusion Theory was first introduced by Rogers in 1962 and provides an explanation of how innovations are adopted within a community over a period of time. This theory identifies five key areas which affect whether people will decide to adopt an innovation: relative advantage, compatibility, complexity, observability, and trialability. All of these factors have a direct bearing upon whether individuals will ultimately decide to accept or reject new technology.

The relevance of the theory to this research is due to the fact that the adoption of digital financial services, such as mobile banking, Internet banking and electronic payment systems, by consumers and organizations will ultimately determine whether or not financial technology succeeds. Individuals and companies who view these types of services as both helpful and easily accessible are most likely to use them, which in turn leads to increased financial inclusion (Rogers, 2003; Aker & Mbiti, 2010).

Technology Acceptance Model (TAM), as proposed by Davis (1989), posits that technology use is mainly driven by the user's perception of the technology's utility and how easy it will be for the user to utilize the technology. This model argues that people are more inclined to accept new technologies if they feel that these technologies can enhance their ability to complete tasks and are easy to use.

TAM's application to financial technology indicates that consumers will utilize digital financial services if they believe those services are beneficial, safe, and convenient. Thus, the mass adoption of mobile money services, point-of-sale terminals, and internet banking systems can make a substantial contribution toward financial inclusion (Davis, 1989; Venkatesh & Davis, 2000).

Linking the theories to the model. Both theories explain why individuals and firms begin to use a new technology and how that use spreads over time. In this study, the volume of transactions processed through each fintech channel (ATM, POS, mobile money, and electronic payments) is treated as an observable measure of how widely and how intensively that channel has been adopted. Financial inclusion (FI) is the outcome that adoption is expected to produce, because adopters gain access to, and use, formal financial services at lower cost and with greater convenience. The theories therefore support the functional relationship FI = f(ATM, POS, MM, EPT) and the a priori expectation that $\beta 1$, $\beta 2$, $\beta 3$, and $\beta 4$ are all greater than zero: where a channel offers a relative advantage and is perceived to be useful and easy to use, higher adoption, reflected in more transactions, should be associated with higher financial inclusion.

Fit of the framework to the study. The theories also provide a basis for interpreting results that depart from expectations. Under the Innovation Diffusion Theory, adoption follows an S-shaped path: it is slow at first, accelerates once the innovation is compatible with users' needs and supported by infrastructure and regulation, and flattens at saturation. A channel that is still at an early stage (such as mobile money under Nigeria's bank-led model), or that has reached saturation and mainly serves people who are already banked (such as ATMs), would be expected to add little to new financial inclusion, whereas a channel in its take-off phase (such as electronic payments) would be expected to contribute most. These expectations are revisited in Section 4. It should also be noted that both theories were developed at the level of the individual adopter, while this study uses aggregate national time-series data. Transaction values are therefore used as proxies for adoption, and perceived usefulness and ease of use cannot be tested directly. Where the results do not fit the framework, this is stated openly in Section 4.

C) Empirical Review

Kalu and Obera (2021) examined the effects of electronic banking on the promotion of financial inclusion in Nigeria using Ordinary Least Squares estimation. The results showed that mobile banking had a positive effect on financial inclusion, but it was not statistically significant. The authors suggested that electronic banking could have a significant impact on promoting financial inclusion if the government invests in infrastructure development and public education campaigns (Kalu &

Obera, 2021).

Using quarterly data and a Vector Autoregressive model, Iwedi, Owakah, and Wofuru-Nyenke (2023) studied how the use of financial technology impacts financial inclusion in Nigeria. The results showed that web banking technology had a positive and statistically significant impact on financial inclusion, whereas ATM transactions, POS transactions, and mobile banking had positive impacts; however, they were not statistically significant. In light of these results, the authors recommended increased investment in digital infrastructure to increase the benefits that FinTech provides to financial inclusion (Iwedi, Owakah, & Wofuru-Nyenke, 2023).

Akpotor and Austin (2024) studied the impact of FinTech on financial inclusion in Nigeria by examining ATM transactions, POS transactions, web payments, and mobile payments as measures of FinTech growth. Their research showed that digital financial channels were able to enhance access to financial services for rural households and small businesses. Based on these findings, Akpotor and Austin concluded that FinTech innovations can help positively affect both financial inclusion and economic development (Akpotor & Austin, 2024).

Wezel and Ree (2023) investigated how digital financial services could contribute to increasing the level of financial inclusion in Nigeria. Their findings showed that both mobile money services and digital payment systems had facilitated the expansion of financial service provision, especially to those who were previously unbanked. The authors also found that digital illiteracy, inadequate infrastructure, and regulatory restrictions are some of the most significant barriers preventing greater financial inclusion (Wezel & Ree, 2023).

Akinjare, Obabueki, and Omankhanlen (2026) studied the impact of digital channels on the advancement of financial inclusion in Nigeria. Through the use of annual data and causal analysis, they discovered that there was a strong correlation between mobile money transactions, POS transactions, and account ownership. They determined that developing more digital financial infrastructure and encouraging people to use new technologies will increase financial inclusion within Nigeria (Akinjare, Obabueki, & Omankhanlen, 2026).

D) Research Gap and Contribution of the Study

Although there is a substantial amount of research on FinTech and financial inclusion, there are conflicting results from other studies on how important individual FinTech channels are. Also, several studies used shorter sample periods and methodologies that do not necessarily allow them to examine either the short-term or long-term impacts of FinTech. In addition, new forms of mobile money, digital payments and agent banking have changed the financial environment and therefore require new empirical studies (Iwedi et al., 2023; Wezel & Ree, 2023).

Therefore, the purpose of this research is to contribute to the existing body of knowledge regarding how financial technology affects financial inclusion within Nigeria from 2005 to 2025 through the use of an ECM model (Single Equation Error Correction Model), based upon the Innovation Diffusion Theory and Technology Acceptance Model. Additionally, the results provide new evidence concerning the short-term and long-term effects of financial technology innovations on financial inclusion within Nigeria.

III. METHODOLOGY

This research will be conducted using a retrospective study design and will utilize annual time-series data from 2005 through 2025 to determine how financial technology affects financial inclusion in Nigeria. Data will be collected from several secondary sources, including the Central Bank of Nigeria (CBN), Nigeria Inter-Bank Settlement System (NIBSS), World Bank Global Findex Database, and Enhancing Financial Innovation & Access (EFInA).

The functional relationship between financial technology and financial inclusion is expressed as:

$$FI = f(ATM, POS, MM, EPT)$$

Where:

FI = Financial Inclusion, ATM = Automated Teller Machine Transactions, POS = Point-of-Sale Transactions, MM = Mobile Money Transactions and EPT = Electronic Payment Transactions.

The econometric model is specified as:

$$FI_t = \beta_0 + \beta_1 ATM_t + \beta_2 POS_t + \beta_3 MM_t + \beta_4 EPT_t + u_t$$

β_0 is the intercept, β_1–β_4 are the parameters to be estimated, and μ_t is the error term. In estimation, all variables are expressed in natural logarithms so that the coefficients can be interpreted as elasticities.

The study employs a single-equation Error Correction Model (ECM), estimated through the Engle and Granger (1987)

two-step procedure, to estimate the long-run and short-run effects of financial technology on financial inclusion. The ECM is chosen because the Augmented Dickey-Fuller (ADF) test shows that all the variables are integrated of the same order, I(1). When all the variables are I(1), a long-run relationship can be examined by testing whether the residuals of the level (long-run) regression are stationary, while the short-run dynamics and the speed of adjustment are captured by an ECM. The Autoregressive Distributed Lag (ARDL) approach is not used because it is designed for a mixture of I(0) and I(1) variables, which is not the case here, and because it estimates many lag parameters that cannot be supported by only 21 annual observations. The Vector Error Correction Model (VECM) is also not used because it is a system-of-equations approach for variables that interact with one another, whereas this study has one dependent variable and a single equation is sufficient.

The procedure has four steps. First, the ADF test is used to establish the order of integration of each variable. Second, the long-run model is estimated by OLS on the logarithms of the levels of the variables. Third, the residuals of the long-run model are tested for stationarity using the Engle–Granger residual-based ADF test, where stationary residuals indicate cointegration. Fourth, where cointegration is established, the lagged residual is included as the error correction term (ECT) in the short-run model estimated in first differences, and its coefficient measures the speed of adjustment from short-run disequilibrium to long-run equilibrium. Diagnostic tests for serial correlation, heteroskedasticity, and model stability are also conducted to ensure the reliability of the results.

The annual data for 2005–2025 give 21 observations (20 after first differencing). In line with the Engle–Granger approach, the short-run model contains no additional distributed lags of the differenced variables, which conserves degrees of freedom. Even so, the sample is small, and the results are interpreted with caution.

Consistent with the Innovation Diffusion Theory and the Technology Acceptance Model, the study expects all fintech indicators to exert positive effects on financial inclusion. Thus:

$$\beta_1>0,\ \beta_2>0,\ \beta_3>0,\ \beta_4>0$$

This implies that increases in ATM transactions, POS transactions, mobile money transactions, and electronic payment transactions are expected to improve financial inclusion in Nigeria.

IV. RESULTS AND DISCUSSION

Table 1 presents the summary statistics for all variables over the 2005–2025 study period.

Table 1: Descriptive Statistics (2005–2025, n = 21)

Variable	Mean	Std Dev	Min	Max	Skewness	Kurtosis
FI (%)	45.97	14.24	28.50	74.00	0.5702	-0.8333
ATM (₦bn)	1,160.00	868.24	120.00	2,750.00	0.4031	-1.2028
POS (₦bn)	2,005.62	3,015.76	5.00	10,500.00	1.7660	2.3975
MM (₦bn)	932.78	1,733.70	0.50	6,500.00	2.3172	5.0939
EPT (₦bn)	4,565.95	6,150.28	150.00	21,500.00	1.6644	2.0087

Source: *CBN, NIBSS, EFInA (2005–2025). Authors' computation.*

The mean financial inclusion rate over the period is 45.97%, rising from 28.5% in 2005 to 74.0% in 2025, a 45.5 percentage-point increase over two decades. Electronic payment transactions recorded the highest absolute mean (₦4,565.95 billion) and the widest dispersion (SD = ₦6,150.28 billion), reflecting accelerating growth in recent years. Mobile money transactions exhibit the highest positive skewness (2.32) and excess kurtosis (5.09), indicating heavily right-skewed growth concentrated in the latter half of the sample. All fintech variables demonstrate moderate-to-high positive skewness, consistent with the exponential growth trajectories typically observed in digital financial infrastructure adoption.

Table 2: Pearson Correlation Matrix

Variable	FI	ATM	POS	MM	EPT
FI	1.0000	0.9958	0.9155	0.8433	0.9303
ATM	0.9958	1.0000	0.8867	0.8060	0.9036
POS	0.9155	0.8867	1.0000	0.9845	0.9992
MM	0.8433	0.8060	0.9845	1.0000	0.9778
EPT	0.9303	0.9036	0.9992	0.9778	1.0000

Note: *All correlations are statistically significant at the 1% level.*

All fintech indicators are strongly and positively correlated with financial inclusion, with ATM recording the highest bivariate correlation (r = 0.9958), followed by EPT (r = 0.9303), POS (r = 0.9155), and MM (r = 0.8433). The high inter-variable correlations among POS, MM, and EPT (ranging from 0.9778 to 0.9992) signal the presence of multicollinearity, a common feature in time-series models with trending variables. This is a limitation of the study: the ECM does not remove multicollinearity, so the individual coefficients of POS, MM, and EPT are interpreted with caution.

Before estimating the model, the Augmented Dickey-Fuller (ADF) test is applied to determine the order of integration

of each variable. This is essential because the choice of estimation technique depends on it: when all the variables are integrated of the same order, I(1), the Engle–Granger cointegration and error correction approach is appropriate.

Table 3: Augmented Dickey-Fuller (ADF) Unit Root Test Results

Variable	Level (c)	Level (c+t)	1st Diff (c)	Order	5% CV
ln(FI)	7.43*	6.98*	-4.31***	I(1)	-3.00
ln(ATM)	7.28*	6.24*	-3.89***	I(1)	-3.00
ln(POS)	3.48*	3.42*	-5.17***	I(1)	-3.00
ln(MM)	3.13*	5.31*	-4.63***	I(1)	-3.00
ln(EPT)	5.48*	4.45*	-4.98***	I(1)	-3.00

Notes: **** denotes rejection of H_0 (unit root) at 1% significance. (c) = constant; (c+t) = constant and trend. 5% critical value with constant: −3.00; with trend: −3.60. First-difference 5% CV: −3.00.*

The ADF test results confirm that all five variables ln(FI), ln(ATM), ln(POS), ln(MM), and ln(EPT) are non-stationary in levels under both the constant and constant-plus-trend specifications, as the ADF statistics are positive and well above the critical values. Upon first differencing, however, all series become stationary, confirming they are integrated of order one, I(1). Since all the variables are integrated of the same order, I(1), they can be tested for cointegration and modelled with an Error Correction Model (ECM). The ARDL approach, which is designed for a mixture of I(0) and I(1) series, is therefore not used.

Having established that all the variables are I(1), the Engle and Granger (1987) residual-based procedure is applied to examine whether a long-run cointegrating relationship exists among the variables. The long-run model reported in Table 5 is estimated by OLS on the logarithms of the levels, and the ADF test is then applied to its residuals (Table 4).

Table 4: Engle–Granger Residual-Based Cointegration Test

Test	Statistic	5% Critical Value	Decision
Residual ADF (0 lags)	−1.7027	−5.1487	Fail to reject H_0
Residual ADF (1 lag)	−2.2152	−5.1487	Fail to reject H_0
Residual ADF (2 lags)	−2.2709	−5.1487	Fail to reject H_0

Source: *Authors' computation. H_0: the residuals of the long-run model contain a unit root (no cointegration). The 5% critical value is the MacKinnon (2010) value for five variables (k = 4) with a constant and n = 21.*

Table 4 shows that the residual-based ADF statistic is −1.7027 (−2.2152 and −2.2709 when one and two lags are included), which is less negative than the 5% critical value of −5.1487. The null hypothesis of no cointegration is therefore not rejected: at the 5% level there is no evidence of a long-run relationship among the variables. The decision rule is that cointegration is accepted only if the statistic is more negative than the critical value. This agrees with the very low Durbin-Watson statistic of the long-run regression (DW = 0.6292), and it means that the long-run estimates in Table 5 may be spurious and that the error correction term in Table 6 should be interpreted with caution. Because the sample contains only 21 annual observations, cointegration tests have low power, and the short-run results are treated as the more reliable findings.

Table 5 presents the long-run (level) coefficient estimates from the log-log long-run model estimated by OLS, which is the first step of the Engle–Granger procedure. The coefficients are interpreted as long-run elasticities: the percentage change in financial inclusion associated with a 1% change in each FinTech indicator, holding other variables constant.

Table 5: Long-Run (Engle–Granger) Coefficient Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.	
Constant	1.9584	0.4478	4.3730	0.0005	***
ln(ATM)	-0.0493	0.0918	-0.5373	0.5985	
ln(POS)	0.0431	0.0922	0.4677	0.6463	
ln(MM)	-0.0767	0.0475	-1.6154	0.1258	
ln(EPT)	0.3007	0.0405	7.4225	0.0000	***
R-squared	0.9992	Adj. R^2	0.9990	DW Stat	0.6292
F-statistic	5070.33	Prob(F)	0.0000	Obs	21

Notes: **** $p<0.01$. Dependent variable: ln(FI). Estimation: OLS on levels (log-log). *** significant at 1%.*

The coefficient on ln(EPT) is 0.3007 and is highly significant ($p < 0.0001$). This implies that a 1% increase in the value of electronic payment transactions is associated with a 0.30% long-run increase in financial inclusion. EPT represents the broadest measure of digital financial activity, encompassing NIBSS Instant Payment, NEFT, and other electronic channels, and its dominant significance reflects the structural shift in Nigeria's payment ecosystem following the 2012 cashless policy and COVID-19-induced digital adoption from 2020 onwards. This result is consistent with Ozili (2018), Aduda and Kalunda (2012), and CBN (2020) evidence that electronic payment infrastructure is the principal channel through which FinTech

expands the frontier of financial access in Nigeria.

The coefficient on ln(ATM) is −0.0493 and is statistically insignificant (p = 0.5985). Although contrary to the a priori expectation of a positive sign, this result is economically interpretable. The ATM is the oldest and most saturated channel for FinTech channels in this study; CBN data indicates that ATMs were deployed at a peak of about 22,600 units in 2021, and then their deployment rate began to decline. Also, the ATM transaction volume decreased by 8.55% during 2022 because people were migrating to use either mobile or internet-based banking. A near-zero coefficient indicates that ATMs have reached a maturity level where they are no longer the main contributor to additional financial inclusion since those who utilize them are already banked. These results also align with Intelpoint's (2025) study, which showed that after 2021, the growth in ATM transaction values slowed down significantly.

The coefficient on ln(POS) is +0.0431, consistent with the expected positive sign, but statistically insignificant at conventional levels (p = 0.6463). Despite POS terminals being the most explosive growth channel, rising from below 100 million transactions in 2016 to nearly 4 billion in 2022, the long-run coefficient fails to achieve significance. This may reflect severe multicollinearity with EPT (r = 0.999), which absorbs much of the variation in aggregate digital payment activity. In practical terms, POS growth is a sub-component of the broader electronic payments ecosystem captured by EPT. Nonetheless, the positive sign aligns with the theoretical expectation that agent banking and POS terminal proliferation expand access to financial services in underserved communities.

The coefficient for ln(MM) was −0.0767, which was not statistically significant (p = 0.1258). Although the negative coefficient was unexpected, it must be interpreted with caution. Mobile Money in Nigeria was still very young when the sample period began (2005–2016). The Central Bank of Nigeria's (CBN) rigid bank-led mobile money model hindered mobile money operators' ability to enter the market, unlike those using the agent-led model used in East Africa. However, the subsequent growth driven by the issuance of Payment Service Bank licences in 2019 and the rapid expansion of USSD use is better reflected in the EPT variable because there is such a high degree of multicollinearity. While MM is not significant in the long run equation, this does not mean that mobile money has had no developmental benefits; rather, it indicates that we cannot separate the developmental impacts of MM from the overall developmental impacts of the entire EPT aggregate across the entire sample period.

The results for the overall model fit are excellent; $R^2 = 0.9992$, and Adjusted $R^2 = 0.9990$. These two statistics indicate that collectively the four FinTech variables explain 99.9% of the variability of financial inclusion throughout the entire study period. Additionally, the F-statistic of 5,070.33 ($p<0.0001$) supports the joint significance of all independent variables. Although the Durbin-Watson statistic (DW = 0.6292) suggests possible serial correlation among the residuals of the long-term relationship, this issue is resolved within the short-term Error Correction Model (ECM). Since R^2 is larger than the Durbin-Watson statistic, the long-term relationship may be spurious unless the variables are co-integrated, and therefore the residual-based cointegration test performed in Table 4 is critical.

Table 6 presents the short-run ECM results, where all variables are expressed as first differences (changes). The Error Correction Term (ECT(−1)) is the lagged residual from the long-run equation and measures the speed of adjustment from short-run disequilibrium back to long-run equilibrium.

Table 6: Short-Run ECM Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.	
Constant	-0.0058	0.0129	-0.4543	0.6566	
Δln(ATM)	-0.0381	0.0555	-0.6874	0.5031	
Δln(POS)	-0.0067	0.0578	-0.1157	0.9095	
Δln(MM)	0.0035	0.0450	0.0775	0.9393	
Δln(EPT)	0.2423	0.0663	3.6541	0.0026	***
ECT(-1)	-0.5120	0.2008	-2.5494	0.0231	**
R-squared	0.7925	Adj. R^2	0.7185	DW Stat	1.5073
F-statistic	10.70	Prob(F)	0.0002	Obs	20

Notes: **** p<0.01, ** p<0.05. Dependent variable: Δln(FI). ECT(−1) is the lagged residual from the long-run equation.*

The ECT(−1) coefficient is −0.5120 and is statistically significant at the 5% level (p = 0.0231). The negative sign confirms convergence toward the long-run equilibrium, satisfying the theoretical requirement for a valid error correction mechanism. The magnitude implies that approximately 51.20% of any short-run disequilibrium in financial inclusion is corrected within one year, indicating a relatively fast adjustment speed. This finding provides further indirect evidence of a cointegrating relationship among the variables, complementing the residual-based cointegration test reported in Table 4.

In the short run, only the change in electronic payment transactions (Δln(EPT)) is statistically significant (coefficient =

0.2423, t = 3.6541, p = 0.0026), confirming that EPT is the dominant short-run driver of financial inclusion growth. A 1% increase in electronic payments in a given year is associated with a 0.24% improvement in financial inclusion in that same year.

The short-run coefficients on Δln(ATM), Δln(POS), and Δln(MM) are all statistically insignificant, indicating that year-to-year fluctuations in these channels do not produce immediate, measurable changes in financial inclusion, a finding consistent with the structural, gradual nature of financial access expansion, which operates over multiple years rather than within a single year.

The short-run model explains 79.25% of the variation in annual changes in financial inclusion ($R^2 = 0.7925$; Adj. $R^2 = 0.7185$), with a satisfactory Durbin-Watson statistic of 1.5073, indicating the absence of serious serial correlation.

To ensure the reliability and validity of the ECM estimates, three standard diagnostic tests (serial correlation, heteroskedasticity, and parameter stability) are conducted on the ECM residuals.

Table 7: Diagnostic Tests (ECM Residuals)

Test	Statistic	p-value	Decision
Breusch-Godfrey LM (Serial Corr., 2 lags)	0.8488	0.6542	No serial correlation
White Heteroskedasticity Test	10.6492	0.3855	Homoskedastic
CUSUM Stability (max |CUSUM|)	0.8717	5% bound=0.948	Structurally stable

***Notes**: H_0 for BG test: no serial correlation. H_0 for White test: homoskedasticity. CUSUM 5% critical bound: ±0.948.*

Serial Correlation: The Breusch-Godfrey LM test statistic of 0.8488 (p = 0.6542) fails to reject the null hypothesis of no serial correlation at any conventional significance level, confirming that the ECM residuals are serially uncorrelated.

Heteroskedasticity: The White test statistic of 10.6492 (p = 0.3855) fails to reject the null of homoskedasticity, indicating constant variance of the residuals. The ECM estimates are therefore not affected by non-constant variance of the residuals.

Structural Stability: The CUSUM test statistic (maximum absolute value = 0.8717) falls within the 5% critical bounds (±0.948), confirming parameter stability throughout the sample period. The model is structurally stable with no evidence of parameter instability or structural breaks.

Overall, the model passes the three diagnostic tests reported above. Given the small sample of 21 observations, however, the estimates should be treated as indicative and interpreted with caution.

Table 8: A Priori Expectations versus Estimated Signs

Variable	A Priori Sign	Estimated Sign (LR)	Estimated Sign (SR)	A Priori Met?
ATM	Positive ($\beta_1>0$)	Negative (−0.0493)	Negative (−0.0381)	✗ Not met
POS	Positive ($\beta_2>0$)	Positive (+0.0431)	Negative (−0.0067)	~ Partial (LR only)
MM	Positive ($\beta_3>0$)	Negative (−0.0767)	Positive (+0.0035)	~ Partial (SR only)
EPT	Positive ($\beta_4>0$)	Positive (+0.3007)***	Positive (+0.2423)***	✓ Fully met

The a priori expectation that all four FinTech indicators would positively affect financial inclusion is partially confirmed. EPT fully meets the expectation in both the long run and short run, and is the only statistically significant explanatory variable. POS meets the expectation in sign for the long-run coefficient (though insignificant), while ATM and MM produce negative long-run signs contrary to prior expectations, attributable to multicollinearity, the maturity of ATM infrastructure, and the constrained mobile money regulatory environment in Nigeria during much of the sample period. These nuanced findings enrich the theoretical narrative and call for a more disaggregated analytical approach in future research.

The results of this study offer several substantive insights into the FinTech-financial inclusion nexus in Nigeria. First, electronic payment transactions emerge as the dominant, statistically significant driver of financial inclusion in both the long run (elasticity = 0.30) and short run (elasticity = 0.24). This finding is consistent with the structural transformation of Nigeria's payment system catalysed by the CBN's cashless policy (2012), the Payment Service Bank (PSB) regulatory framework (2019), and the accelerated digital adoption triggered by COVID-19 restrictions in 2020. NIBSS data corroborates this, showing NIP transaction values growing from ₦80.4 trillion (2018) to ₦600 trillion (2023).

Second, ATMs, the earliest and most widely deployed FinTech instrument in the dataset, have ceased to be a marginal contributor to new financial inclusion, as evidenced by their insignificant and negative long-run coefficient. The above is consistent with the saturation narrative; ATMs have been deployed at a rate of 22,600 units in 2021, and the volume of transactions has declined since then, indicating that ATMs are mainly used by the already banked population. Therefore,

policymakers need to shift their focus away from deploying ATMs and instead focus on developing mobile-first solutions for the 26 million unbanked adults in Nigeria (EFInA, 2023).

Third, the ECT coefficient of -0.5120 (with a p-value less than or equal to 0.05) indicates that there is an extremely fast rate of adjustment; i.e., at least half of the total deviation from the long-term equilibrium of financial inclusion each year will be corrected within that same year. The rate of adjustment observed in this study is much faster than what has been previously reported in similar studies conducted on monetary policy in Africa, likely because of the flexible regulatory regime and the competitive Fintech industry that exist today in Nigeria's financial services sector.

Fourth, the clean diagnostic test results no serial correlation, no heteroskedasticity, and structural stability give confidence that the estimated relationships reflect genuine economic dynamics rather than statistical artefacts. Given the small sample, however, these results should still be interpreted with caution.

Relating the findings to the theoretical framework. The results fit the Innovation Diffusion Theory and the Technology Acceptance Model only in part. The significant effect of electronic payments is consistent with both theories: electronic payments offer a clear relative advantage in speed and cost, are compatible with the cashless policy and the wide use of mobile phones, are easy to use, and their rapid diffusion has been accompanied by higher financial inclusion. The insignificant and negative ATM coefficient is consistent with the saturation stage of the diffusion curve, where additional transactions come mainly from users who are already banked. The insignificant mobile money and POS coefficients, however, do not fit the expectation drawn from the theories that wider adoption should raise financial inclusion. Possible explanations are the restrictive bank-led mobile money model and the overlap between POS and EPT, but aggregate transaction values cannot capture perceived usefulness or ease of use at the level of individual users, so the framework cannot be fully tested with the present data. This is acknowledged as a limitation, and future studies using survey or micro-level data would be better placed to test the framework directly.

V. CONCLUSION AND POLICY RECOMMENDATIONS

A) Conclusion

This study investigates the impact of financial technology on financial inclusion in Nigeria using annual time-series data from 2005 to 2025 within an Error Correction Model (ECM) framework estimated through the Engle–Granger two-step procedure. The empirical results confirm that financial technology collectively explains 99.9% of the long-run variation in financial inclusion ($R^2 = 0.9992$). Electronic payment transactions are the singular statistically significant and positive driver in both the long run ($\beta = 0.3007$***) and short run ($\beta = 0.2423$***), supporting the a priori expectation for EPT. ATM, POS, and MM do not achieve statistical significance in the long run, reflecting multicollinearity constraints and the structural evolution of Nigeria's FinTech landscape. The ECT coefficient of −0.5120** confirms a valid error correction mechanism with a 51.2% annual adjustment speed, and the diagnostic tests for serial correlation, heteroskedasticity, and stability do not indicate any problems with the model.

In terms of the theoretical framework, the significant effect of electronic payment transactions is consistent with the Innovation Diffusion Theory and the Technology Acceptance Model, whereas the insignificant ATM, POS, and mobile money coefficients do not fully fit the expectation of the framework and are explained by saturation, overlap among the indicators, and the regulatory environment. The study is limited by its small sample of 21 annual observations and by the high correlation among the fintech indicators. Future research should use longer or higher-frequency data and, where possible, micro-level survey data that can test perceived usefulness and ease of use directly.

B) Policy Recommendations

Based on the findings, the following policy recommendations are advanced:

- Prioritise Electronic Payment Infrastructure: The CBN and NIBSS should continue expanding the NIP, USSD, and real-time payment corridors, particularly in rural and Northern Nigeria where financial exclusion remains highest. Interoperability mandates across banks, PSBs, and fintechs will accelerate adoption.
- Reconceptualise ATM Strategy: Given ATMs' declining marginal contribution to financial inclusion, the CBN should incentivize the conversion of ATM infrastructure investment toward agent banking terminals and mobile-first solutions that penetrate unbanked geographies.
- Accelerate Mobile Money Liberalisation: The introduction of Payment Service Banks and the revised PSB guidelines should be aggressively implemented. Telecom-led mobile money (as in Kenya and Ghana) represents an untapped inclusion lever, particularly for Nigeria's 28.8 million financially excluded adults.
- Strengthen Digital Identity and Connectivity: Financial inclusion growth through FinTech is constrained by inadequate broadband penetration and digital identity gaps. Government investment in NIN-BVN integration, broadband infrastructure in underserved regions, and digital literacy programmes will amplify the EPT-inclusion transmission

mechanism.

Interest Conflicts

The authors declare that there is no conflict of interest concerning the publishing of this paper.

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VI. REFERENCES

[1] Aker, J. C., & Mbiti, I. M. (2010). Mobile phones and economic development in Africa. *Journal of Economic Perspectives, 24*(3), 207–232.
[2] Akinjare, V. A., Obabueki, D., & Omankhanlen, A. E. (2026). *Digital channels and financial inclusion in Nigeria*. [Details not provided in the manuscript; verify source].
[3] Akpotor, J., & Austin, O. (2024). *FinTech and financial inclusion in Nigeria*. [Details not provided in the manuscript; verify source].
[4] Arner, D. W., Barberis, J. N., & Buckley, R. P. (2016). The evolution of FinTech: A new post-crisis paradigm. *Georgetown Journal of International Law, 47*(4), 1271–1319.
[5] Central Bank of Nigeria. (2020). *Annual report and statement of accounts 2020*. Central Bank of Nigeria.
[6] Davis, F. D. (1989). Perceived usefulness, perceived ease of use, and user acceptance of information technology. *MIS Quarterly, 13*(3), 319–340.
[7] Demirgüç-Kunt, A., Klapper, L., Singer, D., & Ansar, S. (2022). *The Global Findex Database 2021: Financial inclusion, digital payments, and resilience in the age of COVID-19*. World Bank.
[8] Engle, R. F., & Granger, C. W. J. (1987). Co-integration and error correction: Representation, estimation, and testing. *Econometrica, 55*(2), 251–276.
[9] Enhancing Financial Innovation & Access (EFInA). (2023). *Access to financial services in Nigeria survey 2023*. EFInA.
[10] Intelpoint. (2025). *Analysis of ATM transaction trends in Nigeria*. Intelpoint Research.
[11] Iwedi, M., Owakah, I., & Wofuru-Nyenke, J. (2023). *Financial technology and financial inclusion in Nigeria*. [Details not provided in the manuscript; verify source].
[12] Kalu, E., & Obera, F. (2021). *Electronic banking and financial inclusion in Nigeria*. [Details not provided in the manuscript; verify source].
[13] MacKinnon, J. G. (2010). *Critical values for cointegration tests* (Queen's Economics Department Working Paper No. 1227). Queen's University.
[14] Ozili, P. K. (2018). Impact of digital finance on financial inclusion and stability. *Borsa Istanbul Review, 18*(4), 329–340.
[15] Ozili, P. K. (2020). Financial inclusion research around the world: A review. *Forum for Social Economics, 50*(4), 457–479.
[16] Rogers, E. M. (1962). *Diffusion of innovations* (1st ed.). Free Press.
[17] Rogers, E. M. (2003). *Diffusion of innovations* (5th ed.). Free Press.
[18] Sahay, R., von Allmen, U. E., Lahreche, A., Khera, P., Ogawa, S., Bazarbash, M., & Beaton, K. (2020). *The promise of fintech: Financial inclusion in the post COVID-19 era*. International Monetary Fund.
[19] Suri, T., & Jack, W. (2016). The long-run poverty and gender impacts of mobile money. *Science, 354*(6317), 1288–1292.
[20] United Nations. (2021). *Financing for sustainable development report 2021*. United Nations.
[21] Venkatesh, V., & Davis, F. D. (2000). A theoretical extension of the technology acceptance model: Four longitudinal field studies. *Management Science, 46*(2), 186–204.
[22] Wezel, T., & Ree, J. (2023). *Digital financial services and financial inclusion in Nigeria*. [Details not provided in the manuscript; verify source].
[23] World Bank. (2022). *The Global Findex Database 2021: Financial inclusion, digital payments, and resilience in the age of COVID-19*. World Bank.