

SYNERGIZING DIGITAL FINANCIAL INCLUSION AND TAX REVENUE FOR INCLUSIVE ECONOMIC WELL-BEING IN NIGERIA

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ABSTRACT

Nigeria's evolving digital economy presents new opportunities for inclusive development through digital financial inclusion (DFI) and improved tax revenue mobilization. While digital technologies enhance efficiency in tax administration, they also create challenges such as risks of exclusion and potential over-taxation. This study investigates the interactive effect of DFI and tax revenue on economic well-being in Nigeria, filling a key gap in empirical literature. Using annual data from 2000 to 2023 sourced from the World Bank and Global Findex, the study applies the Autoregressive Distributed Lag (ARDL) model to capture short- and long-run dynamics. DFI is measured through indicators of access, usage, and availability, while tax revenue is represented by tax-to-GDP ratio, direct and indirect collections, and efficiency measures. Economic well-being is proxied by a composite index covering income, employment, and living standards. Findings reveal that while DFI and tax revenue positively influence well-being in the long run, their interaction produces a negative effect when tax burdens rise excessively, thereby undermining the benefits of inclusion. The results highlight the importance of balanced fiscal and digital policies that foster equity, avoid regressive digital taxation, and ensure that financial access translates into real welfare gains. This study offers practical insights for Nigeria's pursuit of the Sustainable Development Goals (SDGs), particularly poverty reduction, decent work, and reduced inequality.

Keywords: Autoregressive Distributed Lag (ARDL) model, Digital financial inclusion, Economic well-being, Inclusive economic growth, Nigeria, Tax revenue.

1. INTRODUCTION

Nigeria as an Africa's largest economy by population and one of the most dynamic digital markets, is undergoing a profound transformation driven by digital technologies. The proliferation of mobile money platforms, fintech innovations, and electronic payment systems has created new opportunities for millions of unbanked and underbanked individuals. At the same time, the

Nigerian government faces persistent challenges in mobilizing adequate tax revenue to fund public goods, reduce poverty, and achieve sustainable development.

Despite being a resource-rich country, Nigeria's tax-to-Gross Domestic Product (GDP) ratio has consistently lagged behind global and regional benchmarks. According to the OECD (2022), Nigeria's tax-to-GDP ratio remains below 8%, (13.5% in 2025) compared to an average of 17% in Sub-Saharan Africa and over 30% in advanced economies. This fiscal weakness undermines the government's capacity to deliver essential services and improve economic well-being.

Digital financial inclusion (DFI) has the potential to transform this scenario by expanding access to financial services, formalizing economic activities, and broadening the tax base (World Bank, 2014). Yet, integrating DFI with tax mobilization raises a number of concerns such as how digital finance can facilitate fair and efficient taxation, the interaction between tax revenue and financial inclusion and its effects on economic well-being, and the risks involved in taxing digital transactions without stifling inclusion (Ajaero et al., 2025).

Tax revenue remains a central pillar for financing public goods, reducing inequality, and promoting economic well-being. However, Nigeria's tax-to-GDP ratio remains persistently low relative to peer countries, largely due to widespread informality, weak compliance, and administrative inefficiencies (Federal Inland Revenue Service, 2022). The heavy reliance on oil revenues has further exposed the economy to external shocks, underscoring the urgency of broadening the non-oil tax base. Hence, DFI presents a strategic opportunity to enhance tax revenue performance by formalizing economic transactions, improving traceability, and lowering the cost of tax compliance and collection.

Now, evidences point to the synergy between digital financial inclusion and tax revenue generation as being able to support inclusive economic well-being. As alluded to in Ajaero et al., (2025) and Omojola et al., (2022), this could be achieved by enabling the government to mobilize resources needed for social protection, infrastructure development, and poverty reduction (Bakar et al., 2015). However, the extent of this synergy remains yet unproven and inconclusive in Nigeria. This is the focus of this work. By empirically analyzing the nexus of DFI, tax revenue, and economic well-being in Nigeria, this work contributes to existing knowledge by investigating their interactive effects using time-series data from 2000 to 2023. It employs the Autoregressive Distributed Lag (ARDL) model to distinguish between short and long-run dynamics. The findings will inform fiscal and financial sector policies that advance Nigeria's economic resilience and inclusive growth.

The remainder of this work outlines the literature review (section 2), the methodology (section 3), results and discussion (section 4) and conclusion (section 5).

2. LITERATURE REVIEW

The intersection of financial inclusion, tax revenue mobilization, and welfare outcomes has attracted increasing scholarly interest. Evidence across regions shows that financial inclusion expands the tax base and improves resource mobilization.

Digital financial inclusion involves the deployment of the cost-saving digital means to reach currently financially excluded and underserved populations with a range of formal financial services suited to their needs that are responsibly delivered at a cost affordable to customers and sustainable for providers (World Bank, 2014). It is a unique way of providing financial inclusion for vulnerable groups in the society by overcoming the obstacles of cost, distance and transparency to meet their financial needs (Gallego-Losada et al., 2023). DFI offers a number of benefits for the financially excluded and underserved including access to formal financial services, reduction in costs of transaction, reduced risks of loss, theft, and other financial crimes posed by cash-based transactions, economic empowerment by enabling asset accumulation, amongst others (World Bank, 2014).

Revenue generation remains one of the most important concerns for many governments around the World (Ajaero et al., 2025). In Nigeria, it is a major concern as it poses a significant challenge despite various strategies by successive governments to enhance it over the years. The Nigerian government has introduced and collected taxes to generate revenue to fund both capital projects and expenditures to guarantee economic growth and development.

Digital financial inclusion has been recognized as an important determinant of domestic revenue mobilization, particularly in developing and emerging economies (World Bank, 2014). As individuals and firms adopt digital financial services, their economic transactions become recorded and observable, allowing tax authorities to more accurately identify taxable income, sales, and profits. This process broadens the tax base and enhances revenue collection without the need to increase statutory tax rates (World Bank, 2019). The shift toward digital payments also improves transaction traceability and data availability, which are critical for effective tax administration (Klapper & Singer, 2017). Digital financial records also reduce discrepancies in information between taxpayers and governments, thus making underreporting and tax evasion more difficult. This effect is particularly pronounced for consumption taxes such as value-added tax (VAT) and for small and medium-sized enterprises where digital transaction trails can strengthen enforcement and compliance mechanisms. Beyond administrative channels, DFI contributes to tax revenue growth through its positive effects on economic activity. Access to digital finance enhances savings, credit availability, and participation in digital markets, leading to higher productivity, business expansion, and household income. As economic activity increases, so do taxable profits, wages, and consumption, creating a sustainable and growth-enhancing source of public revenue (Suri & Jack, 2016). Over time, this structural transformation strengthens the fiscal capacity of the state.

Furthermore, a number of researchers have discussed the role of digital financial inclusion in tax revenue generation and how it affects economic well-being. For example, Chebochok & Bayale (2023) found that financial inclusion positively impacts tax collection in West African Economic

and Monetary Union countries, especially through indirect taxes. Raouf (2022) revealed a non-linear effect across Europe, Africa, and the Middle East, showing that inclusion initially reduces but later enhances tax revenue. In Nigeria, Omojola et al., (2022) confirmed that digital payments such as point-of sale (POS) terminals and web transactions support tax revenue collection.

Al-Smadi (2023) demonstrated that digital finance significantly improves financial inclusion in MENA countries. In Nigeria, Ishioro (2023) identified a positive long-run relationship between internet-based finance and inclusion but noted limitations in ATM-driven access. (Uzoma et al., 2020) also highlighted the strong link between digital finance and inclusion across Sub-Saharan Africa.

Mpofu & Mhlanga, (2022) examined the imposition of digital financial service taxes in Africa, cautioning against exclusionary effects on low-income groups. In Nigeria, Maccarthy et al., (2022) showed that electronic tax systems improved efficiency, though with varied effects across tax categories. Studies such as Opeyemi et al., (2022) also emphasize the distributional impacts of digitalization on federal and state tax revenues.

Country	Period	Observed Outcomes	Revenue	Key Empirical Insights	Source
Peru	2014–2018	~5% increase in reported VAT liabilities		Mandatory e-invoicing increased compliance, especially among previously under-reporting firms	
Uganda	2016–2021	Measurable improvement in VAT compliance and revenue		Digital receipts reduced evasion and improved reporting accuracy	
Mexico	2012–2017	Large increase in goods & services tax revenue		Digital invoicing reduced under-reporting and broadened the tax base	
Tanzania	2017–2022	Improved VAT compliance among SMEs		Digital tax systems increased compliance probability	
Senegal	Property tax compliance tripled in pilot areas	Identification of untaxed properties		World Bank (2018); ICTD	
Indonesia	~20% reduction in tax compliance time; higher revenue efficiency	Lower compliance costs increased voluntary compliance		Better Than Cash Alliance (2022)	
Greece	Tax revenues exceeded forecasts; supported budget surplus	Automated detection reduced evasion		Kalogiannidis (2021); AP News	

3.0 Theoretical Foundation/Underpinning

This study is grounded in the endogenous growth theory, which posits that long-run economic growth and improvements in economic wellbeing are driven by internal factors such as human capital accumulation, technological innovation, financial development, and effective public policy rather than exogenous forces. Unlike neoclassical growth models that assume diminishing returns to capital and exogenous technological progress, the endogenous growth framework emphasises the role of institutions, policy choices, and innovation in sustaining growth and welfare over time.

Within this framework, digital financial inclusion represents a form of financial and technological innovation that enhances productivity and welfare by lowering transaction costs, improving access to savings and credit, and integrating households and firms into formal economic systems. By facilitating efficient resource allocation and supporting entrepreneurial activity, digital financial inclusion contributes endogenously to economic wellbeing through improved income opportunities and consumption smoothing. However, the model also recognises adjustment costs and learning effects, implying that the welfare benefits of digital financial inclusion may materialise gradually rather than instantaneously.

Tax revenue plays a central role in the endogenous growth process by providing governments with the fiscal capacity to invest in growth-enhancing and welfare-improving public goods such as education, healthcare, digital infrastructure, and social protection. When efficiently mobilised and allocated, tax revenue supports human capital development and technological diffusion, thereby reinforcing the productivity effects of digital financial inclusion. At the same time, endogenous growth theory acknowledges that excessive or distortionary taxation may weaken incentives for innovation, formalisation, and investment, potentially dampening long-run welfare gains.

Human capital is a core pillar of the endogenous growth model, as skills, knowledge, and education enhance labour productivity and facilitate the adoption and effective use of digital technologies. In this context, human capital interacts with digital financial inclusion by determining the population's ability to utilise digital financial services and benefit from financial innovation. The model therefore implies that the welfare impact of digital finance is conditioned by the quality and relevance of human capital development.

Finally, macroeconomic conditions, proxied by the exchange rate, influence endogenous growth by shaping external competitiveness, investment incentives, and fiscal space. While exchange rate movements may affect economic wellbeing in the short run, the endogenous growth perspective suggests that long-term welfare improvements depend more fundamentally on structural factors such as financial inclusion, human capital, and effective fiscal policy than on nominal price adjustments. Overall, the endogenous growth framework provides a coherent theoretical basis for analysing how digital financial inclusion and tax revenue interact with human capital and macroeconomic conditions to shape economic wellbeing in the long run.

4.0 METHODOLOGY

The primary aim of this study is to analyze the synergy of digital financial inclusion and effective tax revenue mobilization as a strategic pathway toward inclusive and sustainable economic development in Nigeria. This study employs an ex-post facto research approach and utilizes secondary data analysis to provide draw empirical evidence and policy inference. The research design places significant emphasis on detailing the methods for data collection, including the measurement and sources of the various data. Additionally, the research design focuses on the development of a theoretical model, the pre-test analysis illuminating the chosen estimation technique and the subsequent post-test estimation.

The theoretical framework for this study revolves around the endogenous growth model. This model serves as a foundational theoretical model to understand the intricate connections between digital financial inclusion, tax revenue mobilization, and economic wellbeing. The endogenous growth model diverges from traditional growth theories by emphasizing internal factors and mechanisms within an economy that propel sustained economic growth. Unlike the exogenous model, where technological progress is exogenous, endogenous growth theory posits that technological advancements are as a result of intentional actions within the economy.

Using this endogenous growth model, the study aims to establish the interrelationships between digital financial inclusion, tax revenue mobilization, and overall economic wellbeing. Digital financial inclusion, which encompasses the availability, accessibility, and utilization of digital financial services by individuals and businesses is hypothesized to have significant implications for different (direct, indirect and total) tax revenue mobilization. Conversely, it also assumed that tax revenue also has effects on digital financial inclusion hence both tax revenue and digital financial inclusion are mutually dependent and endogenous in the growth model. Similarly, digital financial inclusion and tax have independent and joint effects on economic growth and consequently on economic wellbeing.

Conventional endogenous growth model does not explicitly incorporate digital financial inclusion and even tax as well as their interactive effects, hence in this study, the standard endogenous growth model that recognizes only physical and human capital along with technology as the main drivers of economic growth would be modified to accommodate both digital financial inclusions and tax as growth drivers.

The proposed model incorporates various components of both digital financial inclusion and tax revenue to depict the interactions between digital financial inclusion, tax revenue mobilization, and economic wellbeing. The modified endogenous growth model to be used in this study offers a framework that elucidates how economic factors, including digital financial inclusion, tax revenue generation, and overall economic wellbeing are interconnected and is not limited by diminishing returns to capital. Instead, knowledge, innovation, and human capital accumulation are assumed to have perpetual returns, leading to sustained growth as explained by Spence & Leipziger, (2010).

As noted by Mankiw (2012), when an individual or firm invests in research and development (R&D) such as in digital technology, the benefits spill over to others, leading to greater productivity and efficiency by other private and public entities due to agglomerative effects that capture the overall economic of scale gains accruing to the whole economy beyond the localization effects within the industry where the R&D takes place. The model accounts for positive externalities in the production of knowledge, hence allows for the positive spillover effects of digital technology adoption in enhancing the efficiency of both physical and human capital as well as efficacy of institutional arrangement for tax collection on economic growth (Mankiw, 2012). The starting point of the endogenous growth model use in this study is the conventional growth model that incorporate physical and human capital as fundamental growth drivers in a standard production function, which is given as:

$$Y = f(K, H) \quad 3.1$$

Where Y represents output and K is physical capital, and H is human capital or knowledge. Equation 3.1 implies that output can be produced using both human and physical capital and both exhibit constant return to scale, that is (α and β), they cannot perfectly substitute or complement each other. Also equation 3.1 suggest also that increasing both inputs by same proportion will lead to same proportional increase in output level. to capture. Hence, equation 3.1 can be explicitly written as

$$Y = AK^\alpha H^\beta \quad 3.2$$

Where

A represents the technology innovation which captures factor productivity. It is assumed to be constant at least in the short run but could augment both human and physical capital productivity by improving their efficiency.

α and β are the output elasticity of the two inputs capital. Note that $\alpha + \beta = 1$

4.1 Incorporation of Digital Financial Inclusion Variable in Endogenous Growth Model

Innovation adoption could alter the productivity of the production process. Such innovation adoption changes the constancy of technology (A_t) and increase the total productivity of both physical and human capitals hence A can also become endogenized over time (t). Technology is a form of investment. Consequently, technology as investment augments the existing stock of capital and captures the technological progress which can be given as:

$$A_t = (1 - g)A_{t-1} + I_{A,t} \quad 3.3$$

Where g is the rate of technological progress and $I_{A,t}$ represents investment in new technology. This technology could be digital technology deployed in financial system to improve financial system efficacy and productivity. Hence equation 3.3 can be modified as

$$A_{DFI,t} = (1 - g)A_{DFI,t-1} + I_{DFI,t} \quad 3.3$$

Where DFI is Digital financial inclusion. Hence equation 3.1 can be written as

$$Y = A_{DFI,t}(K^\alpha H^\beta) \quad 3.4$$

DFI plays a pivotal role in the endogenous growth model by enhancing the efficiency of financial transactions, reducing transaction costs and improving resource allocation and also directly affecting output level as independent input variable in production process.

$$Y = A K^\alpha H^\beta DFI^{1-\alpha-\beta} \quad 3.4$$

Therefore, DFI (such ATM, internet infrastructure and mobile phone) complement and or substitute computer and other electronic and physical capital used in the production of financial services. Hence DFI has direct effect as another input capital variable that can be used in conjunction with existing physical and human capital in production process.

$$Y_t = f(DFI, E_{DFI} * K, E_{DFI} * H)_t \quad 3.5$$

Digital financial inclusion influences growth directly by fostering innovation and indirectly by improving human capital accumulation and technological progress hence equation 3.1 can be written as

$$Y = (E_{DFI} * K, E_{DFI} * H) K^\alpha H^\beta DFI^{1-\alpha-\beta} \quad 3.6$$

4.2 Tax as an input in production process

Similarly, tax could also be introduced into the endogenous growth model as both direct and indirect input variable: tax revenue is fraction of total income generated from the monetary value of all goods and services produced in nation hence it could be written as

$$T_t = \tau . Y_t \quad 3.7$$

Where T is the tax revenue, τ denotes the tax rate, and Y represents output. According to Barro, (1990) and Aschauer, (1988) the model ($y = Ak$) of economic growth can be expressed in a manner to capture government as production agent that also contributes part of the capital to the production process. Therefore

$$y = A(k, g) \quad 3.8$$

Or explicitly as

$$Y = Ak^\alpha g^\rho \quad 3.9$$

Equation 3.8 implies that there is constant return to scale in both private (k) and public capital (g) hence the production function represented by equation1 can be written as

$$y = \phi(k, g) = k . \phi\left(\frac{g}{k}\right) \quad 3.10$$

Hence

$$y = \phi(k, g) = k \cdot \phi\left(\frac{g}{k}\right) = A \cdot \left(\frac{g}{k}\right)^\rho \quad 3.11$$

Where $0 < \alpha < 1$ and g is the public capital input into production process and k is the private capital input. Assuming that government expenditure is financed through tax then

$$g = T = \tau y = \tau(k \cdot \phi\left(\frac{g}{k}\right)) = \tau(A \cdot \left(\frac{g}{k}\right)^\alpha) \quad 3.12$$

$$g = \tau(A \cdot \left(\frac{g}{k}\right)^\alpha) \quad 3.13$$

Substituting equation 3.13 into equation 3.9, then we have

$$y = Ak^\alpha \left(\frac{T}{k}\right)^\rho \quad 3.14$$

And then $y = Ak^\vartheta T^\rho$

Where $\vartheta = \alpha - \rho$. Technology innovation could also be affected by the level of tax imposed and also tax revenue could also be affected by technology adoption. The imposition of tax on technology affect the level of adoption, access and usage while technology adoption also aids tax collection. this suggest both tax and technology are endogenous growth process as both tax and technology affect output and output level affects them respectively. Hence, the production process captures by equation 3.1 could be modified to include both tax and technology as independent variable input and also augment factors of human and physical capital.

This implies that digital financial inclusion technology and tax could impact output directly or indirectly through their interactions with other growth fundamentals like human and physical capital. Hence, we have a modified endogenous growth model that capture the individual roles of digital financial inclusion technology and tax and their impacts through interactions with other growth drivers. Thus we have

$$y = (E_{\tau, DFI} * K, E_{\tau, DFI} * H, E_{\tau} * DFI, E_{DFI} * T)^\alpha k^\vartheta H^\beta T^\rho DFI^{1-\beta-\vartheta-\rho} \quad 3.15a$$

The baseline model for the study is hence written as

$$EWB = a_0 + a_1K + a_2H + a_3TAX + a_4DFII + a_5DFII * TAX + a_6DFII * K + a_7DFI * H + a_8TAX * K + a_9TAX * H + a_{10}Z + U \quad 3.15b$$

Where EWB which is economic wellbeing now replacing economic growth in the equation 3. 15. Equation 3,15 suggest that tax could affect technology adoption and technology adoption could also affect tax impact on economic growth. Similarly, tax and technology adoption could affect growth fundamentals like human and physical capital.

Consequently, the above model will be estimated and analyzed using numerical methods and analytical techniques to address the five research questions raised for this study. It will also be used to analyze the implications of digital financial inclusion and tax revenue on different measures of economic wellbeing. This model is structured in a way to capture the all-possible channels through which digital financial inclusion and tax could affect economic growth and wellbeing.

5.0 RESULTS AND DISCUSSION

Table 1: Interactive Effect of Digital Financial Inclusion and Tax Revenue on Economic Wellbeing in Nigeria

Short Run Symmetric				
DV: Δewb_t	Coefficient	Standard error	t-statistics	p-value
c	0.2159***	0.0233	9.2822	0.0026
Δdfi_t	-0.3722**	0.0737	-5.0518	0.0150
Δtax_t	0.0087**	0.0017	4.9690	0.0157
$\Delta dfi * tax_t$	0.0499**	0.0088	5.6502	0.0110
Δhc_t	-9.4957***	0.9473	-10.0242	0.0021
$\Delta lexr_t$	0.4165***	0.0347	11.9922	0.0012
ect_{t-1}	-0.8455***	0.0829	-10.2020	0.0020
Long Run Symmetric				
c	0.1478	0.2676	0.5522	0.5918
dfi_t	0.0171**	0.0061	2.8203	0.0200
tax_t	0.0323**	0.0118	2.7399	0.0229
$dfi * tax_t$	-0.0990**	0.0422	-2.3464	0.0436
hc_t	-0.7841*	0.3885	-2.0184	0.0743
$lexr_t$	0.0200	0.1061	0.1887	0.8624
Diagnostic Tests				

$$R^2 = 0.9813 \quad \bar{R}^2 = 0.9533 \quad DW = 2.8056$$

$$X_{LM}^2 = 2.7209[0.3549] \quad X_{BGP}^2 = 1.8800[0.9996] \quad X_{JB}^2 = 0.5623[0.7549] \quad X_{RS}^2 = 0.2975[0.5854]$$

$$F - statistic = 34.9992[0.0001] \quad STABILITY=CUSUMSQ$$

ARDL bound test

$$F - statistic = 6.5050 [I(0) = 2.62, I(1) = 3.79 @ 5\%]$$

Source: Author's compilation (2025)

Notes: DV: dependent variable, SE: standard error, DW: Durbin Watson statistics indicate significance at 1%,5% and 10%, respectively.. X_{LM}^2 , X_{BGP}^2 , X_{RS}^2 , X_{JB}^2 represent LM test for serial correlation, Breusch-Pagan Godfrey test for heteroscedasticity, Ramsey rest test for model specification and Jarque-Bera normality test, respectively. I(0) and I(1) represent lower and upper bound, respectively. [] indicate respective probability values, ECT; Error correction term.

The insignificance of the long-run constant term indicates that economic wellbeing in Nigeria does not evolve autonomously but is fundamentally shaped by key structural and policy-related variables. This finding suggests that, over time, wellbeing outcomes depend heavily on financial access, fiscal capacity, human capital development, and macroeconomic stability rather than exogenous or residual factors. This result is consistent with the broader development literature, which emphasises that sustained welfare improvements in developing economies are largely driven by institutional quality, effective public finance systems, and inclusive financial structures rather than short-term shocks or autonomous growth dynamics .

In contrast to the short-run dynamics, the long-run coefficient of digital financial inclusion is positive and statistically significant, indicating that digital finance ultimately enhances economic wellbeing once adjustment costs dissipate. This transition from a negative short-run effect to a positive long-run impact supports endogenous growth theory, which views technological progress and financial innovation as key drivers of sustainable welfare improvements. Over time, increased adoption of digital financial services lowers transaction costs, improves access to savings and credit, and integrates households and firms into formal financial systems. This finding is strongly supported by prior evidence showing that digital finance promotes inclusion and long-term economic participation in developing economies, including Nigeria and other Sub-Saharan African countries (Uzoma et al., 2020; Ishioro, 2023)

Tax revenue also maintains a positive and statistically significant effect on economic wellbeing in the long run, reinforcing the central role of fiscal policy in development. This outcome is consistent with public finance theory, which argues that sustained revenue mobilisation enables governments to invest in social services, infrastructure, and inclusive growth strategies. Empirical studies across Africa and Nigeria confirm that improvements in tax collection particularly when supported by digital systems enhance the state's capacity to finance welfare-enhancing expenditures (Chebochok & Bayale, 2023; Omojola et al., 2022). The long-run significance of tax revenue thus highlights the importance of stable and predictable fiscal resources for improving wellbeing outcomes over time

Interestingly, the interaction between digital financial inclusion and tax revenue becomes negative and statistically significant in the long run, revealing a more nuanced relationship between financial digitalisation and fiscal policy. While taxation initially complements digital financial inclusion by strengthening state capacity and funding supportive infrastructure, excessive or poorly designed taxation of digital transactions may, over time, discourage innovation, limit platform usage, or push economic actors back into informality. This finding resonates with concerns raised in the literature regarding the unintended exclusionary effects of digital financial service taxes, particularly for low-income users and small businesses (Mpofu & Mhlanga, 2022). It also aligns with evidence of non-linear effects, where digital inclusion initially constrains but later enhances fiscal outcomes before reaching a point of diminishing or adverse returns (Raouf, 2022)

The long-run negative and weakly significant coefficient on human capital suggests that structural deficiencies in Nigeria's education and skills development systems persist over time. While investments in human capital are theoretically expected to improve productivity and welfare, their effectiveness depends critically on quality, relevance, and alignment with labour market needs. The result implies that without meaningful reforms in curriculum design, technical skills acquisition, and employability, increased educational investment may fail to translate into improved economic wellbeing. This finding echoes broader evidence from developing countries where human capital accumulation does not automatically yield welfare gains in the absence of complementary institutional and labour market reforms.

Finally, the insignificance of the exchange rate in the long run suggests that currency movements do not exert a sustained influence on economic wellbeing once long-term adjustments occur. While exchange rate fluctuations may affect welfare temporarily through trade competitiveness, remittances, or fiscal revenues, these effects tend to be offset over time by inflationary pressures, monetary policy responses, and structural constraints in trade composition. This outcome is consistent with the view that macroeconomic variables such as exchange rates influence wellbeing primarily through short-run channels, while long-run welfare is driven more decisively by structural and institutional factors, including financial inclusion and fiscal capacity.

Marginal Effect

To understand the marginal effect of digital financial inclusion on economic wellbeing, especially given the presence of an interaction term with tax revenue, it is important to interpret the model beyond the main effect coefficients. Specifically, the marginal effect of DFI on EWB is calculated by taking the partial derivative of EWB with respect to DFI, which yields the expression:

$$\frac{\partial ewb_t}{\partial dfi_t} = \alpha_1 + \alpha_3 tax$$

From the long-run model, $\alpha_1 = 0.0171$ and $\alpha_3 = -0.0990$

where α_1 is the coefficient on DFI and α_3 is the coefficient on the interaction term. Substituting the values from the long-run results, we obtain:

$$\frac{\partial ewb_t}{\partial dfi_t} = 0.0171 - 0.0990 tax$$

The marginal effects analysis reveals that the long-run impact of digital financial inclusion on economic wellbeing in Nigeria is conditional on the level of tax revenue. At relatively low levels of taxation ($TAX = 0.1$), the marginal effect of digital financial inclusion remains positive, albeit modest, indicating that digital financial services enhance wellbeing when fiscal pressures are limited. This finding is consistent with the financial inclusion literature, which emphasises that digital finance improves access to savings, payments, and credit, particularly for underserved households and small businesses, thereby supporting inclusive economic participation and welfare improvement (World Bank, 2014; Al-Smadi, 2023).

However, as tax revenue increases to moderate levels ($TAX = 0.3$), the marginal effect of digital financial inclusion becomes negative, signalling a reversal of its welfare-enhancing role. At higher levels of taxation ($TAX = 0.5$), this negative effect intensifies further, clearly indicating the presence of a threshold beyond which the costs associated with taxation outweigh the benefits of digital financial inclusion. This pattern reflects a non-linear relationship, where digital finance initially supports welfare but becomes constrained by rising fiscal burdens. Similar non-linear dynamics have been documented in the literature, with evidence that financial inclusion may initially dampen fiscal outcomes or welfare before yielding benefits, and later experience diminishing or adverse effects when policy pressures become excessive (Raouf, 2022)

This conditional relationship carries important theoretical and policy implications. While digital financial inclusion can promote growth and wellbeing under light or supportive tax regimes, excessive or poorly structured taxation may discourage participation in the formal digital financial system. This aligns with studies cautioning that digital financial service taxes, particularly those imposed on mobile money transactions, can be exclusionary and disproportionately affect low-income users and small businesses (Mpofu & Mhlanga, 2022). In such contexts, digital platforms risk becoming channels of fiscal extraction rather than instruments of inclusion, thereby undermining their long-term welfare potential

The long-run negative marginal effect at higher tax levels also highlights a compliance-cost dilemma, especially for micro-enterprises and small and medium-sized enterprises (SMEs). Digital financial services often serve as an entry point into formal economic activity, improving efficiency and transparency. However, if digital adoption is accompanied by complex, punitive, or opaque tax obligations, firms may be discouraged from remaining within the formal digital ecosystem. This weakens incentives for formalisation and ultimately constrains both financial inclusion objectives and sustainable tax base expansion. Empirical evidence from Nigeria shows that while digital payments enhance tax collection efficiency, their welfare effects vary across tax categories and user groups, underscoring the importance of careful policy design (Maccarthy et al., 2022; Opeyemi et al., 2022)

Importantly, the negative marginal effects observed at higher tax levels do not imply that digital financial inclusion is inherently detrimental to economic wellbeing. On the contrary, the positive long-run coefficient of digital financial inclusion indicates that its baseline effect remains welfare-enhancing. It is the interaction with rising tax burdens that gradually erodes and eventually reverses these gains. This finding reinforces the theoretical argument that technological and financial innovations must be complemented by appropriate governance and institutional frameworks to realise their full development potential. Where institutions prioritise revenue extraction over inclusion, the long-term benefits of digital finance may be compromised.

From a policy perspective, the results underscore the need for carefully calibrated digital taxation strategies. While expanding the tax base through digital channels may be fiscally attractive, such

efforts must not undermine the accessibility and affordability of digital financial services. Progressive tax thresholds, exemptions for micro-transactions, and targeted subsidies for low-income users could help preserve the welfare-enhancing role of digital financial inclusion. In addition, simplifying tax compliance procedures and strengthening digital literacy would reduce the burden on small-scale users and encourage sustained participation in formal financial systems.

Overall, the marginal effects analysis confirms that the long-run contribution of digital financial inclusion to economic wellbeing is not automatic but conditional on the broader fiscal environment. Digital finance delivers its strongest welfare benefits under inclusive, proportionate, and enabling tax regimes. Without such alignment, the promise of digital financial inclusion may be weakened by well-intentioned but poorly designed tax policies. These findings therefore call for an integrated development strategy that harmonises financial innovation with balanced fiscal design to ensure that digitalisation translates into durable and inclusive improvements in economic wellbeing.

The Short Run

In models involving an interaction term, the marginal effect of one variable of DFI in the short-run depends on the level of the other variable it interacts with (TAX). Mathematically, the marginal effect of DFI on EWB is:

$$\frac{\partial ewb_t}{\partial dfi_t} = \alpha_1 + \alpha_3 tax$$

From the short-run model, $\alpha_1 = -0.3722$ and $\alpha_3 = 0.0499$

where α_1 is the coefficient on DFI and α_3 is the coefficient on the interaction term. Substituting the values from the long-run results, we obtain:

$$\frac{\partial ewb_t}{\partial dfi_t} = -0.3722 + 0.04999tax$$

Let's compute the marginal effect for different plausible values of TAX (e.g., 0.1, 0.3, 0.5):

When tax = 0.1:

$$ME = -0.3722 + 0.04999(0.1) = -0.3722 + 0.0050 = -0.3672$$

When tax = 0.3:

$$ME = -0.3722 + 0.04999(0.3) = -0.3722 + 0.0150 = -0.3572$$

When tax = 0.5:

$$ME = -0.3722 + 0.04999(0.5) = -0.3722 + 0.0250 = -0.3472$$

The short-run marginal effect estimates indicate that digital financial inclusion exerts a negative influence on economic wellbeing across all examined levels of tax revenue, although the magnitude of this negative effect declines as tax revenue increases. At a low level of taxation (TAX = 0.1), a one-unit increase in digital financial inclusion reduces economic wellbeing by 0.3672

units in the short run. As tax revenue rises to 0.3, the negative effect diminishes slightly to 0.3572, and at a higher tax level of 0.5, it further moderates to 0.3472. This pattern suggests that while digital financial inclusion is associated with short-run welfare losses, increasing tax revenue plays a cushioning role by reducing the severity of these adverse effects.

The consistently negative short-run effect of digital financial inclusion reflects the transitional challenges associated with rapid digital transformation in developing economies such as Nigeria. Existing literature highlights that although digital finance offers long-term benefits, its early-stage adoption can disrupt traditional financial practices, marginalise digitally illiterate populations, and concentrate benefits among early adopters with better access to technology and infrastructure (World Bank, 2014). These adjustment frictions may temporarily reduce welfare outcomes as households and firms struggle to adapt to new platforms and payment systems. Similar transitional effects have been noted in empirical studies that document initial welfare or revenue setbacks before digital finance begins to yield broader inclusion gains

The gradual reduction in the magnitude of the negative effect as tax revenue increases suggests that fiscal capacity plays a moderating role in managing the disruptive effects of digitalisation. Rising tax revenue signals improved public finance capacity, which may enable governments to support digital transitions through complementary investments. Prior studies emphasise that when governments possess sufficient fiscal space, they are better positioned to expand digital infrastructure, fund financial literacy initiatives, and regulate digital platforms in ways that enhance trust and usability (Maccarthy et al., 2022). These supportive interventions can help mitigate exclusionary effects and smooth the transition to digital finance, thereby reducing short-run welfare losses

This moderating role of tax revenue is consistent with institutional theories of development, which argue that the welfare impact of technological change depends critically on state capacity and governance quality. Digital financial inclusion does not operate in a vacuum; rather, its short-run consequences are shaped by the ability of public institutions to guide, regulate, and complement private-sector innovation. As tax revenue improves, governments can deploy targeted subsidies, invest in digital infrastructure, and strengthen regulatory oversight, all of which can cushion the immediate negative effects of digital adoption on economic wellbeing. This perspective aligns with empirical evidence showing that digitalisation-supported tax systems improve efficiency but produce uneven short-run welfare effects without adequate institutional support (Opeyemi et al., 2022)

Nonetheless, it is important to note that even at higher tax levels, the short-run marginal effect of digital financial inclusion remains negative. This suggests that digital transformation inherently involves a gestation period before net welfare gains materialise. In the short term, policy priorities should therefore focus on mitigating transition costs rather than expecting immediate welfare improvements from digital finance alone. Strengthening social safety nets, promoting inclusive

digital literacy programmes, ensuring affordable access to digital services, and maintaining consumer protection frameworks are essential to prevent short-run welfare deterioration during the early stages of digital adoption.

Overall, the short-run marginal effects analysis highlights that digital financial inclusion is not an instant remedy for economic wellbeing challenges. While its immediate impact may be adverse, an enabling fiscal environment reflected in rising tax revenue can significantly cushion these effects. This underscores the importance of synchronising digital financial reforms with supportive fiscal and institutional policies. By aligning tax policy, public investment, and digital innovation, governments can minimise short-run welfare losses while laying the foundation for the long-run benefits of digital financial inclusion to emerge.

Diagnostic Test

The robustness of the model is supported by a series of diagnostic tests. The F-statistic is 34.9992 with a p-value of 0.0001, indicating that the model is jointly significant and the explanatory variables meaningfully account for variations in economic wellbeing. The adjusted R-squared value of 0.9424 reveals that approximately 94.2% of the variation in economic wellbeing is explained by the model, reflecting a high degree of explanatory power. The Durbin-Watson statistic is 2.8056, suggesting that there is no evidence of positive autocorrelation in the residuals; if anything, the value hints at slight negative autocorrelation, but this is not statistically concerning. The Lagrange Multiplier (LM) test for serial correlation returns a test statistic of 2.7209 and a p-value of 0.3549, meaning the null hypothesis of no autocorrelation cannot be rejected. This confirms that the residuals are independent across time. The Breusch-Pagan-Godfrey (BPG) test for heteroscedasticity also yields favorable results, with a statistic of 1.8880 and a p-value of 0.9996, indicating that the model does not suffer from heteroscedasticity, and the assumption of homoscedastic errors holds. The Jarque-Bera normality test results in a statistic of 0.5623 and a p-value of 0.7549, affirming that the residuals are normally distributed, which is a critical assumption for valid statistical inference in regression models. Additionally, the Ramsey RESET test, which checks for model misspecification, produces a value of 0.2975 with a p-value of 0.5854. This suggests that the model is correctly specified and no relevant variables have been omitted.

Furthermore, the ARDL bounds test confirms the existence of a long-run relationship among the variables, with an F-statistic of 6.5050, which is above the upper bound critical value of 3.79. This result validates the cointegration hypothesis, indicating that despite short-term fluctuations, there exists a stable, long-term equilibrium among digital financial inclusion, tax revenue, and economic wellbeing.

Finally, the CUSUM of squares stability test (in Figure 1) shows that the estimated parameters remain stable over the period of analysis. This reinforces the overall reliability of the ARDL model and supports the policy implications drawn from its results.

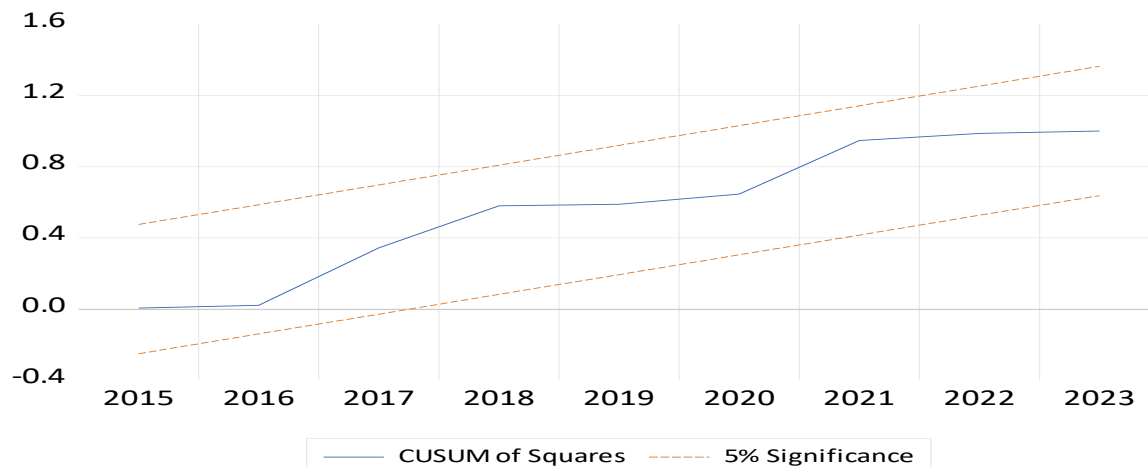


Figure 1: Plot of Cumulative sum square of recursive residuals.

Source: Author's compilation from E-views 12 output

Note: The blue line is the solid line, while the red lines that bounded the blue line are the critical bounds at 0.05

In conclusion, Table 1 provides a robust empirical examination of the conditional effects of digital financial inclusion and tax revenue on economic wellbeing in Nigeria. While digital financial inclusion is shown to have a delayed positive effect on welfare, its benefits are mediated by the tax environment. In the short run, tax revenue enhances the effectiveness of digital financial services, but in the long run, excessive taxation can erode these gains. Human capital, despite being traditionally associated with development, shows a consistently negative effect in this context, signaling the need for educational reforms. Overall, the findings suggest that for digital transformation to translate into inclusive wellbeing, it must be complemented by efficient fiscal policies and strategic investments in human capacity development.

Decision Rule

Based on the empirical evidence provided in Table 1, particularly the statistically significant long-run coefficient of the interaction term between digital financial inclusion and tax revenue ($DFI \cdot TAX = -0.0990, p = 0.0436$), the study rejects the null hypothesis that there is no significant effect of the interaction between digital financial inclusion and tax revenue on economic wellbeing in Nigeria. This finding confirms that the relationship between digital finance and wellbeing is not linear or independent of fiscal context; rather, it is significantly conditioned by tax policy. In essence, while digital financial inclusion has the potential to enhance welfare, its effectiveness is shaped – positively in the short run but adversely in the long run – by the level and structure of tax revenue. In summary, the results underscore the need for harmonized policy frameworks that align digital financial innovation with equitable and growth-friendly tax systems to ensure that technological progress translates into sustained economic wellbeing.

4.2 Discussion of Findings

The empirical findings reported in Table 1 provide important insights into the dynamic relationship between digital financial inclusion (DFI), tax revenue, and economic wellbeing (EWB) in Nigeria. The positive and statistically significant short-run constant term suggests the presence of autonomous or structural factors that sustain a baseline level of wellbeing in the Nigerian economy. This outcome is consistent with the notion that welfare outcomes are partly influenced by institutional arrangements, informal economic activities, and subsistence-based income sources that operate independently of formal fiscal and financial variables, particularly in developing economies with large informal sectors.

The short-run negative and significant effect of changes in digital financial inclusion on economic wellbeing, though counterintuitive at first glance, aligns with existing literature that highlights the transitional costs associated with rapid digitalisation. While digital financial inclusion is widely recognised as a tool for expanding access to financial services and empowering underserved populations (World Bank, 2014; Gallego-Losada et al., 2023), its welfare benefits may not materialise immediately. In contexts such as Nigeria, infrastructural deficits, limited digital literacy, uneven internet penetration, and trust deficits in digital platforms can initially exclude vulnerable groups or disrupt traditional financial practices. These adjustment frictions may temporarily suppress welfare outcomes before the long-run benefits of digital finance fully emerge, a pattern also observed in other developing and emerging economies .

In contrast, tax revenue exhibits a positive and statistically significant short-run effect on economic wellbeing, underscoring the welfare-enhancing role of fiscal capacity. This finding is consistent with public finance theory and empirical evidence emphasising taxation as a key instrument for funding public goods, redistributive programmes, and development-oriented expenditures. In Nigeria, revenue mobilisation remains a critical policy challenge, and improvements in tax revenue when effectively managed can translate into better service delivery and improved welfare outcomes (Ajaero et al., 2025). The result reinforces the argument that domestic revenue mobilisation is central to economic wellbeing, particularly in countries with limited access to external financing and volatile commodity revenues

More importantly, the positive and highly significant interaction between digital financial inclusion and tax revenue provides strong evidence of a synergistic relationship between fiscal policy and financial digitalisation. The positive coefficient of the interaction term indicates that rising tax revenue moderates and offsets the short-run negative effect of digital financial inclusion on economic wellbeing. This finding is well supported by the literature, which suggests that digital financial inclusion strengthens tax administration by improving transaction traceability, expanding the tax base, and reducing opportunities for tax evasion (World Bank, 2019; Klapper & Singer, 2017). When governments possess adequate fiscal space, they are better positioned to invest in

complementary digital infrastructure, subsidise access to digital services, and implement regulatory frameworks that build trust in digital financial systems. Consequently, the welfare-enhancing potential of digital financial inclusion is more likely to be realised in environments where tax revenue mobilisation is effective and stable

The short-run negative and statistically significant coefficient on human capital further highlights the lagged nature of education and skills development in influencing economic wellbeing. While human capital accumulation is widely acknowledged as a cornerstone of long-term development, short-run increases in educational spending or enrolment may not immediately translate into improved welfare outcomes. This result resonates with existing evidence from developing countries, where mismatches between educational curricula and labour market requirements limit the immediate productivity and income effects of education. In Nigeria, structural unemployment, skill gaps, and underemployment among graduates suggest that the returns to human capital investments are realised only over time, rather than instantaneously.

The positive and significant short-run effect of the exchange rate indicates that currency depreciation may temporarily enhance economic wellbeing. This outcome can be interpreted in light of Nigeria's export structure and external income channels. Exchange rate depreciation can improve export competitiveness, increase the domestic value of remittances, and raise government oil revenues in local currency terms, thereby expanding fiscal capacity to finance welfare-enhancing expenditures. However, the literature cautions that such gains may be short-lived, especially in import-dependent economies where depreciation can fuel inflation and erode real incomes over time.

Finally, the negative and highly significant error correction term confirms the existence of a stable long-run relationship among digital financial inclusion, tax revenue, and economic wellbeing. The large magnitude of the adjustment coefficient indicates a rapid convergence to long-run equilibrium following short-run shocks. This finding reinforces the suitability of the ARDL framework and supports the theoretical argument that, despite short-run adjustment costs, the interaction between digital financial inclusion and tax revenue plays a critical role in shaping long-run welfare outcomes in Nigeria.

5. CONCLUSION AND POLICY IMPLICATIONS

This study demonstrates that while digital financial inclusion and tax revenue each enhance economic well-being, their interaction produces complex outcomes. In particular, over-taxation risks eroding the benefits of financial inclusion, creating disincentives for digital adoption and formalization.

5.1 Policy Recommendations

Introduce progressive tax structures that protect low-income users and small businesses while broadening the base. Also, government should harmonize fintech platforms with tax administration

to reduce leakages, enhance compliance, and expand fiscal capacity. Furthermore, ensure digital taxation policies encourage innovation and inclusion, rather than stifle participation. Moreover, reform education and training systems to align skills with digital and financial sector needs. Finally, enhance digital literacy, ensure transparency of fees, and safeguard users against exploitative practices.

By adopting such measures, Nigeria can maximize the welfare benefits of digital finance while securing sustainable fiscal resources. Aligning digital and fiscal strategies will be critical for achieving inclusive growth and advancing the SDGs.

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