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FINANCIAL TECHNOLOGY AND ECONOMIC: QUARTERLY EVIDENCE FROM NIGERIA

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Abstract

Studies exploring the financial technology (FinTech) and economic growth nexus in Nigeria utilized the indirect measures of FinTech along with bundle indicators of financial inclusion, disregarding the discrete index's effect. This study aimed to expand the FinTech frontier by utilizing the direct measures of FinTech, such as automated teller machines, web pay, mobile banking, and point of sale with unbundle financial inclusion indicators to examine their individual degree of effect. We employed the ARDL model in estimating the individual effect and respective equations. Findings revealed several vital insights: direct measures of FinTech positively influence financial inclusion and economic growth. Automated teller machines negatively influence economic growth and financial inclusion, due to high maintenance costs and security concerns, leading to closure of ATMs galleries both within and outside bank branches. This closure resulted in infrastructural deficits, which hindered inclusive financing of the growing banked populations. Individual financial inclusion indicators positively influence economic growth, while economic growth and usage index nexus was non-significant. This study recommends the implementation of regulatory and supervisory frameworks to address the usage, availability, and penetration of FinTech to encourage and inculcate saving habits among the base of the pyramid and their protection from predatory practices.

Contribution/Originality: This study offers novel insights by employing direct measures of FinTech, examining the individual components of financial inclusion, and utilizing a specialized model (Lungs model) to assess the FinTech, financial inclusion, and economic growth nexus in Nigeria. This approach contributes to a more comprehensive understanding of the complex nexus in this context.

JEL Classifications: B22; B23; F65; G21; I30; O15; O16

1. Introduction

The Solow's 1956 neoclassical growth theory revealed the significance of financial technology in the design of macroeconomic policy. According to Solow (1956), advancement in technology, saving rate, and political will are the key determining elements of growth, the level of technological advancement is considered an exogenous vriable. The stability of the 21st-century economic and financial climate is anchored, among other things, on technological advancement for economic and financial service product expansion to the underbanked, unbanked, and financially excluded population. Largely comprising rural dwellers, generically rebranded as "*Base of the Pyramid (BoP)*" (Udoh, et, al 2016). According to the United Nations Special Envoy report (2013) about 200 million SME enterprises in emerging economies are financially and data-excluded, which restricts their competitiveness and ability to prosper.

FinTech, otherwise referred to as retail digital financial platforms or internet finance, involves the integration of technology into the functionalities of the classical financial system for payment and settlement, insurance, transfers, and peer-to-peer lending, among others (Appiah-Otoo & Song, 2021; Shim & Shin, 2016). Despite an all-embracing advancement by microfinance institutions, banks, loan and savings societies among others to spread out financial services to the BoP, about 2.5 billion adults globally are still data poor and financially excluded (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 are men. The World Bank's (2014) report disaggregated financial exclusion into voluntary and involuntary exclusion, as such decisions not to adopt financial services, either due to a lack of urgent need to use them or because of cultural and religious convictions, result in voluntary exclusion. Others blame their involuntary exclusion on poverty, income inequality, burdensome documentation, market failures, and free market flaws, among other things (Park & Mercado, 2015) (see Figure 1).

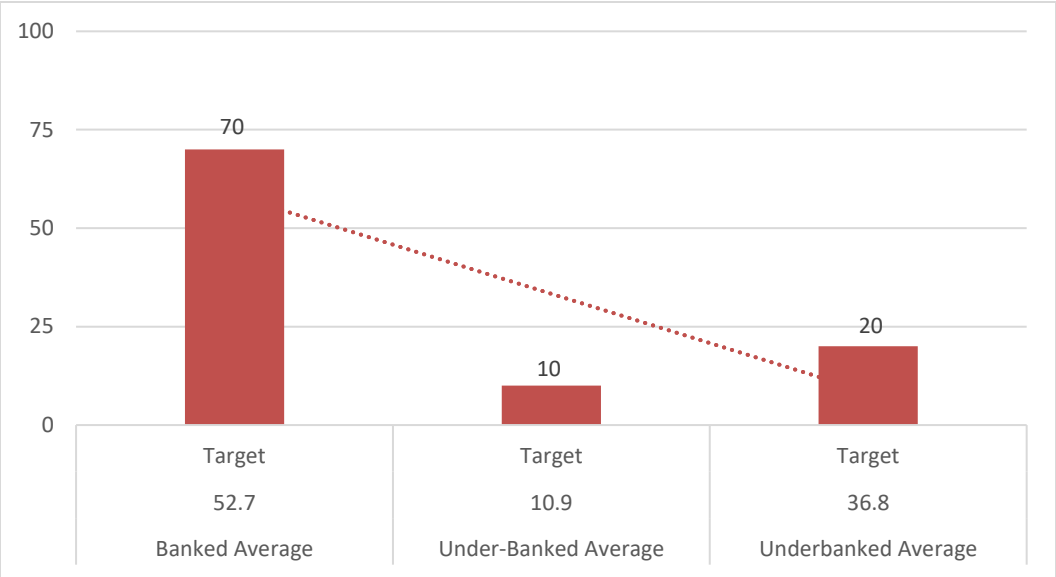
To deal with the effects of widespread involuntary exclusion, the CBN reintroduced the inclusion strategy in 2012 to improve adult access to financial products-services from the 21.6% reported in 2010 to 70% in 2020, access to savings 24.0% to 60%, credit 2% to 40%, insurance 1% to 40%, and pension 5% to 40% (see Figure 2). The first step to formal financial inclusion is maintain an account with any financial institution or other service providers (Demirguc-Kunt, et, al, 2018; Udo, 2023). The findings of Bara et, al (2016); Bourne, et, al, (2010), revealed a financial inclusion and

account ownership causal nexus. On the contrary, Arner, et, al (2020); Demir et al. (2020); Paripunyapat et, al (2018), among others, argued that account ownership is more of data inclusion, since numerous bank accounts and mobile money accounts are inactive, signifying exclusion. An all-inclusive structure diminishes the proliferation of informal sources of credit and protects the financially excluded groups from unethical financial activities. Udo, et, al (2023); Manyika, et, al (2016), Kiilu (2018), Azizah (2018), Choirin (2018), and Motsatsi (2016) attributed the increase in dormant accounts with banks and mobile money providers to financial illiteracy, poverty and income inequality.

The 2022 Nigerian Inter-Bank Settlement System report, revealed that active accounts with a bank, credit union, microfinance organisation, and mobile money service provider rose from 14.41% to 97.485 million and 111.54 million in 2022. Total savings increased by 13.8%, from N114.13 million in 2019 to N138.91 million in May 2022. Due to the COVID-19 safety measures of social and economic lockdown and the recent currency redesign and cash crunch in Nigeria.

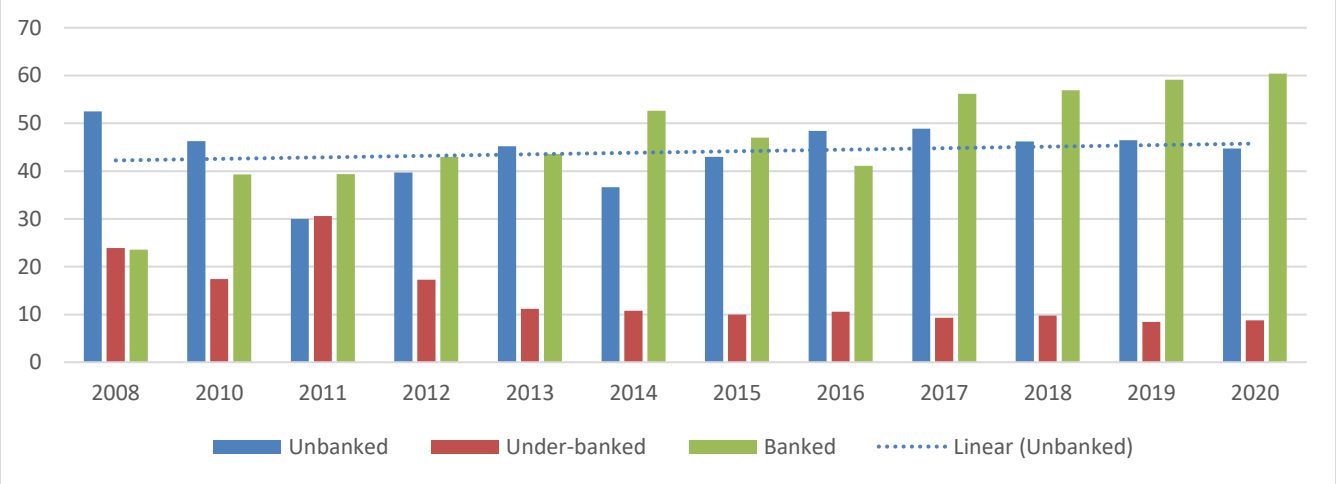
The lockdown period and the currency redesign policy reinforced the importance of cost-effective, affordable, available, and flexible agency banking channels as a vital part of the financial ecosystem for inclusive growth. By including the data and financially excluded individuals, households, and small-medium businesses in the mainstream economic and financial systems. The result of FinTech integration into Nigeria's economic and financial climate is financial inclusion.

Figure 1 Status of Financial Inclusion Gap



Source: National Financial Inclusion Strategy (NFIS) (2020).

Figure 2 National Financial Inclusion Strands (2008 - 2020)



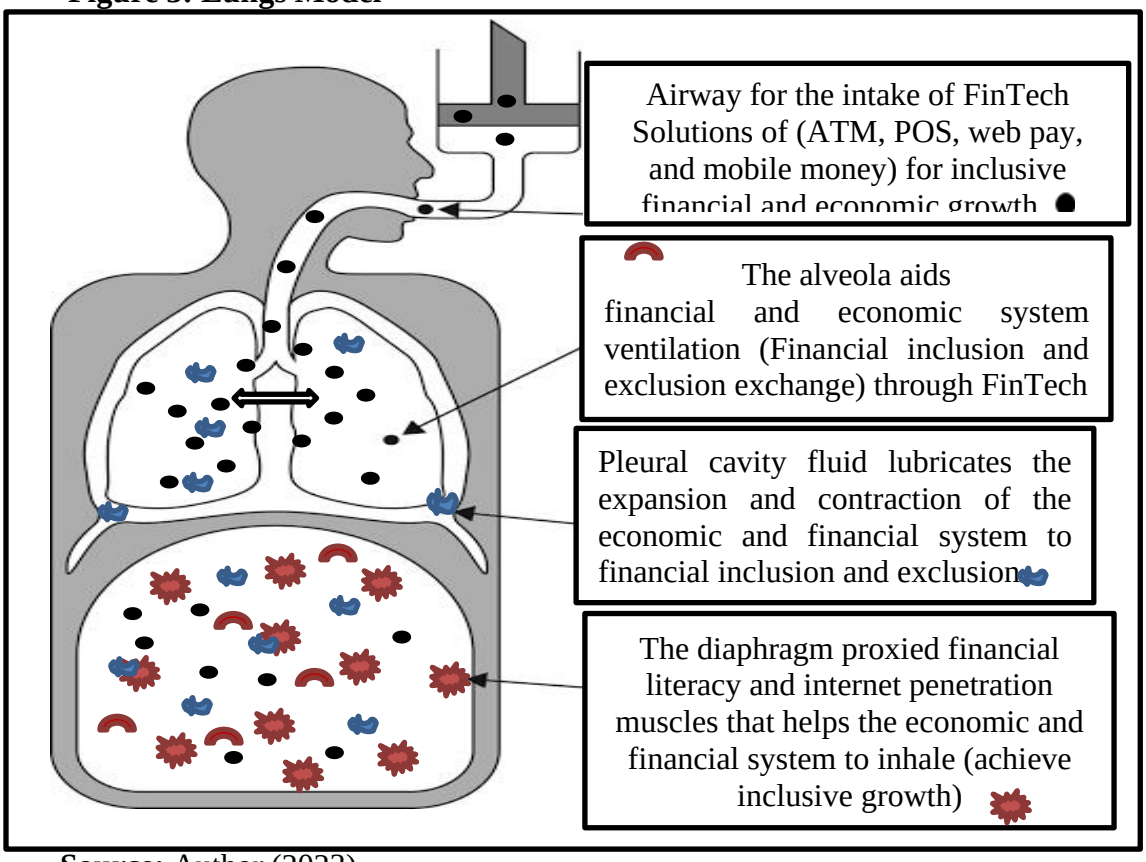
Author (2023)

The basic pivot of inclusiveness includes (a) access to a broader spectrum of financial services; (b) consumer privacy, data protection, and the provision of convenient, affordable, and secure services with dignity; (c) delivery of focused services to the underbanked and unbanked; and (d) a competitive financial system sustained by robust financial infrastructure and a defined regulatory framework, among others (Fadun 2014).

This study developed the lung model to explain the FinTech, inclusion, and economic growth tie in Nigeria (see Figure 3). The lungs are the foundational group of organs and tissues that facilitate the exchange of oxygen from the environment into the bloodstream and the removal of extra carbon dioxide. In the lung model, FinTech (oxygen) and financial inclusion (airways) take in resources and provide growth opportunities for the economy. FinTech eradicates barriers to financial exclusion and expands access to affordable and flexible financial services to BoP.

Financial inclusion is the airway in the lungs, providing a path for FinTech (oxygen) to circulate throughout the body (the economy). By providing access to financial resources, the base of the pyramid, largely rural dwellers, actively participates in productive economic and financial activities. The Nigerian economy, like the body receiving oxygen, must function effectively. Access to financial services enables businesses to revolutionise, and stimulate economic growth. In turn, this diminishes the proliferation of informal sources of credit and protects the new entrance from usurious moneylenders.

Figure 3: Lungs Model



Source: Author (2023)

Empirically country-specific studies of Demir, et, al (2020); Igoni, et, al (2020), Udo, et, al (2019a) among others, revealed diverse results. In cross-country studies of, Charles (2023); Kamalu, et, al. (2019), Mlanga (2019), Iqba et, al (2017, 2018), Niankara, and Muqattash (2019), among others, also reported diverse results. Patrick (1966) argued that a nation's level of development influences its level of technological advancement, economic growth, and financial development. Chortareas et al. (2013); Udo, et, al (2023) collaborate with Patrick's claims, acknowledging cultural, geopolitical, and national characteristics and governance systems, effects on FinTech adoption.

Also, Akhisar, et, al (2015; Udo et, al 2023. 2019a,b), noted that cross-sectional studies, is inept in accounting for a specific country's level of technological, financial and economic sector growth. As a result of country-specific heterogeneous factors grouped under socioeconomic, cultural, political, religious, and financial. Country-specific studies would be more rigorous in clarifying the nexus. The extensive use of the conventional regression analytical model in country-specific studies by Nwant, et, al (2016), Akinwale (2018), Ndubuisi (2017), and Nwakobi, et, al (2019), among others, raises concern on the validity of their research's findings. Inferences drawn based on a unique model are statistically suspicious, according to Gunst and Mason's 1980 argument (pp. 169–206). The adoption of a diverse paradigm to investigate this nexus will provide vital policy formulation (Grassa & Gazdar (2014; Udo, et, al 2023). However, time series data are often skewed and they are leptokurtic in nature (Brooks 2014). The spikes and variations render the linear model inappropriate for an accurate and reliable assessment of this nexus.

This study adds to extant literatures by bordering "FinTech" frontiers to capture the direct measures owing to the upsurge in FinTech in Nigeria. However, most studies confine FinTech indicators to classical banks, ignoring FinTech evolution beyond the classical financial borders. In Nigeria, mobile and internet banking, point of sale, and web pay, among other retail digital financial platforms that control a sizable percentage of access, usage, and penetration of financial services, are maintained, and supported by telecommunications firms.

To assess the crux of "non-conventional banking and financial FinTech. An enlarged characterization of direct measure of FinTech was utilized as the value of transactions on each retail FinTech conduits of; ATMs, POS, WBP, MOB, internet banking among others.

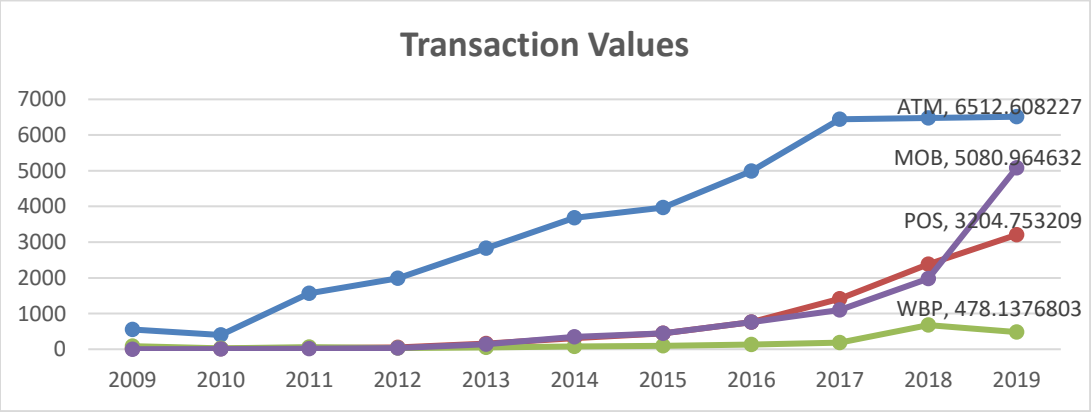
This study considered mobile banking [MOB], point of sale [POS], web pay [WBP], and automated teller machines [ATM] FinTech retail platforms for analysis. Qamruzzaman and

Jianguo (2018); Ujunwa, Onah, Ujunwa, Okeyezuz, and Kalu (2021) and Udo, et, al (2023) adopted this approach. Extant studies in this area habitually focus on the aggregate FinTech index ignoring the direct non-conventional measures.

This study adds to extant literatures by unbundling the inclusion indicators to access individual contributions to economic growth and human capital development in Nigeria. The study also adds by developing the lung model and testing the symmetric FinTech, financial inclusion and economic growth nexus using the ARDL bound approach.

Figure 4 reveals that the transaction values of various retail platforms increased in trajectory from January 2009-December 2019 in Nigeria within the period under review. The possible explanation for the geometric increase could be the ease, availability, and affordability features embedded in these digital platforms. The value of ATM transactions increased from ₦548.6 billion to ₦6512.60 billion from 2009-2019. Similarly, the values of MOB, POS, and WBP transactions also increased geometrically, respectively. The results show that ATM, POS, and MOB are the fastest channels to access and use financial products, notwithstanding the challenges of poor network coverage. This finding supports the results of Udo et, al (2023) in Nigeria and Charles (2023) in Common Market for Eastern and Southern Africa (COMESA) countries.

Figure 4: Values of digital platform transactions in (₦ Billions)



Source: Author (2023)

2. Literature review

Financial Inclusion

Financial inclusion fundamentally infers linking unbanked and underbanked individuals, businesses, and households to all-inclusive economic and financial services benefits (Siddik et al.,

2019). Inclusive financing is the basic determining element of financial development, financial development does not infer inclusive financing since several individuals, businesses, and households may be financially excluded (Lenka, 2021). Both enhances economic growth with divergent magnitudes (Li & Wong, 2018).

Inclusive financial and exclusion instigated by several influences; such as the lack of awareness and literacy, religious believes, self-exclusion, income per capita, bank concentration among others (Chuka et al., 2022, Sotomayor et al., 2018; Pazarbasioglu et al., 2020). Financial exclusion according to Barboni et al., (2017) is a product of social exclusion and poverty.

Indicators of Financial Inclusion

The diversity in the characterisation of financial inclusion is evidenced in the lack of appropriate indicators. In a bid to zero down and develop an all-inclusive indicator, Beck et al. (2007) proxied inclusive financing access by (credit facility; deposit) and usage (payment system). Similarly, Honohan (2008) adopted a percentage of households with an active account with mobile and other financial service providers. Demirguc-Kunt et al. (2018), among others, adopted a set of precise indexes of savings, credit, and payment. Park and Mercado (2015) and Nguyen (2020) posit that, adoption of specific metrics can only offer a hazy picture of an economy's financial system's inclusiveness and degree of coverage. Neaime and Gaysset (2018); Khan, Khan, Sayal, and Khan (2021); and Park and Mercado (2018) collaborated these findings.

Over the decades, diverse theoretical and empirical studies, tried to develop and construct a comprehensive index of inclusive financing. In developing an all-inclusive indicator of financial inclusion, the average of four dimensions: usage, outreach, cost of transactions, and ease of transactions was used by (Gupte et al. (2012). Following the UN human development index Development Programme (UNDP). The major methodological constraint according to Amidic et al. (2014) and Singh and Stakic (2020), in those studies is arbitrary allocation of equal weights to the designated elements.

Amidic et al. (2014); Singh and Stakic (2020) revealed that such weights are allotted on the assumption that all indicators have the same impact on financial inclusiveness. In determining the apt weights, Amidic et al. (2014) and Clamara and Tuesta (2014) recommended factor analysis and principal component analysis (PCA), respectively, as a less arbitrary weights-assigning model that bank on existing data for the several indicators of financial inclusion.

However, studies, in developing the financial inclusion index, adopted either the PCA or individual approach (Dahiya & Kumar, 2020; Chuka, et, al, 2022; Ahamed & Mallick, 2019; Anarfo et al., 2019; Elsherif, 2019; Huang & Zhang, 2019; Nguyen, 2020; Park & Mercado, 2018; Sethi & Sethy, 2019). These methods are not without merits and demerits, which account for non-consensus among scholars and divergency in results.

2.1 FinTech, Financial Inclusion and Economic Growth Nexus

In establishing the financial sector-economic growth nexus, the pioneering studies of Schumpeter (1912), Shaw (1973), and McKinnon (1973) laid the foundation. The basic evidence is that financial development is fundamental in explaining economic growth patterns through efficient mobilisation and allocation of limited economic and financial resources to active economic agents in developed and emerging economies (Chen et al., 2021; Udo et, al 2019a). A healthy financial system initiates wealth creation, trade, and capital formation for growth and development (Ahmed 2006). In accounting for cross-country economic growth variations, exogenous and endogenous growth models were developed.

The significance of high-tech (Solow, 1956); labour and productivity (Domar, 1946) in reducing growth disparities globally is emphasised in the exogenous growth model. Modern economic development is largely influenced by the exogenous growth assumption of high-tech innovation, new organizational and managerial structures for production and transformation of a static to dynamic economy. Contemporary high-tech innovation has evolved from the creation of new products to providing solutions to unending economic glitches (Kotsemir & Abroskin 2013).

3. Econometric Model

Quarterly data from 2009Q1–2019Q4 was collated from the CBN and the World Bank Development Index. For this study, FinTech is proxied by transactions values on each retail digital platforms and are projected to boost economic growth. They are considered the most potent proxy of FinTech (Adil et al. 2020). GDP per capita proxy economic growth expressed in US dollars and natural logarithms.

Financial inclusion was proxied by the unbundle dimensions of (availability, penetration, and usage). Availability (number of bank branches). Sarma (2016) noted that transaction points are fundamental to financial inclusion and should be easily available and convenient for users.

Penetration (bank depositors per 1,000 adults). An all-inclusive financial system entails deep penetration (Nguyen, 2020). Usage (credit to the private sector % of GDP). An all-inclusive financial system ensures full utilization of financial services (Nguyen, 2020; Sarma, 2016). **Control variables:** financial deepening index (domestic credit to the private sector and M3 (% of GDP) and communication index (internet access (% of the population) and mobile cellular subscriptions (per 100 people) were adopted for their influence on financial inclusion and the economy.

3.1 Estimation Strategy

The variables are time series (t), testing of the stationary properties are vital. The NG-Perron unit root was used to address the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) associated weak in determining the stationary properties of the series (Folarin & Asongu, 2019). The Pesaran et al. (2001) autoregressive distributed lag (ARDL) bounds model was used to assess the long-run nexus in the variables as specified in Eqn (2). The model integrates variables of diverse orders of integration; we considered it the most suitable. For eliminating hitches associated with serial correlation and variables endogeneity (Rahman & Kashem, 2017). The linear form of the study model is expressed as follows:

Economic Growth		Retail Digital Products	Financial Inclusion	Financial Deepening	Control Variables	(1)
↕		↕	↕	↕	↕	
GDP	$= f$	FINTECH	BB, CP, BD	DC, M_3	IP, MC	

The ARDL model is expressed as:

$$GDP_t = \beta_0 + \sum_{i=1}^{p} \beta_i GDP_{t-i} + \sum_{i=0}^{k1} \delta_i ATM_{t-i} + \sum_{i=0}^{k2} \lambda_i POS_{t-i} + \sum_{i=0}^{k3} \Upsilon_i WBP_{t-i} + \sum_{i=0}^{k4} \phi_i MOB_{t-i} + \sum_{i=0}^{k5} \pi_i BB_{t-i} + \sum_{i=0}^{k6} \theta_i CP_{t-i} + \sum_{i=0}^{k7} \upsilon_i BD_{t-i} + \sum_{i=0}^{k8} \psi_i DC_{t-i} + \sum_{i=0}^{k9} \omega_i M3_{t-i} + \sum_{i=0}^{k10} \tau_i IP_{t-i} + \sum_{i=0}^{k11} \chi_i MC_{t-i} + \varepsilon_t \quad (2)$$

The optimal lag was automatically determined using Schwarz information criteria (SIC). The ARDL bound test is expressed as follows in equation (3):

$$\Delta InGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta InGDP_{t-i} + \sum_{i=0}^{k1} \delta_i \Delta InATM_{t-i} + \sum_{i=0}^{k2} \lambda_i \Delta InPOS_{t-i} + \sum_{i=0}^{k3} \Upsilon_i \Delta InWBP_{t-i} + \sum_{i=0}^{k4} \phi_i \Delta InMOB_{t-i} + \sum_{i=0}^{k5} \pi_i \Delta InBB_{t-i} + \sum_{i=0}^{k6} \theta_i \Delta InCP_{t-i} + \sum_{i=0}^{k7} \upsilon_i \Delta InBD_{t-i} + \sum_{i=0}^{k8} \psi_i \Delta InDC_{t-i} + \sum_{i=0}^{k9} \omega_i \Delta InM3_{t-i} + \sum_{i=0}^{k10} \tau_i \Delta InIP_{t-i} + \sum_{i=0}^{k11} \chi_i \Delta InMC_{t-i} + \lambda_1 InGDP_{t-1} + \lambda_2 InATM_{t-1} + \lambda_3 InPOS_{t-1} + \lambda_4 InWBP_{t-1} + \lambda_5 InMOB_{t-1} + \lambda_6 InBB_{t-1} + \lambda_7 InCP_{t-1} + \lambda_8 InBD_{t-1} + \lambda_9 InDC_{t-1} + \lambda_{10} InM3_{t-1} + \lambda_{11} InIP_{t-1} + \lambda_{12} InMC_{t-1} + \varepsilon_t \quad (3)$$

Where: Δ = difference operator, and *ln* = natural log of the variables.

The F-statistics value of the bound test was estimated to assess the presence of a long-run nexus and the estimated F-statistics value was compared with the upper and lower-bound critical values.

Decision rule: F-statistics is (>) the upper critical value (cointegration). F-statistics is (<) upper and lower critical values, (no cointegration); F-statistics falls between the upper and lower critical values (inconclusive).

From (3): the short-run dynamics are captured by λi; for i = 1, 2,3,4,5. . .6 and the long-run dynamics are captured by β_i; γ_i; δ_i; ρ_i; τ_i; υ_i; θ_i; ωi; ϕ_i; χ_i and σ_i for i = 1, 2, 3, 4, 5. . . ., p.

The error correction (ECT) model, equation (3) is expressed as:

$$\Delta InGDP_t = \beta_0 + \sum_{i=1}^{p} \beta_i \Delta InGDP_{t-i} + \sum_{i=0}^{p} \delta_i \Delta InATM_{t-i} + \sum_{i=0}^{p} \lambda_i \Delta InPOS_{t-i} + \sum_{i=0}^{p} \Upsilon_i \Delta InWBP_{t-i} + \sum_{i=0}^{p} \phi_i \Delta InMOB_{t-i} + \sum_{i=0}^{p} \pi_i \Delta InBB_{t-i} + \sum_{i=0}^{p} \theta_i \Delta InCP_{t-i} + \sum_{i=0}^{p} \upsilon_i \Delta InBD_{t-i} + \sum_{i=0}^{p} \psi_i \Delta InDC_{t-i} + \sum_{i=0}^{p} \omega_i \Delta InM3_{t-i} + \sum_{i=0}^{p} \tau_i \Delta InIP_{t-i} + \sum_{i=0}^{p} \chi_i \Delta InMC_{t-i} + \infty ECT_{t-1} + \varepsilon_t \quad (4)$$

ECT captures the variables long-run nexus coefficient, ∞, and the speed of convergence to long-run equilibrium from short-run divergence due to shocks in the system. ∞, is negative and significant after an external shock. The diagnostic tests of the ECM result, were conducted.

4. Empirical Estimation

The descriptive statistics result reported in Table 1. Shows that the average value of MOB transactions was ₦900.376 about three times the average value of ATMs and POS, and four times the average of WBP, which suggests that mobile money is the fastest, easiest, and most convenient retail digital platform to access financial services and products within the review period. This signals a gradual shift from ATMs to a more convenient and accessible retail digital platform. WBP is the least patronised retail platform in Nigeria. The average number of deposit accounts is 823.463, (penetration) and credit to the private sector is 18.759 (usage). Indicating that FinTech positively influences inclusive growth and is evident in usage and access to financial services.

The average value of ₦22.507 for M3, (financial deepening), indicates positive impact 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 subscriptions shows the importance of mobile technology for inclusive growth, as evidenced by the average value of 22.497% for individuals using the internet for information. The Ng-Perron unit root test results in Table 2 shows stationarity in diverse order. Thus, satisfying and giving creditability to our ARDL bound model.

Table 1: 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	1.616	3.513
POS	798.277	312.071	3204.75	11.03	1049.10	1.294	3.272	12.421
MOB	900.376	346.467	5080.96	1.27	1460.20	2.140	6.484	55.865
WBP	171.302	84.15	675.916	25.05	202.920	1.645	4.217	22.563
BB	5.2890	4.9802	6.564	4.283	0.8463	0.270	1.502	5.489
BD	823.463	667.464	1458.40	464.479	312.838	0.688	2.288	5.198
CP	18.759	18.667	22.754	15.067	1.723	0.244	4.128	3.2744
DC	12.805	12.491	19.625	10.246	2.437	1.684	5.561	35.8176
M3	22.507	22.898	24.895	19.820	1.394	-0.567	2.726	2.948
GDP	2370.09	2204.18	3200.95	1883.88	400.603	0.734	2.330	5.643
IP	22.497	22.75	35.5	9.3	8.508	0.018	1.743	3.156
MC	75.534	77.467	98.032	47.586	14.981	-0.403	2.101	3.159

Source: Author (2023)

Table 2 Ng-Perron Unit Root Test

	Mza	**MZt**	**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 (0)	3

Note: *, **, *** signify the level of significance; 10%, 5%, and 1% respectively.
Source: Author (2023)

The ARDL cointegrating bound test results and other diagnostic tests are reported in Table 3. The results specify that the various retail digital FinTech platforms of ATM, POS, MOB, and WBP cointegrate with their determinants. The degree of effect was assessed and the results are reported in Table 6.

Table 3: ARDL bound cointegration test results

Models		F-Stat	Normality	BG LM test (1)	BPG heteroskedasticity test	ARCH test (1)
ATM	*F*(InATM,BD,BB, CP, M3, DC, IP MC	10.08	0.54	0.79	0.064	0.182
POS	*F*(InPOS,BD,BB, CP, M3, DC, IP, MC	11.65	0.95	0.07	0.06	0.63
MOB	*F*(InPOS,BD,BB, CP, M3, DC, IP, MC	6.74	0.08	0.639	0.83	0.70
WBP	*F*(InPOS,BD,BB, CP, M3, DC, IP, MC	9.95	0.32	0.60	0.90	0.48

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 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 P-values of the F-stat. ** and *** significant level at 5% and 1% respectively.

Source: Author (2023)

Table 6: The ARDL results

Dependent Variable = 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)**
R^2	0.970	0.989	0.972	0.973
Adjusted R^2	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(s): *, **, *** significance levels at 10%, 5% and 1%, respectively.				

Source: Author (2023)

Individual indicators of financial inclusion were used to estimate their respective effects on growth and to avail us of the benefit for policy implications. The retail digital platforms of ATM, POS, WBP, and MOB, along with the financial inclusion index, had a significant long-run influence on economic growth in Nigeria. A unit rise in the values 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 retail digital channels are vital to the financial ecosystem. The negative nexus with ATMs 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 shows a positive-significant influence on financial inclusion and economic growth at 37%, 35%, 13%, and 0.015%, respectively, in the long run. Availability of transaction points increases economic activities.

Individually, a unit rise in bank branches per 100,000 adults increases economic activities and financial inclusion by 0.37%. This impact could be attributed to increased access to financial services and products through FinTech retail digital platforms for the banked population. Thus, collaborating the exogenous growth model argument on the significance of technology and the results of Udo et, al (2023); Udo, et, al (2019a); Van and Linh (2019), Inoue et, al (2016), and Thomas et al. (2017) on the positive influence of commercial bank branches.

Penetration (deposit account) dimension index of financial inclusion from the various FinTech platforms showed a positive (0.34%, 0.11%, and 0.69%) and substantial impact on economic growth. Penetration begins with operating a formal account with the bank or mobile money service provider to increase economic and financial activities. The reintroduction of the 2012 financial inclusion policy strategy has significantly simplified banking penetration.

The negative nexus with ATMs can also be attributed to high ATM card charges and the rigorous process of renewing or collecting new ATM cards, thus decreasing economic activity by 0.065%. Also, the result specifies that the demographic and behavioural pattern of most Nigerians at the base of the pyramid" (BoP) indicates cash preference due to a lack of trust in retail digital payment systems and high financial and technology illiteracy (Koker & Jentzsch, 2013; Udo, et, 2023). Usage index across the models showed positive influence on economic agents' access to credit facilities for

economic activities. The findings of Sharma (2016), Inoue (2016). Udo, et, al (2019a) and Hamori (2016) collaborate with our findings.

The Schumpeterian growth model acknowledges the multiplicative influence loanable funds have on economic activity. The non-significant bank credit-economic growth nexus suggests that the unstable business climate in Nigeria accounts for 65.9% of MSME credit repayment defaults and the futile utilisation of bank credit for the intended purpose. The general verdicts of this study support the exogenous growth model and emphasise the significance of technological advancement (FinTech) (Solow, 1956); labour productivity (Domar, 1946); new organisational structures; production processes; and management styles in transforming a static financial and economic climate into a dynamic one. As such, the integration of FinTech into the operational and business activities of the classical financial system has not only created new products but has also provided solutions and eliminated barriers to financial and economic growth (Kotsemir and Abroskin 2013). The study findings also lend credence to the endogenous growth theory through financial deepening, to encourage growth (Udo et, al 2019a; Udo, et, al 2023; Ibrahim, et. al., 2018; Sharma, 2016).

The financial deepening (M3 money supply and domestic credit) index positively and significantly influences economic growth. Thus, a unit rise in financial sector efficiency surges economic growth by 0.025%, 0.086%, and 0.069% through money supply for mobilisation, 0.063%, and 0.016% for allocation for investment purposes in Nigeria. Empirically, the results of these studies collaborate with the findings of Peru (2018), Udo et, al (2019b); Tchamyou, Erreyger, and Cassimon (2019); Gabor and Brooks (2017); Dorfleitner and Roble (2018); Eton, et, al (2018); Na Song and Appiah-Otoo (2022) in China. From the results reported in Panel B of Table 6, the ECTs are correctly signed across the models. The speed of convergence to long-run equilibrium ranges from -0.539 to -0.756, denoting short-run divergence.

5. Conclusion and policy implications

Studies on the FinTech-economic growth nexus are evolving and open due to the expanding and dynamic nature of technology and the global economy. Financial inclusion is crucial for achieving inclusive economic and financial growth in Nigeria. Nigeria is considered the epicenter of retail digital platforms for financial inclusion. These studies established that mobile device are fast becoming the preferred channel of payment. The reintroduction of the 2012 financial inclusion strategy in Nigeria motivated this study to adopt the ARDL cointegration technique to examine the long-run nexus among the three constructs of FinTech, financial inclusion, and economic growth. For more informed policy

implications, individual financial inclusion indicators were adopted. Results revealed a long-run nexus while the usage indicator had a non-significant effect.

Indicating that financial infrastructure development is beneficial, but its usage is poor. This study recommends that policies should not only be focused on addressing the usage but also on their availability and penetration, efficiency which are key to encouraging and inculcating saving habits among the base of the pyramid. There is a dire need to toughen the regulatory outlines to safeguard new entrants into mainstream financial or mobile financial systems from predatory practices and also from usurious moneylenders in financial services. The formulation of cost-efficient and purpose-driven fintech solutions to provide citizen-centric funding must be taken into consideration by policymakers as more countries strive to establish legislation that takes into account country-specificities.

COMPETING INTERESTS

The author has no competing interests to declare.

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