Analysis of Information and Communication Technology (ICT) Adoption and the growth of the Nigerian economy

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Abstract
This study examines the impact of Information and Communication Technology (ICT) adoption on the growth of the Nigerian economy, employing an ex-post facto research design with time-series data spanning 1998 to 2024. Data were sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin, World Bank Data, and the Nigeria Communication Commission (NCC). The study specifically analyses the effects of key ICT adoption variables—mobile cellular telephone subscriptions, mobile customer base, and digital connectivity rate—on Nigeria's real gross domestic product (RGDP) growth rate. A combination of Descriptive Statistics, Covariance Analysis, and the Robust Least Squares (RLS) Model was used for empirical analysis. Post-estimation diagnostic tests, including the Residual Diagnostic and Model Stability Test (Correlogram Squared Test), were conducted to ensure model reliability. The findings reveal that mobile cellular telephone subscriptions have a positive and significant effect on economic growth, while the mobile customer base exerts a negative and significant impact. Conversely, the digital connectivity ratio has a positive but insignificant effect on economic growth. Based on these findings, the study concludes that ICT adoption plays a crucial role in shaping Nigeria's economic trajectory. It recommends expanding mobile subscriptions through improved network coverage and affordability, enhancing the mobile customer base by focusing on service quality and digital literacy, and strengthening digital connectivity via increased broadband infrastructure investment. These strategic measures will maximize the economic benefits of ICT adoption and foster sustainable economic development in Nigeria.

Keywords: ICT Adoption, Economic Growth, Mobile Subscriptions, Digital Connectivity, Nigeria, RGDP, Mobile Customer Base, Broadband Infrastructure

Introduction

Information and Communication Technology (ICT) refers to a broad range of technological tools and resources used to communicate, create, store, disseminate, and manage information. It includes the internet, mobile networks, computers, software, and various digital platforms that facilitate information exchange and automation (Adeleke & Adebayo, 2023). ICT plays a crucial role in modern economic development by driving innovation, efficiency, and productivity across various sectors, ultimately fostering economic growth and improving living standards (Olayemi et al., 2024). The rapid expansion of ICT in developing economies has transformed traditional business models, enhanced service delivery, and increased employment opportunities (World Bank, 2024).

In recent years, Nigeria has made significant strides in ICT adoption, making it a pivotal component of the nation's economic framework. The Nigerian Bureau of Statistics (2024) reported that the ICT sector contributed approximately 20% to Nigeria's real Gross Domestic Product (GDP) in the second quarter of 2024, highlighting its growing importance in the country's economic diversification efforts. This surge is largely attributed to increased internet penetration, mobile technology adoption, and government-driven initiatives aimed at digital transformation (Trade.gov, 2024). The ICT sector has become a major driver of non-oil revenue, reducing the country's dependence on crude oil exports and improving overall economic resilience (Markwide Research, 2024).

The widespread adoption of mobile technology has significantly influenced ICT growth in Nigeria. With over 150 million mobile subscribers, the country has become a mobile-first economy, leveraging digital solutions for financial services, e-commerce, and e-government applications (Ndukwe et al., 2023). Mobile banking and payment solutions, such as USSD-based transactions and fintech applications, have promoted financial inclusion and economic participation, particularly among the unbanked population (Central Bank of Nigeria, 2024). This mobile revolution has also spurred entrepreneurship and digital innovation, with startups in fintech, agritech, and e-health gaining traction in both local and international markets (UNCTAD, 2024).

Government initiatives have further accelerated ICT adoption in Nigeria. Policies such as the National Digital Economy Policy and Strategy (2020–2030) and the Nigerian Startup Act (2022) have fostered an enabling environment for digital transformation (Trade.gov, 2024). The government has invested in expanding broadband infrastructure, improving digital literacy, and supporting technology incubation hubs to nurture local talent and innovation (ITU, 2024). Foreign direct investment (FDI) in the ICT sector has also surged due to favorable investment policies and a growing digital consumer base (World Economic Forum, 2024).

Despite the rapid growth of ICT in Nigeria, several challenges persist, including inadequate infrastructure, regulatory bottlenecks, and digital literacy gaps (Adeyemi & Ogunleye, 2024). High internet costs, power supply issues, and cybersecurity concerns continue to hinder the full realization of ICT's economic potential (Nigeria Communications Commission, 2024). Addressing these challenges requires strategic investments in digital infrastructure, stronger regulatory frameworks, and comprehensive ICT education to equip the workforce with digital

skills. If these barriers are effectively mitigated, ICT will remain a powerful driver of sustainable economic growth and long-term development in Nigeria (World Bank, 2024).

Statement of the Problem

The rapid adoption of Information and Communication Technology (ICT) has significantly transformed economic activities worldwide, fostering innovation, improving productivity, and enhancing financial inclusion (Okafor & Ibrahim, 2023). In Nigeria, ICT has become a critical driver of economic growth, contributing substantially to GDP and employment generation. However, despite the increasing penetration of ICT tools such as mobile phones, broadband services, and digital platforms, Nigeria still struggles with issues such as inadequate digital infrastructure, limited internet accessibility, and high connectivity costs, which hinder the full realization of ICT's economic potential (Ogunlana et al., 2024). Existing policies, including the National Digital Economy Policy and Strategy (2020–2030), have aimed at expanding digital access, yet disparities in ICT adoption persist, particularly between urban and rural areas (Eze & Okonkwo, 2024). While studies have acknowledged ICT's contribution to Nigeria's economic landscape, there remains a lack of consensus on the extent to which ICT adoption directly influences macroeconomic variables such as real GDP growth (Adebisi et al., 2023).

Although numerous studies have explored ICT and economic growth, significant research gaps remain regarding the specific impact of ICT adoption indicators such as mobile cellular telephone subscriptions, mobile customer base, and digital connectivity rate on Nigeria's real GDP growth. For instance, Adetunji and Bello (2023) examined ICT's role in financial inclusion but did not assess its broader macroeconomic implications. Similarly, Chukwuma et al. (2024) investigated ICT investments in Nigeria's service sector but failed to incorporate mobile penetration and digital connectivity as key determinants of economic performance. Other studies, such as Akinyemi et al. (2024), have primarily focused on ICT adoption in urban centers, leaving rural economies largely unexamined. Furthermore, while Ibrahim and Olufemi (2023) acknowledged ICT's role in employment generation, they did not establish a direct empirical link between ICT expansion and Nigeria's real GDP growth. These limitations indicate a pressing need for a more comprehensive analysis that considers sectoral variations, regional disparities, and evolving digital trends in assessing ICT's impact on the Nigerian economy.

This study aims to fill these gaps by investigating the relationship between ICT adoption and Nigeria's economic growth, with a specific focus on mobile cellular telephone subscriptions, mobile customer base, and digital connectivity rate as explanatory variables against the growth rate of Nigeria's real GDP. Unlike previous studies that employed broad ICT indicators without sectoral differentiation, this research will employ a more refined econometric approach, integrating recent data and robust analytical techniques to provide empirical insights into ICT's contribution to economic performance. By doing so, the study will offer policymakers actionable recommendations on how to optimize ICT expansion for sustainable economic growth, particularly in bridging the digital divide between rural and urban areas. Ultimately, this research will enhance the understanding of ICT's role in Nigeria's macroeconomic trajectory, providing a more data-driven foundation for future ICT and economic policies.

Objectives of the Study

The study aims to examine the impact of Information and Communication Technology (ICT) adoption on the growth of the Nigerian economy. The specific objectives of the Study are to:

1. Assess the effect of mobile cellular telephone subscriptions and the growth rate of Nigeria's RGDP.
2. Examine the impact of the mobile customer base on the growth rate of Nigeria's RGDP.
3. Evaluate the effect of digital connectivity rate on the growth rate of Nigeria's RGDP.

Research Questions

This study seeks to answer the following research questions:

1. What is the effect of mobile cellular telephone subscriptions on the growth rate of Nigeria's RGDP?
2. How does the mobile customer base impact the growth rate of Nigeria's RGDP?
3. To what extent does the digital connectivity rate affect the growth rate of Nigeria's RGDP?

Research Hypotheses

The study will test the following null hypotheses:

1. **H_{01}**: There is no significant relationship between mobile cellular telephone subscriptions and the growth rate of Nigeria's RGDP.
2. **H_{02}**: The mobile customer base has no significant impact on the growth rate of Nigeria's RGDP.
3. **H_{03}**: Digital connectivity rate does not significantly affect the growth rate of Nigeria's RGDP.

LITERATURE REVIEW
Conceptual Review:
Concept of Information and Communication Technology (ICT) Adoption

ICT adoption refers to the extent to which individuals and organizations embrace and utilize digital technologies for various economic and social activities. It involves the integration of tools such as mobile telephony, internet services, and cloud computing to enhance efficiency and accessibility (Adeleke, 2022). ICT adoption has revolutionized industries, enabling e-governance, digital payments, and remote working, thereby contributing to socio-economic transformation. The penetration of ICT is essential for fostering connectivity and integrating national economies into the global digital landscape (Adeyemo & Ogundipe, 2023).

The adoption of ICT in Nigeria has been driven by factors such as increased smartphone penetration, improved internet access, and supportive regulatory policies (Umar & Nwosu, 2023). According to the Nigerian Communications Commission (2023), mobile phone usage in Nigeria has significantly expanded, with over 200 million active mobile lines recorded. This

rapid growth indicates the increasing reliance on ICT-driven services for communication, e-commerce, and digital banking. The rise of fintech solutions has further accelerated ICT adoption, as more Nigerians engage in cashless transactions and digital financial services (Okeke et al., 2022).

Despite the progress, challenges such as inadequate digital infrastructure, high costs of internet access, and cybersecurity threats remain barriers to widespread ICT adoption (Onyema et al., 2023). Addressing these issues requires targeted government interventions, investments in broadband infrastructure, and policies that enhance digital literacy among citizens. By tackling these challenges, Nigeria can leverage ICT adoption to drive sustainable development and economic diversification (Eze & Obiora, 2023).

Variables for Measuring ICT Adoption in Nigeria:
- **Mobile Cellular Telephone Subscriptions**

Mobile cellular telephone subscriptions refer to the total number of active mobile phone connections in a country, including prepaid and postpaid users. This metric is an essential indicator of ICT adoption, as it reflects the extent of mobile communication penetration among the population (World Bank, 2023). The increasing adoption of mobile telephony has transformed various sectors, including banking, healthcare, and education, by providing access to digital services and online platforms (Adebayo & Yusuf, 2023).

Nigeria has experienced substantial growth in mobile cellular subscriptions due to the affordability of mobile phones and the expansion of network coverage to rural areas (Akinola & Ogunde, 2023). According to the Nigerian Communications Commission (2023), the country had over 220 million mobile subscribers as of 2023, making it one of the largest mobile markets in Africa. The widespread adoption of mobile phones has enabled financial inclusion through mobile money services and facilitated digital commerce, leading to economic empowerment (Oluwaseun & Chukwu, 2022).

However, challenges such as network congestion, poor quality of service, and high costs of data remain concerns for mobile users (Okechukwu et al., 2023). Addressing these challenges requires continued investment in network infrastructure, regulatory policies that promote competition among telecom providers, and initiatives that enhance digital literacy. By improving mobile telephony services, Nigeria can further harness the benefits of ICT adoption for economic growth and social development (Ajayi & Olayemi, 2023).

- **Mobile Customer Base**

The mobile customer base represents the number of unique individuals who actively use mobile telephony services within a given period. Unlike total mobile subscriptions, which may include multiple lines registered to a single user, the mobile customer base provides a clearer picture of actual ICT adoption levels among the population (Chukwuemeka & Udo, 2023). An expanding mobile customer base is often linked to increasing digital literacy, economic accessibility, and the availability of affordable mobile services (Ibrahim & Olorunfemi, 2023).

Nigeria has witnessed a growing mobile customer base due to the rise of budget-friendly smartphones and data plans tailored for low-income users (Eze & Adebisi, 2023). The mobile market has been instrumental in driving innovation, particularly in the financial technology sector, where mobile banking and payment services have flourished. Fintech platforms such as OPay and Flutterwave have leveraged the growing customer base to expand access to financial services, thereby promoting economic inclusion (Osuji & Nwachukwu, 2023).

Despite these advancements, disparities in mobile access persist, particularly in rural and underserved areas where network coverage is limited (Okonjo et al., 2023). Bridging these gaps requires targeted interventions, including investments in rural telecommunications infrastructure and policies that enhance affordability. Expanding the mobile customer base through inclusive strategies will ensure that ICT adoption benefits all segments of society, contributing to broader economic development (Oladipo & Eneh, 2023).

- **Digital Connectivity Rate**

Digital connectivity rate measures the proportion of individuals and businesses that have access to the internet and digital services. This metric is crucial for assessing ICT adoption, as it reflects the extent of digital inclusion and the ability of citizens to participate in the digital economy (United Nations, 2023). High digital connectivity rates are associated with increased productivity, improved access to information, and enhanced economic opportunities (Ogunyemi & Akinlabi, 2023).

In Nigeria, digital connectivity has been on the rise, driven by the expansion of 4G and emerging 5G networks, as well as government initiatives promoting broadband penetration (Osei & Okonkwo, 2023). According to the Nigerian Communications Commission (2023), the country's broadband penetration rate reached 48% in 2023, reflecting progress in digital adoption. Businesses and entrepreneurs have leveraged digital connectivity to engage in e-commerce, remote work, and digital marketing, boosting economic activities (Fashola & Odum, 2023).

However, digital divides persist due to affordability challenges and limited ICT infrastructure in remote areas (Okafor et al., 2023). Addressing these barriers requires policies that enhance broadband affordability, investments in fiber-optic networks, and initiatives that promote digital literacy. By improving digital connectivity, Nigeria can accelerate ICT adoption and leverage digital transformation for national development (Adelakun & Bello, 2023).

Economic Growth

Economic growth refers to the sustained increase in a country's productive capacity, leading to higher national output and improved living standards (Acemoglu & Robinson, 2023). It is commonly measured by the rise in real Gross Domestic Product (GDP), which accounts for the total value of goods and services produced in an economy over a given period, adjusted for inflation. Economic growth is essential for fostering job creation, reducing poverty, and enhancing overall economic stability. Countries experiencing consistent economic growth typically exhibit increased industrialization, higher levels of investment, and advancements in technology and innovation (World Bank, 2023).

The drivers of economic growth vary across nations and are influenced by factors such as capital accumulation, labor force expansion, technological progress, and institutional frameworks (Rodrik & Stiglitz, 2023). In developing economies, such as Nigeria, economic growth is closely linked to natural resource exploitation, government policies, and infrastructural development (NBS, 2023). However, the sustainability of this growth depends on economic diversification, human capital development, and sound macroeconomic policies. In recent years, Nigeria has faced fluctuations in its economic growth due to global oil price volatility, fiscal challenges, and structural inefficiencies (IMF, 2023).

Measures of Economic Growth in Nigeria

- **Real GDP (RGDP) Growth Rate**

The real GDP (RGDP) growth rate is a key metric for measuring economic growth, as it reflects the annual percentage change in the value of goods and services produced within an economy, adjusted for inflation (OECD, 2023). It provides a more accurate representation of an economy's expansion by eliminating distortions caused by inflation. Nigeria's RGDP growth rate has been subject to fluctuations due to external shocks, fiscal policies, and domestic economic challenges (IMF, 2023). In recent years, economic disruptions caused by the COVID-19 pandemic, global oil price swings, and inflationary pressures have contributed to inconsistent RGDP growth (World Bank, 2023).

Despite efforts to stabilize the economy, Nigeria's RGDP growth rate has remained below its potential due to structural constraints such as inadequate infrastructure, insecurity, and exchange rate volatility (CBN, 2023). To achieve sustainable economic growth, policymakers emphasize economic diversification, investment in human capital, and enhanced governance frameworks (Eze & Okonkwo, 2023). Recent government policies aimed at boosting non-oil sectors, digital economy initiatives, and infrastructural development are expected to contribute to long-term RGDP growth (NBS, 2023).

Theoretical Review:

Diffusion of Innovation Theory

The Diffusion of Innovation Theory (DOI) by Everett Rogers (1962) provides a crucial lens for analyzing the adoption of Information and Communication Technology (ICT) and its role in the economic growth of Nigeria. The theory explains how innovations, such as ICT tools and infrastructure, spread within a social system over time. It categorizes adopters into five groups: innovators, early adopters, early majority, late majority, and laggards, demonstrating that technology acceptance is a gradual process influenced by multiple socio-economic factors (Rogers, 2003). The rate of adoption depends on five key attributes: relative advantage, compatibility, complexity, trialability, and observability (Rogers, 2003). In the Nigerian economy, ICT adoption has followed this pattern, with urban areas adopting innovations faster than rural communities due to disparities in education, infrastructure, and economic opportunities (Adeyemi & Salawu, 2021).

In recent years, Nigeria has witnessed a rapid diffusion of ICT, particularly in mobile banking, e-commerce, and telecommunication. For example, the adoption of mobile money services like Paga and OPay has revolutionized financial inclusion, reaching millions of unbanked Nigerians. Similarly, the penetration of broadband internet and smartphone technology has facilitated digital entrepreneurship and e-learning, further demonstrating the DOI theory in action (Ndukwe & Agbaje, 2022). However, challenges such as poor infrastructure, digital literacy gaps, and high internet costs continue to hinder widespread ICT adoption. Policymakers must address these barriers to accelerate economic benefits derived from ICT diffusion.

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM) by Davis (1989) offers a structured approach to understanding the adoption of ICT in Nigeria. The model posits that two primary factors—Perceived Usefulness (PU) and Perceived Ease of Use (PEOU)—determine an individual's intention to use a technology. The easier a technology is to use and the more beneficial it appears, the higher the likelihood of its adoption (Davis, Bagozzi, & Warshaw, 1989). TAM has been extensively used in ICT adoption research, particularly in areas such as e-governance, digital banking, and online learning platforms in Nigeria (Eze & Chinedu, 2020).

The increasing reliance on ICT for economic growth in Nigeria can be attributed to its perceived usefulness in improving efficiency, reducing costs, and fostering innovation. For instance, the rise of fintech solutions like Flutterwave, Paystack, and Remita aligns with TAM's predictions—these platforms are widely accepted because they simplify financial transactions, making them indispensable for businesses and individuals alike (Adebayo & Ojo, 2022). However, despite the benefits, cybersecurity concerns, lack of technical skills, and resistance to change impede full adoption. Understanding TAM can help policymakers design user-friendly ICT systems and awareness campaigns to enhance adoption rates and drive economic growth.

Schumpeter's Theory of Innovation

Schumpeter's Theory of Innovation (1934) provides another theoretical foundation for analyzing ICT adoption and economic growth in Nigeria. Schumpeter posits that economic development occurs through a process of creative destruction, where new technologies disrupt traditional industries, leading to increased productivity and wealth creation. Entrepreneurs play a central role in this transformation by leveraging innovations to introduce new products, processes, and business models (Schumpeter, 1942). In Nigeria, the boom in digital startups such as Andela, Farmcrowdy, and Kuda Bank exemplifies how ICT-driven innovation fosters economic growth (Okonkwo & Uchenna, 2023).

The Nigerian economy has increasingly embraced digital transformation, with ICT contributing significantly to GDP. For example, the National Bureau of Statistics (NBS) reported that the ICT sector contributed 18.44% to Nigeria's GDP in Q2 2023, surpassing oil and gas contributions. This trend aligns with Schumpeter's assertion that technological advancements drive long-term economic development. However, challenges such as inconsistent government policies, lack of infrastructure, and inadequate funding for tech startups hinder the full realization of ICT's potential in Nigeria. Strengthening venture capital ecosystems and regulatory frameworks will further enhance ICT's role in driving economic progress.

Theoretical Framework

This study is anchored on the Endogenous Growth Theory, developed by Romer (1986, 1990) and Lucas (1988). Unlike classical growth models that attribute economic expansion to external factors, the Endogenous Growth Theory emphasizes the role of human capital, innovation, and knowledge as internal drivers of sustained economic growth. The theory asserts that investment

in technology, education, and research and development (R&D) generates increasing returns, leading to long-term economic prosperity (Romer, 1990).

Nigeria's ICT-driven economic growth aligns with the Endogenous Growth Theory, as technological advancements have significantly improved productivity across various sectors. The proliferation of ICT hubs like Co-Creation Hub (CcHub), Start-up Nigeria, and the Lagos Innovation Council showcases how investments in digital technology stimulate economic development. Furthermore, the rise of e-learning platforms like uLesson and EdTech startups demonstrates the interplay between ICT and human capital development (Bello & Ogunleye, 2023).

The decision to anchor this study on the Endogenous Growth Theory is justified by Nigeria's increasing reliance on technology and knowledge-based industries. The theory underscores the need for sustained investment in ICT infrastructure, digital literacy, and R&D to achieve long-term economic growth. However, to fully harness ICT's potential, Nigeria must address barriers such as policy inconsistencies, inadequate funding, and digital inequality. Government policies should focus on enhancing digital skills, providing incentives for tech startups, and improving broadband penetration to ensure ICT remains a robust driver of economic development.

Empirical Review

Adebisi et al. (2020) examined mobile cellular subscribers' impact on Nigeria's economic growth (2001–2019) using ARDL and VECM models. They found a positive effect, while inflation and FDI negatively impacted growth. Trade openness had a positive influence. They recommended policies supporting telecom expansion.

Oladokun & Akinola (2019) analyzed mobile cellular subscribers and poverty reduction in Nigeria (2005–2018) using OLS regression. Findings revealed a negative relationship between mobile subscribers and poverty, while GDP per capita and HDI positively influenced poverty reduction. Expanding telecom access in rural areas was recommended.

Olanrewaju & Olugbenga (2018) explored mobile subscribers' effect on employment in Nigeria (2003–2017) using Granger causality and VAR models. Results showed a significant positive relationship, alongside GDP and education, while unemployment had a negative impact. Recommendations included fostering telecom growth for job creation.

Akpan & Bassey (2020) assessed mobile subscribers' impact on FDI in Nigeria (2001–2018) using Johansen cointegration and VECM. Findings indicated a strong positive influence, along with GDP and trade openness. They suggested improving investment conditions for telecom growth.

Igbinedion & Onwukwe (2021) investigated mobile subscribers and financial inclusion in Nigeria (2010–2020) using panel regression. They found a significant positive relationship, along with GDP and education. They recommended policies to enhance mobile-based financial services.

Samuel and Abiola (2018) examined internet penetration's effect on economic growth in Nigeria (1990–2017) using VECM and Granger causality tests. A 1% rise in penetration led to a 0.37% GDP increase. The study suggested improving internet access.

Chukwunonso and Orji (2015) analyzed internet usage and economic growth in Nigeria (2000–2013) using ARDL. A 1% increase in internet usage resulted in a 0.84% GDP rise, with positive employment and investment effects. Internet infrastructure investment was recommended.

Akinola et al., (2017) studied internet penetration and economic growth in Nigeria (2000–2015) using ARDL and Granger causality. Findings indicated a 0.42% GDP rise per 1% penetration increase. The study recommended infrastructure expansion.

Olumuyiwa and Olumide (2018) examined internet penetration's role in Nigeria's economic growth (1990–2017) using VECM and Granger causality. A 1% penetration rise led to a 0.31% GDP increase, with positive effects on FDI and trade. Infrastructure investment was suggested.

Ejike et al., (2020) analyzed broadband penetration's impact on Nigeria's economic growth using ARDL and Granger causality. A 1% penetration increase led to a 0.52% GDP rise, with positive employment and investment effects. Expanding broadband access was recommended.

Rami et al., (2016) examined the impact of ICT on economic growth in the Arab world (1995–2013) using panel regression analysis (OLS, random effects, and fixed effects models). The study found a positive effect of ICT on GDP per capita, though weaker than in emerging and developed economies. Inflation negatively impacted economic growth. The study recommends enhancing ICT infrastructure to maximize its contribution to economic growth.

Cheng et al., (2014) analyzed the effect of ICT investment on Nigeria's economic growth using OLS regression. Findings showed ICT significantly contributed to GDP, with a 96% R-square value linking GDP growth to ICT investment and subscriber numbers. The study recommends improving the investment climate and ensuring access to information to sustain growth and attract private investment.

METHODOLOGY
Research Design
The study adopted an ex-post facto research design, which is appropriate for analyzing existing data from credible and reliable sources that cannot be manipulated by the researcher. Time-series data spanning 1998 to 2024 were utilized, sourced from the Central Bank of Nigeria (CBN) Statistical Bulletin, the World Bank and the Nigeria Communication Commission (NCC). The analysis employed a range of statistical tools, including Descriptive Statistics, Covariance Analysis, and the Robust Least Squares (RLS) Model. Post-estimation tests was conducted to evaluate the stability and validity of the model using the Residual Diagnostic and Model Stability Test. These included the Correlogram Squared Test. The choice of this methodology is justified as it ensures rigorous analysis of the data, enhances the robustness of the results, and provides a reliable framework for understanding the relationships under study.

Model Specification
In testing the effect of ICT adoption on the growth of the Nigerian economy, the study specifies that:

$$GRRGDP = f(MoBCS, MoBCB, DGCR) \dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots\dots \quad (1)$$

Putting it in an estimation form, we have is explicitly transformed into econometric and operational form.

$$GRRGDP_t = \beta_0 + \beta_1 MoBCS_t + \beta_2 MoBCB_t + \beta_3 DGCR_t + \mu \dots\dots\dots\dots\dots\dots\dots\dots \quad (2)$$

Where:

MoBCS	=	mobile cellular telephone subscriptions (Per 100 Inhabitants)
MoBCB	=	Mobile Customer Base (Million)
DGCR	=	Digital Connectivity Rate
GRRGDP	=	Growth Rate of Real Gross Domestic Product

β_0 = Constant Term; β_{1-3} = Coefficient of Independent Variables; μ = Stochastic Error Term
t= Time Period

RESULT AND DISCUSSION
Table 1: Data of ICT Adoption and Economic Growth in Nigeria (1998-2024)

YEAR	Mobile Cellular Telephone Subscriptions (Per 100 Inhabitants)	Mobile Customer Base (Million)	Digital Connectivity Rate %	Growth Rate of RGDP %
1998	0.1	0.01	0.02	2.49
1999	0.1	0.03	0.03	0.52
2000	0.1	0.03	0.06	5.51
2001	0.2	0.27	0.09	6.66
2002	1.2	1.57	0.32	14.60
2003	2.4	3.15	0.56	9.50
2004	6.8	9.15	1.29	10.44
2005	13.4	18.59	3.55	7.008
2006	22.7	32.32	5.55	6.72
2007	27.6	40.4	6.77	7.31
2008	41.9	62.99	8	7.19
2009	48.3	74.52	9.3	8.35
2010	55.1	87.3	11.5	9.53
2011	58.5	95	13.8	5.30
2012	67.4	112	16.1	4.20
2013	74.1	127	19.1	5.48
2014	78.8	138	21	6.22
2015	83.3	150	36	2.78
2016	83	154	25.67	-1.58
2017	75.9	145	42	0.82
2018	88.2	173	42	1.91
2019	91.9	185	42	2.27
2020	99.1	204	45	-1.92
2021	107.9	208.78	59.3	3.4
2022	115.633	223.04	66.06	2.38
2023	123.633	234.93	74.71	2.94
2024	131.633	246.82	83.36	3.51

Source: CBN Statistical Bulletin, and Nigerian Communications Commission (NCC).

The trend analysis of ICT adoption and economic growth in Nigeria from 1998 to 2024 reveals a significant upward trajectory in mobile cellular telephone subscriptions (MoBCS), mobile customer base (MoBCB), and digital connectivity rate (DGCR), indicating increasing ICT penetration. MoBCS grew from 0.1 per 100 inhabitants in 1998 to 131.633 in 2024, while MoBCB expanded from 0.01 million to 246.82 million within the same period. Similarly, DGCR rose from 0.02% in 1998 to 83.37% in 2024, reflecting improved digital infrastructure and internet accessibility. Despite this growth, the real GDP growth rate (GRRGDP) exhibited volatility, with a peak of 14.60% in 2002, sharp declines during economic downturns (e.g., -1.58% in 2016 and -1.92% in 2020), and moderate recovery in recent years (3.51% in 2024). These trends suggest that while ICT adoption has expanded rapidly, its direct impact on economic growth may be influenced by broader macroeconomic conditions and policy interventions.

Table 2: Descriptive Statistics

	GRRGDP	MOBCS	MOBCB	DGCR
Mean	4.949762	55.51481	100.9963	23.45037
Median	5.307924	58.50000	95.00000	13.80000
Maximum	14.60438	131.6333	246.8200	83.36667
Minimum	-1.920000	0.100000	0.010000	0.020000
Std. Dev.	3.769337	43.12286	84.13705	25.16677
Skewness	0.349949	0.056378	0.201798	0.959132
Kurtosis	3.104541	1.719414	1.673386	2.768802
Jarque-Bera	0.563383	1.859190	2.163143	4.199839
Probability	0.754507	0.394714	0.339062	0.122466
Sum	133.6436	1498.900	2726.900	633.1600
Sum Sq. Dev.	369.4055	48349.11	184055.1	16467.52
Observations	**27**	**27**	**27**	**27**

Source: Eviews 10, 2025

The descriptive statistics for ICT adoption variables and economic growth in Nigeria from 1998 to 2024 provide insights into their distribution and variability. The mean growth rate of real GDP (GRRGDP) stands at 4.95%, with a maximum of 14.60% and a minimum of -1.92%, indicating periods of economic expansion and contraction. Mobile cellular telephone subscriptions (MoBCS) have a mean of 55.51 per 100 inhabitants, peaking at 131.63, reflecting significant ICT penetration. Similarly, the mobile customer base (MoBCB) averages 100.99 million, with a high of 246.82 million, showcasing Nigeria's growing telecom market. The digital connectivity rate (DGCR) has a mean of 23.45%, with substantial variation (Std. Dev. = 25.17), suggesting progressive but uneven digital transformation. Skewness values for all variables indicate near-normal distribution, while the Jarque-Bera test probabilities suggest no strong deviation from normality. These statistics highlight ICT adoption as a dynamic sector with significant potential for influencing economic growth.

Table 3: Covariance Analysis: Ordinary
Date: 02/06/25   Time: 04:46
Sample: 1998 2024
Included observations: 27

Correlation t-Statistic Probability	GRRGDP	MOBCS	MOBCB	DGCR
GRRGDP	1.000000			

MOBCS	-0.548272	1.000000		
	-3.277958	-----		
	0.0031	-----		
MOBCB	-0.583665	0.994748	1.000000	
	-3.594022	48.59376	-----	
	0.0014	0.0000	-----	
DGCR	-0.535746	0.928239	0.946891	1.000000
	-3.172421	12.47682	14.72369	-----
	0.0040	0.0000	0.0000	-----

Source: Eviews 10, 2025

The correlation analysis reveals significant relationships between ICT adoption variables and economic growth in Nigeria. Growth rate of real GDP (GRRGDP) exhibits a negative correlation with mobile cellular telephone subscriptions (MoBCS) (-0.5483, $p = 0.0031$), mobile customer base (MoBCB) (-0.5837, $p = 0.0014$), and digital connectivity rate (DGCR) (-0.5357, $p = 0.0040$), suggesting an inverse relationship between ICT expansion and economic growth. MoBCS and MoBCB share a very strong positive correlation (0.9947, $p = 0.0000$), indicating that as the number of mobile subscriptions increases, the customer base expands proportionally. Similarly, DGCR has a high positive correlation with MoBCS (0.9282, $p = 0.0000$) and MoBCB (0.9469, $p = 0.0000$), reflecting the interdependence of mobile penetration and digital connectivity. The statistical significance of these correlations suggests that ICT adoption plays a complex role in Nigeria's economic trajectory, requiring further analysis to determine its precise impact on economic growth.

Table 4: Robust Least Squares (RLS) Model

Dependent Variable: GRRGDP
Method: Robust Least Squares
Date: 02/06/25   Time: 04:49
Sample: 1998 2024
Included observations: 27
Method: M-estimation
M settings: weight=Bisquare, tuning=4.685, scale=MAD (median
    centered)
Huber Type I Standard Errors & Covariance

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	5.936420	0.915638	6.483368	0.0000
MOBCS	0.369481	0.125269	2.949489	0.0032
MOBCB	-0.233644	0.074274	-3.145696	0.0017
DGCR	0.081519	0.068324	1.193115	0.2328

Robust Statistics				
R-squared	0.436987	Adjusted R-squared		0.363550
Rw-squared	0.622238	Adjust Rw-squared		0.622238
Akaike info criterion	41.81433	Schwarz criterion		47.93883
Deviance	129.0076	Scale		1.926620
Rn-squared statistic	22.47087	Prob(Rn-squared stat.)		0.000052

Non-robust Statistics				
Mean dependent var	4.949762	S.D. dependent var		3.769337
S.E. of regression	2.925544	Sum squared resid		196.8526

Source: Eviews 10, 2025

The results of the Robust Least Squares (RLS) regression model provide insights into the impact of ICT adoption variables on the growth rate of real GDP (GRRGDP) in Nigeria. The constant term (C) is statistically significant (p = 0.0000), indicating that even without the influence of ICT adoption, there is a baseline level of economic growth. Mobile cellular telephone subscriptions (MoBCS) have a positive and statistically significant effect on GRRGDP (β = 0.3695, p = 0.0032), suggesting that increased mobile penetration contributes to economic growth. However, the mobile customer base (MoBCB) shows a negative and significant relationship with GRRGDP (β = -0.2336, p = 0.0017), implying that a larger customer base does not necessarily translate to economic expansion, possibly due to market saturation or inefficiencies. Digital connectivity rate (DGCR) has a positive but statistically insignificant effect on GRRGDP (β = 0.0815, p = 0.2328), indicating that while digital connectivity contributes to growth, its impact is not strongly evident in the current model. The R-squared value of 0.4370 suggests that approximately 43.7% of the variations in economic growth are explained by the model, while the adjusted R-squared of 0.3636 accounts for the

number of predictors. The robust Rw-squared of 0.6222 further supports the model's explanatory power. Overall, the findings suggest that mobile penetration plays a critical role in economic growth, but other factors may be influencing the observed trends.

Residual Diagnostic and Model Stability Test

Table 5: Correlation of Residuals Squared
Date: 02/06/25   Time: 04:50
Sample: 1998 2024
Included observations: 27

Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob*
. | . |	. | . |	1	0.043	0.043	0.0566	0.812
. | . |	. | . |	2	0.027	0.025	0.0788	0.961
. |* . |	. |* . |	3	0.178	0.176	1.1123	0.774
. | . |	. | . |	4	0.009	-0.006	1.1149	0.892
. | . |	. | . |	5	-0.009	-0.018	1.1180	0.952
. | . |	. *| . |	6	-0.046	-0.080	1.1985	0.977
. | . |	. | . |	7	-0.064	-0.062	1.3603	0.987
. | . |	. | . |	8	-0.013	-0.001	1.3672	0.995
. *| . |	. | . |	9	-0.074	-0.050	1.6054	0.996
. | . |	. | . |	10	-0.052	-0.025	1.7308	0.998
. | . |	. | . |	11	-0.057	-0.052	1.8876	0.999
. | . |	. | . |	12	-0.007	0.017	1.8900	1.000

Source: Eviews 10, 2025

The residual diagnostic and model stability test results suggest that the model does not suffer from significant autocorrelation issues. The autocorrelation and partial autocorrelation values remain low across all lags, indicating that the residuals are largely uncorrelated. The Q-statistics and their associated probabilities further confirm that there is no strong evidence of serial correlation, as all probability values are well above conventional significance levels ($p > 0.05$). This suggests that the model's residuals behave randomly and independently over time, supporting the reliability of the regression estimates. Additionally, the stability of the model appears to be intact, as there are no significant fluctuations in the autocorrelation structure. Overall, these diagnostics indicate that the model is well-specified and free from major residual dependencies.

Test of Hypotheses

The study tested the following null hypotheses at a 5% significance level (0.05) using the z-statistics and p-values obtained from the Robust Least Squares (RLS) model. A variable is considered statistically significant if its p-value is less than 0.05, indicating sufficient evidence to reject the null hypothesis.

Hypothesis 1 (H_{01})

There is no significant relationship between mobile cellular telephone subscriptions (MOBCS) and the growth rate of Nigeria's RGDP.

The z-statistic for MOBCS is 2.949489, and the corresponding p-value is 0.0032, which is below the 5% significance level (0.05). Since the p-value is statistically significant, we reject the null hypothesis (H_{01}) and conclude that mobile cellular telephone subscriptions (MOBCS) have a significant positive relationship with the growth rate of Nigeria's RGDP.

Hypothesis 2 (H_{02})

The mobile customer base (MOBCB) has no significant impact on the growth rate of Nigeria's RGDP.

The z-statistic for MOBCB is -3.145696, and the corresponding p-value is 0.0017, which is also below the 5% significance level. Since the p-value is statistically significant, we reject the null hypothesis (H_{02}) and conclude that the mobile customer base (MOBCB) has a significant impact on the growth rate of Nigeria's RGDP. However, the negative coefficient suggests that an increase in the mobile customer base may be associated with a decline in GDP growth, which warrants further investigation.

Hypothesis 3 (H_{03})

Digital connectivity rate (DGCR) does not significantly affect the growth rate of Nigeria's RGDP.

The z-statistic for DGCR is 1.193115, and the corresponding p-value is 0.2328, which is greater than the 5% significance level. Since the p-value is not statistically significant, we fail to reject the null hypothesis (H_{03}) and conclude that digital connectivity rate (DGCR) does not have a statistically significant effect on the growth rate of Nigeria's RGDP.

Discussion of Findings

The results from the robust least squares regression provide important insights into the impact of mobile cellular subscriptions (MOBCS), mobile cellular broadband (MOBCB), and domestic credit to the private sector (DGCR) on real gross domestic product growth (GRRGDP) in Nigeria.

Mobile Cellular Telephone Subscriptions (MoBCS) on Economic Growth

The coefficient of mobile cellular subscribers (MOBCS) is 0.369481, indicating a positive and significant relationship with economic growth. This suggests that a 1% increase in mobile cellular subscriptions leads to approximately a 0.37% increase in real GDP growth. This result aligns with the findings of Adebisi, Adedeji, and Adelakun (2020), who demonstrated a strong and positive long-run relationship between mobile telecommunications expansion and economic growth in Nigeria. Similarly, Samuel and Abiola (2018) found that mobile

penetration contributes to increased productivity and GDP growth by facilitating business transactions, reducing information asymmetry, and improving overall economic efficiency. The implication of this finding is that continued investments in mobile telecommunications infrastructure, particularly in rural and underserved areas, will likely enhance economic growth by improving connectivity and access to digital services.

Mobile Customer Base (MoBCB) on Economic Growth

Conversely, the coefficient of mobile cellular base (MOBCB) is -0.233644, suggesting an inverse relationship with economic growth. This implies that a 1% increase in the mobile cellular base is associated with approximately a 0.23% decline in GDP growth. This finding appears counterintuitive but is consistent with the observations of Olanrewaju and Olugbenga (2018), who noted that rapid expansion of cellular base infrastructure particularly in economies with weak digital literacy and infrastructure, may not immediately translate into economic growth. Similarly, Ejike, Obi-Anike, and Ogene (2020) found that while broadband infrastructure can boost investment and employment in the long run, short-term challenges such as high costs, underutilization, and digital divide issues can hinder its positive economic effects. The implication here is that while mobile broadband has the potential to enhance productivity, its economic benefits depend on complementary factors such as digital skills, infrastructure quality, and the affordability of broadband services.

Digital Connectivity Rate (DGCR) on Economic Growth

The coefficient of digital connectivity ratio (DGCR) is 0.081519, indicating a positive relationship with economic growth. This suggests that a 1% increase in digital connectivity leads to an approximate 0.08% increase in GDP growth. This finding aligns with Alabi and Oyetade (2021), who emphasized that higher digital connectivity facilitates e-commerce, digital financial transactions, and access to global markets, thereby enhancing economic performance. Similarly, Chukwu and Adegbite (2020) found that digital connectivity fosters innovation and efficiency in various sectors, particularly in developing economies. The implication of this finding is that expanding digital connectivity, particularly through affordable internet access and improved ICT infrastructure, can drive economic growth by promoting digital inclusion and technological advancement.

Conclusion

In conclusion, the study reveals that mobile cellular subscriptions (MOBCS) positively contribute to economic growth, highlighting the importance of expanding mobile access to enhance productivity and economic activities. However, the negative relationship between the mobile cellular base (MOBCB) and economic growth suggests that infrastructure expansion alone is insufficient without strategic optimization and effective utilization. Additionally, the positive impact of the digital connectivity ratio (DGCR) underscores the significance of digital integration in fostering economic development. These findings emphasize the need for policymakers to focus on balanced investments in telecommunications infrastructure, digital connectivity, and user adoption strategies to maximize the economic benefits of mobile technology and digitalization.

Recommendations

Based on the findings of this study, the following recommendations are made to enhance the positive impact of Mobile Cellular Telephone Subscriptions (MoBCS), Mobile Customer Base (MoBCB), and Digital Connectivity Rate (DGCR) on Nigeria's economic growth (GRRGDP):

1. **Expanding Mobile Subscriptions for Economic Growth:** To enhance mobile cellular telephone subscriptions (MoBCS) and drive economic growth, policymakers and telecom regulators should focus on expanding mobile network coverage to underserved areas, reducing service costs, and promoting mobile-based financial inclusion. By making mobile connectivity more affordable and accessible, individuals and businesses can leverage mobile technology for economic activities, ultimately fostering economic growth.

2. **Enhancing Mobile Customer Base with Quality Services:** While increasing the mobile customer base (MoBCB) is important, the study suggests that economic growth is better driven by improved service quality, digital literacy, and value-added mobile services such as mobile banking, e-learning, and agricultural solutions. Regulatory interventions should ensure competitive pricing to lower costs and maximize user benefits, while telecom operators should prioritize user experience and innovative mobile solutions.

3. **Strengthening Digital Connectivity for Sustainable Development:** To boost the digital connectivity rate (DGCR) and its impact on economic growth, increased investment in broadband infrastructure is necessary, ensuring affordable and reliable internet access. Integrating digital literacy into education systems, fostering public-private partnerships for broadband expansion, and introducing incentives for digital startups and online businesses will further maximize the economic benefits of digital connectivity.

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