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Effect of Public Expenditure Automation on Economic Growth in Nigeria

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Abstract

This study examines the effect of public expenditure automation on economic growth in Nigeria from 2015Q2 to 2023Q1. An ex post facto research design is employed for the study. Quarterly time series data for capital expenditure automation, recurrent expenditure automation, and gross domestic product are collected from the Central Bank of Nigeria statistical bulletin. The stationarity of the data is tested using the Philip Perron test, while the Johansen cointegration test is utilized to ascertain the presence of a long-run relationship. The Dynamic Ordinary Least Squares technique is applied to assess the effect of public expenditure automation on economic growth in Nigeria. The findings reveal that capital expenditure automation has an insignificant effect on economic growth in Nigeria, whereas recurrent expenditure automation significantly influences economic growth in the country. The study suggests that the Nigerian government should reconsider resource allocation strategies, emphasizing the optimization of funds allocation toward sectors with a more direct and immediate impact on economic development. Additionally, strategic expansion of recurrent expenditure automation initiatives across various government departments and agencies is recommended. This involves identifying key areas within recurrent expenditures where automation has shown positive effects and advocating for systematic and phased implementation in these areas.

Keywords: *Public expenditure automation, Capital expenditure automation, Recurrent expenditure automation, Economic growth, Eviews10*

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Background to the Study

Economic growth, crucial for national progress, involves an increase in real Gross Domestic Product (GDP), leading to enhanced output, income, and expenditure (Acemoglu *et al.*, 2019). This elevation notably improves living standards, strengthens real incomes, and reduces unemployment rates (Barro & Sala-i-Martin, 2004). Moreover, sustained economic growth fosters economic development, diminishes poverty, and broadens career opportunities (World Bank, 2021). Public expenditure, covering investments in education, healthcare, infrastructure, and social services, plays a pivotal role in creating a conducive environment for living and business activities (Uremadu & Nwaeze, 2019). The International Monetary Fund (2020) underscores the growing trend in government spending relative to global GDP, highlighting its significance.

Various economic perspectives present differing views on public spending. Keynesian economists advocate increased public spending during economic downturns to stimulate growth (Keynes, 1936). Conversely, neoclassical economists caution against extensive public spending, emphasizing the role of the private sector (Gill & Pinto, 2005). A third perspective views public spending as evolving alongside economic progress to meet societal needs (Wagner, 1890). In line with the Keynesian approach, Nigeria has witnessed an upward trend in public expenditure since 1999, yet challenges persist in service delivery (Adeyemo, 1989; Aruwa, 2010). Addressing these issues requires comprehensive policy reforms, including the automation of public expenditure. Automation helps mitigate fraud risks, establishes auditable frameworks, and facilitates data-driven decision-making. It also streamlines administrative processes, conserving resources, and optimizing service allocation.

The study explores how public expenditure automation affects Nigeria's economic growth, underscoring its significance in improving government spending efficiency and transparency. It is particularly significant for Nigeria's economic development and contributes valuable insights into financial management strategies. Two key questions guide the investigation: (i) Does capital expenditure automation affect economic growth in Nigeria? (ii) What is the influence of automating recurrent expenditure on economic growth? To answer these questions, they are converted into the following hypotheses for testing:

$H_0$1: Capital expenditure automation has no significant effect on economic growth in Nigeria.

$H_0$2: Recurrent expenditure automation does not significantly affect economic growth in Nigeria.

Concept of Economic Growth

Economic growth can be seen as the expansion of an economy's capacity to produce goods and services, resulting in an improvement in the welfare of the citizens (Ugochukwu & Oruta, 2021). This perspective emphasizes the goal of economic growth to enhance the well-being of the population. However, Potters and Munichiello (2023) argue that economic growth is primarily determined by factors such as productivity levels, volume of trade, and investment in both human and physical capital, suggesting a more production-centric view.

While some define economic growth solely in terms of the increase in total output produced by a country (Ayres & Warr, 2009), Ilori and Akinwunmi (2020) propose a broader perspective, considering economic growth as the improvement in the inflation-adjusted market value of goods and services produced within a financial year. This suggests a focus not only on output but also on the monetary progress of the economy. Uremadu and Nwaeze (2019) highlight economic growth as the increase over time in a country's capacity to produce goods and services needed to enhance the well-being of its citizens. This view underscores the importance of sustained growth for improving living standards. In contrast, the International Monetary Fund (2013) and Sanusi (2010) define economic growth simply as the increase in the quantity of goods and services produced within an economy over time, placing less emphasis on the well-being aspect and focusing more on production metrics.

For the purpose of this study, the authors' position on economic growth aligns with the broader perspective, emphasizing its dual focus on increasing output and improving the well-being of citizens over time, as highlighted by Ilori and Akinwunmi (2020) and Uremadu and Nwaeze (2019). This perspective underscores the importance of sustained growth in enhancing living standards and promoting overall prosperity within society. Thus, our working definition of economic growth encompasses the increase in an economy's capacity to produce goods and services over time, with the ultimate goal of improving the well-being and living standards of its citizens.

Concept of Capital Expenditure Automation

Capital expenditure encompasses investments in critical sectors like infrastructure, healthcare, education, telecommunications, and energy generation, which are vital for economic growth and national development (Ugochukwu & Oruta, 2021). These initiatives, including the construction of health facilities, roads, bridges, and rural electrification, aim to stimulate employment opportunities and expand the country's wealth (Araga, 2016). Recognizing the significance of these investments, this study advocates for the automation. Capital expenditure automation involves the utilization of technological solutions and systems to streamline and automate the planning, allocation, and management of capital expenditures within organizations or government entities. It is regarded as instrumental in enhancing government efficiency and transparency (Adeleke & Mohammed, 2020). While automation can streamline operations and improve project delivery, challenges arise, especially in resource-constrained environments, requiring tailored solutions (Kumar & Patel, 2021).

Despite its potential benefits, caution is warranted regarding the overreliance on capital expenditure automation as a standalone solution to fiscal challenges (Ogundipe & Adeyemi, 2021). Addressing underlying governance issues and investing in capacity-building efforts alongside automation initiatives is crucial. International organizations like the World Bank advocate for a balanced approach to capital expenditure automation, emphasizing the integration of technological innovation with institutional reforms and capacity-building initiatives (World Bank, 2021). For our study we can state that Capital expenditure automation aims to streamline financial processes, such as budget allocation and project management, to improve efficiency and resource utilization within public sector organizations.

Concept of Recurrent Expenditure Automation

Available literature highlights the potential of recurrent expenditure automation to enhance fiscal transparency, accountability, and public sector efficiency (Okonkwo & Nwosu, 2021). Automation of processes like payroll management and procurement is seen as a means to ensure timely salary payments and essential service provision, thereby benefiting citizen welfare and economic advancement. However, caution is advised against excessive reliance on automation to address fiscal challenges. While it can improve efficiency, it must be accompanied by institutional reforms and capacity-building efforts to address underlying governance issues (Ajayi & Oladele, 2020). Additionally, concerns are raised regarding the initial costs of implementing automation systems, especially for governments with limited resources.

Another perspective emphasizes the need for a holistic approach to recurrent expenditure automation, considering socio-economic factors and local contexts (Okeke & Nwankwo, 2021). This approach stresses stakeholder engagement, capacity development, and tailored institutional reforms as essential components of successful automation initiatives. Furthermore, investments in data infrastructure and cybersecurity are deemed crucial to ensuring the reliability and security of automated systems, thereby fostering trust in government institutions. Conversely, some researchers advocate for a cautious approach to recurrent expenditure automation, advocating for thorough cost-benefit analyses and piloting of automation initiatives before widespread implementation (Ogunleye & Adeyemi, 2021). They propose prioritizing investments in areas with the highest potential for efficiency gains while closely monitoring the impact on service delivery and fiscal sustainability. Additionally, continuous evaluation and adjustment of automation strategies based on empirical evidence and stakeholder feedback are emphasized.

Empirical Review

Capital Expenditure Automation and Economic Growth

Adewale and Ojo (2020) undertook a study in Ibadan, concentrating on 300 Nigerian manufacturing firms. The research utilized structural equation modeling to investigate the relationship between capital expenditure automation and economic growth. The study yielded significant results, with an F-statistic of 12.5 and a path coefficient of 0.45, indicating a positive association between automation and economic growth. To further enhance economic growth in Ibadan and beyond, policymakers should encourage the adoption of automation technologies in the manufacturing sector. However, a critique of the study could be the potential presence of omitted variables or unmeasured factors that might confound the relationship between automation and economic growth.

In another study, Okonkwo and Nwosu (2021) conducted a survey of 200 public sector organizations in Enugu, employing panel data analysis and fixed-effects regression. The research findings unveiled a significant positive relationship between capital expenditure automation and economic growth. The β of 0.35 and a p-value of 0.01 indicated a substantial effect of automation on economic growth. As a recommendation, policymakers should prioritize investment in capital expenditure automation initiatives to enhance economic growth and productivity in Enugu. However, a critique of the study lies in the limited scope of analysis, as it focused solely on public sector organizations in one geographical region, potentially limiting the generalizability of the findings.

Furthermore, Ibrahim and Bello (2022) conducted a survey of 500 public sector organizations in Abuja, utilizing multiple regression analysis. The analysis revealed $\beta = 0.35$, with a p-value= 0.01, indicating a significant positive relationship between capital expenditure automation and economic growth. The recommendation is that policymakers and government officials prioritize the implementation and further enhancement of capital expenditure automation initiatives, as investing in advanced technologies and systems to automate capital expenditure processes can streamline operations, improve efficiency, and maximize the utilization of resources within public sector organizations. While the study provides valuable insights, limitations should be noted, such as the reliance on cross-sectional data from a single geographic location, potentially limiting generalizability. Additionally, the focus solely on quantitative aspects overlooks qualitative factors influencing capital expenditure automation effectiveness, suggesting future research should adopt a more comprehensive approach, including longitudinal studies and qualitative analysis.

Recurrent Expenditure Automation and Economic Growth

In the study titled "Impact of Recurrent Expenditure Automation on Economic Growth: Evidence from Nigeria," Yusuf and Ahmed (2023) delve into the relationship between recurrent expenditure automation and economic growth in Nigeria. Employing a quantitative approach, they utilize structural equation modeling (SEM) to analyze data from a sample of 300 Nigerian firms spanning various sectors. The analysis unveils a significant positive correlation between recurrent expenditure automation and economic growth, evidenced by a β coefficient of 0.42 and a p-value below 0.05. Conclusively, they advocate for prioritizing recurrent expenditure automation initiatives to bolster economic development in Nigeria. Nevertheless, the study's applicability beyond the Nigerian context may be constrained.

In another study titled "Exploring the Relationship between Recurrent Expenditure Automation and Economic Growth: A Mixed-Methods Approach," Adebayo and Olufemi (2022) adopt a blend of qualitative interviews and quantitative analysis. Focusing on a sample of 250 Nigerian government agencies and public sector organizations, they uncover a positive association between recurrent expenditure automation and economic growth, supported by a β coefficient of 0.38 and a p-value below 0.05. The study underscores the pivotal role of recurrent expenditure automation in driving economic growth in Nigeria, emphasizing the need for investment in automation projects and capacity building. However, its generalizability may be restricted to the Nigerian setting.

García and Martínez (2022) delve into the impact of recurrent expenditure automation on economic growth in Latin American countries in the study titled "Exploring the Relationship between Recurrent Expenditure Automation and Economic Growth in Latin America." Employing quantitative analysis, they scrutinize data from 200 government agencies and public sector organizations across Latin American nations. Utilizing structural equation modeling (SEM), they uncover a significant positive relationship between recurrent expenditure automation and economic growth, with a β coefficient of 0.48 and a p-value below 0.05. The findings advocate for prioritizing recurrent expenditure automation projects to fuel economic development in Latin America. Nonetheless, the study's generalizability may be limited by its regional focus.

In a comparative analysis titled "Comparative Analysis of Recurrent Expenditure Automation and Economic Growth in EU Countries," Müller and Schmidt (2021) examine the impact of recurrent expenditure automation on economic growth across 15 European Union (EU) member states. Employing econometric modeling techniques, they identify a positive relationship between recurrent expenditure automation and economic growth, demonstrated by a β coefficient of 0.60 and a p-value below 0.01. They underscore the importance of investing in recurrent expenditure automation to enhance economic performance across EU countries. However, variations in institutional frameworks and policy contexts across EU member states may affect the applicability of the findings.

Theoretical Framework

Two theories are discussed in this Paper: The Peacock-Wiseman Hypothesis and the Endogenous Growth Theory.

The Peacock-Wiseman Hypothesis

The Peacock-Wiseman Hypothesis, formulated by Alan T. Peacock and Jack Wiseman in 1961, posits that government spending tends to increase in response to crises or significant events, leading to heightened budgetary pressure. This pressure, according to the hypothesis, prompts the adoption of cost-saving measures, including automation, as a means to manage expenditures more efficiently. This theory is not devoid of critique; while the Peacock-Wiseman Hypothesis offers valuable insights into the relationship between government spending and budgetary pressures, it may oversimplify the complex factors influencing expenditure decisions. Critics argue that the hypothesis may not fully capture the diverse range of factors shaping government priorities and spending patterns. Additionally, its applicability may be limited by variations in institutional frameworks and political contexts across different settings.

Endogenous Growth Theory

The Endogenous Growth Theory, proposed by Paul Romer in 1986, posits that economic growth is driven not only by external factors like capital accumulation but also by internal factors such as technological innovation and human capital development. In this theory, technological progress, including automation, is considered a central driver of long-term economic growth. The critique of the Endogenous Growth Theory suggests that although it offers a compelling framework for comprehending the impact of technological innovation on economic growth, it may overlook potential negative externalities such as job displacement and income inequality associated with rapid technological advancement. Additionally, the theory may not fully account for the institutional and policy factors that influence the diffusion and impact of new technologies in different economic contexts.

Of the two theories discussed, the one that aligns most with the authors' study is the Endogenous Growth Theory, which underscores the transformative power of technological innovation, including automation, in driving economic growth. In this investigation, public expenditure automation, whether in recurrent or capital spending, represents a significant form of technological advancement. By automating expenditure processes, governments can enhance efficiency, reduce costs, and also ignite potential economic growth in Nigeria. Thus, this theory offers a robust framework that vividly supports the idea that public expenditure automation profoundly influences economic growth by revolutionizing traditional spending mechanisms.

Methodology

This study follows an *ex post facto* research design. It uses quarterly time series data from 2015Q2 to 2023Q1, after the introduction of automation in Nigerian government spending in 2015. The variables examined are capital expenditure automation, recurrent expenditure automation, and economic growth. Data was sourced from the Central Bank of Nigeria Statistical Bulletin. Descriptive statistics were used to summarize the data. Stationarity and co-integration tests were conducted to analyze relationships among the variables. A vector error correction model, suitable for non-stationary and co-integrated series, was employed. Dynamic ordinary least squares analysis was conducted using Eviews 10 Statistical Package. The analysis involved several steps, including the Phillips-Perron (PP) **unit root test** (Table2) to determine integration order and stationarity. The PP test is preferred due to its higher unit root detection ability and correction factor for potential correlated errors, indicated through:

$\Delta y_{t-1} = \alpha_0 + \lambda y_{t-1} + \ldots + \lambda y_{t-p} + \varepsilon_t$

Cointegration

The cointegration test assesses whether integrated variables are cointegrated, measuring the long-term relationship between dependent and independent variables. Johansen (1990) introduced two likelihood ratio tests: The Trace Test and the Maximum Eigenvalue Test identify cointegrating vectors among capital expenditure automation, recurrent expenditure automation, and economic growth, as well as estimating a dynamic error correction specification, revealing both short and long-run dynamics.

$$\Delta Y t = \mu + \sum_{i=1}^{n-1} \Gamma i \Delta Y_{t-i} + \sum_{i=0}^{m-1} \gamma i \Delta X_{t-i} - ECM_{t-1} + \varepsilon_t$$

where Δ is the first difference operator, Y_t is a p x 1 vector of stochastic variables, X_t is the independent variable, ECM is the error-correction coefficient (the adjustment coefficient), l is a vector of constants, and ε_t is a vector of normally, independently, and identically distributed errors with zero means and constant variances and p is the number of variables.

Error Correction Model

When two variables are cointegrated, they possess an error correction model (ECM) (Granger, 1987). This model informs us about the relationship between the variables in both the long-term and short-term, as well as the speed at which they adapt to each other. It includes an error correction term (ECT) in the equation to illustrate this adjustment process. $\Delta Y_t = a_0 + b_1 \Delta X_t - \lambda \hat{u}_{t-1} + Y_t$

The study's model is specified as follows: GDP = f(CEXPA, REXPA) …………….. (1)

This has an econometric form represented as:

$GDP_t = \alpha + \beta_1 CEXPA_t + \beta_2 REXPA_t + \mu_t$ …………………… ……………………… (2)

Where: GDP = Gross Domestic Product; CEXPA= Capital Expenditure Automation; REXPA= Recurrent Expenditure Automation; α =Intercept or Constant; β = Slope of the regression line of the independent variables; μ=Error Term. The Cointegration model of the study is represented by:

$$\Delta GDP_t = \mu + \sum_{I=1}^{n-1} \Gamma i \Delta GDP_{t-i} + \sum_{i=0}^{m-1} \gamma_1 \Delta CEXPA_{t-i} + \gamma_2 \Delta REXPA_{t-i} + ECM_{t-1} + \varepsilon_t \quad \text{…………… (3)}$$

Where: GDP = Gross Domestic Product; CEXPA= Capital Expenditure Automation; REXPA= Recurrent Expenditure Automation; and ECM = Error-correction coefficient; ε_t = Error term; μ =Intercept or Constant; t-i = Time lagged; γ_1, γ_2= Coefficients of independent variables.

Results and Analyses

The descriptive statistics in Table1 outline the key characteristics of three variables - Gross Domestic Product (GDP), Capital Expenditure Automation (CEXPA), and Recurrent Expenditure Automation (REXPA) - based on 32 observations.

Table 1: Descriptive Statistics

	GDP	CEXPA	REXPA
Mean	17867743	213754.2	624503.1
Maximum	21423437	763560.0	1412935.
Minimum	15919657	558.0000	221587.0
Std. Dev.	1402559.	173071.0	281491.6
Observations	32	32	32

Source*:* Eviews V.10 Output, 2024

These statistics offer initial insights into the distribution and variability of the data, shedding light on the behavior of public expenditure automation and economic growth in Nigeria. The average Gross Domestic Product over the observed period stands at approximately ₦17,867,743m, with the highest recorded value reaching ₦21,423,437m and the lowest at ₦15,919,657m. Furthermore, the standard deviation of roughly ₦1,402,559m indicates the degree of variation from the mean, suggesting significant variability in the data points.

The average capital expenditure automation over the observed period is about ₦213,754.2m, with the highest recorded value reaching ₦763,560m and the lowest at ₦558 million. The standard deviation of approximately ₦173,071m indicates significant variability from the mean. Similarly, the average recurrent expenditure automation over the 32 observations stands at approximately ₦624,503.1m, with the highest recorded value at ₦1,412,935m and the lowest at ₦221,587m. The standard deviation of roughly ₦281,491.6m also points to substantial variation from the mean. These high standard deviations suggest notable fluctuations in both capital and recurrent expenditure automation, reflecting the potential for significant variability in economic growth. Comparatively, the range and average levels of public expenditure automation and economic growth indicate more pronounced fluctuations in public expenditure automation than in economic growth, as evidenced by the wider range. This data underscores the dynamic nature of public expenditure automation and its impact on economic growth in Nigeria.

Table 2: Unit Root Test

Variables	Adj. T-Statistic	Prob. Values	Order of Integration
GDP	-7.349407	0.0000	*I(0)*
CEXPA	-5.188900	0.0011	*I(0)*
REXPA	-6.241862	0.0001	*I(0)*

Source: Researcher's Computation 2024.

The adjusted t-statistic for Gross Domestic Product (GDP) stands at -7.349407, indicating a rejection of the null hypothesis in the unit root test. This suggests that the GDP series is stationary at level, signifying an integration order of zero (I(0)). Similarly, Capital Expenditure Automation (CEXPA) exhibits a highly negative t-statistic of -5.188900, leading to the rejection of the null hypothesis and indicating stationarity in its original form (I(0)). Recurrent Expenditure Automation (REXPA) also demonstrates a highly negative t-statistic (-6.241862), resulting in the rejection of the null hypothesis and indicating stationarity at its original level (I(0)).

The stationary nature of GDP, CEXPA, and REXPA at the original levels (I(0)) eliminates the need for differencing to achieve stationarity. The exceedingly low probability values close to 0.0000 for these variables enhance the evidence against the presence of a unit root, underscoring the high statistical significance. These findings hold significant implications for subsequent time-series analysis, as stationary data is essential for various econometric models. Given the stationary nature of the variables at level I(0), the application of the Johansen cointegration test approach becomes pertinent in determining the long-run relationship among the variables.

Table 3: Johansen Cointegration Test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.849361	74.50802	29.79707	0.0000
At most 1 *	0.445433	17.72203	15.49471	0.0227
At most 2	0.001166	0.034985	3.841466	0.8516
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.849361	56.78599	21.13162	0.0000
At most 1 *	0.445433	17.68705	14.26460	0.0138
At most 2	0.001166	0.034985	3.841466	0.8516

Source*:* Eviews V.10 Output, 2024

The Trace test of Johansen cointegration (see Table3) indicates a significant cointegration at a 0.05 significance level, with Trace statistics of None and At most 1 (74.50802 and 17.722031) surpassing the respective 0.05 Critical Values (29.79707 and 15.49471), and *p*-values (0.0000 and 0.0227) below the 0.05 level of significance. Similarly, the Maximum Eigenvalue test of Johansen cointegration also shows a significant cointegration at a 0.05 significance level, with Max-Eigen statistics for None and At most 1 (56.78599 and 17.68705) exceeding the respective 0.05 Critical Values (21.13162 and 14.26460), and *p*-values (0.0000 and 0.0138) below the 0.05 threshold values. The presence of cointegration in both criteria of the Johansen test implies a long-run relationship between economic growth and the public expenditure automation variables (capital expenditure automation and recurrent expenditure automation). Consequently, this suggests the utilization of the Vector Error Correction Model for further analysis.

The Dynamic Ordinary Least Squares Regression

The DOLS regression output in Table 4 sheds light on the relationship between the independent variables (CEXPA, REXPA) and economic growth in Nigeria.

Table 4: DOLS Regression Output

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CEXPA	-3.861251	2.780206	-1.388837	0.1802
REXPA	4.654459	1.217104	3.824208	0.0011
C	15785080	520573.9	30.32246	0.0000
R-squared	0.646172	Mean dependent var		17902972
Adjusted R-squared	0.504641	S.D. dependent var		1454883.
S.E. of regression	1023972.	Sum squared resid		2.10E+13
Long-run variance	5.40E+11			

Source: Eviews Version 10 Output, 2024

Upon regression analysis, capital expenditure automation lacks statistical significance ($p>0.05$) in affecting economic growth, while recurrent expenditure automation significantly ($p<0.05$) positively affects growth. The coefficient for capital expenditure automation shows no significant effect on economic growth ($p>0.05$), contrary to recurrent expenditure automation, which significantly boosts growth ($p<0.05$). The constant term remains highly significant ($p=0.0000$), emphasizing its crucial role in predicting economic growth. The R-squared value of 0.646172 indicates that roughly 64.6% of the variability in growth is accounted for by the model.

Test of Hypotheses

Hypothesis1: The null hypothesis ($H_0 1$) posits that capital expenditure automation has no significant effect on economic growth in Nigeria. Based on the regression results, the coefficient (-3.861251) for CEXPA is not statistically significant (p-value of 0.1802 > 0.05) thus failing to reject the null hypothesis. This means that capital expenditure automation does not significantly affect economic growth in Nigeria. This however disagrees with the study by Adewale and Ojo (2020), which found a significant positive association between capital expenditure automation and economic growth in Nigerian manufacturing firms.

Hypothesis2: The null hypothesis ($H_0 2$) suggesting that recurrent expenditure automation has no significant effect on economic growth is rejected, since the coefficient (4.654459) for REXPA has a p-value of 0.0011 < 0.05 indicating a positive effect on economic growth. This finding aligns with the studies conducted by many scholars, such as Yusuf and Ahmed (2023), Adebayo and Olufemi (2022), Müller and Schmidt (2021), all of which reveal a significant positive relationship between recurrent expenditure automation and economic growth.

Post Estimation tests

The table shows results of tests on a regression model: Normality, Serial Correlation, and Heteroskedasticity Tests.

Table 5: Post Estimation test results

Description	Probability values
Normality Test:	
Jarque-Bera	1.964043
P-value:	0.374553
Serial Correlation	
F-statistics	1.388160
P-value	0.2494
Heteroskadasticity Test	
F-statistics	1.030406
P-value	0.3696

Source: Researcher's computation, 2024

Normality Test: In this Test, the null hypothesis assumes data follows a normal distribution. With a p-value of 0.374553, exceeding 0.05, there's no significant deviation, as shown in B14.

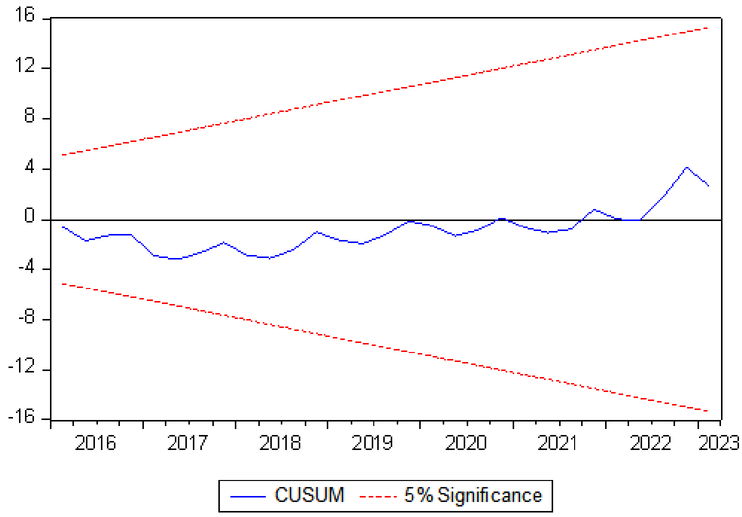
Serial Correlation Test: In the Serial Correlation Test, the Null Hypothesis states no serial correlation in residuals. With a p-value of 0.2494 (>0.05) from table5, no significant evidence refutes it. Thus, no notable serial correlation is detected in the regression model's residuals.

Heteroskedasticity Test: Here, the Null Hypothesis is that there is no heteroskedasticity in the residuals (constant variance). Again, from table5, the p-value of 0.3696 (>0.05); consequently, there is no statistically significant evidence to reject the null hypothesis, suggesting that there is no problem of heteroskedasticity in the regression model. Therefore, based on the results of these post-estimation tests, there is no significant departure from the assumptions underlying the regression model. And so, the model's validity in terms of normality, serial correlation, and heteroskedasticity is supported by the test results.

Parameter stability Test—CUSUM test

The stability of the model is being assessed using the CUSUM test, a method employed to detect structural changes over time. The results indicate that the model remains stable, as it falls within the 5% boundary. This suggests that the model's performance continues to be consistent and reliable, without significant deviations or structural changes that could impact its validity or predictive power.

Fig. 1



Source: Eview Version 10 Output, 2024

Conclusion

This study seeks to examine the effect of public expenditure automation on economic growth in Nigeria, with a specific focus on capital and recurrent expenditure automation. The regression analysis reveals contrasting effects of capital and recurrent expenditure automation on economic growth in Nigeria. While capital expenditure automation does not significantly affect economic growth. This suggests that the anticipated benefits of automation in capital projects, such as infrastructure development and long-term investments, may not directly translate into visible economic growth. However, recurrent expenditure automation emerges as a significant driver of economic growth in Nigeria.

Recommendations

i. **Policy Focus on Recurrent Expenditure Automation:** This study underscores the significant positive impact of recurrent expenditure automation on economic growth, urging policymakers to prioritize initiatives aimed at enhancing automation in recurrent expenditure processes. Such efforts could entail investment in advanced technologies and systems to streamline operations and bolster efficiency within public sector organizations. Moreover, the study advocates for a strategic expansion of recurrent expenditure automation initiatives across various government departments and agencies, pinpointing key areas where automation has demonstrated positive effects. It recommends a systematic and phased implementation approach in these identified areas to maximize benefits. Additionally, emphasis is placed on the importance of investing in robust technology infrastructure and comprehensive training programs. This ensures that government employees are equipped with the necessary skills to effectively operate and manage automated systems. Such investment in human capital is deemed crucial for the sustainable and successful implementation of recurrent expenditure automation.

ii. **Caution in Assessing Capital Expenditure Automation:** While the findings suggest that capital expenditure automation may not directly contribute to economic growth, caution should be exercised in interpreting these results. Nigerian governments may want to reconsider the allocation of resources, focusing on optimizing funding towards areas with a more immediate impact on economic development. This might involve prioritizing other forms of investment or development projects that have proven effectiveness. Additionally, developing and implementing robust evaluation criteria for capital projects, including comprehensive cost-benefit analyses, can help assess the broader economic impact. By refining the selection process for capital projects, policymakers can choose those that align more closely with fostering economic growth. Future research could further explore additional factors influencing the relationship between capital expenditure automation and economic growth, ensuring a comprehensive understanding of its potential impact.

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Appendix A: Data on CEXPA, REXPA and GDP from 2015Q2 to 2023Q1

Period	Capital Expenditure Automation N'm	Recurrent Expenditure Automation N'm	Gross Domestic Product N'm
Jun-15	558.00	221,587.00	16,623,053.88
Sep-15	60,909.00	314,888	18,208,475.09
Dec-15	213,792.00	550,962	18,745,360.19
Mar-16	18,001.00	374,490	16,087,230.32
Jun-16	136,721.00	283,622	16,349,290.03
Sep-16	54,959.00	352,890	17,775,969.03
Dec-16	401,728.00	393,239	18,439,940.98
Mar-17	358,396.00	614,188	15,919,656.99
Jun-17	6,557.00	405,930	16,477,424.32
Sep-17	116,347.00	345,409	17,988,950.81
Dec-17	369,428.00	715,557	18,819,658.99
Mar-18	272,216.00	550,977	16,234,954.95
Jun-18	46,921.00	385,205	16,718,625.28
Sep-18	181,815.00	604,136	18,305,126.40
Dec-18	123,733.00	441,146	19,277,641.99
Mar-19	122,861.00	594,265	16,569,734.73
Jun-19	171,367.00	418,940	17,076,100.72
Sep-19	177,753.00	756,455	18,697,323.82
Dec-19	435,439.00	542,178	19,750,934.72
Mar-20	86,780.00	653,792	16,893,269.79
Jun-20	65,907.00	617,424	16,044,513.73
Sep-20	146,074.00	741,761	18,109,596.02
Dec-20	364,559.00	511,137	19,753,163.95
Mar-21	305,431.00	918,785.00	16,962,505.92
Jun-21	175,377.00	623,309.00	16,904,236.42
Sep-21	430,198.00	943,589.00	18,845,916.29
Dec-21	345,607.00	575,110.00	20,670,112.75
Mar-22	479,923.00	1,074,296.00	17,573,272.22
Jun-22	243,686.00	788,992.00	17,478,222.63
Sep-22	17,693.00	1,203,841.00	19,294,013.81
Dec-22	145,837.00	1,053,064.00	21,423,436.66
Mar-23	763,560.00	1,412,935.00	17,750,060.97

Source: CBN Statistical Bulletin, 2023

Appendix B: Results Output

B1 Descriptive Statistics

	GDP	CEXPA	REXPA
Mean	17867743	213754.2	624503.1
Median	17763015	173372.0	584687.5
Maximum	21423437	763560.0	1412935.
Minimum	15919657	558.0000	221587.0
Std. Dev.	1402559.	173071.0	281491.6
Skewness	0.605833	1.083809	0.991747
Kurtosis	2.747431	4.232424	3.547891
Jarque-Bera	2.042568	8.289909	5.645913
Probability	0.360132	0.015844	0.059430
Sum	5.72E+08	6840133.	19984099
Sum Sq. Dev.	6.10E+13	9.29E+11	2.46E+12
Observations	32	32	32

B2 Least Square Regression with GDP as Dependent Variable

Dependent Variable: GDP
Method: Least Squares
Date: 02/19/24 Time: 12:49
Sample: 2015Q2 2023Q1
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	16961371	453258.3	37.42099	0.0000
@TREND	58475.59	25122.93	2.327579	0.0269

R-squared	0.152964	Mean dependent var	17867743
Adjusted R-squared	0.124730	S.D. dependent var	1402559.
S.E. of regression	1312177.	Akaike info criterion	31.07273
Sum squared resid	5.17E+13	Schwarz criterion	31.16434
Log likelihood	-495.1638	Hannan-Quinn criter.	31.10310
F-statistic	5.417623	Durbin-Watson stat	2.040404
Prob(F-statistic)	0.026869		

B3 Least Square Regression with CEXPA as Dependent Variable

Dependent Variable: CEXPA
Method: Least Squares
Date: 02/19/24 Time: 12:54
Sample: 2015Q2 2023Q1
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	91469.56	54934.69	1.665060	0.1063
@TREND	7889.329	3044.887	2.591009	0.0146

R-squared	0.182858	Mean dependent var	213754.2
Adjusted R-squared	0.155620	S.D. dependent var	173071.0
S.E. of regression	159035.2	Akaike info criterion	26.85210
Sum squared resid	7.59E+11	Schwarz criterion	26.94371
Log likelihood	-427.6336	Hannan-Quinn criter.	26.88247
F-statistic	6.713326	Durbin-Watson stat	1.766288
Prob(F-statistic)	0.014635		

B4 Least Square Regression with REXPA as Dependent Variable

Dependent Variable: REXPA
Method: Least Squares
Date: 02/19/24 Time: 12:57
Sample: 2015Q2 2023Q1
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	247038.7	57750.08	4.277720	0.0002
@TREND	24352.54	3200.937	7.607943	0.0000

R-squared	0.658629	Mean dependent var	624503.1
Adjusted R-squared	0.647249	S.D. dependent var	281491.6
S.E. of regression	167185.8	Akaike info criterion	26.95206
Sum squared resid	8.39E+11	Schwarz criterion	27.04367
Log likelihood	-429.2330	Hannan-Quinn criter.	26.98243
F-statistic	57.88080	Durbin-Watson stat	2.236949
Prob(F-statistic)	0.000000		

B5 Unit Root Tests - GDP: @ Level

Null Hypothesis: GDP has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 11 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-7.349407	0.0000
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	1.66E+12
HAC corrected variance (Bartlett kernel)	2.94E+11

Phillips-Perron Test Equation
Dependent Variable: D(GDP)
Method: Least Squares
Date: 02/19/24 Time: 12:58
Sample (adjusted): 2015Q3 2023Q1
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP(-1)	-1.031716	0.190864	-5.405500	0.0000
C	17540995	3250822.	5.395865	0.0000
@TREND("2015Q2")	58357.06	29926.07	1.950041	0.0612

R-squared	0.511545	Mean dependent var	36355.07
Adjusted R-squared	0.476656	S.D. dependent var	1874214.
S.E. of regression	1355854.	Akaike info criterion	31.16953
Sum squared resid	5.15E+13	Schwarz criterion	31.30830
Log likelihood	-480.1277	Hannan-Quinn criter.	31.21476
F-statistic	14.66182	Durbin-Watson stat	1.987795
Prob(F-statistic)	0.000044		

B6 Unit Root Tests - CEXPA: @ Level

Null Hypothesis: CEXPA has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 25 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.188900	0.0011
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.42E+10
HAC corrected variance (Bartlett kernel)	2.70E+09

Phillips-Perron Test Equation
Dependent Variable: D(CEXPA)
Method: Least Squares
Date: 02/19/24 Time: 13:01
Sample (adjusted): 2015Q3 2023Q1
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CEXPA(-1)	-1.017436	0.220322	-4.617951	0.0001
C	105773.0	65231.88	1.621492	0.1161
@TREND("2015Q2")	7392.271	3473.817	2.127997	0.0423

R-squared	0.437328	Mean dependent var	24612.97
Adjusted R-squared	0.397137	S.D. dependent var	210675.9
S.E. of regression	163577.6	Akaike info criterion	26.93973
Sum squared resid	7.49E+11	Schwarz criterion	27.07850
Log likelihood	-414.5658	Hannan-Quinn criter.	26.98497
F-statistic	10.88129	Durbin-Watson stat	1.776901
Prob(F-statistic)	0.000319		

B7 Unit Root Tests - CEXPA: @ Level

Null Hypothesis: REXPA has a unit root
Exogenous: Constant, Linear Trend
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.241862	0.0001
Test critical values:	1% level	-4.284580	
	5% level	-3.562882	
	10% level	-3.215267	

*MacKinnon (1996) one-sided p-values.

Residual variance (no correction)	2.53E+10
HAC corrected variance (Bartlett kernel)	3.44E+10

Phillips-Perron Test Equation
Dependent Variable: D(REXPA)
Method: Least Squares
Date: 02/19/24 Time: 13:06
Sample (adjusted): 2015Q3 2023Q1
Included observations: 31 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
REXPA(-1)	-1.285824	0.208197	-6.175994	0.0000
C	322472.1	80917.22	3.985210	0.0004
@TREND("2015Q2")	30391.04	5631.829	5.396300	0.0000

R-squared	0.580148	Mean dependent var	38430.58
Adjusted R-squared	0.550158	S.D. dependent var	249640.4
S.E. of regression	167434.4	Akaike info criterion	26.98634
Sum squared resid	7.85E+11	Schwarz criterion	27.12511
Log likelihood	-415.2882	Hannan-Quinn criter.	27.03157
F-statistic	19.34507	Durbin-Watson stat	1.532516
Prob(F-statistic)	0.000005		

B8 Series Cointegration Tests: GDP, CEXPA, REXPA

Date: 02/19/24 Time: 13:09
Sample (adjusted): 2015Q4 2023Q1
Included observations: 30 after adjustments
Trend assumption: Linear deterministic trend
Series: GDP CEXPA REXPA
Lags interval (in first differences): 1 to 1

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.849361	74.50802	29.79707	0.0000
At most 1 *	0.445433	17.72203	15.49471	0.0227
At most 2	0.001166	0.034985	3.841466	0.8516

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.849361	56.78599	21.13162	0.0000
At most 1 *	0.445433	17.68705	14.26460	0.0138
At most 2	0.001166	0.034985	3.841466	0.8516

Max-eigenvalue test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

GDP	CEXPA	REXPA
1.29E-06	-6.44E-08	-2.86E-06
2.42E-07	-1.17E-05	2.39E-06
2.42E-07	-6.31E-07	-5.56E-06

Unrestricted Adjustment Coefficients (alpha):

D(GDP)	-1477412.	38208.19	-5240.625
D(CEXPA)	7837.979	114724.0	-456.1892
D(REXPA)	34007.41	11897.49	-4594.492

1 Cointegrating Equation(s): Log likelihood -1244.357

Normalized cointegrating coefficients (standard error in parentheses)

GDP	CEXPA	REXPA
1.000000	-0.050120	-2.228845
	(0.75253)	(0.38029)

Adjustment coefficients (standard error in parentheses)

D(GDP)	-1.898830
	(0.16539)
D(CEXPA)	0.010074
	(0.04433)
D(REXPA)	0.043708
	(0.03509)

2 Cointegrating Equation(s): Log likelihood -1235.514

Normalized cointegrating coefficients (standard error in parentheses)

GDP	CEXPA	REXPA
1.000000	0.000000	-2.241398
		(0.33419)
0.000000	1.000000	-0.250452
		(0.09755)

Adjustment coefficients (standard error in parentheses)

D(GDP)	-1.889589	-0.351658
	(0.16799)	(1.50222)
D(CEXPA)	0.037820	-1.342148
	(0.03367)	(0.30113)
D(REXPA)	0.046585	-0.141326
	(0.03557)	(0.31807)

B9 Vector Error Correction Estimates

Vector Error Correction Estimates
Date: 02/19/24 Time: 13:10
Sample (adjusted): 2016Q1 2023Q1
Included observations: 29 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1		
GDP(-1)	1.000000		
CEXPA(-1)	1.053119 (0.79215) [1.32944]		
REXPA(-1)	-2.958281 (0.40695) [-7.26933]		
C	-16281694		
Error Correction:	**D(GDP)**	**D(CEXPA)**	**D(REXPA)**
CointEq1	-2.043677 (0.40528) [-5.04261]	-0.122644 (0.10814) [-1.13408]	0.205609 (0.08550) [2.40483]
D(GDP(-1))	0.978630 (0.22864) [4.28019]	0.117617 (0.06101) [1.92783]	-0.085720 (0.04823) [-1.77716]
D(GDP(-2))	0.087023 (0.20983) [0.41474]	0.098981 (0.05599) [1.76786]	-0.077989 (0.04426) [-1.76186]
D(CEXPA(-1))	0.873254 (1.04021) [0.83950]	-0.525890 (0.27757) [-1.89465]	-0.236886 (0.21944) [-1.07949]
D(CEXPA(-2))	0.788434 (0.96527) [0.81680]	-0.510899 (0.25757) [-1.98354]	-0.309155 (0.20363) [-1.51819]
D(REXPA(-1))	-3.202432 (1.34533) [-2.38041]	-0.404022 (0.35898) [-1.12546]	-0.409486 (0.28381) [-1.44281]
D(REXPA(-2))	-2.355793 (0.88560) [-2.66011]	-0.025763 (0.23631) [-0.10902]	-0.032853 (0.18683) [-0.17585]

C	7457.909	9800.793	58821.53
	(132834.)	(35445.0)	(28022.7)
	[0.05614]	[0.27651]	[2.09906]

R-squared	0.910970	0.504672	0.777319
Adj. R-squared	0.881293	0.339563	0.703092
Sum sq. resids	9.13E+12	6.50E+11	4.06E+11
S.E. equation	659480.8	175973.7	139124.5
F-statistic	30.69637	3.056598	10.47218
Log likelihood	-425.0460	-386.7336	-379.9196
Akaike AIC	29.86524	27.22301	26.75308
Schwarz SC	30.24243	27.60019	27.13026
Mean dependent	-34320.66	18957.52	29723.21
S.D. dependent	1914096.	216537.0	255324.6

Determinant resid covariance (dof adj.)	2.31E+32
Determinant resid covariance	8.78E+31
Log likelihood	-1189.965
Akaike information criterion	83.92863
Schwarz criterion	85.20163
Number of coefficients	27

B10 Dynamic Ordinary Least Squares (DOLS)

Dependent Variable: GDP
Method: Dynamic Least Squares (DOLS)
Date: 02/19/24 Time: 13:24
Sample (adjusted): 2015Q4 2022Q4
Included observations: 29 after adjustments
Cointegrating equation deterministics: C
Fixed leads and lags specification (lead=1, lag=1)
Long-run variance estimate (Bartlett kernel, Newey-West fixed bandwidth =
4.0000)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CEXPA	-3.861251	2.780206	-1.388837	0.1802
REXPA	4.654459	1.217104	3.824208	0.0011
C	15785080	520573.9	30.32246	0.0000

R-squared	0.646172	Mean dependent var	17902972
Adjusted R-squared	0.504641	S.D. dependent var	1454883.
S.E. of regression	1023972.	Sum squared resid	2.10E+13
Long-run variance	5.40E+11		

B11 Breusch-Godfrey Serial Correlation LM Test:

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	1.388160	Prob. F(1,26)	0.2494
Obs*R-squared	1.571225	Prob. Chi-Square(1)	0.2100

B12 Residual Tests

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Date: 02/19/24 Time: 11:53
Sample: 2015Q3 2023Q1
Included observations: 31
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-13952958	12471491	-1.118788	0.2735
CEXPA	-0.005908	1.921616	-0.003075	0.9976
REXPA	-0.448251	1.229270	-0.364648	0.7183
LAGGDP	0.799097	0.720158	1.109614	0.2773
RESID(-1)	-0.849594	0.721094	-1.178202	0.2494

R-squared	0.050685	Mean dependent var	-1.80E-09
Adjusted R-squared	-0.095364	S.D. dependent var	1340920.
S.E. of regression	1403402.	Akaike info criterion	31.29339
Sum squared resid	5.12E+13	Schwarz criterion	31.52467
Log likelihood	-480.0475	Hannan-Quinn criter.	31.36878
F-statistic	0.347040	Durbin-Watson stat	1.896205
Prob(F-statistic)	0.843639		

B13 Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.030406	Prob. F(2,29)	0.3696
Obs*R-squared	2.123124	Prob. Chi-Square(2)	0.3459
Scaled explained SS	1.353850	Prob. Chi-Square(2)	0.5082

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 02/19/24 Time: 13:28
Sample: 2015Q2 2023Q1
Included observations: 32

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	5.20E+11	9.44E+11	0.550360	0.5863
CEXPA	1122332.	2664465.	0.421222	0.6767
REXPA	1524908.	1638208.	0.930839	0.3596

R-squared	0.066348	Mean dependent var	1.71E+12
Adjusted R-squared	0.001958	S.D. dependent var	2.17E+12
S.E. of regression	2.17E+12	Akaike info criterion	59.73389
Sum squared resid	1.36E+26	Schwarz criterion	59.87131
Log likelihood	-952.7423	Hannan-Quinn criter.	59.77944
F-statistic	1.030406	Durbin-Watson stat	2.639269
Prob(F-statistic)	0.369560		

B14 Test of normality assumption