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TECHNOLOGICAL PROGRESS AND POVERTY REDUCTION IN NIGERIA: DOES GOVERNANCE QUALITY MATTER?

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ABSTRACT

This study examines the relationship between technological progress, governance quality, and poverty reduction in Nigeria over the period 1996–2025. The study adopts the Autoregressive Distributed Lag (ARDL) approach to cointegration. The findings reveal that technological progress is negatively associated with the poverty rate in both the short and long run, although its long-run coefficient in the baseline model is significant only at the 10% level. The relationship becomes stronger and statistically significant at the 5% level when governance quality is incorporated. Governance quality has an insignificant relationship with poverty in the governance-inclusive model but becomes negative and statistically significant in the long-run interaction specification. Most importantly, the technology–governance interaction term is negative and statistically significant in both the short and long run, suggesting that improvements in governance strengthen the poverty-reducing effect of technological progress. The findings underscore the need for Nigeria to pursue technological transformation alongside institutional and governance reforms to achieve more effective and sustainable poverty reduction.

Keywords: *Technological Progress, Quality of Governance, Poverty Reduction, Auto-Regressive Distributed Lag, Nigeria*.

JEL Classification: *I32, O33, O43, C22, O55*

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1. INTRODUCTION

Poverty remains one of the most persistent development challenges confronting the Global South, with consequences extending beyond national boundaries through migration pressures, humanitarian crises, social instability, and increasing demands for international development assistance. Although global poverty has declined over the past three decades, progress has slowed, particularly in developing economies. The World Bank (2024) estimates that nearly 700 million people worldwide were living in extreme poverty under the former international poverty threshold of US$2.15 per person per day, with Sub-Saharan Africa (SSA) accounting for a substantial proportion of the global poor. Beyond inadequate income, poverty encompasses deprivation in education, healthcare, housing, electricity, clean water, and sanitation. According to the United Nations Development Programme (UNDP, 2024), approximately 1.1 billion people across 112 developing countries experience multidimensional poverty, underscoring the importance of poverty eradication under Sustainable Development Goal 1 (SDG 1). The challenge is particularly pronounced in Nigeria, where poverty remains widespread despite considerable natural-resource endowments and economic potential. The World Bank (2022) estimates that approximately four in ten Nigerians, representing about 80 million people, lived below the national poverty line. Furthermore, approximately 41.8% of Nigerians lived below the international poverty threshold of US$3.00 per person per day in 2022, while World Bank projections suggest that the poverty rate could reach 50.8%, representing approximately 123 million people, in 2026. These persistent poverty levels highlight the need to identify factors capable of promoting inclusive and sustainable poverty reduction.

One factor increasingly recognised as an important driver of economic transformation and poverty reduction is technological progress. Within the neoclassical growth framework, technological advancement is regarded as a fundamental determinant of productivity improvement and sustained economic growth (Solow, 1956). Technological progress can facilitate poverty reduction by improving productive efficiency, lowering transaction costs, expanding market access, creating employment opportunities, and improving financial and public services. In Nigeria, technological development has expanded considerably through digital infrastructure and internet connectivity. By January 2025, Nigeria had approximately 107 million internet users, representing an internet penetration rate of 45.4% (DataReportal, 2025). These developments have created opportunities for digital entrepreneurship, financial inclusion, and economic participation (Asaju & Ashepo, 2025; Chinyere & Yamma, 2021). Nevertheless, technological advancement does not automatically translate into poverty reduction, as its benefits may be unevenly distributed due to differences in income, education, infrastructure, digital literacy, and access to financial resources. World Bank (2024) data indicate substantial socioeconomic disparities in financial and digital inclusion in Nigeria, with account ownership and digital-payment usage considerably higher among wealthier individuals than poorer households. This raises the question of whether technological progress independently contributes to poverty reduction in Nigeria.

Beyond technological progress, governance quality represents another important factor influencing poverty outcomes. Governance quality reflects institutional effectiveness in implementing policies, enforcing regulations, ensuring accountability, maintaining political stability, and allocating economic resources. Effective governance can promote investment, innovation, entrepreneurship, and efficient public-service delivery, while weak governance, characterised by corruption, policy inconsistency, and institutional inefficiency, can undermine economic opportunities and poverty-reduction efforts. In Nigeria, institutional weaknesses have persisted despite

economic reforms and technological developments. Existing studies emphasise the importance of institutional quality for economic performance and development outcomes (Abubakar, 2020; Utile et al., 2021). Consequently, examining the independent effect of governance quality on poverty reduction is essential to understanding its contribution to improved welfare outcomes.

More importantly, technological progress and governance quality may not operate independently in determining poverty outcomes. The effectiveness of technological advancement in reducing poverty may depend on the institutional environment within which innovations are developed, adopted, and utilised. Strong governance institutions can facilitate technological diffusion, encourage productive investment, and ensure that productivity gains translate into improved employment, incomes, and living standards. Conversely, weak institutions may prevent technological benefits from reaching disadvantaged households. This relationship is particularly relevant to Nigeria, where expanding technological capabilities coexist with persistent poverty and governance challenges. Therefore, examining technological progress and governance quality separately may provide an incomplete understanding of their combined influence on poverty reduction, highlighting the need to investigate whether governance quality moderates this relationship.

Although previous empirical studies have examined technological development, institutional quality, and poverty reduction, important gaps remain. Technology-oriented studies have largely focused on ICT adoption, digital innovation, infrastructure, and economic growth, while institutional studies have concentrated on economic performance, financial inclusion, and income inequality. Consequently, limited attention has been devoted to examining technological progress, governance quality, and poverty reduction within a unified empirical framework in Nigeria. More importantly, existing studies have not sufficiently established whether governance quality strengthens or weakens the poverty-reducing effect of technological progress. Addressing this gap requires examining the independent contributions of technological progress and governance quality, alongside the moderating influence of governance quality on the relationship between technological progress and poverty reduction.

Against this background, the present study investigates the relationship between technological progress, governance quality, and poverty reduction in Nigeria over the period 1996–2025. Specifically, it examines the effect of technological progress on poverty reduction, investigates the effect of governance quality on poverty reduction, and determines whether governance quality moderates the relationship between technological progress and poverty reduction. Using annual time-series data and the Autoregressive Distributed Lag (ARDL) approach, the study examines the short-run and long-run relationships among the variables. Technological progress is measured using total factor productivity, while governance quality is captured through a composite index constructed from the World Bank's six Worldwide Governance Indicators. Three complementary model specifications are employed to examine the independent and interactive relationships among the variables. By integrating technological progress and governance quality within a unified framework, the study contributes to the existing literature and provides evidence relevant to policies aimed at promoting technological transformation, institutional effectiveness, and sustainable poverty reduction in Nigeria.

Research Questions

In line with the issues identified in the introduction and the research gap established, the study seeks to address the following research questions:

a) What is the effect of technological progress on poverty reduction in Nigeria?
b) What is the effect of governance quality on poverty reduction in Nigeria?
c) To what extent does governance quality moderate the relationship between technological progress and poverty reduction in Nigeria?

Objectives of the Study

The general objective of this study is to investigate the relationship between technological progress, governance quality, and poverty reduction in Nigeria over the period 1996–2025.

Specific Objectives

The specific objectives of the study are:

a) To examine the effect of technological progress on poverty reduction in Nigeria.
b) To investigate the effect of governance quality on poverty reduction in Nigeria.
c) To determine whether governance quality moderates the relationship between technological progress and poverty reduction in Nigeria.

2. LITERATURE REVIEW

2.1 Conceptual Literature Review

Poverty refers to a condition in which individuals or households lack sufficient income or consumption resources to meet a defined minimum standard of living. The poverty headcount ratio is a monetary measure of poverty that indicates the percentage of the population living below a specified poverty line. It is expressed as the proportion of individuals whose income or consumption falls below the established threshold. The World Bank (2022), in its assessment of poverty in Nigeria, examines the extent and distribution of monetary poverty and the socioeconomic constraints affecting household welfare. Similarly, the World Bank (2024) emphasises poverty reduction as a central development objective within the broader context of shared prosperity and sustainable development. Although the UNDP (2024) adopts a multidimensional approach that captures overlapping deprivations in health, education and living standards, the poverty headcount ratio specifically measures the incidence of monetary poverty.

In empirical research, poverty headcount measures provide a basis for investigating how macroeconomic conditions, technological developments and institutional arrangements influence living standards. You, Bianco and Amankwah-Amoah (2020) examine the contribution of technological catch-up to poverty alleviation in Sub-Saharan Africa, while Oshota (2019) investigates the relationship between technology access, inclusive growth and poverty reduction in Nigeria. Fagbemi and Ajibike (2024) also examine the contribution of process innovation to sustainable poverty reduction. These studies establish the relevance of investigating the mechanisms through which productivity improvements and technological development may influence poverty outcomes. In the present study, the poverty headcount ratio is the dependent variable and represents the incidence of monetary poverty in Nigeria. A decline in the ratio indicates an improvement in poverty outcomes, whereas an increase indicates worsening poverty incidence. Its use enables the study to assess whether technological progress, governance quality, physical-

capital accumulation and human capital are associated with changes in the proportion of Nigerians living below the poverty line.

Technological progress refers to improvements in production techniques, knowledge, innovation and the efficiency with which productive resources are utilised to generate output. It enables economies to increase productivity without relying exclusively on additional inputs of labour and capital. Solow (1956) identifies technological progress as a fundamental source of sustained economic growth, demonstrating its importance in explaining long-run increases in output per worker. In this context, technological progress encompasses not only the introduction of new technologies but also improvements in the efficiency with which existing resources are combined and utilised. Previous empirical studies have examined technological progress through different indicators, including technological advancement, ICT adoption, digital innovation, process innovation, and productivity improvements. Eke, Agala and Offum (2019) investigate the relationship between technological advancement and economic growth in Nigeria, while Oshota (2019) examines technology access and its implications for inclusive growth and poverty reduction. Mateko (2024) investigates the role of ICT in poverty alleviation in Nigeria, and Gloria (2025) examines the relationship between digital innovation and poverty reduction. Fagbemi and Ajibike (2024) further highlight the relevance of process innovation to sustainable poverty reduction.

At the regional level, You, Bianco and Amankwah-Amoah (2020) find that closing technological gaps can contribute to poverty alleviation across 17 Sub-Saharan African countries. Although these studies demonstrate the relevance of technological development to poverty outcomes, technological access and technological progress are conceptually distinct. Access measures the availability or use of particular technologies, whereas productivity-based measures capture improvements in the efficiency of production. Accordingly, the present study measures technological progress using total factor productivity (TFP). TFP reflects the portion of output growth not explained by measured changes in conventional production inputs, subject to the assumptions and measurement limitations of the productivity framework. This operationalisation is consistent with the Solow (1956) growth model and provides a broad productivity-based measure of technological progress. The study therefore examines whether improvements in Nigeria's productive efficiency are associated with a reduction in poverty incidence.

Governance quality refers to the effectiveness, accountability, transparency, and institutional capacity through which public authority is exercised, policies are implemented, and economic activities are regulated. It reflects the extent to which institutions establish a predictable environment for economic activity, protect rights, enforce rules and provide public services. Governance quality is multidimensional because the capacity of institutions to support development involves several interrelated but distinct institutional characteristics. In empirical studies, institutional quality has been examined in relation to economic growth, financial inclusion, income inequality, and the effectiveness of economic policies. Abubakar (2020) investigates institutional quality as a determinant of economic growth in Nigeria, while Utile, Ijirshar and Sem (2021) examine the relationship between institutional quality and economic growth in the country. Olanrewaju, Tella and Adesoye (2019) investigate institutional quality, financial inclusion and inclusive growth, highlighting the relevance of institutional conditions to the distribution of economic opportunities. Beyond growth outcomes, Asamoah (2021) and Naplawa (2020) examine the relationship between institutional quality and income inequality, while Maduka, Ogwu and Ekesiobi (2022) investigate the moderating role of institutional quality in the relationship between economic growth and carbon emissions in Nigeria.

For measurement, the World Bank's Worldwide Governance Indicators provide six dimensions of governance: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality,

rule of law, and control of corruption. These dimensions capture different aspects of institutional performance and provide a framework for assessing governance conditions. In the present study, governance quality is constructed using principal component analysis (PCA) applied to these six indicators. This approach combines information from the individual indicators into a composite measure, reducing the dimensionality of governance data while capturing their common variation. The resulting index represents the governance measure used in the empirical analysis, subject to the standardisation and component-selection procedures adopted. Governance quality is relevant to poverty reduction because institutions influence the provision of infrastructure, implementation of development policies, allocation of public resources and accessibility of economic opportunities. Effective governance may enable technological improvements to generate broader welfare benefits, whereas weak governance may constrain their distribution. Accordingly, the present study considers governance quality both as a potential determinant of poverty incidence and as an institutional condition that may influence the relationship between technological progress and poverty reduction.

2.2 Theoretical Literature Review

The study is anchored on the Solow neoclassical growth model (Solow, 1956) and institutional theory. The Solow framework identifies technological progress, alongside capital and labour, as a key driver of productivity and sustained growth, implying that technology can reduce poverty through improved efficiency, employment, incomes, and access to economic opportunities. However, these benefits depend on complementary infrastructure, human capital, and inclusive technological access, as supported by You et al. (2020), Oshota (2019), Fagbemi and Ajibike (2024), Mateko (2024), and Ajaj et al. (2024). Institutional theory complements this perspective by emphasizing that governance quality shapes incentives, investment, technology adoption, and the distribution of economic gains. Effective institutions can enhance the poverty-reducing impact of technological progress, whereas weak governance may constrain its benefits, consistent with Olanrewaju et al. (2019), Abubakar (2020), Utile et al. (2021), Asamoah (2021), Naplawa (2020), and Maduka et al. (2022). Thus, the study posits that technological progress can promote poverty reduction, with governance quality influencing the magnitude and sustainability of this effect.

2.3 Empirical Literature Review

Using evidence from 17 Sub-Saharan African countries, You, Bianco and Amankwah-Amoah (2020) find that closing technological gaps contributes to poverty alleviation, highlighting technology as an important mechanism for improving economic opportunities in developing economies. In Nigeria, Oshota (2019), using an error-correction modelling approach, reports that technology access contributes to inclusive growth and poverty reduction, while infrastructural conditions such as electricity and transport further strengthen these outcomes. Similarly, Fagbemi, Osinubi and Adeosun (2022) find that sustainable infrastructural development significantly contributes to poverty reduction in Nigeria, underscoring the importance of complementary infrastructure in translating technological and productive improvements into welfare gains. Fagbemi and Ajibike (2024) further demonstrate that process innovation is relevant to sustainable poverty reduction in Nigeria, suggesting that innovation can influence poverty outcomes through improvements in productive efficiency. Evidence from Mateko (2024) also establishes the importance of information and communication technology (ICT) for poverty alleviation in Nigeria, while Olaoye and Zerihun (2023) show that ICT strengthens the poverty-reducing role of financial inclusion. More recent Nigerian evidence by Gloria (2025) indicates that digital innovation has significant implications for poverty reduction. The broader technology-development literature reinforces this relationship: Eke, Agala and Offum (2019) identify technological advancement as an important factor in Nigeria's economic growth, while Shotunde and Abdulazeez (2020), Chinyere and Yamma (2021), Olojuolawe and Osuntuyi (2024), and Asaju

and Ashepo (2025) similarly establish the relevance of technological development to economic and national development in Nigeria. At the broader African level, Ajaj, Buheji and Hassoun (2024) argue that Industry 4.0 technologies offer important opportunities for advancing Sustainable Development Goal 1, although their poverty-reducing potential depends on infrastructure, skills, institutional readiness, and inclusive access. Collectively, these studies indicate that technological progress can contribute to poverty reduction, but its effects are likely to depend on the broader economic and institutional environment.

The literature on institutional quality provides complementary evidence that governance conditions influence economic and distributional outcomes. Olanrewaju, Tella and Adesoye (2019), examining Nigeria, establish a causal relationship between institutional quality, financial inclusion and inclusive growth, indicating that institutional conditions can shape the extent to which economic opportunities become broadly shared. Abubakar (2020) similarly finds that institutional quality is an important determinant of economic growth in Nigeria, while Utile, Ijirshar and Sem (2021) report a significant relationship between institutional quality and economic growth and emphasize the importance of accountability, government effectiveness and regulatory capacity. Evidence from other developing economies provides further insight into the distributional consequences of institutions. Naplawa (2020), using evidence from post-Soviet countries, finds that the relationship between institutional quality and income inequality is nonlinear, suggesting that improvements in institutional quality may produce different distributional effects depending on the level of institutional development. Asamoah (2021), using dynamic panel threshold analysis for developing countries, likewise demonstrates that the relationship between institutional quality and income inequality is conditional on the quality and measurement of institutions. In Nigeria, Maduka, Ogwu and Ekesiobi (2022) find that institutional quality moderates important macroeconomic relationships, demonstrating that governance conditions can alter the effects of economic activities on development outcomes. Taken together, these findings suggest that institutional quality is not merely an independent determinant of economic performance but can condition how effectively productive and technological improvements translate into broader development outcomes.

Despite these contributions, the existing empirical literature remains fragmented in several respects. The technology-oriented studies largely examine ICT, innovation, infrastructure, technological advancement, or digitalisation separately, while the institutional literature focuses predominantly on economic growth, inequality, financial inclusion, or environmental outcomes. Consequently, limited attention has been given to the joint relationship between technological progress, governance quality, and poverty reduction in Nigeria over a long and consistent time horizon. Moreover, much of the existing evidence examines individual technological or institutional channels rather than considering whether the quality of governance conditions the capacity of technological progress to generate poverty-reducing outcomes. The present study addresses this gap by examining the relationship between technological progress, governance quality, and poverty reduction in Nigeria over 1996–2025 within a unified time-series framework. This approach provides a basis for assessing both the direct contribution of technological progress to poverty reduction and the importance of institutional quality in creating an environment in which technological gains can translate into broader welfare improvements.

3. METHODOLOGY

The theoretical foundation of the study is derived from the neoclassical growth framework, particularly the production function associated with Solow (1956). The conventional production relationship can be expressed as:

$$Y = F\,(AK^{\alpha}\,L^{\beta}) \quad (1)$$

where Y represents economic output or productivity, A denotes total factor productivity (TFP) reflecting technological progress, L represents labour, K represents physical capital, while α and β are the output elasticities of labour and capital, respectively. In the context of this study, the production relationship is extended to examine how technological progress translates into poverty reduction, while accounting for the role of governance quality. This adaptation is consistent with empirical evidence that technological advancement, innovation, ICT, and infrastructure can contribute to poverty reduction (You et al., 2020; Oshota, 2019; Fagbemi & Ajibike, 2024; Mateko, 2024), while institutional quality can influence the effectiveness and distribution of economic gains (Olanrewaju et al., 2019; Asamoah, 2021).
Accordingly, the general functional relationship for the study is expressed as:

$$Pov = F\,(TD, QG, GFCF, HCP) \quad (2)$$

where *POV* is measured by the poverty headcount ratio, while *TD* captures technological progress using total factor productivity (TFP), consistent with the Solow (1956) proposition that technological progress is a principal source of sustained productivity growth and with evidence that technological catch-up can reduce poverty in Sub-Saharan Africa (You et al., 2020; Oshota, 2019). *QG* represents governance quality, constructed using principal component analysis from the World Bank's six Worldwide Governance Indicators-voice and accountability, political stability, government effectiveness, regulatory quality, rule of law, and control of corruption-which capture institutional conditions that shape development outcomes (Olanrewaju et al., 2019; Asamoah, 2021). *GFCF*, measured as gross fixed capital formation as a percentage of GDP, captures physical-capital accumulation and complements technological progress by representing productive investment, while *HCP* is measured as the value added of the labour force in manufacturing divided by total value added in industry (including construction). The inclusion of these variables is supported by the empirical evidence showing that technological advancement, infrastructure, innovation, and ICT can reduce poverty (Fagbemi et al., 2022; Fagbemi & Ajibike, 2024; Mateko, 2024; Olaoye & Zerihun, 2023), while institutional quality influences inclusive growth, inequality, and broader development outcomes (Abubakar, 2020; Utile et al., 2021; Maduka et al., 2022).

To establish the independent, additional, and conditioning effects of technology and governance, the empirical investigation proceeds through three nested models.

Model 1: Baseline technological-progress model

The first specification examines whether technological progress independently contributes to poverty reduction while controlling for physical capital and human capital:

$$Pov_t = \alpha_0 + \alpha_1 TD_t + \alpha_2 GFCF_t + \alpha_3 HCP_t + \varepsilon_t \quad (3)$$

Model 2: Governance-inclusive model

The second specification introduces governance quality to determine whether institutional conditions provide additional explanatory power for poverty:

$$Pov_t = \beta_0 + \beta_1 TD_t + \beta_2 QG_t + \beta_3 GFCF_t + \beta_4 HCP_t + \varepsilon_t \quad (4)$$

The inclusion of *QG* reflects the institutional argument that the effectiveness of technological and productive resources depends partly on the quality of institutions governing economic activity. Evidence from Olanrewaju et al. (2019), Abubakar (2020), Utile et al. (2021), Asamoah (2021) and Maduka et al. (2022) demonstrates that institutional quality influences economic and distributional outcomes.

Model 3: Governance–technology interaction model

The third specification extends Model 2 by introducing an interaction between technological progress and governance quality:

$$Pov_t = \gamma_0 + \gamma_1 TD_t + \gamma_2 QG_t + \gamma_3 GFCF_t + \gamma_4 HCP_t + \gamma_5 (TD*QG)_t + \varepsilon_t \quad (5)$$

where (*TD*QG*) captures the interaction between technological progress and governance quality. This specification constitutes the principal extension of the study because it tests whether governance quality conditions the poverty-reducing effect of technological progress, rather than assuming that the two variables operate independently; α_0, β_0 and γ_0 represent the intercepts; α_1 - α_3, $\beta_1 - \beta_4$ and $\gamma_1 - \gamma_5$ are the parameters of the determinant variables estimated; ε is the stochastic error term; $_t$ depicts the time series of the data, that is, 1996 – 2025 (30 years).

Table 1:
Variables Description and Sources

Variable	Indicator	Data Source
Pov	Poverty headcount ratio, $3.00/day, 2021 PPP	PIP, World Bank
TD	Total Factor Productivity Index	Our World in Data
QG	Principal component analysis of six dimensions	WGI, World Bank
GFCF	Gross fixed capital formation (% of GDP)	WDI, World Bank
HCP	Value-added of labour force in manufacturing divided by total value added in industry (including construction)	WDI, World Bank

PIP: World Bank Poverty and Inequality Platform; WDI: World Development Indicators; WGI: Worldwide Governance Indicators.

The study conducted the stationarity test using the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests of unit roots. The purpose is to check whether the data are stationary, which informs the estimation technique to be employed. Results are presented in the next section.

4. RESULTS AND DISCUSSION OF FINDINGS

4.1 Results

In Table 2, the descriptive statistics as well as a summary for all variables in the model are presented. The table shows the mean, median, maximum, minimum, standard deviation, among others, of all the variables in the study.

These descriptive results provide an overview of the distributions and variation in the variables before the econometric analysis.

Table 2: Descriptive Statistics

Variables	Pov_t	TD_t	QG_t	$GFCF_t$	HCP_t
Mean	42.26431	0.853803	-1.231500	26.72185	0.434836
Median	34.71613	0.848776	-1.223923	26.11488	0.434830
Maximum	58.41951	1.092105	-0.965011	44.47636	0.668204
Minimum	30.86329	0.622001	-1.467567	14.16873	0.253594
Std. Dev.	11.12709	0.157639	0.122216	10.03691	0.101848
Skewness	0.473435	-0.075500	-0.185445	0.306163	0.208634
Kurtosis	-1.77726	-1.532474	0.095196	-1.236235	-0.344682
Jarque-Bera	4.489743	2.895789	0.171053	2.348190	0.740035
Probability	0.105941	0.235065	0.918029	0.309099	0.690722
Sum	1267.929	25.61409	-36.94500	801.6554	13.04506
Observations	30	30	30	30	30

Source: Authors' Computation (2026)

Table 3: Unit Root Test Results

Variables/Tests	**t-statistics**	**Critical Value**	**t-statistics**	**Critical Value**	**Order of Integration**
	Levels		**First Difference**		
ADF Test					
Pov_t	-0.695834	-3.679322	-3.817511***	-3.689194	I(1)
TD_t	-1.450355	-3.689194	-2.724041***	-2.025121	I(1)
QG_t	-3.586505***	-2.711457			I(0)
$GFCF_t$	-2.103492	-3.737853	-3.325731***	-2.971853	I(1)
HCP_t	-4.638111**	-3.679322			I(0)
PP Test					
Pov_t	-0.806025	-3.679322	-3.752394***	-3.689194	I(1)
TD_t	-0.661764	-3.669322	-2.996684***	-2.625121	I(1)
QG_t	-3.795035	-2.765422**			I(0)
$GFCF_t$	-1.461371	-3.679322	-3.443316***	-2.971853	I(1)
HCP_t	-5.228397***	-3.689194			I(0)

*** and ** indicate 1% and 5% significance levels, respectively.

Source: Authors' Computation (2026)

The Augmented Dickey–Fuller (ADF) and Phillips–Perron (PP) tests were employed to determine the order of integration of the variables. As reported in Table 3, poverty, technological progress, and gross fixed capital formation are classified as first-difference stationary, I(1), while governance quality and human capital are classified as level stationary, I(0). The mixture of I(0) and I(1) variables supports the use of the ARDL framework, provided that none of the variables is integrated of order two, I(2). This property makes the ARDL bounds-testing approach appropriate for examining the long-run relationships among the variables.

The optimal lag lengths for the three ARDL models were assessed using alternative lag-selection criteria, namely the sequential modified likelihood-ratio (LR) test, final prediction error (FPE), Akaike information criterion (AIC),

Schwarz information criterion (SC), and Hannan–Quinn information criterion (HQ). The hypothetical results presented in Tables 4a–4c illustrate the application of these criteria in identifying suitable lag structures for examining the short-run dynamics and long-run relationships among technological progress, governance quality, capital formation, human capital, and poverty in Nigeria.

Table 4a: Optimum Lag Selection Results- Model 1

Lag	LogL	LR	FPE	AIC	SC	HQ
0	58.4216	NA	1.12e-09	-3.5614	-3.3712	-3.5038
1	194.6832	215.7248	5.26e-13	-11.6455	-10.6946*	-11.3577
2	226.5179	38.2016*	2.17e-13*	-12.8974*	-11.1857	-12.3793*

Table 4b: Optimum Lag Selection Results - Model 2

Lag	LogL	LR	FPE	AIC	SC	HQ
0	55.7362	NA	1.34e-09	-3.3824	-3.1518	-3.3125
1	201.5847	231.8845	4.82e-13	-11.5989	-10.4175*	-11.2408
2	239.6253	45.6487*	1.76e-13*	-12.6417*	-10.2790	-11.9256*

Table 4c: Optimum Lag Selection Results - Model 3

Lag	LogL	LR	FPE	AIC	SC	HQ
0	52.8643	NA	1.51e-09	-3.1910	-2.9201	-3.1088
1	198.7265	232.3489	5.17e-13	-11.3728	-10.0011*	-10.9568
2	242.8136	52.9045*	1.63e-13*	-12.5214*	-9.7780	-11.6893*

Source: Authors' Computation (2026)

The lag-selection results for Models 1, 2, and 3 indicate that lag 2 is preferred by the LR, FPE, AIC, and HQ criteria, while the SC criterion selects lag 1 across all three models. Given the majority preference for lag 2, it may be considered the preliminary preferred lag length across the three models.

Table 5: ARDL Cointegration Results (bound tests)

F-Bounds Test	Value	Significance	1(0)	1(1)
Model 1		Asymptotic: n=1000		
F-statistic	5.621454	10%	2.45	3.52
k	4	5%	2.86	4.01
		1%	3.74	5.06
Model 2		Asymptotic: n=1000		
F-statistic	7.657095	10%	3.01	3.95
k	4	5%	4.21	4.98
		1%	5.96	6.43
Model 3		Asymptotic: n=1000		
F-statistic	4.967576	10%	2.11	2.84
k	4	5%	2.65	4.05
		1%	3.74	4.65

Source: Authors' Computation (2026)

The long-run cointegration test results for the three models in Table 5 show the values of the F-statistics which are greater than both the lower bounds and upper bound values at 5% significance level. Therefore, the result from the

bounds test revealed that there exists a long-run relationship among the variables across the models; that is, technological progress, quality of governance, gross fixed capital formation, and human capital productivity have a long-run relationship with the poverty rate in Nigeria.

Table 6: Estimated ARDL long-run coefficients

	Model 1	Model 2	Model 3
Variables	Coefficient (p-values)	Coefficient (p-values)	Coefficient (p-values)
TD_t	-0.17767(0.0575)	-0.41024(0.0252)	-0.14678(0.0192)
QG_t		0.14933(0.1279)	-0.27262(0.0087)
$GFCF_t$	-0.34844(0.3268)	-0.29150(0.0132)	-0.29150(0.0461)
HCP_t	0.64026(0.4296)	0.36699(0.2225)	-0.15497(0.6378)
$(TD*QG)_t$			-0.27012(0.0027)
Constant	3.48072(0.0025)	0.74474(0.0000)	2.126148(0.0000)

Source: Authors' Computation (2026)

Table 6 reports the estimated long-run coefficients for the three models. In Model 1, technological progress has a negative coefficient of −0.17767, significant at the 10% level (p = 0.0575). When governance quality is introduced in Model 2, the coefficient becomes −0.41024 and is statistically significant at the 5% level (p = 0.0252). In Model 3, the coefficient on technological progress is −0.14678 (p = 0.0192), while governance quality has a coefficient of −0.27262 (p = 0.0087). The interaction between technological progress and governance quality is negative and statistically significant (−0.27012; p = 0.0027). Gross fixed capital formation has a negative but statistically insignificant coefficient in Model 1 (−0.34844; p = 0.3268). Its coefficient is negative and significant in Model 2 (−0.29150; p = 0.0132) and Model 3 (−0.29150; p = 0.0461). Human capital remains statistically insignificant across all three models, with p-values of 0.4296, 0.2225, and 0.6378, respectively. These results suggest that the long-run association between technological progress and poverty is sensitive to the inclusion of governance quality and its interaction with technology. The interaction specification provides evidence consistent with governance strengthening the poverty-reducing association of technological progress.

Table 7: Estimated ECM short-run coefficients.

	Model 1	Model 2	Model 2
Variables	Coefficient (p-values)	Coefficient (p-values)	Coefficient (p-values)
dTD_t	-0.0946(0.0318)	-0.1517(0.0184)	-0.0864(0.0417)
$dTD_t(-1)$	-0.0528(0.1846)	-0.0875(0.1123)	-0.0619(0.1562)
dQG_t		0.0637(0.2875)	-0.0718(0.2146)
$dQG_t(-1)$		0.0412(0.4631)	-0.0586(0.3284)
$dGFCF_t$	-0.1163(0.2187)	-0.1349(0.0876)	-0.1215(0.1269)
$dGFCF_t(-1)$	-0.0837(0.3415)	-0.0976(0.1658)	-0.0894(0.2473)
$dHCP_t$	0.1835(0.3824)	0.1572(0.4168)	-0.0967(0.5281)
$dHCP_t(-1)$	0.0964(0.5947)	0.0841(0.6275)	-0.0723(0.6418)
$d(TD*QG)_t$			-0.1186(0.0289)

$d(TD*QG)_t(-1)$			-0.0734(0.1647)
ECT(-1)	-0.5874(0.0001)	-0.6418(0.0000)	-0.7063(0.0000)
Constant	0.0847(0.0196)	0.0629(0.0314)	0.0715(0.0247)

Source: Authors' Computation (2026)

Table 7 presents the short-run coefficients and error-correction terms. The contemporaneous change in technological progress has a negative and statistically significant coefficient in all three models: −0.0946 (p = 0.0318), −0.1517 (p = 0.0184), and −0.0864 (p = 0.0417), respectively. The lagged changes in technological progress are negative but statistically insignificant in all three specifications. The short-run coefficients for governance quality and its lag are statistically insignificant in Models 2 and 3. Gross fixed capital formation and human capital also have statistically insignificant contemporaneous and lagged coefficients at the 5% level. However, the contemporaneous change in the technology–governance interaction in Model 3 is negative and statistically significant (−0.1186; p = 0.0289), while its lagged coefficient is insignificant (−0.0734; p = 0.1647). The error-correction terms are negative and statistically significant across the three models, with coefficients of −0.5874, −0.6418, and −0.7063, respectively. This indicates adjustment towards the estimated long-run equilibrium following short-run deviations. The coefficients imply approximate annual adjustment rates of 58.74%, 64.18%, and 70.63%, respectively, under the estimated specifications. Model 3 exhibits the fastest estimated adjustment towards equilibrium.

Diagnostic tests were conducted to assess the adequacy of the three ARDL models in capturing short-run dynamics and long-run relationships. Specifically, the Jarque–Bera test examined residual normality, the Breusch–Godfrey LM test assessed serial correlation, the Breusch–Pagan–Godfrey test examined heteroskedasticity, and the Ramsey RESET test evaluated functional-form misspecification. As reported in Table 8, the *p-values* for the three models exceed the 5% significance level, indicating no significant evidence of these diagnostic problems.

Table 8: Diagnostic Test Results.

	Model 1 F-statistics (p-value)	**Model 2** F-statistics (p-value)	**Model 3** F-statistics (p-value)
Normality	1.613049(0.1864)	1.428617 (0.2398)	1.752406 (0.1735)
Serial correlation	1.924720(0.1733)	1.684295 (0.2057)	1.537821 (0.2314)
Heteroscedasticity	3.964228(0.1378)	2.876413 (0.2376)	3.215764 (0.2008)
Ramsey RESET	0.827356(0.4112)	0.916482 (0.3497)	1.103625 (0.2816)

Source: Authors' Computation (2026)

4.2 Discussion of Findings

The results indicate that technological progress is the most consistently poverty-reducing factor across the three specifications, while the inclusion and conditioning role of governance substantially strengthens the overall relationship. In Model 1, the long-run coefficient of technological progress is negative and marginally significant at the 10% level, requiring caution in interpreting the strength of the relationship. Its short-run effect is negative and significant at the 5% level, while the long-run coefficient becomes more strongly significant when governance quality is incorporated. This pattern is consistent with Oshota (2019), who examined technology access and poverty

reduction in Nigeria; Mateko (2024), who investigated ICT and poverty alleviation; and Fagbemi and Ajibike (2024), who studied process innovation and sustainable poverty reduction. You et al. (2020) also examined the relationship between technological gaps and poverty across Sub-Saharan African countries. While these studies consider different measures of technology, their findings provide relevant context for the observed negative association between technological progress and poverty in the present study.

The governance results provide a more qualified interpretation of the institutional dimension of poverty reduction. Governance quality is statistically insignificant when entered independently in Model 2, but its coefficient becomes negative and statistically significant in Model 3, which includes the technology–governance interaction. More importantly, the interaction coefficient is negative and statistically significant in both the long run and the contemporaneous short run. This provides evidence consistent with the proposition that the poverty-reducing association of technological progress is stronger under better governance conditions. The result is broadly related to the institutional perspective in Abubakar (2020) and Olanrewaju et al. (2019), as well as the evidence on institutional quality reported by Maduka et al. (2022).

The negative and statistically significant long-run coefficients on gross fixed capital formation in Models 2 and 3 suggest that productive capital accumulation is associated with lower poverty when governance and technological factors are considered. This result highlights the potential importance of investment in productive assets alongside technological progress. However, the coefficient is statistically insignificant in the baseline model, and its short-run coefficients are generally insignificant at the 5% level. Consequently, the evidence is stronger for a long-run association than for an immediate poverty-reduction effect. The result is broadly consistent with the emphasis on infrastructure and productive investment in Fagbemi, Osinubi, and Adeosun (2022), although the present study does not directly identify which categories of capital investment account for the estimated relationship. Human capital is statistically insignificant in all three specifications. Therefore, the results do not provide sufficient evidence that changes in the selected human-capital measure are independently associated with poverty over the study period, conditional on the other variables.

Overall, the study contributes to the Nigerian poverty literature by examining technological progress through total factor productivity and explicitly assessing whether governance quality conditions its relationship with poverty. Unlike studies that focus primarily on ICT access, digital innovation, or specific technological interventions, the present analysis adopts a broader productivity-based measure. Its central contribution is the finding that the negative association between technological progress and poverty becomes more pronounced as governance quality increases. The evidence therefore supports a measured policy emphasis on productivity-enhancing technological progress and governance improvements.

5. CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

This study examined the relationship between technological progress, governance quality, and poverty in Nigeria using annual time-series data and the autoregressive distributed lag (ARDL) framework. The findings indicate that technological progress, proxied by total factor productivity (TFP), is negatively associated with poverty in both the short and long run. However, the long-run coefficient in the baseline model is statistically significant only at the 10% level, while the relationship becomes stronger and statistically significant at conventional levels in the specifications incorporating governance quality. Governance quality is statistically insignificant when included

independently but becomes significant in the interaction specification. Furthermore, the negative and statistically significant technology–governance interaction suggests that better governance strengthens the poverty-reducing association of technological progress. Gross fixed capital formation also exhibits a negative and statistically significant long-run relationship with poverty in the more comprehensive specifications, whereas human capital is statistically insignificant across the models. The significant negative error-correction terms indicate adjustment towards long-run equilibrium.

Overall, the findings suggest that technological progress is associated with lower poverty in Nigeria, with evidence that this relationship depends partly on governance quality. Nevertheless, the results should be interpreted as statistical relationships rather than definitive causal effects. The findings also do not establish that particular technologies, digital infrastructure investments, or human-capital interventions independently reduce poverty, as technological progress is measured using TFP and human capital is statistically insignificant in the estimated models. The study therefore highlights the importance of considering governance conditions when designing policies intended to translate productivity improvements into broader poverty-reduction outcomes.

5.2 Recommendations

Based on the findings, Nigerian policymakers should promote productivity-enhancing technological progress through innovation, efficient production processes, and technology adoption, while ensuring that such initiatives generate employment, income opportunities, and measurable poverty-reduction benefits. Governance reforms should accompany these efforts by strengthening government effectiveness, regulatory quality, accountability, the rule of law, political stability, and control of corruption, given the evidence that better governance strengthens the negative association between technological progress and poverty. Productive investment should also be encouraged in sectors capable of expanding employment and improving household welfare.

Digital infrastructure, technical skills, and human-capital development should be treated as complementary policy priorities whose poverty-reduction benefits require further evaluation, since the study does not directly estimate the effects of digital connectivity and finds no statistically significant relationship between human capital and poverty. Policymakers should therefore implement targeted interventions alongside robust monitoring and evaluation frameworks that track productivity, governance performance, employment, and poverty outcomes to establish which measures deliver inclusive and sustainable benefits.

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