Moderating Effect of Digitalisation on the Relationship Between Petroleum Revenue and Budget Performance in Nigeria

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ABSTRACT

Motivated by the persistent fiscal discrepancies evident in Nigeria, the ongoing inadequacies in revenue collection, along with the volatility of oil prices, have resulted in chronic budget deficits, thereby jeopardizing Nigeria's long-term fiscal viability. This research seeks to elucidate the moderating influence of digitalisation on the relationship between petroleum revenue and budget performance in Nigeria, with annual data spanning from 1981 to 2024. The study employed quantitative longitudinal research design. Key variables included petroleum revenue as independent variable, with global oil prices and government expenditure growth as controls. The Autoregressive Distributed Lag (ARDL) model was employed to analyze both short-run and long-run dynamics after unit root tests (Augmented Dickey-Fuller and Philip-Perron) confirmed a mix of stationary variables. The results revealed that petroleum revenue has a significant negative effect on budget performance in both the short and long run, aligning with the "resource curse" theory. The interaction term with petroleum revenue was positive and statistically significant. This indicates that digitalisation effectively moderates the relationship, enhancing the efficiency and transparency of revenue collection and thereby bolstering budget performance. The consistently significant negative error correction terms across all models confirmed a long-run equilibrium relationship. Government expenditure growth also demonstrated a positive and significant influence on budgetary performance, highlighting the importance of prudent spending. Robustness tests revealed that both pre-digitalization (1981–2002) and post-digitalization (2003–2024) eras significantly and positively influenced Nigeria's short-run budget performance. The study concluded that digitalisation adoption in Nigeria significantly moderates the relationship between petroleum revenue and budget performance. The study recommends that the Nigerian government should increase the current 0.5% stabilization fund to mitigate the negative effects of oil price volatility and strengthen fiscal discipline by insulating the fund from political spending pressures. Moreover, it advocates for the full implementation of the Nigeria Tax Act 2025, which promotes the digitalisation of government revenue streams to improve collection efficiency and effectiveness by agencies and institutions of the federal government of Nigeria.

Keywords: Digitalisation, petroleum revenue, budget performance, ARDL Model.

INTRODUCTION

Budget performance is crucial for Nigeria's financial management, fiscal health and economic growth, as it dictates how effectively government revenue is managed to fund public services and infrastructure (Olaoye & Akinola, 2019). Historically, Nigeria has faced challenges in revenue generation and budget performance, often resulting in a budget imbalance (deficit) where expenditure exceeds revenue (Michael et al., 2024). This deficit represents a shortfall in government finances over a specific budget period (Momodu & Monogbe,

2017). The government's capacity to generate revenue is the cornerstone of effective and efficient budget performance, underpinning public finances and macroeconomic stability (Olaoye & Alabadan, 2024).

In 2024 and 2025 fiscal year, the budget deficits of the Federal Government of Nigeria were N9.18 trillion and N13.08 trillion, which constitutes a reduction of N4.6 trillion compared to the N11.60 trillion deficit recorded in 2023. This figure represents approximately 50% of the aggregate revenue generated by the Federal Government of Nigeria, as well as 3.88% of the anticipated Gross Domestic Product (GDP). This signifies a decline of 6.11% relative to the budgeted fiscal deficit for 2023, although it remains above the 3% limit established by the Fiscal Responsibility Act of 2007 (Olusegun et al., 2024). The issue of budget deficits is of paramount importance, evidenced by the 2023 budget reflecting 3.88% of the GDP, while the total expenditure is nearly twice that of the projected revenue. The underlying factors contributing to this predicament include the nation's insufficient revenue, low levels of compliance, volatility of oil prices, crude oil production shortfalls, and a limited tax base (Felix & Elisha, 2023).

Historically, the actual revenue has typically been less than 70% of the overall budget. Similarly, the spending budget for 2024 is ₦28.78 trillion which comprising recurrent expenditure of ₦8.77 trillion and capital spending of N9.99 trillion. Expenditures have not exceeded, on average, 85% of the budgeted figure because of low revenue realization. Government fiscal outlays in Nigeria have persistently surpassed income for most years commencing in 1980, except for the years 1995 and 1996, during which the federal budget recorded a surplus (Amade & Oyigebe, 2024).

Nigeria has been positioned at 191 out of 193 nations globally, exhibiting a general government revenue constituting 7.3 percent of its Gross Domestic Product (GDP) in the year 2023, which is markedly inferior to fifty percent of the mean revenue documented among the member states of the Economic Community of West African States (ECOWAS) and approximately one-third of the average revenue noted in nations situated within Sub-Saharan Africa (SSA). The fiscal framework of Nigeria is acutely susceptible to external perturbations, given that it sustains one of the lowest revenue-to-GDP ratios on an international scale (Jung, 2023). Through the implementation of strategic revenue growth initiative, the Nigerian government aspires to augment this ratio to 15% by the year 2027, with the objectives of enhancing fiscal sustainability and diminishing dependence on fluctuating petroleum revenue sources (Kolawole, 2021). Furthermore, Nigeria's fiscal revenue has evidenced a downward trajectory, predominantly attributable to the decline in oil revenue over the preceding decade (Jung, 2023).

Petroleum revenue is central to Nigeria's fiscal health, contributing over 60% of government income and directly influencing budget performance. Fluctuations in global oil prices significantly impact fiscal stability, with price drops leading to budget deficits and reduced public project funding (EIA, 2020). Despite its importance, inefficiencies like corruption, oil theft, and poor administration hinder this revenue stream, exacerbating fiscal shortfalls and highlighting the risks of petroleum dependency for sustainable budget performance (Newiak et al., 2019; Nwuke, 2021).

International Public Sector Accounting Standard (IPSAS) 24 is fundamentally about enhancing financial transparency and accountability in public sector entities by requiring them to demonstrate compliance with their approved budgets. This standard mandate the presentation of a comparison between budgeted and actual financial amounts, along with explanations for any significant differences. IPSAS 24 is crucial because it provides a framework for evaluating fiscal discipline and the effectiveness of public financial management (Mohammed & Ibrahim, 2024).

Nigeria's budget performance is challenged by its over-reliance on volatile petroleum revenues, which were impacted by crude oil theft and pipeline vandalism, and by stagnant non-oil revenue streams (Jung, 2023). Despite substantial inflows of petroleum revenue, budget performance has been characterized by the effective execution of capital and recurrent expenditures remain hampered by manual inefficiencies, lack of transparency, and persistent fiscal deficits. Furthermore, petroleum revenue targets were surpassed in 2024, the inherent volatility of global oil prices and production challenges complicates future budgetary planning. These issues create substantial revenue shortfalls, hindering fiscal sustainability and public service funding

(Sowande, 2024). All deficiencies in the public sector must be meticulously addressed to eliminate avenues through which corruption may proliferate (Isgogo & Abdullahi, 2024).

Digitalisation is revolutionizing Nigeria's public sector by leveraging e-government frameworks to enhance revenue collection and budget performance (Awogbade, 2023). Tools like Integrated Tax Administration Systme, Treasury Single Account, and ASYCUDA streamline e-filing and payments, fostering transparency and reducing deficits through improved fiscal decision-making (Ater, 2023; Vărzaru et al., 2023). Globally, this trend accelerates post-pandemic recovery and digital economy growth (United Nations, 2024). These technologies moderate the relationship between revenue and budget performance by boosting compliance (Asomba et al., 2024). However, success depends on overcoming infrastructure gaps, digital literacy barriers, and cybersecurity risks (Ater, 2023). This investigation assessed the ramifications of petroleum revenue on the fiscal performance of Nigeria, with a particular focus on its direct effects as well as the moderating role of digitalisation. It sought to fill the existing research void regarding the contribution of digitalisation in enhancing compliance and mitigating leakages in a resource-abundant, developing economy. Through the analysis of these interrelations, the study offered empirical data concerning how digital integration functions as a conduit for bolstering fiscal sustainability and optimizing budgetary outcomes amidst the volatility of oil revenues.

Conceptual Review

A budget is a strategic financial plan for projected earnings and expenditures (CBN, 2017). In the public sector, budget performance is evaluated through the three "E's": economy, efficiency, and effectiveness (Otley, 1999). It measures how well a government achieves its fiscal goals, including revenue targets and debt sustainability. Nigeria faces challenges such as poor resource distribution and corruption, though improved transparency and accountability could foster sustainable development (Osadola et al., 2023).

Budget performance denotes the degree to which a governmental entity fulfills its financial objectives via the execution of its fiscal plan. This measure acts as a crucial gauge of economic governance, reflecting the efficiency, effectiveness, and accountability involved in the oversight of public resources (Osadume, 2020). Budget performance also known as fiscal performance refers to the effectiveness of a government's fiscal policies in achieving their intended goals (Uwaleke et al., 2024).

Modern public financial reporting, guided by the IPSAS 24 framework, mandates comparing actual versus budgeted amounts to enhance allocation and execution (Ibrahim et al., 2021; Dominic & Ubong, 2018). While performance is often proxied by GDP growth or capital expenditure, these metrics may overlook fiscal discipline (Akano & Salawu, 2024; Okoye et al., 2021). Consequently, this study adopts the budget balance-to-GDP ratio, a globally recognized indicator of fiscal health and compliance with the Fiscal Responsibility Act (A. Arif & U. Arif, 2023; Vasilev, 2023; Ehizuelen & Bassey, 2025).

The Petroleum Industry Act (PIA) 2021 defines petroleum as hydrocarbons, including crude oil and natural gas, excluding bitumen (Section 318). Beyond petroleum profit tax (PPT), hydrocarbon tax (HT) and royalty, petroleum revenue encompasses diverse income streams such as crude oil export and domestic sales. signature bonuses, rents, and dividends from NNPC Limited's equity stakes (Nyemachi & Dike, 2022; Ekiran, 2024). Crucially, export and domestic sales of crude oil remain Nigeria's largest revenue sources, funding over 70% of federal operations (Dominic, 2018; Ekiran, 2024). While studies often narrowly focus on oil revenue (Abiodun and Emmanuel, 2020; Rotimi et al., 2021; Maikano, 2022), this research utilizes a comprehensive petroleum revenue index, incorporating crude oil export, domestic sales and other non-tax oil revenue such signature bonuses and rents to capture the total fiscal impact of the sector (Nyemachi & Dike, 2022).

Digitalisation in public finance represents a comprehensive integration of ICT to revolutionize government operations and financial management. While digitisation refers to the technical conversion of analog items into digital artifacts, digitalisation describes the broader socioeconomic metamorphosis driven by the implementation and utilization of these tools (Gradillas & Thomas, 2023). In the public sector, this involves adopting technologies like Artificial Intelligence (AI), blockchain, and e-government platforms to enhance efficiency, transparency, and citizen engagement (Gavrilă, 2024; Gherghin, 2025). Digital transformation

further signifies a revolutionary shift in how institutions capitalize on these technologies to provide enriched value and ignite innovation (Ikwuanusi et al., 2024; Setyawan et al., 2024).

The evolution of digital governance, a global policy priority, aims to optimize revenue collection and maximize revenue generation (United Nations, 2024; World Bank, 2016). In Nigeria, the telecommunications sector transitioned from government monopolies like Nigerian Telecommunications Limited (NITEL - 1980) to a liberalized market regulated by the Nigerian Communications Commission (NCC - 2003) (Eke et al., 2019; Anie, 2011). This shift improved infrastructure and teledensity, the number of phone connections per 100 residents, which serves as a critical measure of ICT connectedness (World Bank, 2023; Ndam et al., 2023). The E-Government Development Index showcases the status of E-Government Development among United Nations Member States, including Nigeria (United Nations, 2022). The concept of EGDI was introduced by the United Nations in 2001 to measure the development of e-government globally. Nigeria began to recognize the importance of ICT for governance during this period, leading to the establishment of the National Information Technology Development Agency (NITDA) in 2001 (Ishola, Abdulkareem & Omolabi, 2020).

To modernize fiscal operations, Nigeria implemented several digital platforms. Key initiatives include the Treasury Single Account (TSA - 2015) and e-Collection scheme for consolidated revenue oversight, and the Government Integrated Financial Management Information System (GIFMIS -2003) for automated resource allocation. Other essential tools include the Integrated Payroll and Personnel Information System (IPPIS - 2007) for manpower planning, TaxPro-Max (in 2021) and Integrated Tax Administration System (ITAS - 2017) for electronic tax filing, and Automated Systems for Customs Data (ASYCUDA - 2000) for customs data automation (Ater, 2023; Oloyede, 2022). Furthermore, the Nigeria Open Contracting Portal (NOCOPO - 2018) enhances transparency in public procurement.

The E-Government Development Index (EGDI), introduced by the United Nations in 2001, serves as a global benchmark measuring national commitment to utilizing ICT for citizen welfare (United Nations, 2022). Following its inception, Nigeria established the National Information Technology Development Agency (NITDA) in 2001 to spearhead related policies (Ishola et al., 2020). Nigeria EDGI scoring commence in 2003. The EGDI is a composite measure comprising the online services index (OSI), telecommunications infrastructure index (TII), and human capital index (HCI) (United Nations, 2024).

While studies proxied digitalization via digital literacy (Omotayo et al., 2025), hardware penetration (Okere et al., 2024), teledensity (Ndam et al., 2023; Usman & Mazadu, 2021), online payments (Akinyosoye et al., 2025), or electronic tax reporting (Adefulu et al., 2024), this research utilized the EGDI and Telecommunication Density (TELD). These metrics collectively evaluate infrastructure, human skills, and service inclusivity, reflecting Nigeria's capacity to foster a digital community through robust networks and accessible platforms (United Nations, 2024; Ishola et al., 2020).

Empirical Review

Nigeria's budget performance is characterized by a duality of structural potential and persistent gaps, often falling below international credibility benchmarks (Osadola et al., 2023; Nwaorgu & Alozie, 2017). Sub-Saharan trends reflect deteriorating fiscal balances and an increasing reliance on high-cost borrowing (Emenike & Edirin, 2017). Sule and Mulyanto (2024) used a survey approach to highlight persistent budget underperformance exacerbated by oil theft and debt. Utilizing multiple regression (1981–2016), Okoye et al. (2021) found significant links between oil revenue, government expenditure, and GDP. Conversely, Babatayo and Audu (2023) employed an ex-post facto design (2005–2018), discovering that illicit financial flows negatively impacted oil revenue but positively affected non-oil sectors.

Analyzing 2000–2019 data via ordinary least square regression, Maikano (2022) identified significant positive relationships between total revenue components and GDP. Ebimobowei (2022) utilized ex-post facto methods and multiple regression, finding that while petroleum profit taxes positively influenced growth, crude oil exports and domestic sales exhibited significant negative or insignificant relationship.

Methodological variations significantly influence findings. Ebieri (2022) applied the ARDL Bounds test (1986–2018), revealing that while aggregate revenue substantially impacts performance, individual oil and non-oil revenues often show insignificant long-term effects. This aligns with Rotimi et al. (2021), whose regression results indicated that non-oil revenue promotes growth while oil revenue hinders it. Finally, Oti et al. (2016) utilized Johansen Co-integration and Granger Causality, confirming long-term balances between diverse revenue streams and economic development. Collectively, these studies emphasize the need for diversification and robust fiscal reforms to mitigate oil-dependency risks and enhance budgetary endurance.

Recent studies highlight e-governance as a critical driver of public sector efficiency. Omotayo et al. (2025) found that digital literacy and network coverage significantly enhance public service delivery in Nigeria. Similarly, Temba (2025) demonstrated that e-governance markedly improves service efficiency and transparency by reducing paper-based errors. While Nigeria's digital trajectory is upward, it remains below global benchmarks due to persistent implementation challenges (Nwokoroeze et al., 2025). Digitalisation optimizes revenue collection and allocation, directly influencing budget performance. Consequently, this research investigates the moderating effect of digitalisation on the relationship between petroleum revenue and budget performance to provide insights into how digital tools enhance fiscal management and accountability in Nigeria (Omotayo et al., 2025; Temba, 2025)

Theoretical Review

Technology Acceptance Model (TAM)

The Technology Acceptance Model (TAM), created by Fred Davis in 1989, serves as a theoretical framework that elucidates how individuals begin to accept and utilize technology, and it establishes a basis for comprehending the adoption of e-government systems (Asomba et al., 2024). TAM is a premier framework for predicting how users embrace information systems (Asomba et al., 2024; Emeh et al., 2023). TAM posits that technology adoption is primarily driven by perceived usefulness (PU) which is the belief that a system enhances performance and perceived ease of use (PEOU) the expectation of minimal effort (Davis, 1989; Zhao et al., 2024).

TAM explains how digitalisation (e.g., ASYCUDA, automated tax systems) improves revenue collection and budget performance. Studies show that when taxpayers and agencies perceive digital tools as beneficial and user-friendly, compliance increases and tax evasion decreases (Kaliky et al., 2024; Umar et al., 2023). High PU and PEOU foster widespread adoption, leading to greater transparency, reduced leakages, and enhanced fiscal discipline (Babatunde & Remilekun, 2024). The integration of digital taxation models can significantly modernize Nigeria's tax administration, improving efficiency and compliance while reducing corruption risks in fiscal management (Okeke et al., 2023). Ultimately, TAM links digitalisation to fiscal strength by demonstrating that accessible, effective tools (measured via the EGDI) optimize revenue generation and public financial management (Sepasgozar et al., 2020; Umar et al., 2023).

Resource Curse Theory

The Resource Curse Theory, initially coined by Richard Auty in 1993, describes the paradox where countries with abundant natural resources, especially non-renewable resources like oil, tend to experience slower economic growth and weaker development outcomes compared to resource-poor countries. The theory highlights how resource wealth can lead to economic distortions, governance challenges, and institutional weaknesses, undermining sustainable development (Auty, 1993). In Nigeria, the relevance of the Resource Curse Theory is pronounced due to its heavy reliance on petroleum revenue, which constitutes a major portion of government income and export earnings. Despite the vast oil wealth, Nigeria has faced persistent economic challenges such as poverty, corruption, political instability, and poor budget performance ((Chairul et al., 2025; Idemudia, 2014).

The theory explains Nigeria's fiscal and economic difficulties by emphasizing how petroleum revenue encourages rent-seeking behaviour, weakens institutions, and causes macroeconomic volatility, hindering effective public financial management and budget execution (Ologunla et al., 2014). The Resource Curse

Theory provides a critical lens to analyze how Nigeria's budget performance is influenced by petroleum revenue, emphasizing the role of governance frameworks in translating resource wealth into sustainable fiscal and economic outcomes.

Gaps in Literature

A multitude of empirical studies have produced varied results, for instance, Muhammad (2025) and Maikano (2022) find positive relationship between petroleum revenue and growth, Ebimobowei (2022) and Ebieri (2022) report negative or insignificant long-term effects. Regression analyses (Okoye et al., 2021) and ex-post facto designs (Babatayo & Audu, 2023; Ebimobowei, 2022) show inconsistent impacts of oil and non-oil revenues on growth, providing conflicting results based on methodological variations. Although ARDL and co-integration methods (Ebieri, 2022; Oti et al., 2016) highlight long-term fiscal balances, most literature overlooks the specific moderating role of digitalisation in the petroleum revenue and budget nexus. Despite emerging evidence that e-governance improves efficiency and transparency (Omotayo et al., 2025; Temba, 2025), implementation challenges persist (Nwokoroeze et al., 2025). This study addresses the gap by investigating how digitalisation moderates the relationship between petroleum revenue and budget performance to enhance fiscal accountability and management in Nigeria.

METHODOLOGY

This investigation employed a quantitative longitudinal methodology (Muhammad, 2025; Okoroigwe et al., 2023; Craig et al., 2020) to scrutinize fiscal data pertaining to Nigeria from the years 1981 to 2024. In accordance with the works of Oladejo (2024) and Okegbe and Osisioma (2019), the entire demographic was engaged without the application of sampling techniques. The utilization of secondary data sourced from the Central Bank of Nigeria statistical bulletins, World Bank World Development Indicators for telecommunication density and United Nations E-Government Development Index, and Organization of Petroleum Exporting Countries (OPEC) enabled both descriptive and inferential statistical analyses.

The research covered a period of 44 years combining the pre E-Government Development index (1981-2002) to capture telecommunication infrastructure, development, contributions, using overall average of telecommunication density, measure as number of telephones connections per 100 inhabitants in Nigeria, both mobile and fixed line telephone subscribers (treated as a theoretical construct that captured foundational technological preparedness), and the EGDI era (2003-2024), to assess the progress in using digital technologies to deliver public services in Nigeria, measure as the overall average of EGDI values of online services index, telecommunications infrastructure index, and human capital index. This approach allows for a comprehensive analysis of how advancements in telecommunications infrastructure and e-governance initiatives interact to influence budgetary outcomes.

Employing EViews 12, the Autoregressive Distributed Lag (ARDL) methodology estimated both short-run and long-run relationships amidst a backdrop of mixed-order stationarity (Kripfganz & Schneider, 2023; Kolawole, 2023), while Principal Component Analysis facilitated the derivation of petroleum revenue index, thereby ensuring a robust econometric evaluation of Nigeria's fiscal performance. A robust test was further conducted by undertaken comparative analysis using ARDL to examine pre digitalisation telecommunication development era (1981-2002) and EGDI era (2003-2024).

Table 1.1 Summary of Variables, Acronyms, Measurements, and Sources

Variable	Symbol	Description & Measurement	Source
Budget	BP	Measured as overall budget balance (deficit) expressed as percentage of Gross Domestic Product (GDP) over time	Ehizuelen & Bassy (2025)
Petroleum Revenue	PR	Measured as absolute value of annual petroleum revenue for the period	Ebimobowei (2022)
Digitalisation	DIG	Measured as the E-Government Development Index and World Development Indicators	Kotenok et al. (2020); Usman & Mazadu

		Telecommunication Density in Nigeria	(2021)
Global Oil Price	GOP	Measured as log of oil price (OPEC Reference Basket) for the period	Muhammad (2025)
Government Expenditure	GE	Measured as log of government expenditure as percentage of GDP in Nigeria for the period	Gombe et al. (2024)

Source: Author's Compilation, 2026

Model Specifications

The study employed the ARDL multiple regression model to analyze the relationship between petroleum revenue and budget performance. ARDL provides valid estimation irrespective of mixed integration order up to I(1) (Umaru, Aliero & Abubakar, 2021) and allows for examining temporal effects using a contemporary framework (Aboudi, Allam & Bakkouchi, 2023).

The generalized ARDL (p, q) model is specified as:

$$\mathbf{Y}_t = g_{0i} + \sum_{i=1}^{p} d_i \, \mathbf{Y}_{t-i} + \sum_{i=1}^{q} b'_i \mathbf{X}_{t-i} + \mathbf{e}_t \quad \text{..... (1)}$$

Where Y'_t is a vector and the variable in (X'_t) are allowed to be purely I(0) or I(1) or cointegrated; d and b are the coefficients; γ is the constant; i =1..k; p, q are optimal lag orders; ε_t is a vector of the error terms – unobserved zero mean white noise vector process (serial uncorrelated or independent).

Model 1: The effect of petroleum revenue on budget performance in Nigeria.

$$BP_t = \beta_0 + \beta_1 PRI_t + \beta_2 lnGOP_t + \beta_3 lnInGE_t + \varepsilon_t \text{ ----------(2)}$$

Where:

BP = Budget performance proxied as Budget balances (% GDP)

β_0 = The constant term represents the expected value of the budget deficit when all independent variables are zero.

PRI = Petroleum revenue index

lnGOP = Natural log of global oil price.

lnGE = Natural log of government expenditure growth (%GDP)

$\beta_{1-3,}$ = The coefficients of direct relationship that represent the impact of each petroleum revenue and control variable on the budget performance

ε_t = Error term.

Equation 2 isolated the long-run impact of petroleum revenue (PRI) on budget performance. It measured how these resource-based drivers, alongside government spending, determined Nigeria's fiscal balance and structural stability.

The ARDL model is specified as follows:

$$\Delta BP_t = \beta_0 + \sum_{t=1}^{p} \phi i \, \Delta BP_{t-i} + \sum_{t=1}^{q} \alpha_1 \Delta PRI_{t-i} + \sum_{t=1}^{q} \alpha_2 \Delta lnGOP_{t-i} + \sum_{t=1}^{q} \alpha_3 \Delta lnGE_{t-i} + \beta_1 BP_{t-1} + \beta_2 PRI_{t-1} + \beta_3 lnGOP_{t-1} + \beta_4 lnGE_{t-1} + \varepsilon_t \text{ ----------} \quad (3)$$

Cointegration was established, therefore, the Error Correction Model (ECM) model for BP_t was estimated as:

$$\Delta BP_t = \beta_0 + \sum_{t=1}^{p} \phi_1 \Delta BP_{t-i} + \sum_{t=1}^{q} \alpha_1 \Delta PRI_{t-i} + \sum_{t=1}^{q} \alpha_2 \Delta lnGOP_{t-I} + \sum_{t=1}^{q} \alpha_3 \Delta lnGE_{t-I} + lECT_{t-1} + \varepsilon_t \text{ ----------} \quad (4)$$

Where:

p = lag is the lag length associated with the dependent variable

q = lags are the lags length associated with the exogenous variables

t=1 = are the optimal lag orders.

t-1 = are the lag values.

ϕ, α = short term dynamics. Captures the shock and instability of the oil market.

β = long term dynamics. Captures the structural dependency of Nigeria on oil.

p = the maximum number of lags for independent variable in the study. It represents fiscal inertia. The parameter p tells us how many previous periods of Budget Performance (BP_{t-1}, $BP_{t-2,}$ …) affect the current budget performance. This year's budget deficit is often a direct consequence of last year's commitments, debts, or surplus. If p=1, it means the budget performance from just one year ago is a significant predictor of today's balance

q=The lag of the independent and control variables (PRI, GOP and GE). It represents the transmission delay (or time lag). The parameter q tells us how many previous periods of the petroleum revenue, global oil price, and expenditure growth affect the current budget. When the global oil price (lnGOP) drops today, the Nigerian budget might not feel the full impact immediately. There might be a delay due to existing oil contracts, foreign reserve buffers and administrative delays in revenue collection. The lag length for p, q, may not necessarily be the same.

ε_t = Error term.

Δ = is the difference operator (compute the difference between consecutive observations). Useful to transform non-stationary data into stationary data. Long run models do not have a difference operator, only the short run model.

λ = $(1 - \sum_{i=1}^{p} d_i)$, speed of adjustment (speed limit of the recovery)
parameter back to equilibrium, with a negative sign and statistically significant. Tells us how resilient the Nigerian fiscal system is in returning to normal after a crisis.

ECT_{t-1} = $(BP_{t-I} - \theta X_t)$, the error correction term which is the extracted residuals from the regressions of the long-run equation. This is the most critical partof the model. It represents the gap or error from the previous period. The ECT calculates how much of that gap needs to be closed

θ = $\sum_{i=0}^{q} b_i$, is the long-run parameters

a

The model was designed to elucidate the immediate responses of the budget to shocks (short-run dynamics) engendered by fluctuations in petroleum revenues. Notwithstanding the daily variances, there existed a consistent equilibrium relationship between oil revenue and the budget that remained valid over extended periods (long-run dynamics).

Model 2: The moderating effect of digitalisation on the relationship between petroleum revenue and budget performance in Nigeria.

$BP_t = \beta_0 + \beta_1 PRI_t + \beta_2 DIG_t + \beta_3 PRI_t * DIG_t + \beta_4 lnGE_t + \varepsilon_t$ ---------- (5)

Where: All variables are as previously defined except

DIG = Digitalisation index

PRI*DIG = Interaction between petroleum revenue and digitalisation.

Equation 5 introduced an interaction term (PRI*DIG) to examine the moderating effect of digitalization on petroleum revenue. It intended to determine if digital technology enhanced revenue collection efficiency and reduced leakages, thereby strengthening oil's overall impact on budget performance.

The ARDL model is specified as follows:

$$\Delta BP_t = \beta_0 + \sum_{t=1}^{p} \phi i\, \Delta BP_{t-i} + \sum_{t=1}^{q} \alpha_1 \Delta PRI_{t-i} + \sum_{t=1}^{q} \alpha_2 \Delta DIG_{t-i} + \sum_{t=1}^{q} \alpha_3 \Delta PRI_{t-i} * DIG_{t-i} + \sum_{t=1}^{q} \alpha_4 \Delta \ln GE_{t-i} + \beta_1 BP_{t-1} + \beta_2 PRI_{t-1} + \beta_3 DIG_{t-1} + \beta_4 PRI_t * DIG_{t-i} + \beta_5 \ln GE_{t-1} + \varepsilon_t \quad \text{---- (6)}$$

Where: All variables are as previously defined.

Cointegration was established, the Error Correction Model (ECM) model for BP_t is therefore estimated as follows:

$$\Delta BP_t = \beta_0 + \sum_{t=1}^{p} \phi_1 \Delta BP_{t-i} + \sum_{t=1}^{q} \alpha_1 \Delta PRI_{t-i} + \sum_{t=1}^{q} \alpha_2 \Delta DIG_{t-i} + \sum_{t=1}^{q} \alpha_3 \Delta PRI_{t-i} * DIG_{t-i} + \sum_{t=1}^{q} \alpha_4 \Delta \ln GE_{t-i} + lECT_{t-1} + \varepsilon_t \quad \text{----------(7)}$$

Where: All variables are as previously defined.

Equation 7 used an ECM to measure how quickly digitalization and petroleum revenue interactions corrected budget imbalances. It aimed to reconcile short-run technological shocks with long-term fiscal stability using the Error Correction Term.

RESULTS AND DISCUSSIONS

Descriptive Statistics

Raw data was utilized for descriptive statistics to ensured precision, facilitated outlier identification, and provided a rigorous foundation for econometric modeling (Asuquo, 2021; Montgomery & Runger, 2018). Descriptive statistics in table 1.2 revealed a mean budget balance (BP) of 2.71%, staying within the 3% Fiscal Responsibility Act limit despite non-compliant peaks of 8.57%. BP follows a near-normal distribution with positive skewness and a leptokurtic kurtosis (3.7576).

Table 1.2 Descriptive Statistics

Variable	Mean	Median	Max	Min	Std. Dev.	Skewness	Kurtosis	Jarque - Bera	Probability	Obs.
BP	2.7098	2.6136	8.5696	0.0322	1.8733	0.7844	3.7576	5.5646	0.0618	44
PR	1366.5	1067.4	4902.7	2.2400	1354.8	0.6829	2.3870	4.1095	0.1281	44
DIG	0.2567	0.2580	0.8684	0.0979	0.1369	2.1158	10.133	126.11	0.000	44
GOP	45.804	35.310	109.45	12.280	30.255	0.7514	2.2706	5.1161	0.0774	44
GE	8.3114	8.0117	17.286	5.0893	2.4816	1.5935	6.1894	37.273	0.0000	44

Source: Researcher Computation Using Eviews12 Output, 2026.

Petroleum revenue (PR) and volatile global oil prices (GOP) show high positive skewness, driving erratic government expenditure (GE) (mean: 8.3114, kurtosis: 6.1894). Digitalisation (DIG) exhibits sporadic growth, with a mean (0.2567) near its median, but severe non-normality (kurtosis: 10.133; p = 0.000). This suggests digital adoption in Nigeria occurs in policy-driven bursts rather than gradual, widespread implementation, potentially limiting consistent fiscal benefits.

Principal Component Analysis

Principal component analysis (PCA) was employed to construct a robust petroleum revenue composite index, mitigating multicollinearity and resolving proxy inconsistencies (Adedokun & Ukafor, 2024; Otekunrin et al., 2023). PCA transformed heterogeneous revenue streams into orthogonal components, with the first two factors accounting for over 90% of total variance.

Table 1.3 Principal Component Analysis of Petroleum Revenue Components

Component	Eigenvalues	Difference	Proportion	Cumulative Value	Cumulative Proportion
Included Observations	44				
COGE	1.675785	0.637559	0.5586	1.675785	0.5586
DSCOG	1.038225	0.752235	0.3461	2.714010	0.9047
ONTOR	0.285990	----------	0.0953	3.000000	1.0000

Source: Researcher Computation Using Eviews12 Output, 2026.

Component 1 (crude oil/gas exports) explains the largest share of variance, while Component 2 (domestic sales) provides the next significant contribution, followed by the third component (other non-tax oil revenues). The resulting index provides a more reliable indicator for fiscal analysis by capturing the maximum common variance of Nigeria's oil revenues (Ramesh et al., 2025; Ebimobowei, 2022). This dimensionality reduction ensures a concise representation of the major drivers of Nigeria's fiscal position.

Correlation Analysis

The pairwise correlation matrix served as a diagnostic tool to identify multicollinearity and examine variable interactions (Kyriazos & Poga, 2023). Results in Table 1.4 reveal that petroleum revenue (PR) has a significant negative correlation with budget performance (BP) (-0.390), suggesting that oil windfalls often worsen fiscal gaps when debt servicing is prioritized (Azu & Agbobu, 2023). In contrast, government expenditure (lnGE) correlates positively with BP (0.400), supporting the "spend-and-revenue" hypothesis where rising expenditures widen deficits (Kaka, 2020). Digitalisation (DIG) shows weak correlations with fiscal indicators, reflecting persistent infrastructural hurdles (NCC, 2024). Crucially, the matrix confirms no significant multicollinearity issues, ensuring the regression model's predictive integrity.

Table 1.4 Correlation Analysis of Petroleum Revenue and Budget Performance in Nigeria

Variable	BP	PRI	DIG	lnGOP	lnGE
BP	1.000				
PRI	-0.390	1.000			
DIG	-0.020	0.368	1.000		
lnGOP	-0.260	0.814	0.438	1.000	
lnGE	0.400	-0.460	-0.220	-0.640	1.000

Source: Researcher Computation Using Eviews12 Output, 2026.

Pre-test Analysis of the Data

In analysis involving time series data, it is imperative to examine this property of series. Assumptions such as stationarity, nonstationary, optimal lag length selection, and cointegration were tested to ensure unbiased regression analysis. The following subsections discuss the application of these tests in this study.

Stationarity Test

The unit root tests were utilized to evaluate the integration level of the variables in the models. To ensure the reliability of the time-series analysis, stationarity was evaluated using the Augmented Dickey-Fuller (ADF)

and Phillips-Perron (PP) tests, addressing the limitations of single-testing approaches (Adedokun & Ukafor, 2024). Stationarity means a series' statistical properties remain constant over time (Adedokun & Ukafor, 2024). The Augmented Dickey-Fuller (ADF) test uses parametric autoregression for errors, while the Phillips-Perron (PP) test uses a non-parametric method to address serial correlation and heteroscedasticity differently. Using both tests ensures robustness. Evaluating both intercept and trend and intercept-only specifications, the results show that budget performance (BP) and digitalisation (DIG) are stationary at its level, while petroleum revenue, global oil prices, and government expenditure are stationary at their first difference, with PP test results aligning with ADF findings (Table 1.5).

The unit root test conducted above indicates that some of the variables are stationary I(0) while some variables are not stationary I(1). Hence, the Autoregressive Distributed Lag (ARDL) bounds test is employed, which allows for the combination of stationary and non-stationary series.

Table 1.5 Stationarity test using Augmented Dickey-Fuller (ADF) and Philip Perron (PP)Unit Root Test

Augmented Dickey-Fuller (ADF)						
	Level			First Difference		
Variables	t-statistic	Critical Value	I(d)	t-statistic	Critical Value	I(d)
BP	-3.285[a]	-2.931[**]	I(0)	----------	----------	--------
PRI	--------	----------	--------	-6.681[b]	-4.198[***]	I(1)
DIG	-5.654[a]	-4.186[***]	I(0)	----------	----------	--------
lnGOP	--------	----------	--------	-5.633[b]	-4.198[***]	I(1)
lnGE	--------	----------	--------	-9.375[b]	-4.192[***]	I(1)
Philip Perron (PP)						
BP	-3.273[a]	-2.931[**]	I(0)	----------	----------	------
PRI	--------	----------	-------	-8.216[b]	-4.192[***]	I(1)
DIG	-5.654[a]	-4.186[***]	I(0)	---------	----------	------
lnGOP	--------	----------	-------	-6.313[b]	-4.192[***]	I(1)
lnGE	--------	----------	-------	-9.367[b]	-4.192[***]	I(1)

Note: The [a] indicates constant without deterministic trend; [b] is the model with constant and deterministic trend as exogenous lags are selected based on Schwarz info criteria. *, **, *** imply that the series is stationary at 10%, 5%, and 1% respectively. ADF and PP denote Augmented Dickey-Fuller and Phillip-Perron Unit Root tests. Source: Researcher Computation Using Eviews12 Output, 2026.

Optimal Lag Length Selection

Lag values are included to allow the researcher to capture how pass revenue influences the current budget balances. The choice of an optimal lag for a model is an empirical issue, which is resolved using some criterion. The unrestricted VAR (Vector Autoregression) was used to assume that the variables are not cointegrated. Information Criterion was used to determine the optimal lag structure for each model. It helps to evaluate the goodness of fit of a model while penalizing for the number of parameters included. The incorporation of lag is essential in addressing autocorrelation to establish an accurate functional representation of an equation.

The general guideline is to select the criterion exhibiting the minimal value accompanied by an asterisk across each model (referred to appendix 1). The automatic lag selection along with Akaike information criterion was used as optimal lag for the model with lag length 1. This was to ensure best model fit, consistency, statistical and robust results.

ARDL Bounds Test

The ARDL bounds testing methodology (Pesaran and Shin, 1998; Pesaran, Shin and Smith, 2001) determines

if a long-run relationship (cointegration) exists among variables (Oladipupo, 2023). Cointegration means variables, despite short-term divergence, converge back to a long-run equilibrium over time.

Table 1.6 ARDL Bounds Cointegration Test Results

	Models				
Model	*F*-Stat.	Lower Bound I(0) at 5%	Upper Bound I(1) at 5%	Cointegration	Remark
1	4.71	3.23**	4.35**	Yes	ECM
2	5.85	4.4***	5.72***	Yes	ECM

Note: *, ** and *** imply cointegration at 10%, 5% and 1* level of significance, respectively. *Researcher Computation Using Eviews12 Output, 2026.*

The co-integration bounds test result for the Model (Table 1.6) show that the statistical values exceed the I(1) critical bound at the 5% level of significance. This outcome confirms the existence of a long-run relationship among the variables. Consequently, the study proceeds to analyze both the short-run dynamics and long-run relationships using the Autoregressive Distributed Lag (ARDL) approach and the Error Correction Model (ECM).

Regression Results

This section presents the ARDL analyses of the variables used in the regression analyses.

Effect of Petroleum Revenue on Budget Performance in Nigeria

Long-run ARDL results (Table 1.7) demonstrate that petroleum revenue significantly impairs budget performance (coefficient: -1.763), validating the "resource curse" theory in Nigeria (Chairul et al., 2025; Usman et al., 2024). Conversely, global oil prices and government expenditure growth show significant positive relationships with fiscal gaps, as rising spending correlates with persistent deficits (Umaru et al., 2021).

Short-run dynamics reveal a significant error correction term (-0.427), indicating a 42.7% annual adjustment toward equilibrium (Bawa et al., 2025). The model is statistically robust, with an Adjusted R-squared of 0.657 and an F-statistic of 12.502. Diagnostic tests (Durbin-Watson, LM, ARCH, and Ramsey RESET) confirm the absence of serial correlation, heteroscedasticity, or misspecification. Consequently, the null hypothesis is rejected, affirming petroleum revenue's significant impact on Nigeria's budget performance.

Table 1.7 Regression Analysis: ARDL long run and short run results for model 1: BP=F(PRI, lnGOP, lnGE) – (1,1,1,1)

Estimated ARDL Long Run Results					
Variable	Coefficient (β)	Std. Error	t-Statistics	p-value	VIF
PRI	-1.763	0.642	-2.746	0.009	NA
lnGOP	4.812	1.645	2.925	0.006	NA
lnGE	7.680	2.264	2.778	0.008	NA
Estimated ARDL Short Run Results					
Variable	Coefficient (β)	Std. Error	t-Statistics	p-Value	VIF
Constant	-13.041	4.170	-3.126	0.003	NA
BP(-1)*	-0.427	0.116	-3.670	0.000	1.64
PRI(-1)	-0.754	0.311	-2.425	0.020	5.16
lnGOP(-1)	2.059	0.674	3.054	0.004	9.23
lnGE(-1)	3.286	1.092	3.008	0.004	2.80

D(PRI)	0.152	0.293	0.519	0.606	5.24
D((lnGOP)	-1.400	0.772	-1.812	0.078	9.88
D(lnGE)	5.620	1.023	5.492	0.000	2.70
CointEq(-1)	-0.427829	0.094	-4.523	0.000	NA
Mean VIF					5.83

R-squared	0.714
Adjusted R-squared	0.657
Durbin Watson Stat	1.981
F-Statistic	12.50
Prob(F-statistic)	0.000

Diagnostics tests

Tests:	F-Statistics	P-value	Decision (H_0)
B-G LM test	0.241	0.626	Accept
B.P.G Test	1.218	0.319	Accept
ARCH test	1.937	0.171	Accept
J-B test	0.198	0.905	Accept
RESET test	1.524	0.225	Accept
CUSUM	----------	----------	Stable
CUSUMSQ	----------	----------	Stable

Note: The test includes only constant and is at 5% level of significance. * p-value incompatible with t-bounds distribution () ** variables interpret as Z = Z(-1) + D(Z) – this indicates a dynamic regressor with an optimal lag of zero, as such Eviews does not include lags and difference of such variables but estimates them contemporaneously. Source: Researcher Computation Using Eviews12 Output, 2026.

Moderating Effect of Digitalisation on the Relationship between Petroleum Revenue and Budget Performance in Nigeria.

Long-run ARDL results for Model 2 reveal that petroleum revenue (PRI) significantly impairs budget performance (coefficient = -4.085, p = 0.049), while government expenditure (lnGE) exerts a positive influence (4.436, p = 0.025). Although digitalisation (DIG) alone is insignificant, its interaction with petroleum revenue (PRI*DIG) is positive and significant (12.284, p=0.06), confirming its role as a crucial moderator that mitigates "resource curse" effects by improving transparency and reducing leakages. The findings align with Memon et al. (2019) on assessing moderation, where the significant interaction term confirms a moderating effect. This also aligns with a growing body of literature on the potential of e-governance and digital public financial management to enhance transparency, accountability, and revenue mobilization in developing countries, including Nigeria, by streamlining processes and reducing opportunities for corruption, as discussed by Omotayo et al. (2025), Temba (2025) and Asomba et al. (2024).

Table 1.8 Regression analysis: Estimated ARDL long run and short run results for model 2: BP=F(PRI, DIG, PRI*DIG lnGE) – (1,0,0,0,0)

Estimated ARDL Long Run Results				
Variable	Coefficient (β)	Std. Error	t-Statistics	p-Value
PRI	-4.085	2.741	-2.345	0.024
DIG	4.243	4.743	0.894	0.377
PRI*DIG	12.284	6.370	1.928	0.061
lnGE	4.436	1.609	2.756	0.009
Estimated ARDL Short Run Results				
Variable	Coefficient (β)	Std. Error	t-Statistics	p-Value

Constant	-7.073	2.572	-2.749	0.009
Trend	0.077	0.030	2.544	0.015
BP(-1)*	-0.644	0.131	-4.912	0.000
PRI**	-2.631	1.173	-2.242	0.031
DIG**	2.732	3.101	0.881	0.384
PRI*DIG**	7.911	4.199	1.884	0.067
lnGE**	2.857	0.965	2.959	0.005
CointEq(-1)	-0.644070	0.112	-5.703	0.000

R-squared	0.534
Adjusted R-squared	0.457
Durbin Watson Stat	1.858
F-Statistic	6.892
Prob(F-statistic)	0.000

Diagnostics tests:

Tests:	F-Statistics	P-value	Decision (H_0)
B-G LM test	0.057	0.812	Accept
B.P.G Test	1.320	0.273	Accept
ARCH test	0.067	0.795	Accept
J-B test	1.694	0.428	Accept
RESET test	0.034	0.854	Accept
CUSUM	----------	----------	Stable
CUSUMSQ	----------	----------	Stable

Note: The test includes both constant and trend and all are at 5% level of significance. * p-value incompatible with t-bounds distribution () ** variables interpret as Z = Z(-1) + D(Z) – this indicates a dynamic regressor with an optimal lag of zero, as such Eviews does not include lags and difference of such variables but estimates them contemporaneously. Source: Researcher Computation Using Eviews12 Output, 2026.

Short-run dynamics mirror these findings, with a highly significant error correction term (-0.644, p=0.000) indicating that 64.4% of fiscal disequilibrium is corrected annually toward long-run stability. The positive interaction term (7.911, p = 0.067) remains consistent with literature highlighting digitalisation's capacity to stabilize fiscal management in resource-rich nations (Chime, 2022). Robustness is confirmed by an Adjusted R-squared of 45.7%, an F-statistic of 6.892 (p = 0.000), and diagnostic tests (CUSUM, ARCH, and Ramsey RESET) showing no serial correlation or instability. The adjusted R^2 of 45.7% indicated a moderate fit, suggesting that unobserved factors such as public debt ratio, institutional corruption, political instability, and inflation accounted for the remaining variance. Consequently, the null hypothesis is rejected, affirming that digitalisation significantly moderates the relationship between petroleum revenue and budget performance in Nigeria.

SUMMARY OF FINDINGS

Models 1 and 2 revealed that petroleum revenue exerted significant negative effects on budget performance, confirming a "resource curse" where oil dependency undermined long-run fiscal stability. Conversely, global oil prices and government expenditure growth demonstrated significant positive impacts. While digitalization's direct effect was statistically insignificant, its interaction with petroleum revenue was significantly positive, suggesting it mitigated oil-related volatility. Short-run dynamics mirrored these results, with highly significant error correction terms (-0.427) confirming stable long-run equilibria and rapid adjustment speeds following fiscal shocks. Ultimately, the findings indicated that while oil revenues posed structural challenges, digitalization and strategic spending offered pathways to enhanced budget performance.

Robustness Test

Robustness test was conducted through comparative ARDL regressions of ICT and EGDI interaction models

across 44 years (1981–2024). This approach addressed time-series dependence by separately analyzing two 22-year development eras (Ajaero et al., 2025; Ramadhan & Purnomo, 2024).

ICT Development Index (1981 – 2002): Pre-digitalisation

Transitioning from rudimentary ICT to e-government, the 1981–2002 period utilized the IDI as a theoretical construct, proxied by telephone and internet connectivity. Infrastructure improvements, interacting with petroleum and tax revenues, drove foundational fiscal impacts (Mohammed & Gemu, 2024).

Moderating Effect of ICT Development Index on the Relationship between Petroleum Revenue and Budget Performance in Nigeria.

Table 1.9 revealed that petroleum revenue (PRI) and ICT development (ICTI) individually negatively impacted budget performance (BP). However, their interaction term yielded a positive coefficient, indicating that ICT development significantly moderates the relationship by reducing petroleum revenue's adverse fiscal effects. Consequently, higher ICT integration enhanced revenue management and improved budget balances. Consistent with Anthony (2023), findings underscored that digitalisation optimized resource management and fiscal discipline.

Table 1.9 Regression analysis: Estimated Pre-Digitalisation ARDL long run and short run results for model 1: BP=F(PRI, ICTI, PRI*ICTI, lnGE) – (1,0,0,0,0)

Estimated ARDL Long Run Results				
Variable	Coefficient (β)	Std. Error	t-Statistics	p-Value
PRI	-0.946	0.424	-2.227	0.041
ICTI	-1.055	0.964	-1.095	0.290
PRI*ICTI	0.514	0.284	1.807	0.090
lnGE	8.072	1.543	5.230	0.000
Estimated ARDL Short Run Results				
Variable	Coefficient (β)	Std. Error	t-Statistics	p-Value
Constant	-13.94	2.720	-5.124	0.000
BP(-1)*	-0.886	0.110	-8.004	0.000
PRI**	-0.838	0.394	-2.124	0.050
ICTI**	-0.935	0.826	-1.132	0.275
PRI*ICTI**	0.456	0.238	1.916	0.074
lnGE**	7.156	1.090	6.565	0.000
CointEq(-1)	-0.886498	0.076	-11.63	0.000

R-squared	0.840
Adjusted R-squared	0.787
Durbin Watson Stat	2.299
F-Statistic	15.84
Prob(F-statistic)	0.000

Diagnostics tests:			
Tests:	F-Statistics	P-value	Decision (H_0)
B-G LM test	0.437	0.519	Accept
B.P.G Test	1.533	0.238	Accept
ARCH test	0.291	0.595	Accept
J-B test	0.296	0.862	Accept
RESET test	0.461	0.508	Accept
CUSUM	----------	----------	Stable
CUSUMSQ	----------	----------	Stable

Note: The test include constant only and are at 5% level of significance. * p-value incompatible with t-bounds distribution () ** variables interpret as Z = Z(-1) + D(Z) – this indicates a dynamic regressor with an optimal

lag of zero, as such Eviews does not include lags and difference of such variables but estimates them contemporaneously. Source: Researcher Computation Using Eviews12 Output, 2026.

E-Government Development Index (2003 – 2024): Post-digitalisation

The E-Government Development Index (EGDI), which was established by the United Nations in 2001, serves as a composite metric that evaluates the advancements in e-government initiatives within a given nation. It's a weighted average of three sub-indices: the online services index (OSI), the telecommunication infrastructure index (TII), and the human capital index (HCI) (Nwokoroeze, et al., 2025; Adams & Paul, 2023; Kotenok et al., 2020). The E-government development index was used to interact with petroleum revenue.

Moderating Effect of E-government Development Index on the Relationship between Petroleum Revenue and Budget Performance in Nigeria.

The result in table 1.10 revealed that although petroleum revenue (PRI) and e-Government development (EGDI) individually had insignificant negative impacts, their interaction term yielded a significant positive coefficient. This indicated that e-government initiatives significantly enhanced petroleum revenue management and fiscal efficiency. Consistent with Njoku et al. (2024) and Asomba et al. (2024), these findings confirmed that digital governance strengthened public financial management. Consequently, the results highlighted that integrating digital systems mitigated revenue volatility, consistently improving budget performance within Nigeria's emerging digital economy.

Table 1.10 Regression analysis: Estimated Post-Digitalisation ARDL long run and short run results for model 2: BP=F(PRI, EGDI, PRI*EGDI, lnGE) – (1,0,0,1,1)

Estimated ARDL Long Run Results				
Variable	Coefficient (β)	Std. Error	t-Statistics	p-Value
PRI	-1.167	0.715	-1.631	0.128
EGDI	-1.479	3.954	-0.374	0.714
PRI*EGDI	2.285	2.175	1.050	0.314
lnGE	3.178	1.347	2.357	0.036
Estimated ARDL Short Run Results				
Variable	Coefficient (β)	Std. Error	t-Statistics	p-Value
Constant	-5.492	3.474	-1.580	0.139
Trend	0.235	0.069	3.398	0.005
BP(-1)*	-0.929	0.191	-4.846	0.000
PRI**	-1.085	0.613	-1.769	0.102
EGDI**	-1.375	3.617	-0.380	0.710
PRI*EGDI**	2.124	1.972	1.077	0.302
lnGE(-1)	2.954	1.486	1.987	0.070
D(PRI*EGDI)	3.104	0.517	5.999	0.000
D(lnGE)	0.484	1.217	0.398	0.697
CointEq(-1)	-0.929748	0.117	-7.924	0.000
R-squared	0.956			
Adjusted R-squared	0.927			
Durbin Watson Stat	2.377			

F-Statistic	32.91
Prob(F-statistic)	0.000

Diagnostics tests:

Tests:	F-Statistics	P-value	Decision (H_0)
B-G LM test	0.876	0.369	Accept
B.P.G Test	0.391	0.904	Accept
ARCH test	1.430	0.247	Accept
J-B test	2.553	0.278	Accept
RESET test	0.052	0.823	Accept
CUSUM	----------	----------	Stable
CUSUMSQ	----------	----------	Stable

Note: The test includes both constant and trend and are at 5% level of significance. * p-value incompatible with t-bounds distribution () ** variables interpret as Z = Z(-1) + D(Z) – this indicates a dynamic regressor with an optimal lag of zero, as such Eviews does not include lags and difference of such variables but estimates them contemporaneously. Source: Researcher Computation Using Eviews12 Output, 2026.

CONCLUSION

Based on the findings that petroleum revenue has a negative and significant effect on budget performance while its interactions with digitalisation shows a positive and significant effect, the study conclude that digitalisation adoption has significant moderating short run and long run effect on the relationship between petroleum revenue and budget performance in Nigeria. Ultimately, despite the challenges presented by petroleum revenue, strategic government spending and the interplay of digitalisation with revenue management are essential for enhancing budget performance. Furthermore, the study concludes that transitioning from rudimentary ICT to comprehensive e-government significantly influenced Nigeria's fiscal performance. Both digital frameworks effectively moderated revenue volatility and optimized resource management, enhancing budget performance through improved fiscal discipline and digital governance.

RECOMMENDATIONS

The study recommends that the National Assembly provide legislative backing for the digitalisation of revenue mobilization across all agencies. To mitigate oil revenue volatility, the legislature should implement stringent fiscal regulations and increase the stabilization fund beyond the current 0.5% rate. The Federal Government must prioritize investment in digital transformation for public financial management. Because digitalisation enhances transparency and collection efficiency, it serves as a vital tool to neutralize the "resource curse," ensuring long-term fiscal stability and sustainable resource utilization.

Finally, Nigeria should prioritize e-government implementation with targeted investments in digital infrastructure for revenue collection to maximize budget performance. This requires addressing institutional weaknesses and using a hybrid approach to ensure digital platforms effectively boost revenue across all sectors.

Contributions to Knowledge

This study pioneers empirical research into the moderating role of digitalisation on the relationship between government revenue and budget performance in Nigeria. While Model 1 confirms a direct "resource curse" effect where petroleum revenue negatively impacts budget stability, Model 2 provides novel evidence that digitalisation acts as a critical mitigator. The findings demonstrate that digital initiatives enhance the

management and transparency of volatile resource revenues, offering a strategic pathway to manage fiscal risks. Rather than just generating revenue, digitalisation improves overall fiscal outcomes by neutralizing the inherent volatility of oil-dependent economies. Additionally, this study makes a significant contribution to knowledge by providing the first empirical analysis of how the transition from basic ICT to a holistic e-government framework has influenced Nigeria's fiscal performance.

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APPENDIX

Optimal lag selection criteria for the 2 models

Model 1

VAR Lag Order Selection Criteria
Endogenous variables: BP
Exogenous variables: C PRI LNGOP LNGE
Date: 02/27/26 Time: 16:09
Sample: 1981 2024
Included observations: 41

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-76.89784	NA	3.031270	3.946236	4.113414	4.007113
1	-71.31132	9.810475*	2.425036*	3.722503*	3.931476*	3.798599*
2	-71.30811	0.005477	2.548148	3.771127	4.021894	3.862443
3	-71.22727	0.134068	2.668362	3.815965	4.108526	3.922499

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Model 2:

VAR Lag Order Selection Criteria
Endogenous variables: BP
Exogenous variables: C PRI DIG PRI DIG LNGE
Date: 02/27/26 Time: 16:22
Sample: 1981 2024
Included observations: 41

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-76.78691	NA	3.167517	3.989605	4.198577	4.065701
1	-71.32089	9.332219*	2.549737*	3.771751*	4.022517*	3.863066*
2	-71.32057	0.000542	2.680532	3.820515	4.113076	3.927050
3	-71.00779	0.503492	2.776609	3.854039	4.188394	3.975792

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

ARDL Estimations for the two models

Model 1

ARDL Estimation Regression Results Table:

Dependent Variable: BP
Method: ARDL
Date: 02/27/26 Time: 16:50
Sample (adjusted): 1982 2024
Included observations: 43 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): PRI LNGOP LNGE
Fixed regressors: C
Number of models evaluated: 8
Selected Model: ARDL(1, 1, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
BP(-1)	0.572170	0.116571	4.908333	0.0000
PRI	0.152400	0.293438	0.519359	0.6068
PRI(-1)	-0.906845	0.288578	-3.142457	0.0034
LNGOP	-1.400691	0.772921	-1.812205	0.0785
LNGOP(-1)	3.459748	0.756192	4.575222	0.0001
LNGE	5.621006	1.023482	5.492043	0.0000
LNGE(-1)	-2.334869	1.042434	-2.239824	0.0316
C	-13.04205	4.170929	-3.126893	0.0035

R-squared	0.714324	Mean dependent var	2.707691
Adjusted R-squared	0.657189	S.D. dependent var	1.860004
S.E. of regression	1.089033	Akaike info criterion	3.174698
Sum squared resid	41.50975	Schwarz criterion	3.502364
Log likelihood	-60.25601	Hannan-Quinn criter.	3.295531
F-statistic	12.50236	Durbin-Watson stat	1.981784
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Bound Test Results Table:

ARDL Long Run Form and Bounds Test
Dependent Variable: D(BP)
Selected Model: ARDL(1, 1, 1, 1)
Case 3: Unrestricted Constant and No Trend
Date: 02/27/26 Time: 16:51
Sample: 1981 2024
Included observations: 43

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.04205	4.170929	-3.126893	0.0035
BP(-1)*	-0.427830	0.116571	-3.670126	0.0008
PRI(-1)	-0.754445	0.311029	-2.425639	0.0206
LNGOP(-1)	2.059056	0.674028	3.054852	0.0043
LNGE(-1)	3.286137	1.092269	3.008541	0.0048
D(PRI)	0.152400	0.293438	0.519359	0.6068
D(LNGOP)	-1.400691	0.772921	-1.812205	0.0785
D(LNGE)	5.621006	1.023482	5.492043	0.0000

* p-value incompatible with t-Bounds distribution.

Levels Equation
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PRI	-1.763421	0.642134	-2.746189	0.0095
LNGOP	4.812786	1.645012	2.925684	0.0060
LNGE	7.680932	2.764418	2.778499	0.0087

EC = BP - (-1.7634*PRI + 4.8128*LNGOP + 7.6809*LNGE)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	4.710713	10%	2.72	3.77
k	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61
Actual Sample Size	43		Finite Sample: n=45	
		10%	2.893	3.983
		5%	3.535	4.733
		1%	4.983	6.423
			Finite Sample: n=40	
		10%	2.933	4.02
		5%	3.548	4.803
		1%	5.018	6.61

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-3.670126	10%	-2.57	-3.46
		5%	-2.86	-3.78
		2.5%	-3.13	-4.05
		1%	-3.43	-4.37

ARDL Error Correction Regression Table:

ARDL Error Correction Regression
Dependent Variable: D(BP)
Selected Model: ARDL(1, 1, 1, 1)
Case 3: Unrestricted Constant and No Trend
Date: 02/27/26 Time: 16:52
Sample: 1981 2024
Included observations: 43

ECM Regression
Case 3: Unrestricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13.04205	2.898953	-4.498882	0.0001
D(PRI)	0.152400	0.251001	0.607169	0.5477
D(LNGOP)	-1.400691	0.669862	-2.091015	0.0439
D(LNGE)	5.621006	0.808460	6.952729	0.0000
CointEq(-1)*	-0.427830	0.094589	-4.523047	0.0001

R-squared	0.661779	Mean dependent var	0.025093
Adjusted R-squared	0.626177	S.D. dependent var	1.709426
S.E. of regression	1.045161	Akaike info criterion	3.035163
Sum squared resid	41.50975	Schwarz criterion	3.239954
Log likelihood	-60.25601	Hannan-Quinn criter.	3.110684
F-statistic	18.58816	Durbin-Watson stat	1.981784
Prob(F-statistic)	0.000000		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	4.710713	10%	2.72	3.77
k	3	5%	3.23	4.35
		2.5%	3.69	4.89
		1%	4.29	5.61

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-4.523047	10%	-2.57	-3.46
		5%	-2.86	-3.78
		2.5%	-3.13	-4.05
		1%	-3.43	-4.37

Model 2:

ARDL Estimation Regression Results Table:

Dependent Variable: BP
Method: ARDL
Date: 02/27/26 Time: 22:03
Sample (adjusted): 1982 2024
Included observations: 43 after adjustments
Maximum dependent lags: 1 (Automatic selection)
Model selection method: Akaike info criterion (AIC)
Dynamic regressors (1 lag, automatic): PRI DIG PRI_DIG LNGE
Fixed regressors: C @TREND
Number of models evaluated: 16
Selected Model: ARDL(1, 0, 0, 0, 0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
BP(-1)	0.355927	0.131115	2.714615	0.0101
PRI	-2.631220	1.173135	-2.242895	0.0312
DIG	2.732937	3.101137	0.881269	0.3840
PRI_DIG	7.912051	4.199339	1.884118	0.0676
LNGE	2.857153	0.965480	2.959307	0.0054
C	-7.073695	2.572632	-2.749594	0.0093
@TREND	0.077318	0.030380	2.545013	0.0154

R-squared	0.534626	Mean dependent var	2.707691
Adjusted R-squared	0.457063	S.D. dependent var	1.860004
S.E. of regression	1.370530	Akaike info criterion	3.616172
Sum squared resid	67.62064	Schwarz criterion	3.902879
Log likelihood	-70.74769	Hannan-Quinn criter.	3.721900
F-statistic	6.892847	Durbin-Watson stat	1.858612
Prob(F-statistic)	0.000062		

*Note: p-values and any subsequent tests do not account for model selection.

ARDL Bound Test Results Table:

ARDL Long Run Form and Bounds Test
Dependent Variable: D(BP)
Selected Model: ARDL(1, 0, 0, 0, 0)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 02/27/26 Time: 22:07
Sample: 1981 2024
Included observations: 43

Conditional Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.073695	2.572632	-2.749594	0.0093
@TREND	0.077318	0.030380	2.545013	0.0154
BP(-1)*	-0.644073	0.131115	-4.912263	0.0000
PRI**	-2.631220	1.173135	-2.242895	0.0312
DIG**	2.732937	3.101137	0.881269	0.3840
PRI_DIG**	7.912051	4.199339	1.884118	0.0676
LNGE**	2.857153	0.965480	2.959307	0.0054

* p-value incompatible with t-Bounds distribution.
** Variable interpreted as Z = Z(-1) + D(Z).

Levels Equation
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
PRI	-4.085285	1.741381	-2.346002	0.0246
DIG	4.243213	4.743701	0.894494	0.3770
PRI_DIG	12.28441	6.370383	1.928362	0.0617
LNGE	4.436072	1.609563	2.756073	0.0091

EC = BP - (-4.0853*PRI + 4.2432*DIG + 12.2844*PRI_DIG + 4.4361*LNGE)

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	5.855434	10%	3.03	4.06
k	4	5%	3.47	4.57
		2.5%	3.89	5.07
		1%	4.4	5.72
Actual Sample Size	43		Finite Sample: n=45	
		10%	3.298	4.378
		5%	3.89	5.104
		1%	5.224	6.696
			Finite Sample: n=40	
		10%	3.334	4.438
		5%	3.958	5.226
		1%	5.376	7.092

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-4.912263	10%	-3.13	-4.04
		5%	-3.41	-4.36
		2.5%	-3.65	-4.62
		1%	-3.96	-4.96

ARDL Error Correction Regression Table:

ARDL Error Correction Regression
Dependent Variable: D(BP)
Selected Model: ARDL(1, 0, 0, 0, 0)
Case 5: Unrestricted Constant and Unrestricted Trend
Date: 02/27/26 Time: 22:08
Sample: 1981 2024
Included observations: 43

ECM Regression
Case 5: Unrestricted Constant and Unrestricted Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-7.073695	1.293061	-5.470505	0.0000
@TREND	0.077318	0.020486	3.774190	0.0006
CointEq(-1)*	-0.644073	0.112925	-5.703524	0.0000

R-squared	0.449028	Mean dependent var	0.025093
Adjusted R-squared	0.421479	S.D. dependent var	1.709426
S.E. of regression	1.300198	Akaike info criterion	3.430125
Sum squared resid	67.62064	Schwarz criterion	3.553000
Log likelihood	-70.74769	Hannan-Quinn criter.	3.475437
F-statistic	16.29949	Durbin-Watson stat	1.858612
Prob(F-statistic)	0.000007		

* p-value incompatible with t-Bounds distribution.

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.855434	10%	3.03	4.06
k	4	5%	3.47	4.57
		2.5%	3.89	5.07
		1%	4.4	5.72

t-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
t-statistic	-5.703524	10%	-3.13	-4.04
		5%	-3.41	-4.36
		2.5%	-3.65	-4.62
		1%	-3.96	-4.96

Post estimation results

Model 1:

Variance Inflation Factors
Date: 02/27/26 Time: 16:58
Sample: 1981 2024
Included observations: 43

Variable	Coefficient Variance	Uncentered VIF	Centered VIF
BP(-1)	0.013589	5.194411	1.648897
PRI	0.086106	5.243921	5.241377
PRI(-1)	0.083277	5.170153	5.169983
LNGOP	0.597407	291.3638	9.887034
LNGOP(-1)	0.571827	276.4611	9.233895
LNGE	1.047515	167.0280	2.709310
LNGE(-1)	1.086669	173.5031	2.809682
C	17.39664	630.7421	NA

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 1 lag

F-statistic	0.241408	Prob. F(1,34)	0.6263
Obs*R-squared	0.303157	Prob. Chi-Square(1)	0.5819

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.218187	Prob. F(7,35)	0.3191
Obs*R-squared	8.424004	Prob. Chi-Square(7)	0.2967
Scaled explained SS	5.769685	Prob. Chi-Square(7)	0.5669

Heteroskedasticity Test: ARCH

F-statistic	1.937096	Prob. F(1,40)	0.1717
Obs*R-squared	1.940001	Prob. Chi-Square(1)	0.1637

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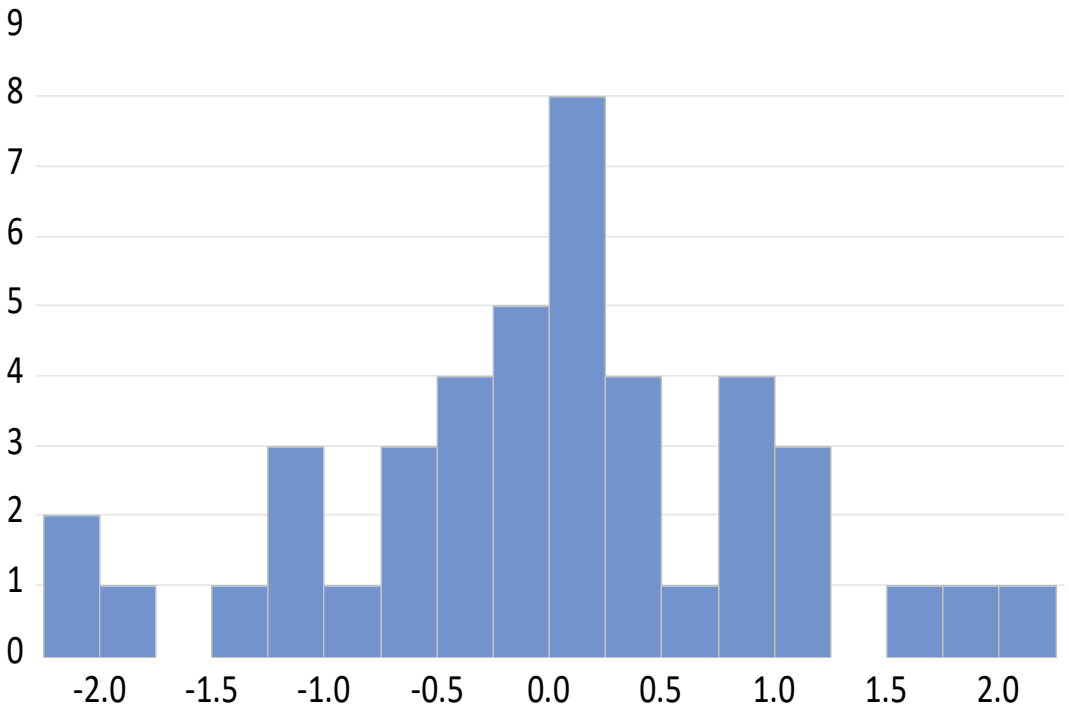


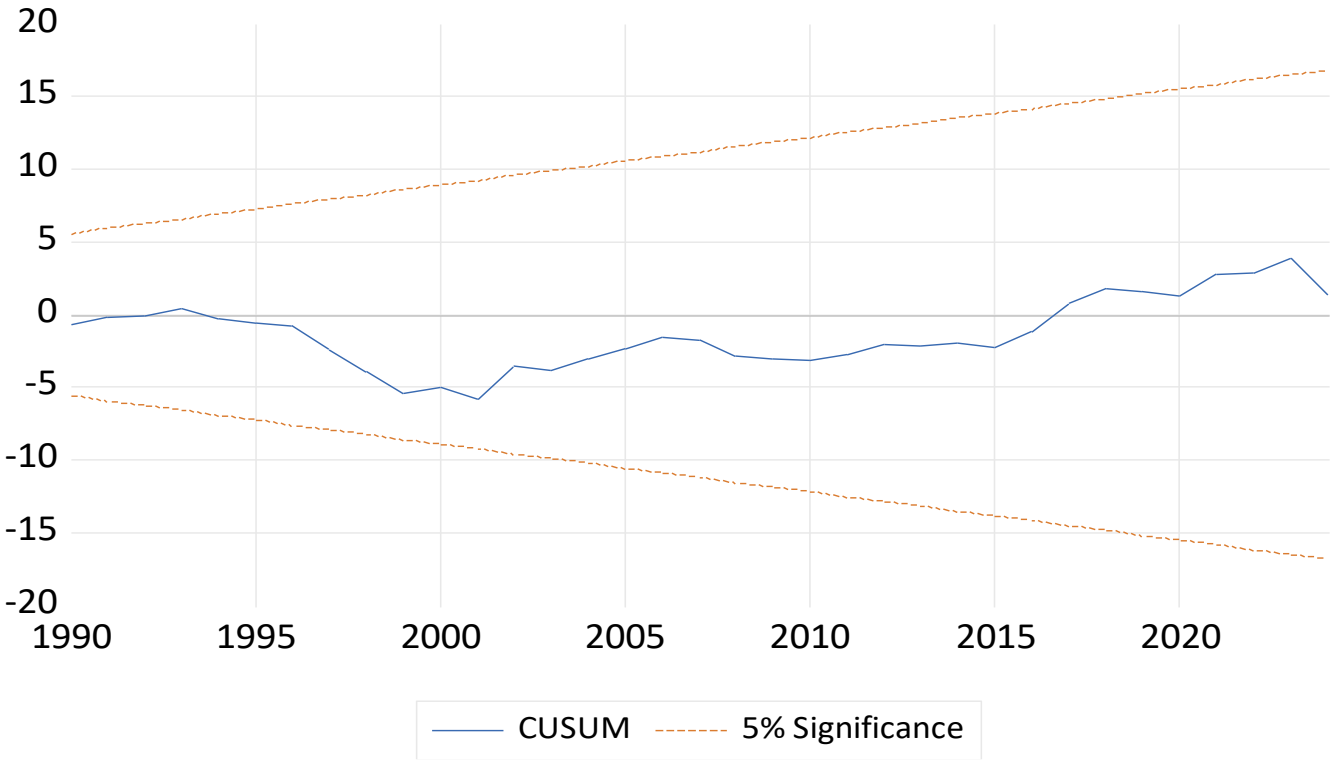
Series: Residuals	
Sample 1982 2024	
Observations 43	
Mean	-1.15e-15
Median	0.037609
Maximum	2.219610
Minimum	-2.246398
Std. Dev.	0.994147
Skewness	-0.163062
Kurtosis	3.067590
Jarque-Bera	0.198742
Probability	0.905407

Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: BP BP(-1) PRI PRI(-1) LNGOP LNGOP(-1) LNGE LNGE(-1) C

	Value	df	Probability
t-statistic	1.234724	34	0.2254
F-statistic	1.524543	(1, 34)	0.2254
Likelihood ratio	1.886121	1	0.1696

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	1.781399	1	1.781399
Restricted SSR	41.50975	35	1.185993
Unrestricted SSR	39.72835	34	1.168481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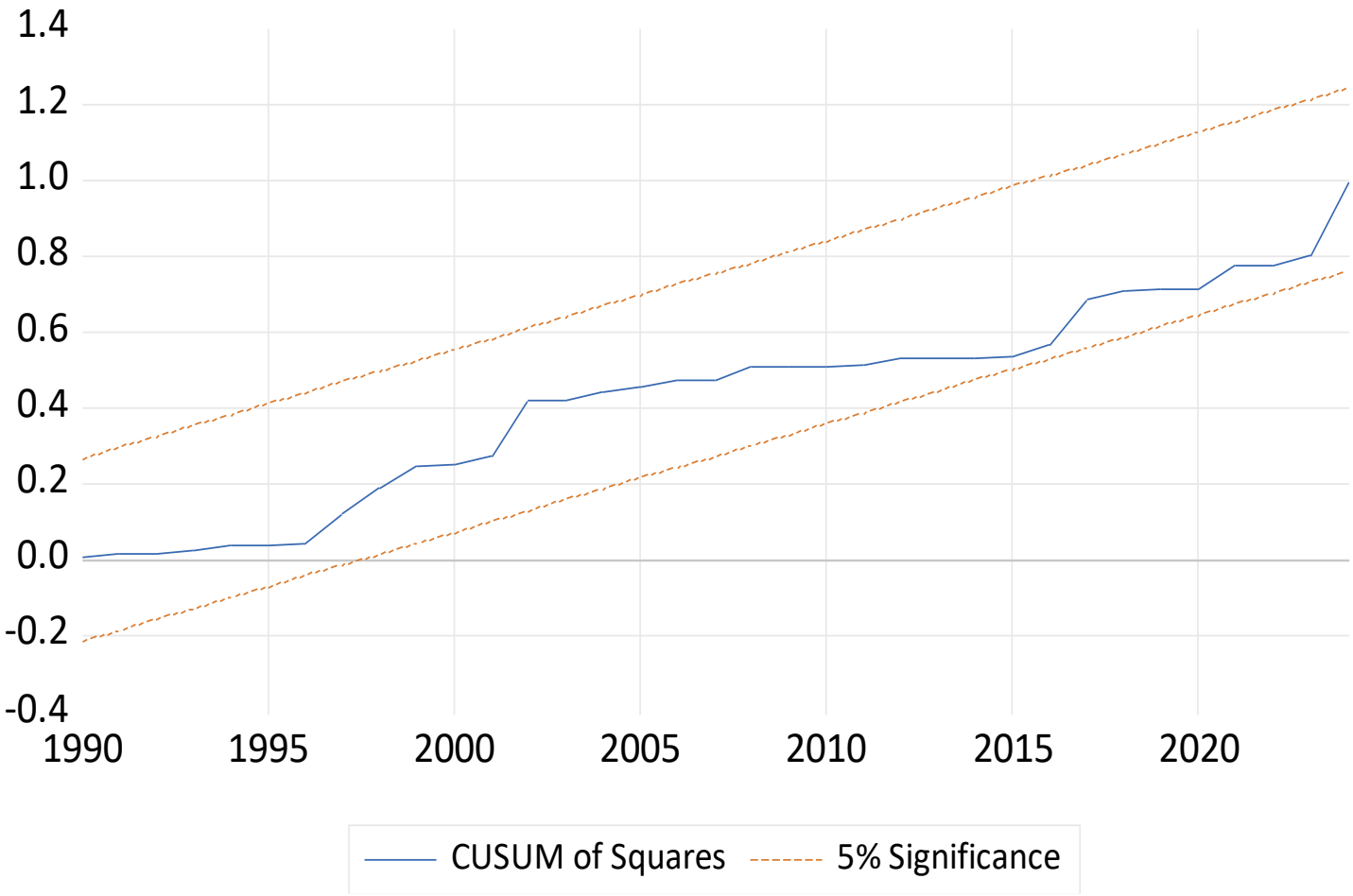
5% Significance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-0.4
1990
1995
2000
2005
2010
2015
2020
CUSUM of Squares
5% Significance

Model 2:

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 1 lag

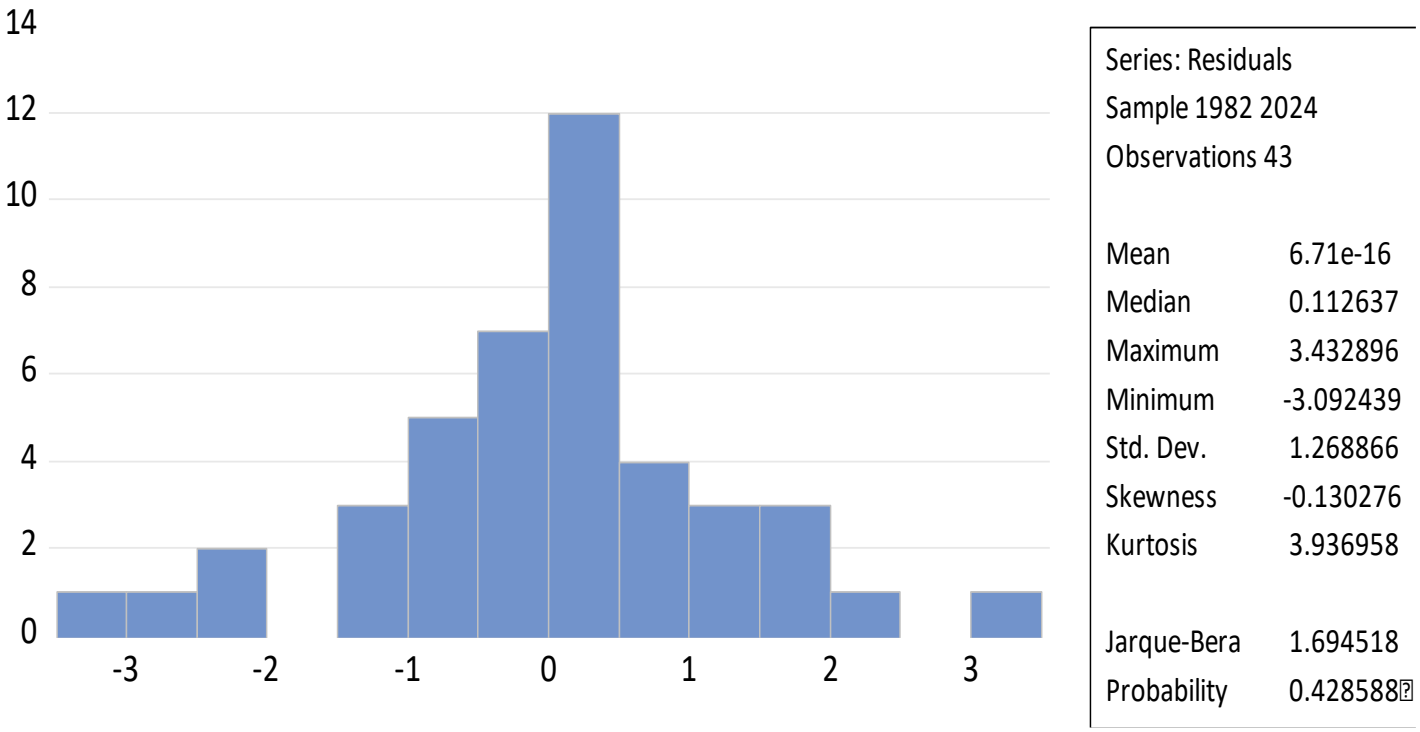
F-statistic	0.057044	Prob. F(1,35)	0.8126
Obs*R-squared	0.069968	Prob. Chi-Square(1)	0.7914

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.320605	Prob. F(6,36)	0.2733
Obs*R-squared	7.757012	Prob. Chi-Square(6)	0.2565
Scaled explained SS	7.984180	Prob. Chi-Square(6)	0.2393

Heteroskedasticity Test: ARCH

F-statistic	0.067822	Prob. F(1,40)	0.7959
Obs*R-squared	0.071092	Prob. Chi-Square(1)	0.7898



Ramsey RESET Test
Equation: UNTITLED
Omitted Variables: Squares of fitted values
Specification: BP BP(-1) PRI DIG PRI_DIG LNGE C @TREND

	Value	df	Probability
t-statistic	0.185347	35	0.8540
F-statistic	0.034354	(1, 35)	0.8540
Likelihood ratio	0.042185	1	0.8373

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.066307	1	0.066307
Restricted SSR	67.62091	36	1.878359
Unrestricted SSR	67.55461	35	1.930132