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AI-Powered Predictive Analytics and Its Relationship with Budgeting Efficiency and Financial Accountability in Nigeria's Federal Public Sector

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Abstract

Budgets are the plans against which public financial reports are judged, and weak forecasting undermines both budget credibility and accountability. This study examines whether documented adoption of artificial intelligence (AI)-powered predictive analytics is associated with budgeting efficiency and financial accountability in Nigeria's federal public sector. A balanced panel of five federal institutions, the Federal Ministry of Finance, the Office of the Accountant-General of the Federation, the Federal Inland Revenue Service, the Central Bank of Nigeria and the Bureau of Public Procurement, is observed over 2015–2024. Documentary evidence from annual reports, audit-related documents and AI-implementation documents is scored on a five-point (0–4) rubric and analysed with pooled, fixed-effects, trend-adjusted, first-difference and lagged regressions, interpreted through agency theory. Predictive analytics adoption is positively and significantly associated with budgeting efficiency and accountability (pooled $\beta = 0.694$, $R^2 = 0.853$; fixed-effects $\beta = 0.712$, within $R^2 = 0.845$). The association remains significant after adjusting for a common trend ($\beta = 0.639$), in first differences ($\beta = 0.727$) and with a one-year lag ($\beta = 0.585$). The lagged estimate is the smallest of the specifications, consistent with, though not proof of, a maturation period during which models learn from data and users learn to rely on forecasts. Because the design is observational, the measures are documentary indices, and the sample is small and purposively selected, the results indicate association rather than proven causation and are interpreted for the five institutions examined rather than for all federal ministries, departments and agencies. The results support investment in forecasting capability and data infrastructure, with realistic expectations about time-to-benefit, accompanied by data-quality programmes, staff training, publication of forecast errors and expert review of model outputs.

Keywords: *Artificial intelligence; predictive analytics; budgeting efficiency; fiscal forecasting; financial accountability; public sector; Nigeria.*

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Introduction

A budget is both a plan and a standard of accountability. Revenue forecasts determine what can be spent; expenditure plans determine what officials will later be asked to explain; and the comparison of budgeted with actual outcomes is among the most important uses of financial reports. When forecasts are poor, budgets lack credibility, deviations are large, and the reports that record them are difficult to interpret. Nigerian public finance has long contended with under-implementation of budgets and revenue forecasts that diverge from outcomes, and the delays documented in the preparation and audit of federal consolidated statements (Office of the Auditor-General for the Federation, 2024) make it harder to learn from budget performance in time to correct it.

Predictive analytics, which uses machine learning and statistical models to forecast revenue, expenditure and fiscal risks, offers a means of improving this cycle. Models trained on historical and current data can generate forecasts that adapt to changing conditions, detect expected overruns early and support scenario analysis. Evidence from several countries indicates gains in forecast accuracy and budget control (Khan et al., 2023; Martínez & Gómez, 2020; Zhang & Li, 2023), and Nigerian studies of state and local government budgeting report similar benefits (Adeyemi & Balogun, 2024; Ojo & Adewale, 2023). However, forecasting systems require good data, technical skills and organisational acceptance, which are not equally available across institutions.

The present study investigates whether federal institutions with higher documented adoption of AI-powered predictive analytics show greater budgeting efficiency and accountability, and how stable that association is under demanding specifications. Two features distinguish it. First, it examines federal institutions with central roles in revenue, treasury, procurement and monetary policy, whereas much Nigerian evidence concerns state or local governments. Second, it is explicit that budgeting efficiency is a financial-management outcome that is not identical to financial reporting quality; it matters for reporting because budgets define the benchmarks against which reports are read.

Statement of the Problem

Budget credibility depends on forecasts that are accurate enough to support resource allocation and to provide a meaningful baseline against which actual outcomes can be assessed. Where forecasts diverge substantially from outcomes, budgets cease to function as reliable plans, deviations become difficult to interpret, and the accountability relationship between those who approve budgets and those who execute them is weakened. In Nigeria's federal public sector, this problem is compounded by delays in the preparation and audit of consolidated financial statements, which limit the timeliness with which budget performance can be reviewed and corrected (Office of the Auditor-General for the Federation, 2024).

Predictive analytics offers a potential response by improving the accuracy of revenue and expenditure forecasts, enabling earlier detection of variances and supporting scenario analysis. However, the existing evidence is dominated by single-site, descriptive or sub-national studies. There is little panel evidence for federal institutions on how predictive-analytics adoption relates to budgeting efficiency over time, and little attention to whether

benefits arrive with a lag, a question of practical importance because forecasting models require historical data and user experience before they can be expected to improve decisions.

A further problem concerns the measurement of the outcome. Budgeting efficiency is a broad concept influenced by revenue shocks, fiscal rules, political decisions and macroeconomic conditions, none of which are controlled in a documentary study. A composite index of documented budget effectiveness may therefore capture factors unrelated to forecasting models. The relationship between predictive-analytics adoption and budgeting efficiency requires careful empirical assessment, with explicit acknowledgement that an observed association may reflect institutional capacity, common trends or reverse causality rather than a direct effect of the technology.

Accordingly, this study examines the association between documented AI-powered predictive analytics and budgeting efficiency and financial accountability in five Nigerian federal institutions over the period 2015–2024, and assesses whether the association is stable under alternative specifications that account for institutional differences, common temporal trends and potential reverse causality.

Aim and Objectives of the Study

The main aim of this study is to examine the association between AI-powered predictive analytics and budgeting efficiency and financial accountability in Nigeria's federal public sector.

The specific objective is:

i. To examine the association between documented AI-powered predictive analytics and budgeting efficiency and financial accountability in Nigeria's federal public sector.

Research Question

The study is guided by the following research question:

i. What is the association between documented AI-powered predictive analytics and budgeting efficiency and financial accountability in Nigeria's federal public sector?

Research Hypothesis

The study tests the following hypothesis at the 5% level of significance:

H_0: Documented AI-powered predictive analytics is not significantly associated with budgeting efficiency and financial accountability in Nigeria's federal public sector.

H_1: Documented AI-powered predictive analytics is positively and significantly associated with budgeting efficiency and financial accountability in Nigeria's federal public sector.

Significance of the Study

For policy, the findings will provide evidence on whether documented predictive-analytics adoption is associated with budgeting efficiency and accountability in Nigeria's federal public sector. This evidence can inform decisions about investment in forecasting capability and data infrastructure, and can support realistic expectations about the time required before benefits materialise.

For practice, the study will identify whether federal institutions with higher documented adoption show better budget effectiveness, and will highlight the conditions such as data quality, staff training, model transparency and expert review, on which the benefits of forecasting analytics depend. It will also recommend the publication of forecast errors and budget-execution rates so that models can be evaluated directly.

For research, the study will contribute panel evidence for federal institutions to a literature dominated by single-site and sub-national studies, and will identify directions for future research, including higher-frequency data, direct measures of forecast error and user-acceptance studies.

Scope of the Study

The study covers five purposively selected federal institutions: the Federal Ministry of Finance, the Office of the Accountant-General of the Federation, the Federal Inland Revenue Service, the Central Bank of Nigeria and the Bureau of Public Procurement. Each institution is observed annually from 2015 to 2024, yielding a balanced panel of 50 institution-year observations. The study is limited to documentary evidence, annual reports, audit-related documents and AI-implementation documents, and does not collect survey or interview data. The findings are interpreted for the selected institutions and the period examined, not for all federal ministries, departments and agencies.

Review of Related Literature

Conceptual Review

Predictive Analytics in Public Budgeting

Predictive analytics represents a shift from traditional, predominantly historical approaches to budgeting towards data-driven financial planning. By applying statistical models and machine learning techniques to historical financial data, revenue trends and economic indicators, public institutions can anticipate future fiscal conditions and make more informed budgetary decisions. Khan et al. (2023) discuss the relevance of predictive analytics to public budgeting, particularly in relation to forecasting accuracy, the identification of potential budget shortfalls and resource allocation. Conceptually, these capabilities suggest that predictive analytics can strengthen the quality of budget preparation by enabling public institutions to make decisions based on anticipated fiscal conditions rather than relying exclusively on past expenditure patterns.

The potential contribution of predictive analytics to budgeting efficiency can be understood through three interrelated mechanisms: improved forecasting accuracy, early identification of budgetary deviations and more effective resource allocation. Zhang and Li (2023), in their discussion of AI-based budgeting in Chinese provincial governments, highlight the relevance of analytical tools to reducing resource misallocation and responding to economic changes. From a conceptual perspective, more reliable forecasts can support realistic revenue projections and expenditure planning, while the early identification of potential shortfalls and spending overruns can facilitate timely adjustments. Predictive insights may also help public institutions prioritize programmes according to anticipated needs and available resources. These mechanisms indicate that the value of predictive analytics lies not merely in generating forecasts, but in translating analytical information into more efficient budgeting decisions.

The relationship between predictive analytics and budgeting efficiency, however, should not be regarded as automatic. Martínez and Gómez (2020), in their discussion of predictive analytics in Spanish municipal budget management, provide a basis for considering its potential contribution to forecasting and expenditure control. Nevertheless, the extent to which such benefits can be realized depends on data quality, technological infrastructure, analytical competence and institutional capacity. Conceptually, these conditions determine whether predictive outputs can be translated into practical budgeting decisions. Thus, predictive analytics should be understood as an enabling capability whose contribution to budgeting efficiency depends partly on the institutional environment in which it is applied.

In Nigeria's federal public sector, this perspective provides a basis for examining how AI-powered predictive analytics could support more efficient budgeting within ministries, departments and agencies. Although insights from other public-sector contexts help explain the potential mechanisms involved, their applicability to Nigeria requires consideration of the country's own institutional and fiscal circumstances. The central conceptual issue is therefore not simply whether predictive technologies are available, but whether they can support more accurate forecasting, better expenditure planning and more responsive resource allocation. This distinction establishes a foundation for examining the relationship between AI-powered predictive analytics and budgeting efficiency in Nigeria's federal public sector, while recognizing that technological adoption alone does not guarantee improved financial management.

Nigerian Evidence

The application of predictive analytics in Nigeria's public sector can be conceptualized in relation to the country's efforts to strengthen budgetary control, expenditure monitoring and fiscal discipline. Ojo and Adewale (2023) discuss the use of predictive models in state budgeting, highlighting their potential to identify inefficiencies and anticipate revenue gaps. From a conceptual perspective, these capabilities are important because early identification of fiscal pressures can enable public institutions to adjust expenditure priorities and align spending plans more closely with available resources. Similarly, Adeyemi and Balogun (2024) examine predictive analytics in budgetary control within Nigerian local governments, emphasizing its relevance to detecting expenditure overruns and strengthening financial management. These perspectives suggest that predictive analytics may support budgeting efficiency by improving the timeliness and quality of financial information available to decision-makers.

Beyond budget formulation, predictive analytics may also strengthen expenditure monitoring and financial control. Ibe and Nnaji (2024) discuss the contribution of AI to budget forecasting and real-time variance reporting in the Nigerian public sector, while Njoku et al. (2024) highlight the potential of predictive digital tools to reduce financial leakages and improve monitoring. Conceptually, these applications demonstrate how analytical technologies may connect budget planning with implementation by enabling public officials to identify discrepancies between approved allocations and actual expenditure. However, the effectiveness of such technologies depends on whether identified discrepancies lead to timely corrective action and whether institutional control mechanisms can respond appropriately to the information generated.

The potential benefits of predictive analytics must also be considered alongside the institutional and technological conditions that shape its adoption. Jejeniwa et al. (2024) emphasize the importance of technical infrastructure and appropriate regulation, while Nsoke (2024) identifies technical expertise and implementation costs as potential constraints. Similarly, Obiora and Agwu (2024) draw attention to differences in institutional readiness. Taken together, these perspectives suggest that the relationship between predictive analytics and improved public financial management is conditional rather than automatic. Data availability, staff competence, implementation costs, regulatory arrangements and organizational preparedness may influence the extent to which predictive tools can be effectively integrated into budgeting processes.

For Nigeria's federal public sector, these considerations provide a basis for examining predictive analytics as both a technological capability and an institutional challenge. Although the literature discussed above offers insights into its potential applications across Nigerian public institutions, the implications for federal ministries, departments and agencies require careful conceptual consideration. In particular, the relationship between AI-powered predictive analytics, budgeting efficiency and financial accountability warrants attention to how improved forecasting and expenditure monitoring may support more disciplined resource use and stronger accountability practices. This perspective positions institutional readiness and implementation capacity as important considerations in understanding the potential contribution of predictive analytics to public financial management in Nigeria.

Empirical Review

Adeyemi and Balogun (2024), in Effectiveness of Predictive Analytics on Budgetary Control in Nigerian Local Governments, deployed support vector machines to analyse budget variance reports. Their empirical results demonstrated enhanced detection of budget overruns and improved financial management outcomes.

Njoku et al. (2024), in Improving Financial Management of the Nigerian Public Sector Using Digital Technologies, employed empirical analysis using quantitative data to evaluate the impact of predictive tools on financial leakages and monitoring. Their findings demonstrated enhanced financial accountability through better oversight in Nigerian public finance.

Singh and Gupta (2024), in Predictive Analytics and Financial Accountability in Indian Local Governments, used random forest and gradient boosting techniques on budget data across several states. Their analysis demonstrated

significant improvements in predicting revenue collection and expenditure, supporting transparent and accountable budgeting practices.

Khan et al. (2023), in Predictive Analytics in Public Sector Budgeting: A Case Study of South Korea, applied time series forecasting and regression analysis on government expenditure data. Their predictive models improved budget accuracy and anticipated financial shortfalls, promoting better public financial accountability and resource allocation.

Ojo and Adewale (2023), in The Role of Predictive Analytics in Nigerian State Budgeting, applied machine learning algorithms to state budget data from 2015–2021. The predictive models identified inefficiencies and forecasted revenue gaps, facilitating improved budget discipline and accountability in Nigerian states.

Zhang and Li (2023), in AI-Driven Predictive Budgeting Models in Chinese Provincial Governments, applied big data analytics on fiscal datasets. Their analysis demonstrated that AI-enhanced budgeting reduced misallocation and increased responsiveness to economic changes, thereby promoting financial accountability.

Ezeani and Chukwu (2022), in Machine Learning Applications in Nigerian Public Budget Control, analysed budgetary performance reports using machine learning classifiers. Their findings showed predictive analytics helped detect inconsistencies and improved compliance with budgetary controls.

Nguyen and Tran (2022), in Implementing Predictive Budgeting Tools in Vietnamese Municipalities, used a mixed-methods approach combining surveys and budget data analysis. Their study found that municipalities adopting predictive analytics achieved more accurate forecasts and better policy-aligned expenditures, enhancing financial controls.

Al-Besher and Kumar (2022), in Use of Artificial Intelligence to Enhance E-Government Services, conducted multiple case analyses demonstrating that AI-driven predictive analytics improve operational efficiency and budgeting foresight, leading to stronger financial accountability in digital government services.
Aliyu et al. (2021), in Anomaly Detection of Budgetary Allocations Using Machine-Learning-Based Techniques, applied machine learning algorithms to Nigerian federal budget data to detect irregularities. Their predictive models successfully identified anomalies, supporting enhanced transparency and fiscal integrity in public budgeting.

Mauro et al. (2021), in New Public Management between Reality and Illusion, combined qualitative and quantitative methods to evaluate performance-based budgeting in European governments. They concluded that predictive tools improved budget tracking but emphasized the need to align metrics with accountability to avoid inefficiencies.

Wang et al. (2021), in AI-Based Predictive Budgeting in Chinese Public Finance, focused on supervised learning techniques applied to government expenditure records. Their findings indicated significant improvements in budget monitoring, reducing fiscal leakages and boosting accountability.

Pereira and Silva (2021), in Predictive Analytics for Public Budget Forecasting in Brazil, used artificial neural networks on multi-year budget datasets to forecast expenditure trends. Their empirical findings suggested that predictive analytics supported proactive budget adjustments, reducing deficits and enhancing transparency.

Research Gap

The evidence above is dominated by single-site, descriptive or sub-national studies. There is little panel evidence for federal institutions on how predictive-analytics adoption relates to budgeting efficiency over time, and little attention to whether benefits arrive with a lag. The gap, then, is empirical rather than conceptual: whether documented AI-powered predictive analytics and budgeting efficiency move together in Nigerian federal institutions, once institutional differences and common temporal trends are accounted for, has not been examined with institution-level, multi-year documentary evidence.

Theoretical Framework: Agency Theory

Agency theory (Jensen & Meckling, 1976) implies that principals depend on credible budgets and variance reports to evaluate agents. Predictive analytics can reduce information asymmetry between budget planners and those who must approve and oversee budgets by making forecasts more accurate, assumptions more explicit and deviations more visible, thereby strengthening financial accountability. This study is therefore anchored on agency theory, which establishes the accountability rationale for examining budgeting efficiency as an outcome of predictive-analytics adoption.

The study hypothesises that AI-powered predictive analytics is positively associated with budgeting efficiency and financial accountability in Nigeria's federal public sector.

Methodology

Sample

The study uses a longitudinal archival research design with five purposively selected federal institutions, the Federal Ministry of Finance (FMF), the Office of the Accountant-General of the Federation (OAGF), the Federal Inland Revenue Service (FIRS), the Central Bank of Nigeria (CBN) and the Bureau of Public Procurement (BPP), observed annually from 2015 to 2024, giving 50 institution-year observations. Selection reflected relevance to public financial management and the availability of documentary evidence. The sample is not probability-based, and results apply to these institutions, not to all federal ministries, departments and agencies.

Variables

AI-powered predictive analytics (AIPA) is a five-point (0–4) composite index of documented use of AI models to forecast financial trends and support budget planning. The rubric assigns scores as follows: 0 = no documentary evidence; 1 = policy statement or intention only; 2 = pilot, tender or procurement stage documented; 3 = partial deployment in at least one functional area; 4 = full documented deployment across core budgeting operations. Higher scores indicate greater documented adoption.

Budgeting efficiency and financial accountability (FRQ4) is a five-point (0–4) composite index reflecting documented effectiveness of budget preparation, allocation and monitoring. The rubric assigns scores on the same 0–4 scale. Higher scores indicate more favourable documented outcomes.

Scores are derived from annual reports, audit-related documents and AI-implementation documents using the predefined rubrics. Both variables are ordinal-derived indices; coefficients are therefore in index points, not physical measures of forecast error or budget deviation. To support scoring consistency, a second coder independently scored a random subset of 20% of the institution-year observations, and discrepancies were resolved by re-examining the underlying documentary evidence.

Estimation

The baseline model is specified as:

$$FRQ4_{it} = \beta_0 + \beta_1 AIPA_{it} + \varepsilon_{it}$$

where $FRQ4_{it}$denotes the budgeting efficiency and accountability score for institution $i$in year t, $AIPA_{it}$represents the corresponding predictive-analytics adoption score, and $\varepsilon_{it}$is the error term. The model is estimated by pooled ordinary least squares (OLS) and by an institution fixed-effects estimator with HC3 robust standard errors, which are preferable to clustered errors when there are only five clusters.

A Hausman test does not reject random effects ($\chi^2 = 0.738$, $p = 0.390$); the random-effects slope (0.696) is close to the fixed-effects slope (0.712). Fixed effects are reported because institutional mandates, budget autonomy and data capacity plausibly correlate with adoption, and the panel has only five units.

Robustness checks add a linear trend:

$$FRQ4_{it} = \alpha_i + \beta_1 AIPA_{it} + \beta_2 Trend_t + \varepsilon_{it}$$

use of first differences:

$$\Delta FRQ4_{it} = \beta_1 \Delta AIPA_{it} + \Delta\varepsilon_{it}$$

and lag AIPA by one year:

$$FRQ4_{it} = \alpha_i + \beta_1 AIPA_{i,t-1} + \varepsilon_{it}$$

The lagged specification also allows a check of the maturation hypothesis: whether benefits arrive with a delay as models learn from data and users learn to rely on forecasts. These specifications assess whether the association survives controls for institutional differences and common temporal drift, and they mitigate, but do not eliminate, concerns about reverse causality. A formal test of the maturation hypothesis would require higher-frequency data and is left to future research.

Statistical significance is assessed at the 5% level. The results are interpreted with consideration of the small number of institutions, the documentary basis of the measurements and the observational nature of the research design. In particular, the use of heteroskedasticity-consistent standard errors does not, by itself, eliminate concerns about serial dependence or common shocks in a panel containing only five institutions, so the reported p-values are treated as lower bounds on uncertainty rather than as exact. The estimates are therefore interpreted conservatively: the pooled and fixed-effects coefficients are treated as upper references, the trend-adjusted and first-difference

coefficients as the more demanding tests, and the lagged coefficient as evidence on timing rather than on contemporaneous association.

Results

Descriptive Statistics

Mean budgeting efficiency and accountability is 3.30 (SD = 0.53), and mean predictive-analytics adoption is 3.70 (SD = 0.71). Over the decade, institutional averages rise from 2.63 to 4.04 for budgeting efficiency and from 2.67 to 4.59 for adoption. The two are strongly correlated (r = 0.92), reflecting this common upward drift. Adoption started lower than other AI applications in 2015 and rose faster; the BPP records the lowest average and the CBN and FIRS the highest.

The high correlation and the parallel upward trends in both series motivate the estimation strategy set out: the trend and first-difference specifications are needed to assess how much of the raw association survives once common temporal drift is removed.

Table 1. Descriptive statistics and correlation matrix (N = 50)

Variable	Mean	SD	Min	Max	1	2
1. FRQ4 (budgeting efficiency and accountability)	3.30	0.53	2.00	4.50	1.00	
2. AIPA (predictive-analytics adoption)	3.70	0.71	2.00	5.00	0.92	1.00

Note: FRQ4 = budgeting efficiency and financial accountability; AIPA = AI-powered predictive analytics. Scores are composite indices on a 0–4 rubric, rescaled here to a 1–5 reporting range for presentation. The final two columns report pairwise Pearson correlations; the diagonal is 1.00 by construction and the upper triangle is left blank. Source: Author's computation from the panel dataset.

Main Estimates

Table 2. Predictive analytics and budgeting efficiency and accountability (dependent variable: FRQ4)

Specification	Coefficient on AIPA	Robust SE	p-value	N
Pooled OLS	0.694	0.042	< 0.001	50
Fixed effects (institution)	0.712	0.046	< 0.001	50
Fixed effects + linear trend	0.639	0.173	< 0.001	50
First differences	0.727	0.158	< 0.001	45
Fixed effects, AIPA lagged one year	0.585	0.101	< 0.001	45

Note: Pooled model: constant = 0.730 ($p < 0.001$), $R^2 = 0.853$, adjusted $R^2 = 0.850$, $F = 279.1$. Standard errors other than pooled are HC3-robust. The first-difference and lagged models lose the first year for each institution (5 observations), yielding N = 45. Source: Author's computation from the panel dataset.

In the pooled model, one additional point of predictive-analytics adoption is associated with 0.694 points higher budgeting efficiency and accountability (SE = 0.042, t = 16.71, $p < 0.001$), and the model accounts for 85.3 per cent of its variation. The within-institution estimate is 0.712 (robust SE = 0.046), with a within R^2 of 0.845.

Diagnostics are satisfactory: the Durbin–Watson statistic of 2.17 is close to the conventional value of 2, indicating no first-order autocorrelation; the Breusch–Pagan test provides no evidence of heteroskedasticity ($p = 0.868$); and the Jarque–Bera test does not reject normality of residuals ($p = 0.923$). On this evidence the null hypothesis of no association (H_0) is rejected in favour of the alternative (H_1).

Robustness and Timing

The trend-adjusted coefficient is 0.639 and the first-difference coefficient is 0.727, both significant at the 1 per cent level. The lagged specification yields 0.585, the smallest coefficient in Table 2 but still highly significant. This pattern is compatible with a maturation process, since forecasting models need history and calibration and users need experience before they act on predictions; it is equally compatible with measurement noise or with the coarse annual frequency of the data, so the timing result should be treated as suggestive. Taking the trend-adjusted and lagged estimates together, a conservative reading is that one additional point of adoption is associated with about 0.6 points of higher budgeting efficiency and accountability, with the pooled estimate of 0.7 serving as an upper reference.

Discussion

This section discusses the findings in relation to theory and prior evidence, states four interpretive cautions, and identifies the study's limitations.

The findings are consistent with agency theory and with evidence from other countries and from Nigerian sub-national governments that forecasting analytics improve budget control (Adeyemi & Balogun, 2024; Khan et al., 2023; Ojo & Adewale, 2023; Zhang & Li, 2023). They extend that evidence to federal institutions and show that the association is not merely the product of a shared upward trend.

Four interpretive cautions deserve emphasis. First, budgeting efficiency is a broad outcome influenced by revenue shocks, fiscal rules, political decisions and macroeconomic conditions, none of which are controlled; a five-point rubric of documented budget effectiveness will also be influenced by factors unrelated to forecasting models. Second, adoption may be easier in institutions with strong data and planning capacity, so causality may in part run from capacity to adoption. Third, the institutions studied differ in mandate: forecasting revenue at the FIRS is a different task from forecasting expenditure at the Ministry of Finance, and the index averages over such differences. Fourth, forecasting models can fail where data are poor, and a model's output is only as credible as the assumptions behind it, so transparency about model assumptions and uncertainty is a prerequisite for accountability, not a substitute for it.

The lagged result also has practical meaning. If benefits do build over time, evaluation of pilot projects in their first year may understate eventual gains, and funders should plan multi-year horizons for evaluation. This is a hypothesis for further study rather than a finding of this study.

Limitations. The study has four principal limitations. First, budgeting efficiency is influenced by factors not controlled in a documentary design, and the composite index averages over institutional differences in mandate. Second,

reverse causality cannot be excluded: institutions with stronger data and planning capacity may be better placed to adopt and document predictive analytics. Third, the sample is small (five institutions) and purposively selected for documentary availability, which may favour better-resourced entities. Fourth, the dependent variable is an index of documented budget effectiveness, and the data do not allow forecast error or budget-execution rates to be observed directly. The study should not be read as evidence that predictive analytics caused budgeting efficiency to improve, nor that the pattern generalises to all federal MDAs.

Conclusion and Recommendations

Conclusion

This study examined the association between documented AI-powered predictive analytics and budgeting efficiency and financial accountability in five Nigerian federal institutions over the period 2015–2024. Using a balanced panel of 50 institution-year observations and a composite-index measurement strategy, the analysis finds a positive and statistically significant association in every specification estimated. The pooled and fixed-effects models produce coefficients of 0.694 and 0.712 respectively; the association remains large and significant when a linear time trend is added (0.639), in first differences (0.727) and in the lagged specification (0.585).

The conclusion must be stated with precision. The coefficients are associations between two documented indices, not causal estimates of the effect of AI on budget performance. The shrinkage under the trend specification shows that part of the raw association reflects common temporal drift, including broader public financial management reforms over the period, and the fixed-effects and lagged results mitigate, but cannot eliminate, concerns about reverse causality. The lagged estimate being the smallest of the specifications is consistent with a maturation process, but this interpretation should be treated as suggestive rather than established. The findings therefore support a conditional and directional conclusion: in the selected institutions, deeper documented adoption of AI-powered predictive analytics is associated with better documented budgeting efficiency and accountability, with the conservative estimate placing the association at roughly 0.6 index points per additional point of adoption. They do not establish that predictive analytics caused budget performance to improve, nor that the pattern generalises to Nigeria's wider federal public sector.

Recommendations

i. The results support investment in forecasting capability, combined with data-quality programmes, continuous staff training and the publication of forecast errors, so that models are held to account like other instruments of fiscal policy.
ii. Budget offices should pair model outputs with expert review and scenario analysis. Because forecasting models can fail where data are poor, transparency about model assumptions and uncertainty is a prerequisite for accountability, not a substitute for it.
iii. If benefits build over time, evaluation of pilot projects in their first year may understate eventual gains; funders should plan multi-year horizons for evaluation.

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