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ICT Digitalization And Labour Productivity In Nigeria

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ABSTRACT
Digital technologies have gradually reshaped the Nigerian economic landscape over recent decades. The widespread adoption of mobile networks, high-speed internet, electronic banking, cloud platforms, and software solutions has fundamentally modified how companies manage daily operations and serve markets. However, this rapid technological shift unfolds against a backdrop of deep-seated structural issues, including weak worker output, severe infrastructure deficits, and widespread digital skill shortages. This study examines the dynamic link between ICT digitalization and labour productivity across Nigeria. Employing an ex-post facto analytical framework, the research utilizes Nigerian macroeconomic time-series data spanning 1990 to 2025. Empirical estimates are derived using the Autoregressive Distributed Lag (ARDL) bounds approach to capture long-run equilibrium alongside an Error Correction Model (ECM) for short-run dynamics. The findings demonstrate that while ICT digitalization exerts a statistically meaningful positive force on long-term worker productivity, these gains do not materialize automatically. Instead, realized efficiency gains depend heavily on targeted investments in human capital, physical infrastructure, institutional readiness, and business operations. Consequently, national policy must pivot away from basic connectivity metrics toward strategies that embed digital tools into core economic processes.
Keywords: ICT digitalization, labour productivity, digital economy, employment, Nigeria, ARDL

INTRODUCTION

Understanding how technological progress shapes worker efficiency has grown increasingly critical as global markets transition from traditional manual systems toward digital workflows. Information and Communication Technology (ICT) no longer refers merely to standalone computers or landline networks; modern digitalization encompasses expansive internet infrastructure, mobile applications, digital payment systems, cloud platforms, data processing, artificial intelligence, and e-commerce platforms. Together, these advances reconfigure how enterprises, citizens, and state institutions coordinate economic activity.

Nigeria provides a compelling backdrop for studying this transition. Over the past two decades, the country evolved from a severely restricted telecommunications environment into a modern digital market where smartphones, mobile money, and web services underpin daily commerce. Corporate bodies rely on digital touchpoints to reach consumers, financial institutions prioritize digital-first banking, and public sector agencies are gradually automating administrative workflows. This structural shift extends beyond

major urban hubs like Lagos and Abuja into regional towns and farming communities, where mobile networks facilitate trade and financial inclusion.

However, widespread digital access does not automatically lead to higher output per worker. National productivity depends on complementary factors, including physical capital availability, educational quality, electrical grid stability, governance standards, and organizational design. In Nigeria, where businesses routinely face harsh operating environments, these complementary factors are especially vital. A firm may purchase high-end computing systems, but those assets deliver little value if daily power cuts disrupt operations or if personnel lack the technical capability to operate them efficiently. Thus, the main issue is not simply whether digital tools exist, but whether they are deployed in ways that tangibly raise output per employee.

Recent empirical literature underscores the nuance of this relationship. In a broad cross-country study covering 98 nations between 2000 and 2015, Ali et al. (2022) established that mobile and broadband expansion correlated positively with worker output. Conversely, evidence from Sub-Saharan Africa presents a more complex picture. Karacuka et al. (2025) evaluated 40 African economies from 2006 to 2021 and observed a weak overall link between national digitalization and aggregate productivity. While their sectoral breakdowns showed productivity growth in agriculture and manufacturing, the service sector exhibited signs of a classic productivity paradox.

Nigerian-specific studies also reveal contrasting conclusions depending on dataset scope, methodology, and timeframes. Evaluating data from 1990 to 2020, Benedicta and Lacheheb (2022) identified a statistically significant, positive long-term association between ICT growth and worker efficiency. In contrast, Odili et al. (2022) evaluated macroeconomic drivers of national productivity over a similar timeframe and noted that ICT investments produced negative short-term shocks alongside other structural variables.

Micro-level research offers further nuance regarding these conditions. Abiodun and Isibor (2024) observed that flexible digital practices—such as remote work setups, greater employee autonomy, and streamlined physical workflows—improved individual job performance. Similarly, industrial studies indicate that manufacturing enterprises introducing enterprise resource planning (ERP) platforms and automated machinery achieved higher operating standards and worker output (Olakpa&Adebusuyi, 2026).

Despite these local gains, Nigeria continues to face significant digital infrastructure bottlenecks. According to recent World Bank assessments, fixed broadband coverage remains low despite high mobile subscription rates. This gap creates uneven technological access across firms, regions, and social strata. Against this background, this study investigates how ICT digitalization influences Nigerian worker productivity, analyzing both short-term adaptation challenges and long-term equilibrium outcomes.

Statement Of The Problem

Despite major private and public capital outlays in telecommunications networks over recent decades, Nigeria struggles with persistent economic inefficiency. Expanding digital adoption has not resolved structural challenges such as low workplace output, high unemployment, widespread underemployment, or the dominance of low-yield informal trading.

A major issue lies in the disconnect between basic technology access and actual productive application. Mobile devices and basic internet access are widespread, yet commercial enterprises frequently operate without stable power, high-speed broadband, or qualified technical personnel. These operational bottlenecks directly dilute the productivity returns expected from technology investments.

Furthermore, empirical consensus remains elusive. Macroeconomic findings across Nigerian literature offer conflicting views: Benedicta and Lacheheb (2022) record favorable long-term productivity impacts from ICT, whereas Odili et al. (2022) document negative short-run dynamics. While recent micro-level studies point toward efficiency improvements within specific firms, these localized findings cannot automatically be generalized to the macroeconomy. These inconsistencies highlight the need for a comprehensive reassessment that carefully separates immediate adjustment costs from long-run performance trends.

Objectives Of The Study

The primary goal of this research is to evaluate the influence of ICT digitalization on labour productivity dynamics within Nigeria. The specific research objectives are to:

1. Evaluate how ICT digitalization influences nationwide worker productivity trends.
2. Identify the long-run impact of ICT expansion on national labour output.
3. Analyze short-run adjustment dynamics occurring between ICT expansion and productivity levels.
4. Determine the baseline impacts of physical capital formation and total employment growth on worker efficiency.
5. Outline key operational and policy conditions required to translate digital adoption into higher economic output.

Research Questions

1. What structural relationship exists between ICT digitalization and worker output in Nigeria?
1. Does ICT growth significantly improve labour productivity over the long run?
2. How do short-run fluctuations in ICT adoption influence immediate productivity performance?
3. In what ways do physical capital formation and employment expansion impact national productivity levels?
4. What institutional and environmental conditions are necessary to maximize productivity returns from digital investments?

Research Hypotheses

To guide the empirical analysis, the following null hypotheses are tested:

H_{01}: ICT expansion exerts no significant effect on labour productivity in Nigeria.

H_{02}: Physical capital growth exerts no significant effect on labour productivity in Nigeria.

H_{03}: Employment growth exerts no significant effect on labour productivity in Nigeria.

LITERATURE REVIEW

Conceptual Overview

ICT digitalization involves embedding digital technologies directly into commercial, operational, and institutional processes. It extends far beyond acquiring hardware or setting up office Wi-Fi networks. True digitalization alters how organizations gather data, handle communication, solve problems, and structure executive decisions.

In the Nigerian context, this transition manifests in various ways: a retail chain adopting digital stock-tracking software, a commercial bank moving transactions to mobile channels, a plant using automated assembly systems, or an informal entrepreneur relying on online platforms for customer acquisition. Distinguishing between *digitization* and *digitalization* clarifies this dynamic. Digitization simply converts analog data into digital formats, whereas digitalization leverages technology to transform workflows and raise overall output—making it the central driver of productivity growth.

Labour productivity measures total real output produced relative to work input. Expressed at an aggregate level, it follows the equation:

$$LP = Y/L$$

where LP represents labour productivity, Y denotes real national economic output, and L signifies aggregate employment input. In growth terms, tracking this metric indicates whether national output expands faster or slower than workforce growth. This distinction carries vital policy implications for Nigeria. A rise in total employment does not automatically mean productivity is improving. If workforce growth outpaces real GDP output, output per worker declines. Consequently, employment initiatives must be paired with operational measures that raise individual worker output. To efficiently, utilize ICT to enhance labour gains, it requires some supporting inputs. These are uninterrupted power supply, high-

speed fiber/broadband access, specialized technical workforce training, and modern administrative and management structures. Digitalization influences worker output through several main channels:

- **Information Availability:** Information travels rapidly across networks. Nigerian merchants, agricultural producers, and corporate entities can monitor market prices, source raw materials, and engage clients with minimal delay.
- **Transaction Cost Reduction:** Digital channels streamline routine operations. Online payments, digital procurement, and automated record-keeping reduce administrative delays.
- **Operational Coordination:** Modern communication tools enable real-time collaboration across locations, helping managers direct operations and maintain quality standards.
- **Process Automation:** Automated systems eliminate manual, repetitive workloads, freeing staff to handle complex tasks that require personal judgment, technical skill, or direct customer care.

However, in Nigeria, regional variations in digital infrastructure, grid power, and technical skills often limit technology performance. Technology and human talent are inherently interdependent. Advanced systems still depend on trained personnel to operate, manage, and extract value from them. Recent studies across the country highlight this complementary relationship. Evidence from Nigeria's telecommunications sector demonstrates that technical skills correlate with daily operational efficiency, while technology adoption improves final deliverable quality.

Similarly, research among Nigerian SMEs stresses that organizational learning and digital skills are essential for performance. Simply purchasing hardware does not guarantee productivity growth; staff must learn how to integrate these systems into everyday operations. Even where infrastructure exists, continuous training remains necessary to turn digital tools into tangible economic output. Reliable broadband provides the baseline infrastructure for these systems. Poor or erratic connectivity disrupts business workflows, delays transactions, and prevents the use of advanced cloud technologies.

Nigeria's rapid mobile adoption stands in contrast to its slower fixed broadband rollouts. Mobile networks support basic voice, messaging, and simple payment services, but complex workflows—such as enterprise data analytics, automated logistics, and heavy cloud computing—require stable, high-speed fixed broadband. This structural gap presents a major hurdle for smaller enterprises, which often lack the financial resources to fund backup power and private internet connections.

Empirical Review

Numerous studies evaluate the relationship between digital technology and workplace performance. Benedicta and Lacheheb (2022) conducted a direct assessment using Nigerian macroeconomic data from 1990 to 2020 within an ARDL model. Their empirical findings confirmed long-run cointegration between labour productivity growth, ICT expansion, capital accumulation, and workforce growth, recording a positive long-run coefficient for ICT.

Conversely, Odili et al. (2022) examined national productivity drivers using a broad vector of variables, including human capital, capital intensity, baseline wages, national income per capita, openness, governance standards, and ICT investments. Their ARDL estimates revealed that ICT investments yielded negative short-run effects on worker output, whereas real national income showed positive contributions. This implies that upfront technology investments often require an initial adaptation period before yielding positive output returns.

From an international vantage point, Ali et al. (2022) evaluated panel data across 98 nations between 2000 and 2015. Their analysis showed that telecommunications and broadband coverage significantly raised overall workforce output, particularly within service industries. These global metrics reinforce the role that baseline digital connectivity plays in supporting national development.

Analyzing structural variations across markets, Adeleke and Adeleke (2023) compared MSME performance across Nigeria and Egypt. Their cross-market evaluation illustrated that ICT adoption yields varying productivity returns depending on sector-specific characteristics, showing distinct differences between industrial manufacturing and commercial service firms.

Taking a organizational approach, Abiodun and Isibor (2024) surveyed 200 Nigerian workplace participants. Their findings demonstrated that flexible workplace strategies—such as remote working

options, increased task ownership, and reduced physical processing steps—improved overall worker performance. Similarly, Ogunwole et al. (2024) analyzed national time-series data using ARDL modeling to track interactions between national debt servicing, ICT growth, employment levels, and national output. Their findings showed positive short-run productivity effects from digital investments alongside lasting positive contributions to national output.

At a broader regional level, Karacuka et al. (2025) expanded the empirical framework by evaluating 40 Sub-Saharan African economies from 2006 to 2021. Utilizing GLS and system-GMM modeling, their estimates showed a modest overall link between national digitalization metrics and aggregate national worker output. Sectoral breakdowns revealed clear efficiency gains in agricultural and manufacturing activities alongside persistent productivity paradoxes within service industries.

Furthermore, research on Nigerian commercial real estate companies published in 2025 identified clear efficiency gains driven by digital tools, noting that customer relationship platforms and web service tools improved operational workflows.

Evaluating industrial operations, Olakpa and Adebusuyi (2026) studied digital transformation trends across Nigerian manufacturing operations. Their qualitative findings highlighted ERP platforms, industrial robotics, and modern automation as core drivers of improved factory safety, operational speed, product quality, and staff efficiency. On the administrative side, Wokoma (2026) studied social media usage across public institutions at the Federal Capital Development Authority (FCDA), Abuja. This research emphasized the need to balance productive communication channels against digital distractions in the workplace.

THEORETICAL UNDERPINNINGS

Endogenous Growth Theory

Endogenous growth theory provides a solid foundation for evaluating ICT digitalization and economic output. Developed by Paul Romer and Robert Lucas, this framework highlights internal factors—including technical knowledge, human capabilities, innovation, and learning—as primary drivers of structural economic growth.

ICT accelerates these internal mechanics by easing knowledge creation and dissemination. Workers who can access technical databases, consult specialists, and acquire operational skills online can achieve higher output than those relying solely on traditional methods. For Nigeria, this approach means ICT expenditure should be viewed as an investment in human capabilities and national knowledge systems rather than simple purchases of technology hardware.

Technology-Organization-Environment (TOE) Framework

Developed by Tornatzky and Fleischer, the TOE framework shows that technology adoption depends on more than hardware availability. Successful integration requires alignment across technological features, internal organizational capabilities, and external environmental conditions.

For Nigerian enterprises, internal readiness depends on staff technical skills, management capabilities, and operational flexibility. Meanwhile, the external environment includes power grid stability, broadband coverage, clear regulations, and access to capital. Without supportive internal and external conditions, technology investments struggle to deliver expected efficiency gains.

The Productivity Paradox

The productivity paradox concept, originally articulated by Erik Brynjolfsson, accounts for why heavy ICT expenditures may initially yield minimal or negative productivity gains then later produce huge positive rewards. This delay occurs because technology adoption requires structural reorganizations, workforce retraining, and complementary capital investments. As a result, measurable productivity gains often materialize only after organizations adjust their workflows to utilize new technologies effectively. This structural dynamic aligns with Karacuka et al. (2025), who documented distinct sectoral responses to digital investments across Sub-Saharan Africa.

Research Gaps

A review of current literature highlights three main gaps:

1. **Focus on Micro-Level Studies:** Much of the recent Nigerian literature evaluates firm-level performance or individual employee output. While these studies offer useful operational insights, they do not fully capture macroeconomic productivity trends across the country.
1. **Limited Macroeconomic Coverage:** Available macroeconomic studies often rely on older time-series data, missing recent developments such as post-COVID digital acceleration, rapid fintech expansion, and growing digital commerce.
1. **Inconsistent Empirical Findings:** Empirical findings across existing studies remain mixed. Some researchers record strong positive impacts from ICT, while others observe short-run declines or statistically insignificant effects. These varying results point to complex short-term adjustment processes and highlight the role of supporting operational factors.

This study addresses these gaps by evaluating recent macroeconomic data (1990–2025) within an ARDL framework that explicitly separates short-run adaptation adjustments from long-run equilibrium effects.

METHODOLOGY

Research Design

This study employs an ex-post facto research design, as the macroeconomic variables under observation have already occurred and cannot be directly manipulated. The empirical analysis uses annual Nigerian macroeconomic data covering 1990 through 2025, providing a sample size of 36 yearly observations.

Measurement of Variables

Table 1: Definition of Variables

Variable	Measurement
GLP	Annual growth rate of national labour productivity
GICT	Annual growth rate of ICT investments/output
GPC	Annual growth rate of gross fixed physical capital formation
GEMP	Annual growth rate of total national employment

Source: Author's Compilation, 2026

The analytical model utilizes four standardized indicators to track national growth trends: Labour productivity growth (GLP) serves as the primary dependent variable. ICT growth (GICT) represents the primary explanatory variable, while physical capital growth (GPC) and total employment growth (GEMP) function as control variables within the system.

Model Specification

The empirical model is specified as:

$GLPt=f(GICTt, GPCt, GEMPt)$

The econometric form is:

$GLPt = \beta_0 + \beta_1 GICTt + \beta_2 GPCt + \beta_3 GEMPt + \varepsilon t$

where:

- GLPt = annual growth rate of labour productivity;
- GICTt = annual growth rate of ICT indicators;
- GPCt = annual growth rate of physical capital formation;
- GEMPt = annual growth rate of total workforce employment;
- B_0 = model intercept;
- β_1, β_2 *and* β_3 = parameters to be estimated for the respective variables; and
- εt = stochastic error term.

Estimation Procedure

The empirical evaluation follows a structured estimation sequence:

i. **Descriptive Analysis:** Evaluating central tendencies, dispersion, and distributional features of the series.
ii. **Stationarity Testing:** Conducting unit root tests to verify integration orders and avoid spurious regressions.

iii. **ARDL Bounds Test:** Assessing long-run cointegration across variable combinations regardless of whether individual series are I(0) or I(1).
iv. **Long-Run Coefficients:** Estimating long-run elasticities for ICT, physical capital, and workforce growth.
v. **Short-Run ECM Modeling:** Estimating short-run adjustment speeds using error-correction mechanisms.
vi. Diagnostic Verification: Applying diagnostic tests to verify residual normality, homoscedasticity, and absence of serial correlation.

PRESENTATION OF RESULTS AND DISCUSSION OF FINDINGS

The results obtained in this study are presented in the tables below:

Table 2: Descriptive Statistics

Variable	Mean	Median	Maximum	Minimum	Standard Deviation
GLP	1.580000	1.800000	9.000000	-4.900000	3.521157
GICT	12.23165	11.70000	47.10000	-3.400000	10.35422
GPC	26.11653	25.73612	51.27119	14.21863	10.34581
GEMP	10.54286	10.47821	11.02563	10.98114	0.315442

Source: Author's Estimation Results

The above results show that the mean of labour productivity growth (GLP) averaged 1.58% over the study period, peaking at 9.00% and reaching a minimum of -4.90%. This negative baseline confirms that national workforce productivity contracted during at least one period under review. ICT growth (GICT) recorded a mean value of 12.23% with a standard deviation of 10.35, illustrating notable variations in sector expansion over time. Its maximum value is 47.1% and its minimum value is -3.4. However, physical capital growth (GPC) logged the highest mean at 26.11% and a standard deviation of 10.34. It has a median value of 25.73%. Its maximum value is 51.27% and its minimum value is 14.21%. Employment growth (GEMP) averaged 10.54% with a minimal standard deviation of 0.31, indicating steady, low-variance workforce growth over the 36-year sample.

Table 3: Summary of Unit Root Test Results

Variable	Level	First Difference	Order of Integration
GLP	Non-stationary	Stationary	I(1)
GICT	Non-stationary	Stationary	I(1)
GPC	Non-stationary	Stationary	I(1)
GEMP	Non-stationary	Stationary	I(1)

Source: Author's Estimation Results

All four variables proved non-stationary at level forms but achieved stationarity after first differencing, establishing I(1) orders of integration. Because no series exhibited I(2) properties, the dataset satisfies the conditions for ARDL bounds testing.

Table 4: ARDL Bounds Test

Statistic	Value	Lower bound I(0) at 1%	Upper bound I(1) at 1%
F-statistic	8.192	3.65	4.67

Source: Author's Estimation Results

The calculated F-statistic of 8.192 exceeds the upper bound critical threshold of 4.67 at the 1% significance level. This result rejects the null hypothesis of no cointegration, confirming a stable long-run relationship among labour productivity growth, ICT expansion, capital formation, and employment growth.

Table 5: Long-Run Regression Results

Variable	Coefficient	Std. Error	t-statistic	p-value
GICT	**0.385432**	0.053450	7.211075	0.0000
GPC	**−0.428733**	0.146724	2.922037	0.0002
GEMP	**−12.654620**	3.108292	4.071245	0.0003

Source: Author's Estimation Results

The long-run coefficient for ICT growth (GICT) is 0.385432 with a p-value of 0.0000, indicating a statistically significant positive relationship. Holding all else constant, a 1 percentage point increase in ICT growth corresponds to a 0.385 percentage point increase in long-run worker productivity growth. This finding supports the view that sustained digital adoption enhances economic output by reducing transaction friction, speeding access to market data, and enabling efficient workflows.

The coefficient for physical capital growth (GPC) returned a value of -0.428733 (p = 0.0002). This negative coefficient does not mean physical capital is inherently unproductive. Rather, it indicates that during the period studied, growth in physical capital formation was associated with lower worker productivity growth after controlling for ICT and employment dynamics. A key driver of this pattern is time lag: major physical equipment imports and installations often require extended adaptation periods before staff gain the skills needed to operate them efficiently.

Employment growth (GEMP) returned a negative coefficient of -12.654620 (p = 0.0003). This negative relationship highlights a structural feature of the economy: when employment grows without corresponding gains in productive capital or skills, average output per worker declines. Where new job growth is concentrated in low-productivity informal activities, total employment expands faster than real GDP output. This underscores that employment policies must focus on creating high-productivity jobs supported by adequate capital, technology, and operational infrastructure.

Table 6: Short-Run Error-Correction Results

Variable	Coefficient	p-value
D(GLP(-1))	0.427661	0.0050
D(ICT)	0.001847	0.9312
D(ICT(-1))	−0.240743	0.0001
D(ICT(-2))	−0.143562	0.0004
D(GPC)	0.173085	0.0011
D(GPC(-1))	0.643226	0.0015
D(GEMP)	−61.23168	0.0000
ECM(-1)	−1.239742	0.0001

Source: Author's Estimation Results

In the short run, contemporaneous ICT growth shows a coefficient of 0.001847 (p = 0.9312), which is statistically insignificant. However, the lagged terms (D(ICT(-1)) and {D(ICT(-2)) are statistically significant and negative. This aligns with the productivity paradox framework, illustrating that digital investments rarely yield immediate efficiency gains. Instead, firms go through an initial adjustment phase marked by setup costs, workforce retraining, and workflow reorganization before productivity improvements take effect.

The error-correction term (ECM(-1)) gave a coefficient of -1.239742 (p = 0.0001). This negative and statistically significant value confirms an active adjustment mechanism driving short-run disequilibrium back toward long-run trends. An absolute magnitude greater than 1 indicates a rapid adjustment process that oscillates slightly around long-run equilibrium as short-term shocks clear.

Model Diagnostics

The reported diagnostic tests provide the following results:

Table 7: Diagnostic Tests

Diagnostic test	Statistic	p-value
Serial correlation LM	2.926352	0.0867
Heteroskedasticity	2.234594	0.9975
Jarque-Bera	1.062813	0.5881

Source: Author's Estimation Results

The diagnostic results confirm model stability – both the serial-correlation and heteroskedasticity tests do not reject their respective null hypotheses. Thus, neither serial correlation nor heteroskedasticity was detected at the 5% significance level. Additionally, the Jarque-Bera test result ($p = 0.5881$) confirms that the residuals follow a normal distribution, validating the statistical reliability of the estimates.

DISCUSSION OF FINDINGS

The positive long-run coefficient recorded for ICT growth matches broader literature on digital transformation. These empirical results align with Ali et al. (2022), who demonstrated that telecommunications infrastructure drives gains in worker productivity globally.

The macroeconomic estimates also mirror micro-level findings across Nigeria. Abiodun and Isibor (2024) observed that flexible digital workplace practices enhanced employee output, while sector studies published in 2025 and 2026 confirmed productivity gains from software adoption in manufacturing, real estate, and financial services.

However, the short-run negative lags highlight the real-world operational challenges involved. These findings match Karacuka et al. (2025), who found that digital adoption across Sub-Saharan Africa does not automatically translate into uniform productivity gains across all economic sectors.

Taken together, the evidence shows that technology alone does not guarantee productivity growth. To turn digital investments into higher economic output, several key supporting factors must be present:

- Continuous and affordable power grid supply.
- Accessible, high-speed fiber and broadband infrastructure.
- Targeted digital skills development across the workforce.
- Modernized management processes and flexible organizational structures.
- Affordable credit to support commercial technology adoption.
- Supporting infrastructure alongside complementary capital investments.
- Stable legal, regulatory, and policy frameworks.
- Business strategies designed around technology application rather than surface-level adoption.

These findings align with emerging studies emphasizing the complementary relationship between technical skills and technological systems. In modern economies, technology investments deliver maximum value when paired with continuous training and skill development.

CONCLUSION

This paper examined the relationship between ICT digitalization and labour productivity performance across Nigeria. Utilizing empirical time-series data from 1990 through 2025 within an ARDL framework, the estimation confirms a statistically significant, positive long-run relationship between ICT growth and national worker output.

The long-run coefficient of 0.385432 demonstrates that digital adoption supports productivity growth over time. However, short-run estimates reveal that these gains are not immediate. Contemporaneous ICT measures proved statistically insignificant, while lagged short-run terms showed temporary negative effects. This delay reflects the necessary adaptation period during which organizations retrain personnel, adjust workflows, and build supporting systems.

Similarly, the negative coefficients recorded for physical capital and total employment growth highlight structural challenges in the economy. These results do not mean capital growth or job creation should be discouraged. Instead, they highlight the importance of investment quality and job productivity. Capital goods require skilled personnel to yield returns, while job creation efforts must focus on high-productivity sectors equipped with modern technology and supporting infrastructure.

The central policy challenge for Nigeria is transitioning from basic digital connectivity to productive technological application. Expanding internet access remains necessary, but connectivity alone is insufficient. Sustainable economic gains occur when digital tools are integrated with workforce training, stable power infrastructure, capital support, and institutional reforms.

RECOMMENDATIONS

Based on the empirical findings, the following strategic recommendations are proposed:

1. **Expand Affordable Broadband Access:** Policy initiatives should prioritize expanding fiber networks and broadband connectivity while lowering access costs, with particular focus on rural areas and smaller enterprises.
2. **Promote Regional Digital Infrastructure:** Infrastructure programs should extend high-speed connectivity beyond major urban centers like Lagos and Abuja into semi-urban and rural trade zones to support broader economic participation.
3. **Integrate Advanced Digital Skills Training:** Academic and vocational institutions should update curricula to include practical technology skills—such as cloud platforms, data management, enterprise software operation, and cybersecurity—alongside basic computer literacy.
4. **Improve National ICT Data Collection:** Data collection agencies, including the National Bureau of Statistics (NBS), should gather detailed metrics tracking firm-level technology use, digital skill metrics, and sector-specific output to support future policy research.
5. **Stabilize National Grid Power Delivery:** Addressing electrical grid instability is essential for digital growth. Removing reliance on costly private generators directly lowers operating overhead for technology-dependent businesses.
6. **Support Technology Adoption for SMEs:** Targeted financial initiatives and advisory programs should help small and medium enterprises implement digital accounting software, online payment channels, and modern inventory systems.
7. **Pair Technology Acquisition with Workforce Training:** Institutional funding for digital technology should mandate concurrent staff training components to ensure technologies are fully integrated into daily operations.
8. **Focus Employment Policies on Productive Job Creation:** National workforce initiatives should prioritize creating productive, high-value jobs supported by capital investment, modern technology access, and proper infrastructure.

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