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Fintech for Financial Inclusion: A Framework for Digital Financial Transformation

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Abstract
Studies exploring the nexus between FinTech and financial inclusion in Nigeria employed the indirect measures of FinTech. Previous studies in this area also adopted a bundle indicator of financial inclusion ignoring the individual indicators effect. This study contributes to the extant literature by expanding the generic FinTech frontier to capture the direct measures (automated teller machine, web pay, mobile banking, and point of sale) and also test the model on Nigeria by unbundling financial inclusion indicators individual index to examine the degree of contribution. The autoregressive distributed lag (ARDL) bounds test cointegration approach was used to estimate the respective equations and find evidence of a long-run nexus between FinTech, financial inclusion, and economic growth. The direct measures of FinTech positively and significantly impact financial inclusion and economic growth. The negative nexus between automated teller machines, financial inclusion, and economic growth can be attributed to the closure of most automated teller machine galleries in bank branches and outside the branches due to, high maintenance costs and insecurity around galleries. This is evident in the long waiting time to use the automated teller machine and the growing number of bank customers further suggests that the current 22,500 automated teller machines are insufficient to enhance inclusive growth in Nigeria. Individual financial inclusion indicators positively impact economic growth while the usage dimension of financial inclusion improves economic growth but not significantly. Also, bank branches had a positive and significant impact on economic growth, and credit to private had a non-significant effect.

Keywords: *Financial inclusion; economic growth; FinTech; ARDL; Nigeria*

INTRODUCTION

The 21st-century economic and financial policy objectives include the realization of inclusive economic and financial development through FinTech resourceful mobilisation and allocation of economic and financial resources to economic agents particularly the active poor. Largely comprising of the rural dwellers most commonly referred to as the "Base of the Pyramid" (BoP) living in extreme poverty on an income of less than $2.00 per day (Udoh, Udo, Abner, Ike, Tingir, &Ibekwe, 2016). According to the United Nations Secretary-General's Special Advocate (2013) for inclusive financial development, more than 200 million small- and medium-sized businesses in emerging economies are financially and data excluded, thus limiting their competitiveness and ability to thrive. Despite extensive progress made by banks, microfinance, savings and loans institutions, credit unions, and cooperative societies in extending financial services to marginalized groups, about 2.5 billion of the world's adult population, are excluded from the formal financial services (Udo, et, al 2023; Udo, et, al 2019; Hannig& Jansen, 2010).

In Nigeria, about 38.3 million adults are data and financially excluded out of which 21.3 million are adult women representing 20% and 17 million men (Udo, et, al 2023). The WorldBank (2014) report disaggregated financial exclusion into; voluntary and involuntary exclusion. Voluntary exclusion arises from economic agents' decision not to use financial services either because they have no immediate need for them or due to cultural and religious beliefs. Others also cite inadequate household incomes, commuter distances from financial service providers, cumbersome documentation, market failures, and imperfections associated with the free market as reasons for their involuntary exclusion (Park & Mercado, 2015).

FinTech involves the integration of information and communication technology into the operational and business activities of classical financial systems for financial transactions, payment, insurance, and peer-to-peer lending. The incorporation of financial technology (FinTech) into the mainstream operational and business activities of the classical financial systems has successfully reshaped, restyled, and eliminated some of these barriers (Udo, et, al2023). Financial inclusion is the integration of the various FinTech platforms to make formal financial services available, accessible, and affordable to all households and enterprises, regardless of their level of income (Diniz, Birochi, &Pozzebon, 2018; Demir, Pesque-Cela, Yener Altunbas, &Murinde, 2020).

Formal financial inclusion begins with operating a deposit or transaction account with any financial institution or other financial service providers (Demirguc-Kunt, Klapper, & Singer,2017; Udo, et, al 2023).

Also, in a bid to address the upshot of widespread involuntary exclusion, in Nigeria the Central Bank of Nigeria (CBN) in 2012, reintroduced the financial inclusion strategy to improve adult access to financial products and services from the 21.6% reported in 2010 to 70% in 2020, access to savings from 24.0% to 60%, credit from 2% to 40%, insurance from 1% to 40%, and pension from 5% to 40% (Udo, et. al 2023; Mckinsey Global Institute, 2014; Ayinde, Ganiyu, &Yinusa, 2016; Madichie, Maduka, Oguanobi, & Ekesiobi, 2014; Cyn-Young & Ragelio, 2015). The rapid evolution in development communication, internet services, availability of mobile and smartphones, and the availability of information technology infrastructure, to the rural dwellers, has enormously transformed and provided secure, low-cost, and contactless financial instruments across ecosystems, enhanced cashless financial systems and limited

traditional branch-based banking (Dahiya& Kumar, 2020; Udo, et. 2019; Inoue &Hamori, 2016; Kim et al., 2017; Sethi & Acharya, 2018; Sharma, 2016; Lenka & Sharma, 2017 and others). This is evidenced in the Nigerian Inter-Bank Settlement System (NIBSS) report (2022) on active accounts with a bank, credit union, microfinance institution, and mobile money service provides increasing by 14.41% from 97.485million to 111.54million in 2022 (Udo, et, al 2023). Total savings increased by 13.8% from ₦114.13 million in 2019 to ₦138.91 million in May 2022.

The geometric increase could be attributed to the Covid-19 safety measures of social and economic lockdown (Udo, et, al 2023; Udo, et al., 2019). To curtail the spread of the virus, the lockdown period reinforced the importance of cost-effective, affordable, available, and flexible, agency banking channels as a vital part of the financial ecosystem. On an operational basis, most agents rebalance through the ATM to meet liquidity needs (Udo, et, al, 2019). The positive influence of FinTech on economic growth, extreme poverty, and income inequality gap reduction through financial inclusion is acknowledged in the theoretical and empirical literature. This significance and the contribution as observed can be explained under three key aspects: (a) boosting financial inclusion, improving international trade finance transactions, enabling remittances, and enhancing financial efficiency, (b) in response to the innovation-growth hypothesis, FinTech improves investment and allocation procedures (Allen 2011), accelerates the financial development process (Ozcan 2008), contributes to financial institutions efficiency level (Shaughnessy 2015), and builds the quality of financial products and services, (c) with greater accessibility to formal financial services through FinTech platforms (Raffaelli and Glynn 2013). By including the data and financially excluded individuals, households, and small-medium businesses in the mainstream economic and financial systems. The outcome of FinTech integration into the economic and financial climate is financial inclusion.

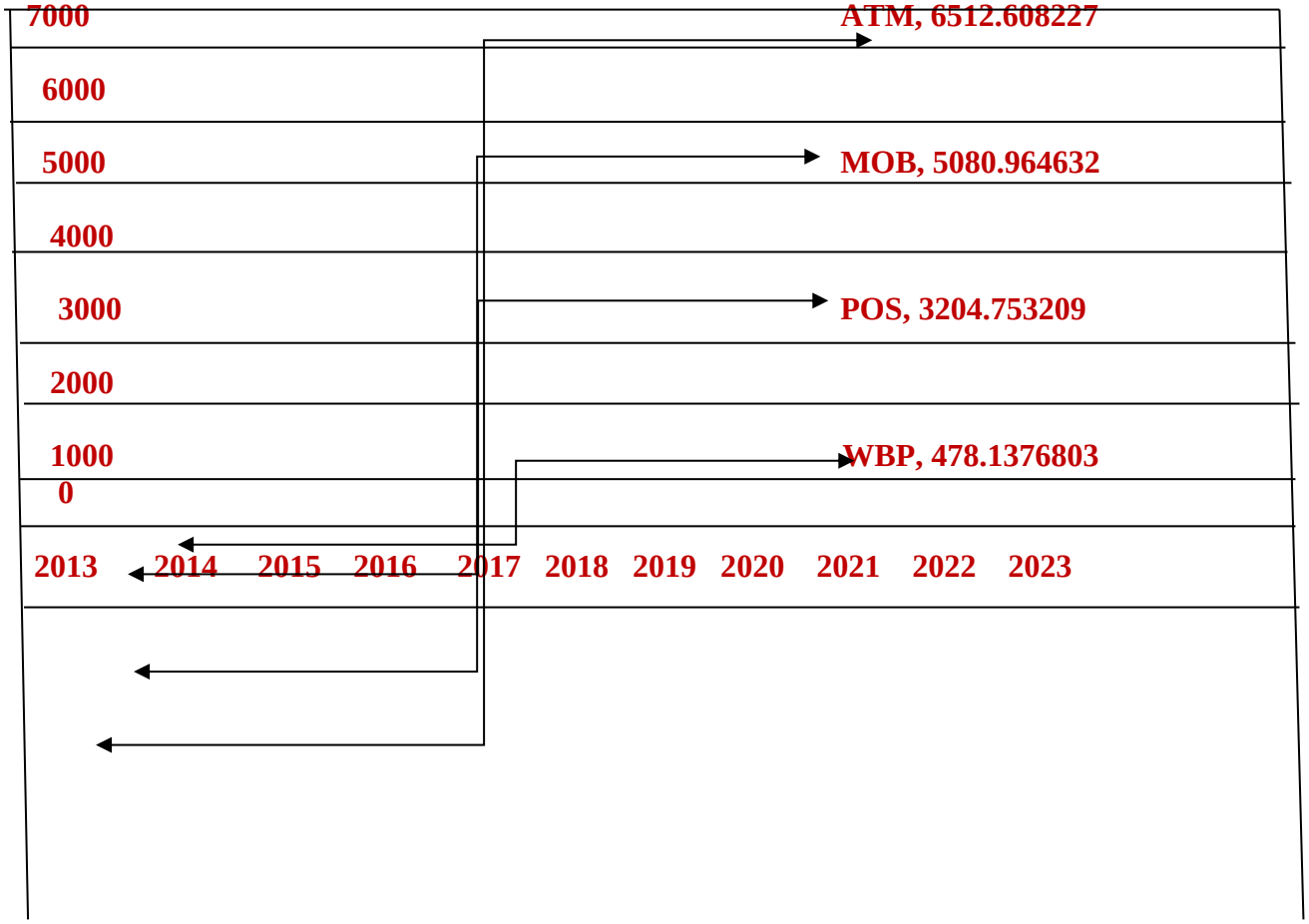
This study contributes to the literature by expanding the generic FinTech to include direct measures, due to the upsurge in FinTech in Nigeria. However, most of the proxies within the literature restrict FinTech to traditional banks and obscure the current evolution of FinTech outside the mainstream financial boundaries. In Nigeria mobile banking, internet banking, point of sale, and web pay among other digital products (that control a substantial portion of access, usage, and penetration of financial services are innovations initiated, owned, and championed by telecommunication companies).

To capture the essence of "out of mainstream banking and financial FinTech, this study broadened the definition of a direct measure of FinTech as the total value of transactions on retail digital platforms which include ATMs, point of sales, internet banking, mobile payment, Nigerian Interbank Settlement System Instant Payment (NIP), Nigerian Interbank Settlement System Electronic Fund Transfer (NEFT) and E-billsPay transactions. The FinTech platforms considered in this study are mobile banking (MOB), point of sales (POSs), web pay (WBP), and automated teller machines (ATM). This study contributed by unbundling the financial inclusion indicators to access individual contributions to financial inclusion and economics in Nigeria and also help tailor specific policies to each of the individual indicators of financial inclusion.

This study also contributes to the literature by testing the linear influence of FinTech on financial inclusion and economic growth using the autoregressive distributed lag (ARDL) bounds testing model. Figure 1 reveals that the values of ATM, MOB, POS, and WBP transactions increase trajectory from January 2009 to December 2019 in Nigeria within the

period under review. The possible explanation for the geometric increase could be the ease, availability, and affordability features associated with these digital products. Between 2009 and 2019, the value of ATM transactions increased from naira ₦548.6 billion to N 6512.60 billion, representing above 1,415% change. Similarly, the values of MOB, POS, and WBP transactions also increased geometrically respectively. Figure 1 also revealed ATM to be the most popular digital platform in Nigeria, followed by MOB and POS, while WEP witness the lowest growth rate within the period under review. The results show that ATM, POS, and MOB account for the fastest channels to access and use financial products, while poor internet services and coverage affect access and usage of financial products by individuals.

Figure 1: Monetary value of digital platform transactions in (₦ Billions) Nigeria



LITERATURE REVIEW

Financial Inclusion

Financial inclusion is a process by which all households, individuals, and businesses regardless of income level have access to affordable, flexible, eco-friendly, and appropriate financial services that meet their daily financial and economic needs to improve their lives.

Indicators of Financial Inclusion

The lack of consensus on the definition of financial inclusion is also evidenced in the lack of appropriate indicators of financial inclusion. In a bid to zero down and developed an all

inclusive indicator of financial inclusion. Beck et al. (2007) measured financial inclusion under access (credit facility; deposit) and usage (payment system). Similarly, Honohan (2008) adopted a percentage of households with an active account in the formal financial sector. Demirguc- Kunt et al., (2018) among others adopted a set of specific indicators to include savings, credit, and payment.
The construction of the financial inclusion index is not only divergent in method, but it also varies in the choice of indicators among studies (Nguyen, 2020).

THEORETICAL FRAMEWORK

FinTech, Financial Inclusion, and Economic Growth

In establishing the financial sector-economic growth nexus, the pioneering studies of Schumpeter (1912), Shaw (1973), and McKinnon (1973) laid the foundation. The underlying evidence is that financial development is fundamental in explaining economic growth patterns through efficient mobilization and allocation of limited economic-financial resources to active economic agents in developed and emerging economies (Chen et al., 2021). An efficient financial system drives the processes of creating wealth, trade, and, most importantly, capital formation (Ahmed 2006). In accounting for cross-country variations in economic growth, exogenous and endogenous growth models were developed. The exogenous growth model emphasizes the significance of technological advancement (Solow, 1956) and labour productivity (Domar, 1946) in growth disparities globally. Contemporary, studies criticized exogenous growth for disregarding efficiency variables such as macroeconomic conditions, appropriate regulatory framework, and institutions that convert savings into investments (Chirwa & Odhiambo (2018).
Modern economic development is largely influenced by the exogenous growth assumption of, innovation through the diffusion of technological advancement, new organisational structures, production processes, and management styles in transforming a static economy into a dynamic economy. Contemporary, innovation has evolved from the creation of new products to provide solutions to ongoing problems in an economy (Kotsemir and Abroskin 2013). Financial innovation is considered the “engine” driving a financial system toward its goal of improving the performance of the real economy (Merton 1992).

The theoretical nexus between FinTech, financial inclusion, and economic growth are underpinned in, two major channels; (a) the provision of affordable, flexible, and cost - effective financial services to the "Base of the Pyramid" (BoP) to encourage economic activities and increase national output and improve welfare (Udo, et, al 2023; Adedokun & Aga, 2021; Nanda & Kaur, 2016; Sahay et al., 2015 Udoh, Udo, Abner, Ike, Tingir, and Ibekwe, 2016); (b) including the excluded individuals, households and small-business into the mainstream financial systems to boost saving, funds mobilization and allocation for investment, poverty reduction among others (Ramkumar, 2017). Mobile technology and development communication are the springboards for digital financial inclusion (Chu 2018). Aside from the adoption of financial digital technology, the extension of development telecommunications services to rural areas for digital communication completes the digital inclusion of the economy (Peru 2018; Ghosh, 2016; Gosavi, 2018; Tchamyou, Erreyger, & Cassimon 2019).

EMPIRICAL LITERATURE

The FinTech-financial inclusion nexus has been extensively examined; these studies report diverse and contradictory results as presented in Table 1. Most of these studies focused on measuring the degree of financial inclusion (Abdulmumin et al., 2019; Lenka & Barik, 2018; Nguyen, 2020). Evans and Adeoye, (2016); Soumaré et al., (2016); Oyelami et al., (2017); Sotomayor et al., (2018); Chinodaet al., (2019) focused on the micro-macro level determinants of financial inclusion. The studies of Inoue and Hamori, (2016); Chatterjee, (2020); Nizam et al., (2020), and others opined that FinTech through financial inclusion promotes economic prosperity. This study empirically examined the FinTech financial inclusion nexus on economic growth due to the upsurge in digital retail financial services platforms (that control a substantial portion of deposits innovations initiated, owned, and championed by telecommunication companies, when developing the index of financial inclusion in Nigeria also close the literature gaps.

METHODOLOGY

Data and Econometric Model

The dataset was collated from the CBN statistical database and World Bank Development Index for the period 2009Q1–2019Q4. For this study, FinTech is measured as the sum of financial transactions on retail digital platforms evaluated at a constant price. Transactions on these platforms are expected to increase financial inclusion and boost economic growth. According to Adil et al. (2020), retail digital financial products are the most potent measure of FinTech.

The dependent variable for this study is the GDP per capita as a measure of economic growth (Inoue & Hamori, 2016; Kim et al., 2017). The value of the expressed in US dollars and natural logarithm. Financial inclusion was proxied by the bundle indicators taking on three dimensions (availability, penetration, and usage). Availability is unbundled as (number of bank branches); Sarma (2016) argued that transaction points are fundamental to financial inclusion and should be easily available and convenient to users. Penetration as (banks depositors per 1,000 adults). An all-inclusive financial system requires numerous users, implying that it needs to penetrate deeply (Nguyen, 2020). Usage as (credit to the private sector (% of GDP). This is a reflection of the extent to which the private sector contracts loans from financial institutions for various projects. A more comprehensive financial system guarantees that financial services are wholly utilized (Nguyen, 2020; Sarma, 2016). Control variables: financial deepening index (Domestic credit to the private sector and M3 (% of GDP) and development communication index (the internet access (% of the population) and Mobile cellular subscriptions (per 100 people) were adopted for their influence on financial inclusion and the economy.

Estimation Strategy

Given that the variables are time series (t), testing the stationary properties of the variables is extremely vital. The stationary properties of the variables were estimated using the NG-Perron, to address Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) associated weak powers (Folarin&Asongu, 2019). The autoregressive distributed lag (ARDL) bounds test framework developed by Pesaran et al. (2001) was used to examine the long-run nexus among the variables as specified in Eqn (1). The ARDL integrates variables of diverse orders of integration, we considered it the most suitable. The bound test eliminates issues of serial correlation and endogeneity of variables (Rahman &Kashem, 2017). The ARDL model is expressed as:

GDP t = β0 + βiGDPt-i + δiATMt-i + λiPOSt-i + ϒiWBPt-i + ϕiMOBt-i + πiBBt-i + θiCPt-i + υiBDt-i + ψiDCt-i + ωi M3t-i + τiIPt-i + χiMCt-i + εt (1)

Where;

Economic Growth (GDP); Retail Digital Products (ATM, POS, WBR and MOB) Financial Inclusion (BB, CP, BD); Financial Deepening (DC, M3) Development Communication (IP, MC).

The optimal lag for each variable was automatically determined using Schwarz information criteria (SIC). The ARDL bound test is expressed as follows in equation (2):

ΔInGDPt = β0 + βiΔInGDPt-i + δiΔInATMt-i + λiΔInPOSt-i + ϒiΔInWBPt-i + ϕiΔInMOBt-i +
πiΔInBBt-i + θiΔInCPt-i + υiΔInBDt-i + ψiΔInDCt-i + ωi ΔInM3t-i + τiΔInIPt-i + χiΔInMCt-i +
λ1InGDPt-1 + λ2 InATMt-1 + λ3 InPOSt-1 + λ4 InWBPt-1 + λ5 InMOBt-1 + λ6 InBBt-1 + λ7 InCPt-1 + λ8
InBDt-1 + λ9 InDCt-1 + λ10 InM3t-1 + λ11 InIPt-1 + λ12 InMCt-1 + εt (2)

Where;

Δ = the difference operator, and lnis the natural log of the variables. The F-statisticsvalue of the bound test was estimated to evaluate the presence of a long-run nexus among the variables as prescribed by Pesaran et al. (2001). The value of the estimated F-statistics is compared with the upper and lower critical values.

Decision rule: "If the calculated F-statistics is greater than the upper critical value, the null hypothesis of no cointegration is rejected, denoting the existence of a long-run nexus, if the value of the F-statistics is less than the lower critical value, a long-run nexus does not exist".There could also be an inconclusive scenario where the value of the F-statistics falls between the upper and lower critical values. From equation (2), the short-run dynamics are captured by

λi; for i = 1, 2,3,4,5. . ., 11 and the long-run dynamics are captured by βi; γi; δi; ρi; τi; υi; θi; ωi; ϕi;
χi and σi for i = 1, 2, 3, 4, 5. . . ., p.

The error correction model, equation (2) could be expressed as:

ΔInGDPt = β0 + βiΔInGDPt-i + δiΔInATMt-i + λiΔInPOSt-i + ϒiΔInWBPt-i + ϕiΔInMOBt-i +
πiΔInBBt-i + θiΔInCPt-i + υiΔInBDt-i + ψiΔInDCt-i + ωi ΔInM3t-i + τiΔInIPt-i + χiΔInMCt-i + ∞ECTt-1 + εt (3)

ECT is the error correction term that captures the long-run nexus between the variables.The coefficient, ∞, and the speed (between 0 and 1) of convergence to long-run equilibrium from short-run divergence due to shocks in the system. ∞ is expected to be negative and significant after an external shock. 0 = the absence of any adjustment, 1 = perfect or full adjustment after the occurrence of shock. The diagnostic tests of the ECM result, that is, autoregressive conditional heteroscedasticity (ARCH), the Breusch–Godfrey (BG) test for serial correlation, and the Jargue–Bera (JB) test for normality.

Table 2 Summary of Variables Description

Variable	Dimension	Description	Sources
GDP per	Economic Growth	GDP per capita is gross domestic product divided by mid year population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products.	Evans (2015)
ATM, POS,WEP, and MOB	Retail digital Platforms	Ease access to financial services (Automated teller machine, web pay, point of sales, and mobile banking)	Asongu and Nwachukwu (2018);Asongu and Odhiambo (2019); Demir et al. (2020)
Bank Branches (BB)	Availability	Number of commercial bank branches per 100,000 adults	Adeola and Evans (2017)
Credit to the private sector(% of GDP(CP)	Usage	Reflection of the extent to which the private sector contracts loans from financial institutions for various projects. A more comprehensive financial system guarantees that financial services are wholly utilized.	Nguyen, (2020); Sarma, (2016).
Banks depositors(BD)	Penetration	Number of deposit accounts with commercial banks per1,000 adults	Evans (2015); Adeola and Evans (2017)
Domestic credit to the private sector(% of GDP)(DC)	Financial deepening		
	Domestic credit to the private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of non equity securities, trade credits, and other accounts		Qamruzzaman and Wei (2018)

	receivable, that establish a claim for repayment. Forsome countries, these claims include credit to public enterprises.		
M3 (% ofGDP) (M3)	M3 Money Supply is an indirectly derived measure of the supply of money which includes currency with the public; current and savings deposits with the banking system; bank-issued certificates of deposit; Term deposits of residents; call/term borrowings from 'no depository' corporations by the banking system.		
Individuals using the Internet(% of the population)(IP)	Development Communication	Internet users are individuals who have used the Internet (from any location) in the last 3 months. The Internet can be used via a computer, mobile phone, personal digital assistant, games machine, digital TV, etc.	
Mobile cellular Subscriptions per 100 people. (MC)	Mobile cellular telephone subscriptions are subscriptions to a public mobile telephone service that provide access to the PSTN using cellular technology. The indicator includes (and is split into) the number of Postpaid subscriptions and the number of active prepaid accounts, The indicator applies to all mobile cellular		

	subscriptions that offer voice communications.		

EMPIRICAL ESTIMATION

The descriptive statistics result is reported in Table 3. The result shows that the average value of MOB transaction for the review period is ₦900.376 bn, and about thrice the average value of ATM, POS and four-fold the average of WBP, which suggest that mobile money is the fastest, easiest, and most convenient retail digital platform to access financial service-product. This signals a gradual shift from ATM to a more convenient and accessible retail digital platform. WBP is the least patronized retail platform in Nigeria. The average number of deposit accounts is 823. 463 denoting penetration and usage proxy by credit to the private sector is 18.759. This is an indication that FinTech has a positive influence on financial inclusion and is evident in usage and access to financial services. The average value of ₦22.507 for M3 denoting financial deepening show that financial sector development has a positive influence on economic growth with an average value of ₦2370.09 bn and ₦12.805 bn for domestic credit for the reviewed period. The average value of 75.543 for mobile cellular subscription show the importance of developing communication on financial inclusion and is evidenced in the average value of 22.497% for individuals using the internet for information. The Ng–Perron unit root test presented in Table 4 reveals that all the variables are stationary either at level or at first difference. Thus, satisfying the condition for using Pesaran et al.'s (2001) ARDL bounds test to determine the FinTech, financial inclusion, and economic growth long-run nexus.

Table 3: Descriptive Statistics

Mean	Median	Max	Min	Std. Dev.	Skew	Kurt	Jarque-Bera
ATM	3581.10	3679.87	6512.60	399.71	2237.27	0.024	1.6164	3.5138
POS	798.277	312.071	3204.75	11.03	1049.10	1.2943	3.2727	12.4217
MOB	900.376	346.467	5080.96	1.27	1460.20	2.1406	6.4846	55.8650
WBP	171.302	84.15	675.916	25.05	202.920	1.6451	4.21742	22.5638
BB	5.28908	4.9802	6.5643	4.2830	0.8463	0.2704	1.5028	5.48995
BD	823.463	667.464	1458.40	464.479	312.838	0.68804	2.2889	5.1981
CP	18.7595	18.667	22.7548	15.0675	1.72326	0.24431	4.12806	3.27442
DC	12.8058	12.4919	19.6256	10.2465	2.43790	1.68434	5.56140	35.8176
M3	22.5079	22.8982	24.8952	19.8205	1.39415	-0.5670	2.72619	2.94878
GDP	2370.09	2204.18	3200.95	1883.88	400.603	0.73423	2.33059	5.64306
IP	22.4975	22.75	35.5	9.3	8.50816	0.00188	1.74372	3.15648
MC	75.5349	77.4674	98.0325	47.5863	14.9815	-0.4034	2.10167	3.15902

Table 4: Ng-Perron Unit Root Test

MzaMZt	MSB	MPT	Decision	Lag	
ATM	-17.30**	-2.92**	0.18**	0.59**	I (1) 2
POS	-33.00***	-4.06***	0.12***	0.74***	I (1) 1
WBP	-9.97**	-2.21**	0.22**	2.54**	I (0) 0
MOB	-18.86***	-2.68***	0.14***	2.63***	I (1) 0
BD	-18.95***	-3.06***	0.16***	1.34***	I (1) 0
BB	-8.70**	-2.08**	0.24**	2.84**	I (1) 3
CP	-24.93***	-8.24***	0.03***	3.05**	I (0) 2
M3	-19.26***	-3.10***	0.16***	1.28***	I (1) 1

DC	**-25.82*** **	**-21.70*** **	**0.029*** **	**0.42*** **	**I (1) 0**
IP	**-8.81****	**-2.09****	**0.24****	**2.82****	**I (0) 2**
MC	**--10.68****	**-2.25****	**0.21****	**2.54****	**I (1) 2**
GDP	**--69.67*** **	**-5.90*** **	**0.08*** **	**0.35*** **	**I (1) 3**
Critical Values					
	1%	**-13.8**	**-2.58**	**0.174**	**1.78**
	5%	**-8.1**	**-1.98**	**0.233**	**3.17**
	10%	**-5.7**	**-1.62**	**0.275**	**4.45**

Note: *, **, * signify the level of significance; 10%, 5%, and 1% respectively.** The ARDL cointegrating bound test results and other diagnostic tests are reported in Table 5. The results indicate that the various retail digital FinTech platforms of ATM, POS, MOB, and WBP cointegrated with their determinants. The ARDL results reported in Table 6 is line with the study objectives of investigating the FinTech effect on financial inclusion and economic growth in Nigeria.

Table 5: ARDL bound cointegration test results

Models	**F-Statistics**	**BG LM test (1)**	**BPG heteroskedasticity test**	**ARCH test (1)**
ATM F(InATM,BD,BB, CP, M3, DC, IP MC	**9.92**	**0.80**	**0.087**	**0.176**
POS F(InPOS,BD,BB, CP, M3, DC, IP, MC	**8.05**	**0.09**	**0.04**	**0.86**
MOB F(InPOS,BD,BB, CP, M3, DC, IP, MC	**7.04**	**0.897**	**0.71**	**0.64**
WBP F(InPOS,BD,BB, CP, M3, DC, IP, MC	**10.50**	**0.51**	**0.85**	**0.59**

Notes: The F-statistics upper (lower) bounds critical value at 1% and 5% are 3.77(2.62) and 3.15(2.11) respectively. The reported values for the normality test, Breusch–Godfrey serial correlation LM test (BG LM test), Breusch–Pagan–Godfrey (BPG) heteroskedasticity test, and ARCH test are the probability values of the F-statistics. ARDL is autoregressive distributive lag. ** and * imply statistically significant at 5% and 1% respectively.**

From the results reported in Table 5, it can be inferred that there is a long-run nexus between FinTech, financial inclusion, economic growth, and its determinants. To assess the degree of effect the ARDL estimation was conducted. The results are presented in Table 6.

Table 6: The ARDL results

Dependent Variable = Economic Growth (GDP per capita)				
Independent Variables	ATM	POS	WBP	MOB
Panel A				
Log(ATM)	-0.21 (3.77)**			
Log(POS)		0.62(7.72)***		
Log(WBP)			0.33(3.69)***	
Log(MOB)				0.59(4.42)***

BD	-0.065	(-3.158)*	0.34(8.06)**	0.117(2.27)** 0.69(5.50)***
BB	0.375(4.874)**	0.35(4.84)**	0.132(1.54)	0.015(4.219)***
CP	0.061(2.675)	0.09(2.82)**	0.62(5.08)****	0.40(3.053)**
M3	0.025(1.513)	-0.09(-2.25)	0.086(4.46)***	0.069(3.450)***
DC	0.063(5.325)**	-0.09(-4.91)**	0.016(4.82)***	-0.039(-2.74)
IP	0.049(0.3520)*	0.16(3.34)	0.46(3.38)***	0.024(1.14)
MC	0.013(3.096)***	0.039(0.768)	0.019(3.90)***	0.014(2.55)
C	2.75(3.384)	6.48(11.93)	5.81(6.66)	5.70(8.78)
Panel B: Error Correction Model				
CointEq(-1)*	-0.756(-11.543)**	-0.662(-8.339)**	-0.923 (-6.481)**	-0.539 (-5.921)**
R2	0.970	0.989	0.972	0.973
Adjusted R2	0.957	0.980	0.950	0.953
F-Stat (Prob)	76.429 (0.000)	122.019 (0.000)	43.940 (0.000)	49.436 (0.000)

Note: *, **, * imply statistical significance levels at 10%, 5% and 1%, respectively.**

Individual financial inclusion indicators were used to estimate their respective effect in the financial inclusion–growth nexus and to avail us of the advantage of further policy implications. FinTech proxy by the retail digital platforms of ATM, POS, WBP, and MOB along with the financial inclusion index had a long-run significant influence on economic growth in Nigeria.

Specifically, a 1% increase in the value of POS, WBP, and MOB transactions increases access to convenient, affordable, and flexible financial services by 62% 33%, and 59% respectively in the long run. The results revealed that retail digital banking channels are vital in the financial ecosystem. The negative effect of ATMs on financial inclusion and economic growth can be attributed to the closure of most ATM galleries in bank branches and outside the branches due to, high maintenance costs, and insecurity around the ATM galleries among others. This is evident in the long waiting time to use the ATMs and the growing number of bank customers further suggests that the current 22,500 ATMs in bank branches are insufficient to enhance inclusive growth.

The availability index (bank branches) across the models had a positive and significant influence on financial inclusion and economic growth at 37%, 35% 13%, and 0.015% respectively in the long run. The more the financial sector provides transaction points, the more economic agents respond by increasing economic activities.

Individually a percentage increase in bank branches per 100,000 adults increases economic growth and financial inclusion by 0.37%. This impact could be attributed to increased access to financial services- products through the FinTech retail digital platforms to the banked population. Thus, collaborating the exogenous growth model argument on the significance of technology and the results of Van and Linh (2019), Inoue and Hamori (2016), and Thomas et al. (2017) on the positive and significant impact of commercial bank branches on economic growth.

CONCLUSION AND RECOMENDATIONS

The study on FinTech, financial inclusion, and economic growth nexus is still evolving and very open because of the changing and dynamic structure of technology and the global economy. Financial inclusion is vital to achieving inclusive financial and economic growth in

Nigeria. Nigeria is considered an epicenter of retail digital platforms for financial inclusion. The study revealed a shift from the ATM usage to mobile device for its flexibility, convenient and accessibility. The digitalization of financial services has successfully restyled the operational and business activities of the classical financial system in Nigeria. Access to financial services imbalances arising from voluntary and involuntary exclusion accounts for drawbacks limiting socioeconomic development and also diminishing economic growth. The reintroduction of the 2012 financial inclusion strategy in Nigeria motivated this study, and the study objective is to establish the effect of FinTech on financial inclusion and economic growth in Nigeria. The study controlled for financial deepening and development communication. For more informed policy implications, individual financial inclusion indicators were adopted. A long-run nexus between the direct measures of FinTech on financial inclusion and economic growth was observed. The financial inclusion index positively and significantly influences economic growth. The usage indicators showed a non-significant effect. Indicating that although the development of financial infrastructure benefits the Nigerian economy, its application has not significantly influenced economic growth. Financial inclusion positively and significantly influences economic growth, deposit accounts, and credit to the private sector promotes economic growth.

Recommendations

This study recommends that policies should not only be focused on addressing the usage of financial services but also on the availability and penetration that are key to encouraging and inculcating saving habits among the new entrance into the financial system. There is a dire need to strengthen the regulatory and supervisory frameworks for consumer protection to safeguard new entrants into the mainstream financial or mobile financial systems from predatory practices and also from usurious moneylenders in financial services. This study further recommends the adoption of a triangular model to assess fintech and financial inclusion effect on economic growth in both urban and rural areas in Nigeria.

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