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ASSESSING THE IMPACT OF MACROECONOMIC INDICATORS ON TAX REVENUE PERFORMANCE IN NIGERIA: EVIDENCE FROM A MARKOV SWITCHING MODEL

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Abstract

Tax revenue plays a vital role in financing public services in Nigeria. However, its performance has shown significant fluctuations in recent years. This study investigates the influence of macroeconomic variables on tax revenue performance in South Africa over the period from the first quarter of 2000 to the third quarter of 2024, employing the Markov Switching Model (MSM). The analysis reveals that the effects of macroeconomic factors vary across different economic regimes. Specifically, inflation and interest rates are found to reduce tax revenue in the first regime but contribute positively in the second. Conversely, the exchange rate and current account balance enhance revenue in regime one, while exerting a negative influence in regime two. Notably, economic growth consistently promotes tax revenue across both regimes. These findings underscore the importance of accounting for prevailing economic conditions when assessing tax revenue dynamics. Policymakers should tailor fiscal strategies to these varying impacts in order to strengthen and stabilize tax collection. A clear understanding of the relationship between economic conditions and revenue performance is crucial for designing policies that support long-term fiscal sustainability.

Keywords: Macroeconomic Variables, Markov Switching Model, Tax Revenue Performance.

INTRODUCTION

Markov-switching models serve as valuable analytical tools for examining processes that undergo occasional and distinct shifts over time. Since their introduction by Hamilton (2023), these models have gained prominence as nonlinear time series frameworks, particularly in economic and financial analyses. In the Nigeria context, Markov-switching models are especially useful for identifying transitions and fluctuations in macroeconomic variables that influence tax revenue performance. As noted by Gökpnar (2023), any element that affects income, expenditure, or wealth—core components of the tax base—can have an immediate impact on tax revenue. These economic factors often interact in

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complex ways, especially under varying macroeconomic conditions. Strengthening tax revenue is therefore essential for enhancing the government's ability to respond to economic, health, and financial crises, and for funding essential public services Gnangnon & Jean-François, (2024). Improved revenue collection can support infrastructure development, bolster healthcare and education systems, and ultimately improve citizens' quality of life Streimikiene et al., (2023).

While these studies underscore the role of macroeconomic indicators in shaping tax revenue, many adopt linear models and fail to consider possible regime shifts or non-linear relationships. This study argues that tax revenue responses to macroeconomic variables may differ under varying economic conditions and should be modeled accordingly. For example, during an economic boom (regime one), higher earnings may stimulate tax collections through increased consumer expenditure. In contrast, during downturns (regime two), elevated inflation may dampen investment and reduce consumption, thereby weakening tax revenue performance.

Accordingly, this research investigates whether fluctuations in key macroeconomic variables significantly affect tax revenue performance in Nigeria, and whether their effects differ across economic regimes. Using a Markov Switching Model (MSM), the study analyzes the behavior of these macroeconomic variables across two distinct phases—expansion and recession. The results suggest that these variables exhibit regime-dependent impacts, indicating the necessity for policymakers to adapt tax policies based on prevailing economic conditions to enhance revenue outcomes.

LITERATURE REVIEW

Theoretical Framework

Optimal Taxation Theory

The optimal taxation framework, initially introduced by Ramsey (2023), advocates for a tax system that aims to minimize economic inefficiencies while enhancing overall social welfare. Over the years, the theory has evolved through the contributions of scholars such as Diamond and Mirrlees (2024) and Saez (2022), who have refined its principles to better suit modern economic conditions. The theory emphasizes critical goals such as economic efficiency, equity, simplicity, and pragmatic trade-offs in policy design. A central element of the theory is the "tax schedule," which involves setting tax rates across different income brackets to achieve a balance between equity and efficiency. By applying progressive tax rates, governments can foster equitable income distribution while minimizing adverse effects on economic performance. Higher taxes on the affluent can help curb income disparities, whereas reduced rates for lower-income earners can stimulate consumption and support growth.

In the context of Nigeria, issues such as income inequality, persistent unemployment, and fiscal imbalances Simkins, 2024; Marire, (2022) present unique challenges in implementing optimal tax policies. The South African tax structure adopts vertical equity, whereby individuals with higher earnings are taxed at higher rates. While this strategy

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aims to address inequality, overly burdensome tax rates may risk deterring investment and productivity, highlighting the delicate balance required in tax policy design.

Laffer curve Theory

The Laffer curve illustrates the relationship between tax rates and government revenue, a concept popularized by economist Arthur Laffer (Fedeli et al., 2024). According to Laffer (2004), there exists an optimal tax rate at which revenue is maximized. If tax rates are too low, government income may be insufficient to support public expenditures. On the other hand, excessively high rates can suppress economic activity and encourage tax evasion, thereby diminishing overall revenue (Quentin, 2024).

Amadeo (2021) notes that reducing tax rates can increase individuals' disposable income, thereby stimulating consumption and economic expansion. This, in turn, can broaden the tax base, potentially offsetting revenue losses due to the lower rates. However, once rates exceed a certain threshold, the negative effects on productivity and compliance may outweigh any gains. Thus, identifying a balanced tax rate is vital for ensuring sustainable revenue generation while fostering economic vitality.

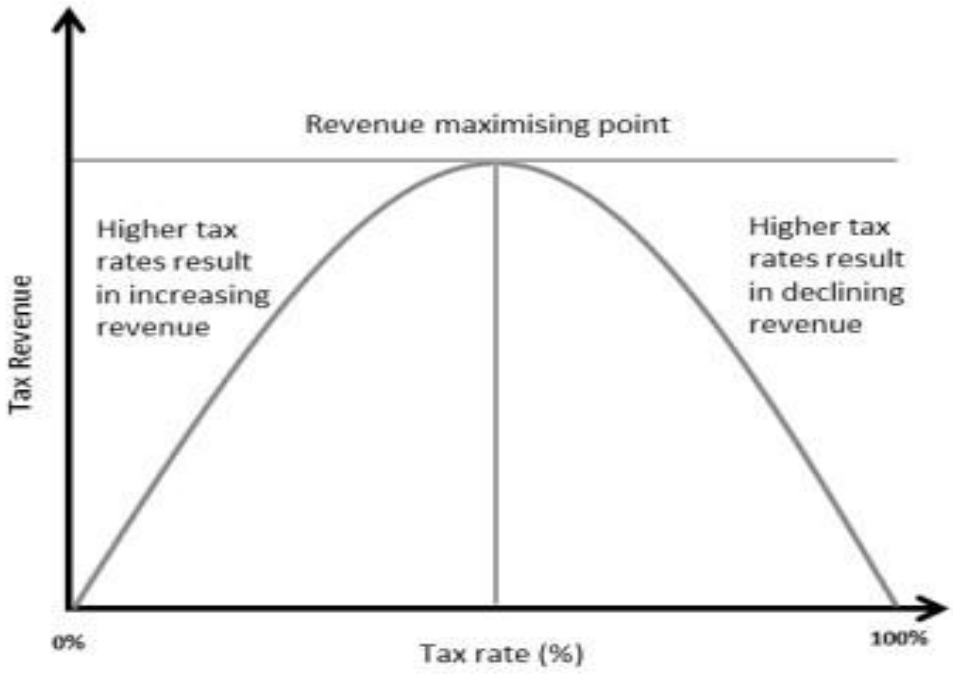

Figure 1: General form of a Laffer Curve

Source (Laffer, 2024)

Application of the Laffer Curve to South Africa

Figure 1 illustrates the Laffer Curve, which depicts how changes in tax rates can influence government revenue. The curve suggests that there is a specific tax rate at which revenue is maximized. This theory is applicable when analyzing Nigeria tax policy. According to

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Pamba (2022), the country's primary sources of tax income include value-added tax (VAT), corporate income tax (CIT), and personal income tax (PIT). However, relatively low rates in both the personal and corporate tax categories may limit the government's ability to generate sufficient revenue for essential services such as healthcare, education, and infrastructure development.

For Nigeria to optimize its tax revenue, moderate tax rates that encourage voluntary compliance are ideal. These rates reduce the incentive for tax evasion and promote a broader tax base. In contrast, excessively high tax rates may prompt avoidance strategies or lead individuals and businesses to move their wealth to other jurisdictions. The Laffer Curve is thus particularly relevant for Nigeria in the context of reforming tax policy to address deep-rooted income disparities.

Schoeman and Van Heerden (2023) explored optimal taxation in Nigeria from 1960 to 2017, concluding that the country's actual tax burden exceeded the level considered optimal for growth. They recommended tax policy adjustments to enhance economic performance. Their analysis suggested an ideal tax-to-GDP ratio of 18.5%, a figure consistent with estimates by Scully (2023), who identified optimal tax rates of 19% for the United States and 23% for New Zealand.

Empirical Literature Review

Đurović et al. (2024) analyzed the determinants of tax revenue across the Visegrad Group countries over the 2000–2024 period using a panel data approach. Their study employed the Pooled Mean Group (PMG) estimator and found that short-term changes in GDP and population had a notable impact on tax revenue, while inflation exerted a negative influence. Additionally, the expansion of the European Union affected tax revenue dynamics in both the short and long term, with government revenue growth showing a positive long-run association with tax income. However, rising long-term unemployment was identified as a limiting factor.

In a Nigerian context, Atolagbe and Abiodun (2021) investigated the effect of trade liberalization on tax revenue from 2000 to 2024. Using the Error Correction Model (ECM) and the Autoregressive Distributed Lag (ARDL) approach, they discovered that a one-unit increase in trade liberalization resulted in a 3% increase in tax revenue. Their findings highlighted the influence of key macroeconomic variables such as mining and petroleum outputs, agricultural production, foreign direct investment (FDI), per capita income, inflation, and exchange rates on revenue collection. Similarly, Ikpesu (2022) employed the Dynamic Ordinary Least Squares (DOLS) technique to evaluate the drivers of tax revenue in Nigeria between 1981 and 2021. The analysis identified GDP growth, FDI inflows, foreign debt, foreign aid, inflation, and exchange rate fluctuations as major influencers of Nigeria's tax performance.

Panel data studies conducted by Sulaiman et al. (2021). examined tax revenue determinants in broader international contexts. The former covered 59 developed and developing nations between 1995 and 2015, while the latter focused on 29 lower-middle-income economies from 2001 to 2024. Both studies concluded that variables such as

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government spending, per capita GDP, inflation, trade openness, population size, and the economic contributions of agriculture and services significantly influenced the tax-to-GDP ratio. In Nigeria, Okonkwo (2018) utilized the Ordinary Least Squares (OLS) method to analyze the period from 1980 to 2024, identifying inflation, money supply, interest rates, and income levels as critical factors shaping tax outcomes.

In their study of sub-Saharan Africa, Addison and Levin (2012) analyzed data from 39 countries spanning 1980 to 2015. They found that tax base structure, institutional weaknesses, foreign aid, and conflict were key variables impacting tax collection across the region.

In Croatia, Belullo and Dužman (2023) explored the relationship between GDP and government revenue from 2000 to 2025, revealing a strong Granger causality between changes in GDP and variations in revenue.

Focusing on Nigeria, Mmbulaheni et al. (2024) examined the period from 1990 to 2018 using Johansen's cointegration technique and error correction modeling. Their results showed that trade openness, FDI, and GDP per capita positively influenced tax revenue in both the short and long run. However, inflation and unemployment had a significant inverse effect on tax revenue performance.

Similarly, Hlongwane et al. (2022) employed the ARDL model to assess factors affecting tax performance in Nigeria between 1972 and 2023. They observed that government expenditure consistently promoted tax revenue generation in both timeframes. Inflation was found to have a negative impact, while economic growth contributed positively in the short term but was statistically insignificant in the long run.

Identified Gaps in the Literature

Despite a wealth of studies on tax revenue determinants, few have explored these relationships using nonlinear or regime-switching models. This limitation restricts our understanding of how tax revenue dynamics shift under different economic conditions.

Nonlinear and regime-switching models provide more robust insights into how macroeconomic variables behave across various economic regimes, such as expansion or recession. Employing these advanced methodologies can enhance the accuracy of tax revenue predictions and support the development of more responsive and context-specific fiscal strategies Sulaiman et al. (2021).

Research Hypotheses

- **H1:** Macroeconomic indicators such as inflation, interest rates, exchange rates, GDP growth, and current account balances have a statistically significant and regime-dependent effect on tax revenue performance in Nigeria.
- **H2:** The influence of macroeconomic variables on tax revenue performance differs significantly between periods of economic growth and economic contraction.

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METHODOLOGY

Data Collection

This study relied on secondary quarterly time series data sourced from three reputable institutions: the South African Reserve Bank (SARB), the World Bank, and the International Monetary Fund (IMF). The SARB offers comprehensive economic data relevant to South Africa, including figures on tax revenue, inflation, interest rates, and exchange rates (Source: https://www.resbank.co.za). Real GDP growth statistics were retrieved from the World Bank's World Development Indicators database (https://www.worldbank.org), while data on current account balances were obtained from the IMF's official datasets (https://www.imf.org). The dataset spans the period from the first quarter of 2000 (2000Q1) to the third quarter of 2023 (2023Q3). All variables were extracted from publicly accessible sources. When quarterly data were not directly available, particularly from the World Bank, the frequency conversion feature in EViews was employed, following the approach used by Mamvura and Sibanda (2020).

Variable Specification

Dependent Variable

The primary outcome variable in this analysis is tax revenue (TR) performance, measured as a percentage of GDP, following Queku et al. (2024). This indicator reflects the government's ability to mobilize domestic resources for public spending and infrastructure development Mohammed & Tangl, (2024). By evaluating the macroeconomic factors that influence TR performance, the study aims to provide insight into effective fiscal strategies for economic development.

Independent Variables

- **Inflation (INF):** Measured by the Consumer Price Index (CPI), inflation reflects the quarterly percentage change in the average price level of a standard basket of goods and services (Anware, 2014). Increases in inflation can reduce consumer purchasing power, limit demand, and, consequently, lower tax revenues. Previous findings by Mmbulaheni et al. (2024) report a negative correlation between inflation and tax revenue in South Africa. This study similarly expects inflation to have a detrimental effect on TR across different economic regimes.
- **Interest Rates (IR):** Interest rates significantly influence borrowing and investment behavior. Elevated interest rates raise the cost of credit for businesses and consumers, suppressing economic activity and reducing the tax base Chamisa & Sunde, 2024; Kozlov, (2023). In contrast, lower rates may stimulate consumption and investment, potentially enhancing government revenue. However, the strength of this relationship may vary with the economic cycle—more pronounced during expansions than recessions.
- **Exchange Rate (EXR):** Exchange rate movements also play a key role in shaping tax revenue. A weaker domestic currency can enhance export competitiveness, leading to increased economic activity and higher tax collections Sulaiman et al. (2021).

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Conversely, a stronger currency might suppress exports, reducing taxable income. These effects are context-dependent; during downturns, even favorable exchange rates may not lead to revenue gains if overall demand remains low.

- **Real GDP Growth (RGDP):** Economic growth, captured by changes in real GDP, typically boosts tax revenue as corporate profits and household incomes rise Pamba, 2022; Mmbulaheni et al., (2024). While expansions often result in increased government revenue, contractions can erode the tax base through business losses and rising unemployment. As such, the impact of GDP growth on tax revenue may differ depending on whether the economy is in an expansion or recession phase.
- **Current Account Balance (CAB):** The state of the current account—whether in surplus or deficit—can influence a country's fiscal capacity. A sustained current account deficit may indicate a reliance on external financing, which could undermine domestic revenue collection (Abiad et al., 2019; Abbas et al., 2021). In times of economic prosperity, these deficits may exert less pressure on tax performance, while during recessions, they could severely constrain fiscal space.

Stationarity Testing

Unit Root Tests

Prior to model estimation, it is important to determine the time series properties of each variable to avoid spurious regression results. Specifically, the analysis tested for the presence of unit roots to assess stationarity.

Augmented Dickey-Fuller (ADF) Test

To test for stationarity, the Augmented Dickey-Fuller (ADF) test (2024) was applied. The null hypothesis posits that the series is non-stationary (i.e., has a unit root), while the alternative hypothesis suggests stationarity. Identifying whether the series are stationary at levels or require differencing helps in selecting the appropriate econometric techniques for further analysis.

The ADF test equation is:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \sum_{i=1}^{p} \delta_i \Delta Y_{t-i} + \epsilon_t \quad (1)$$

Where:

- Y_t is the time series (e.g., tax revenue or a macroeconomic factor),
- $\Delta Y_t = Y_t - Y_{t-1}$ is the first difference of the series,
- α is a constant (drift term),
- βt represents the trend in the series,
- γ is the coefficient of the lagged level of the series, which is critical for testing the unit root (if $\gamma = 0$, there is a unit root),
- δ_i are the coefficients of the lagged differences to account for autocorrelation,

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- ϵ_t is the error term.

The decision rule is:

- The null hypothesis should be rejected (the series is stationary) if the test statistic is less than the critical value.
- Reject the null hypothesis if the test statistic exceeds the critical value (there is a unit root in the series).

Phillips-Perron (PP) Test (1988)

The Phillips-Perron (PP) test offers an alternative approach to examining the presence of unit roots in time series data. Unlike the Augmented Dickey-Fuller (ADF) test, the PP test does not rely on adding lagged difference terms to correct for serial correlation. Instead, it applies a **non-parametric adjustment** to the test statistics, making it more flexible in handling issues such as **autocorrelation and heteroscedasticity** in the error terms.

Although the regression equation used in the PP test is structurally similar to that of the ADF test, the key distinction lies in its correction method. The PP test modifies the standard error of the coefficient to account for serial correlation, thus providing more reliable results under certain data conditions.

The PP test is based on the following regression:

$$Y_t = \alpha + \beta t + \gamma Y_{t-1} + \epsilon_t \quad (2)$$

Where:

- Y_t is the time series,
- α is the constant,
- βt is the deterministic trend,
- γ is the coefficient of the lagged dependent variable,
- ϵ_t is the error term.

Phillips-Perron (PP) Test – Additional Clarification

Unlike the Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) test does not handle serial correlation by including lagged terms of the dependent variable. Instead, it corrects for both **serial correlation** and **heteroscedasticity** directly in the test statistic using non-parametric techniques applied to the residuals. This approach makes the PP test especially useful when the data may suffer from issues that standard ADF procedures cannot fully address.

The **decision rule** for the PP test is consistent with that of the ADF test:

- If the calculated test statistic is **less than the critical value**, the null hypothesis of a unit root is **rejected**, indicating that the series is **stationary**.

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- If the test statistic is **greater than the critical value**, the null hypothesis **cannot be rejected**, suggesting the series is **non-stationary**.

Markov Switching Model (MSM)

The Markov Switching Model (MSM) was initially introduced by Goldfeld and Quandt in 1973 and later refined by Hamilton (2023), particularly in his study of business cycle fluctuations. This econometric technique is designed to capture changes in the structure of a time series by allowing model parameters to shift between different regimes or states over time. In the context of this study, the MSM is applied to evaluate how **macroeconomic variables**—including inflation, real GDP growth, interest rates, exchange rates, and current account balances—affect **tax revenue performance** under varying economic environments, such as **periods of expansion** and **recession**. This framework recognizes that economic relationships may not remain constant across time and allows for transitions between different states that reflect underlying shifts in economic conditions.

For instance, let YtY_tYt represent tax revenue, and let XtX_tXt include the relevant macroeconomic indicators. The relationship between YtY_tYt and XtX_tXt is assumed to differ depending on the regime or state of the economy—such as high-growth phases (state 1) versus low-growth phases (state 2). The movement between these states is governed by a **first-order Markov process**, which determines the probability of switching from one regime to another based on historical behavior. By incorporating regime-dependent dynamics, the MSM provides deeper insights into how fiscal performance responds to macroeconomic shifts. This makes it a valuable tool for policymakers aiming to design adaptive and responsive tax policies that align with changing economic realities.

General Model:

$$Y_t = \beta_{St} X_t + \epsilon_t \quad (3)$$

Where:

- Y_t is the tax revenue at time t
- X_t is a vector of macroeconomic factors (e.g., like inflation, interest rates, exchange rate, RGDP and current account balance)
- β_{St} is a state-dependent coefficient (varying with regime S_t),
- ϵ_t is an error term (usually assumed to be normally distributed),
- First-order Markov processes determine the unobserved (latent) state variable, S_t.

Markov Process:

Markov processes with transition probabilities evolve the state variable S_t:

$$P = (S_t = j \mid S_{t-1} = i) = p_{ij} \quad (4)$$

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Where:

- p_{ij} is the probability of switching from state i to state j,
- i and $j \in \{1,2,\ldots,k\}$, with k being the number of states (regimes).

Transition Probability Matrix:

As a matrix of transition probabilities, P can be expressed as follows:

$$P = \begin{matrix} p_{11} & p_{12} \\ p_{21} & p_{22} \end{matrix}$$

In this equation, p_{ij} represents the probability of switching between regimes i and j

State-Specific Equations

The equation might be as follows in regime 1 (e.g., expansionary period):

$$Y_t^{(1)} = \beta_1 X_t + \epsilon_t^{(1)} \quad (5)$$

The equation might be as follows in regime 2 (e.g., recessionary period):

$$Y_t^{(2)} = \beta_1 X_t + \epsilon_t^{(2)} \quad (6)$$

Estimation

The parameters of the MS model (i.e.,β_1, β_2, p_{ij}) are estimated using Maximum Likelihood Estimation (MLE). To construct the likelihood function, we use the joint distribution of Y_t and the unobserved state S_t, assuming that X_t is a macroeconomic factor. Example:

Let Y_t be the tax revenue, and X_t include inflation, interest rates, exchange rate, RGDP and current account balance. Then, the Markov-Switching model could look like:

For Regime 1:

$$Yt = \beta 0(1) + \beta 1(1)\, INFt\, \beta 2(1) + \beta 3(1)\, IRt + \beta 4(1)\, EXRt + \beta 5(1)\, RGDPt + \beta 6(1)\, CABt + \epsilon t1 \quad \text{if } S_t = 1 \quad (7)$$

For Regime 2:

$$Yt = \beta 0(2) + \beta 1(2)\, INFt\, \beta 2(2) + \beta 3(2)\, IRt + \beta 4(2)\, EXRt + \beta 5(2)\, RGDPt + \beta 6(2)\, CABt + \epsilon t2 \quad \text{if } S_t = 2 \quad (8)$$

Where the parameters $\beta_0^{(1)} + \beta_1^{(1)}$, etc., differ across regimes.

According to the Markov Switching framework, the relationship between tax revenue and macroeconomic indicators depends on the prevailing economic conditions—whether the economy is in a phase of rapid growth or a downturn. The model captures shifts between these economic states through a Markov process, which allows the parameters of the model to change according to the regime, thereby reflecting structural changes in the economy over time.

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RESULTS

Descriptive Statistics

Table 1 provides a summary of key macroeconomic indicators related to tax revenue performance in Nigeria. On average, tax revenue (TR) is 10.08% of GDP. The average inflation index stands at 112.41, while the mean interest rate (IR) is 10.80%. The mean exchange rate (EXR) is recorded at 85.85, with the average real GDP growth (RGDP) at 2.34%. The current account balance (CAB), on the other hand, shows an average of -2.06%, suggesting the presence of a consistent deficit, which may have implications for the country's fiscal capacity.

The elevated average inflation index implies notable inflationary pressure, which could affect consumer behavior and, consequently, tax collections. Similarly, the negative current account balance points to a trade imbalance or capital outflows, which may constrain revenue generation through reduced economic activity.

In terms of variability, the standard deviation for tax revenue is 12.03, indicating moderate fluctuations over the study period. Inflation exhibits a higher standard deviation of 37.16, reflecting substantial variability in price levels, while the exchange rate also shows notable volatility with a standard deviation of 11.96. In contrast, interest rates demonstrate lower variability (standard deviation of 2.56), implying a relatively stable monetary environment. The current account balance displays a standard deviation of 2.78, suggesting moderate fluctuations, likely influenced by trade and external investment flows.

These descriptive statistics offer a preliminary understanding of the dynamics and volatility of macroeconomic factors influencing tax revenue in Nigeria. The observed patterns underscore the importance of regime-sensitive models—such as the Markov Switching Model—for capturing the varying effects of these indicators across different economic phases.

Table 1: A Summary of Descriptive Statistics

Description	TR	INF	IR	EXR	RGDP	CAB
Mean	10.07895	112.4117	10.80063	85.84947	2.336842	-2.060138
Median	9.500000	107.2600	10.25000	83.04000	2.500000	-2.805575
Maximum	77.90000	174.9900	17.00000	108.9900	5.600000	4.123380
Minimum	-35.40000	58.14000	7.000000	64.68000	-6.300000	-5.836930
Std. Deviation	12.03482	37.16027	2.558710	11.95657	2.169521	2.778180
Skewness	1.485138	0.211790	0.659412	0.269724	-1.188351	0.564215
Kurtosis	15.18447	1.624717	2.626748	1.831482	5.689875	2.250728
Jarque-Bera (JB)	622.5821	8.197014	7.436177	6.556740	50.99974	7.262601
Probability	0.000000	0.016597	0.024280	0.037690	0.000000	0.026482
Observations	95	95	95	95	95	95

Skewness and Kurtosis Analysis

The skewness statistics for the macroeconomic variables examined in Nigeria reveal the following: tax revenue exhibits a skewness of 1.485, inflation stands at 0.212, interest

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rates at 0.659, exchange rates at 0.270, real GDP growth (RGDP) at -1.188, and the current account balance (CAB) at 0.564. The positive skewness in tax revenue indicates that the distribution is right-skewed, suggesting the presence of a few unusually high values. Similarly, inflation, interest rates, and exchange rate variables display mild positive skewness, implying slightly asymmetric distributions skewed toward higher values. In contrast, the negative skewness observed in RGDP implies that the distribution leans toward lower values, possibly reflecting economic slowdowns or recessions. These findings provide insight into how asymmetries in macroeconomic variables may influence tax revenue behavior over time. Kurtosis values further highlight the nature of distributional characteristics across these variables. Tax revenue has a kurtosis of 15.18, indicating a distribution with extremely heavy tails and a high likelihood of outliers or extreme values—characteristic of high tail risk. Inflation and exchange rate variables have relatively low kurtosis values of 1.62 and 1.83, respectively, suggesting flatter distributions with lighter tails. Interest rates present moderate kurtosis at 2.63, implying some probability of outliers but less extreme than tax revenue. RGDP shows a kurtosis of 5.69, indicating moderate tail risk, while the current account balance registers a kurtosis of 2.25. The positive kurtosis values for both RGDP and CAB suggest the distributions are more peaked than normal, with a higher chance of observing extreme positive values. These statistical moments enhance the understanding of volatility and distributional behavior among macroeconomic indicators in Nigeria.

Unit Root Testing

Unit root testing is an essential step in time series analysis used to determine whether a variable is stationary or exhibits non-stationary behavior over time. In the context of this study, applying unit root tests to tax revenue and related macroeconomic indicators helps to identify whether these variables follow a stable, mean-reverting pattern or contain stochastic trends. This distinction is critical because non-stationary variables can lead to misleading statistical inferences if not properly treated. By assessing the stationarity of the series, researchers can ensure the reliability of the Markov Switching Model and other econometric techniques used to evaluate the relationship between macroeconomic dynamics and tax revenue performance in Nigeria.

Table 2: ADF and PP Unit Root Test Results

Variables	ADF Test		PP Test	Status
	t-statistic	Status	t-statistic	
*ln*TR	-6.108745***	I(1)	-18.23193***	I(1)
*ln*INF	-4.931731***	I(1)	-7.257942**	I(1)
*ln*IR	-6.954122***	I(1)	-7.048832***	I(1)
*ln*EXR	-7.779816***	I(1)	-7.794500***	I(1)
*ln*RGDP	-6.288055***	I(1)	-6.516299***	I(1)
*ln*CAB	-3.968834***	I(1)	-4.049544***	I(1)

Note. (***), indicate significant at 1%. All the variables are log linearized.

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Unit Root Test Results and Interpretation

The findings from the unit root tests reveal that all variables under investigation are integrated of order one, I (1), indicating they are non-stationary in their levels but become stationary after first differencing. This suggests the presence of persistent trends over time in each series. In the context of Nigeria, this means that tax revenue performance is influenced by long-term movements in key macroeconomic variables such as inflation, interest rates, exchange rates, real GDP growth, and the current account balance.

Understanding the long-run behavior of these variables is essential for crafting effective fiscal strategies. Recognizing that these factors exert sustained effects on tax revenue allows policymakers to develop more forward-looking and stable revenue forecasting models. This underlines the necessity of incorporating trend components in tax revenue models to improve their accuracy and relevance over time.

Interpretation of Results

Following the framework used by Agyemang-Badu et al. (2024), this study employs a two-regime Markov Switching Model to differentiate between periods of economic stability and instability. **Regime 1** represents times of low volatility, typically associated with economic expansion, while **Regime 2** captures high-volatility periods, often aligned with recessions or economic crises. The results from the Markov Switching estimations are detailed in Table 2.

In Regime 1 (economic stability), the inflation coefficient is estimated at **-0.3195**, whereas in Regime 2 (economic turbulence), the coefficient is **0.0356**. Neither coefficient is statistically significant, indicating that inflation does not have a meaningful direct impact on tax revenue in either economic condition. This outcome suggests that other macroeconomic factors may play a more dominant role in shaping tax revenue trends, and inflation alone may not be a reliable policy lever in this context.

Interest rate effects, however, vary across regimes. In Regime 1, the interest rate coefficient is **-7.9822**, and this result is statistically significant at the 5% level. This indicates that during periods of economic growth, interest rates have a substantial negative influence on tax revenue—possibly because higher borrowing costs suppress investment and consumption, thereby reducing taxable economic activity. Conversely, in Regime 2, the coefficient is **0.3448**, which is not statistically significant, implying that during recessions or crises, changes in interest rates do not have a measurable impact on tax revenue.

These findings underscore the importance of **regime-specific policy responses**. In times of economic growth, interest rate adjustments can be an effective tool for managing tax revenue. However, during downturns, fiscal policymakers may need to focus on other instruments—such as targeted spending or tax reform—to stabilize revenue streams. The ability to differentiate between these regimes enhances the government's capacity to design adaptive and efficient tax policies that align with the prevailing economic environment.

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Table 3: MSM Results

Variables	Coefficient	Std. Error	z-Statistics	Prob.
Regime 1: low volatility				
C	136.9223	126.6250	1.081321	0.2796
INF	-0.319524	0.431203	-0.741007	0.4587
IR	-7.982160	3.508217	-2.275276	0.0229
EXR	0.180268	0.630094	0.286097	0.7748
RGDP	3.940239	1.466517	2.686801	0.0072
CAB	7.176762	1.850433	3.878424	0.0001
Regime 2: high volatility				
C	-7.638301	20.00059	-0.381904	0.7025
INF	0.035567	0.058228	0.610825	0.5413
IR	0.344795	0.615406	0.560272	0.5753
EXR	-0.009495	0.119537	-0.079428	0.9367
RGDP	3.087525	0.650268	4.748081	0.0000
CAB	-0.805281	0.335695	-2.398848	0.0164
Common				
LOG(SIGMA)	1.911993	0.083057	23.02024	0.0000
Transition Matrix Parameters				
Variable	**Coefficient**	**Std. Error**	**z-Statistics**	
P11-C	-1.103636	1.468483	-0.751548	0.4523
P21-C	-2.523294	0.848991	-2.972110	0.0030
Mean dependent var	10.07895	S.D. dependent var		12.03482
S.E. of regression	12.56115	Sum squared resid		12938.17
Durbin-Watson stat	2.517923	Log likelihood		-330.3028
Akaike info criterion	7.269532	Schwarz criterion		7.672776
Hannan-Quinn criter.	7.432473			

In the first regime, the exchange rate has a coefficient of 0.180268, whereas in the second regime, the value is 0.009495. Both coefficients are statistically insignificant, implying that exchange rate fluctuations have a limited effect on tax revenue performance in Nigeria Sulaiman et al. (2021). This outcome indicates that changes in the value of the Nigeria Rand relative to other currencies do not considerably influence the country's tax collection. Instead, other macroeconomic indicators may have a more pronounced effect on revenue variability.

Real Gross Domestic Product (RGDP) shows a coefficient of 3.940239 in regime 1, which is significant at the 1% level. Similarly, regime 2 yields a coefficient of 3.087525, also significant at the 1% level. These results point to a positive relationship between economic growth and tax revenue performance. The effect is more prominent during stable periods (regime 1), while it slightly weakens—but remains significant—during downturns or periods of heightened economic uncertainty (regime 2). This underscores the critical role of overall economic health in shaping tax collection outcomes and highlights the need for policymakers to align tax policies with broader economic strategies aimed at fostering growth.

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Regarding the current account balance, regime 1 produces a coefficient of 7.176762, which is significant at the 1% level. On the other hand, regime 2 shows a negative coefficient of -0.805281, significant at the 5% level. These contrasting results suggest that a strong current account balance is positively associated with tax revenue during periods of economic stability. Conversely, when the economy is in distress (as in regime 2), a deteriorating current account is linked to reduced tax revenue. This finding reinforces the importance of maintaining a sound external balance to support fiscal performance.

The log of the standard deviation term (LOG(SIGMA)) is estimated at 1.911993, showing a significant and positive relationship with tax revenue. This suggests that the model captures regime shifts in macroeconomic variables that influence tax revenue in Nigeria. The 1% significance level further highlights the importance of economic volatility in determining tax outcomes Sulaiman et al. (2021). These findings imply that instability in macroeconomic conditions can substantially disrupt the government's ability to collect taxes, thereby necessitating careful consideration of volatility when formulating fiscal strategies.

Furthermore, the probability transition matrix results indicate that movement from regime 1 to regime 2 significantly influences tax revenue. The coefficient for the transition probability (P11-C) from regime 1 is not statistically significant, implying a limited impact. In contrast, the significant coefficient for P21-C, significant at the 1% level, suggests that transitioning to regime 2 has a strong and positive influence on tax revenue. This implies that the macroeconomic environment represented by regime 2 is more influential in determining tax performance.

The model's average dependent variable is 10.07895, representing the typical level of tax revenue during the study period. The standard error of regression (12.56115) provides a measure of the accuracy of the model's estimates. A Durbin-Watson statistic of 2.517923 hints at possible autocorrelation in the residuals. The sum of squared residuals, which stands at 12938.17, serves as an indicator of model fit—with lower values being preferable. Additionally, a log-likelihood value of 330.3028 and the associated information criteria help assess the model's balance between explanatory power and complexity. Collectively, these diagnostics affirm the robustness and reliability of the Markov-Switching Model in capturing the dynamics of tax revenue performance in Nigeria.

Wald Test

The Wald test is employed to evaluate whether the regression coefficients in a model significantly differ from zero. In this study, a Markov-switching model is used to examine how macroeconomic variables influence tax revenue performance in Nigeria, accounting for shifts in the economic environment over time. Applying the Wald test allows us to determine the statistical relevance of these relationships, thereby deepening our understanding of the dynamic nature of tax revenue behavior in response to changing macroeconomic conditions.

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Table 4: Wald Test

Test Statistic	Value	df	Probability
F-statistic	10.39490	(6, 80)	0.0000
Chi-square	62.36939	6	0.0000

Statistical evidence confirms a strong relationship between macroeconomic variables and tax revenue performance in Nigeria. The Wald Test's F-statistic demonstrates that the model provides a good representation of the data, with a very low likelihood that the observed outcomes occurred by chance. Likewise, the Chi-square test supports the conclusion that macroeconomic indicators have a substantial effect on tax revenue dynamics. These results highlight the critical role of economic conditions in shaping tax revenue trends and underscore the necessity for their inclusion in fiscal policy analysis.

Probability Plot

The probability plot generated from the Markov-switching model visually captures how shifts in economic regimes affect tax revenue in Nigeria. This tool offers valuable insight into the extent to which varying economic scenarios influence revenue collection, thereby guiding policymakers in formulating strategies to strengthen tax administration and improve overall fiscal performance.

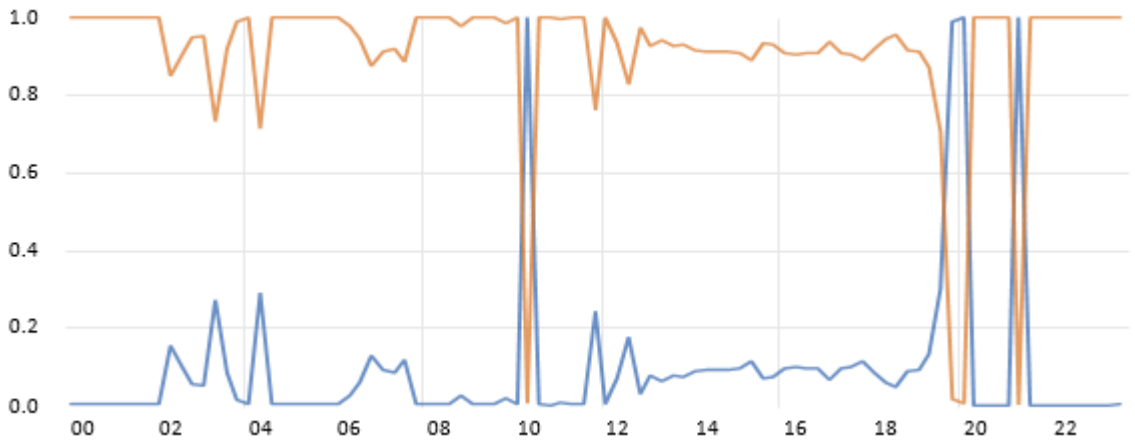

Figure 2: TR Smoothed Probabilities in the MSM-VAR Model

Figure 2 reveals that Nigeria tax revenue performance is predominantly associated with regime 2, with a smoothed probability of approximately 90.96%. In contrast, the likelihood of being in regime 1 stands at just 9.04%. This distribution implies that the macroeconomic factors influencing tax revenue tend to follow a more stable pattern rather than undergoing abrupt transitions Sulaiman et al. (2021). These results provide valuable implications for policymakers and economic analysts aiming to interpret and forecast tax revenue trends in the Nigeria context.

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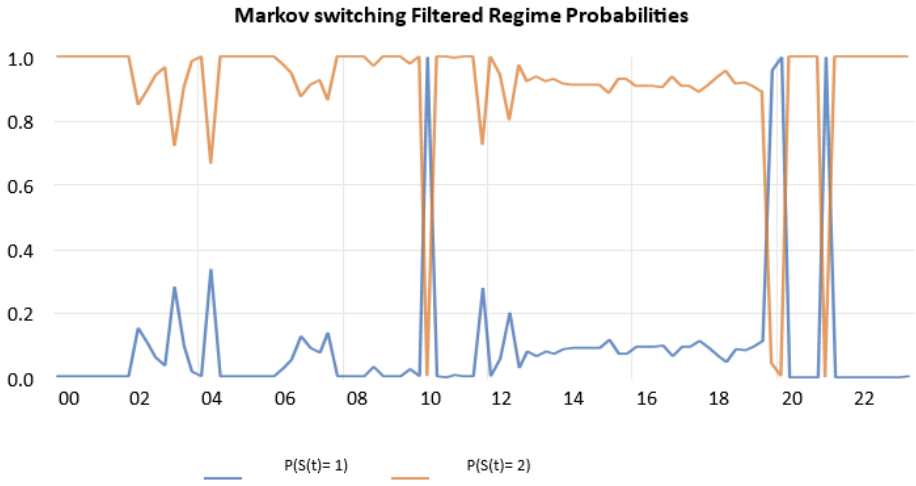

Figure 3: TR Filtered Probabilities in the MSM-VAR model

Figure 3: Smoothed Probabilities of Average Tax Revenue

Figure 3 illustrates that Nigeria average tax revenue is predominantly associated with regime 2, with a high probability of 0.901054. This indicates that tax revenue performance is generally stable and not highly susceptible to abrupt changes. Nevertheless, there remains a smaller probability—0.089496—that tax revenue could shift to regime 1, reflecting some level of uncertainty in the economic environment Sulaiman et al. (2021).

Transition Probability

Transition probability refers to the likelihood of shifting from one economic regime to another within a dynamic system. As reflected in Table 5, higher transition probabilities for tax revenue (TR values) suggest a stronger tendency for the system to remain in regime 2. This supports the interpretation that tax revenue behavior is more likely to persist in a stable regime over time.

Table 5: Transition Probability

South Africa	Regime 1	Regime 2
Regime 1	0.249059	0.750941
Regime 2	0.074241	0.925759
Durations	1.331663	13.46961

Regime Classification and Tax Revenue Performance

The findings reveal that Nigeria tax revenue dynamics can be divided into two distinct regimes. Regime 1, which occurs with a probability of 24.91%, is associated with lower levels of tax revenue. Conversely, Regime 2, with a higher probability of 75.09%, corresponds to periods of elevated tax revenue performance. The average duration of Regime 1 is approximately 1.33 quarters, while Regime 2 tends to persist for around 13.47 quarters. This pattern indicates that Nigeria tax revenue fluctuates between shorter periods of low revenue and longer phases of higher collections.

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DISCUSSION

Inflation and Tax Revenue

In Regime 1, inflation appears to negatively affect tax revenue in Nigeria, although the relationship lacks statistical significance. This finding aligns with previous research by Đurović et al. (2024) and Ayenew (2021), who identified similar negative associations in the Nigeria. In contrast, Regime 2 shows a positive, yet also statistically insignificant, relationship between inflation and tax revenue. These results are consistent with those of Imam and Jacobs (2021), Onakoya et al. (2020), and Desta et al. (2022), who found inflation to have a positive effect on tax revenue in regions such as the Nigeria. Overall, the evidence suggests that the influence of inflation on tax revenue varies depending on the prevailing economic regime. This supports the view that fiscal policy responses to inflation should be tailored to the specific economic context.

Interest Rates and Tax Revenue

In Regime 1, there is a statistically significant negative relationship between interest rates and tax revenue in Nigeria, which is in line with findings from Onakoya et al. (2020) in Nigeria. However, in Regime 2, the relationship turns positive, though not statistically significant. This mirrors observations by Sulaiman et al. (2021), who reported a positive association between interest rates and tax revenue in the Nigeria. These results suggest that the effect of interest rates on tax revenue in Nigeria is contingent on the broader economic climate. While higher interest rates may suppress revenue in periods of economic instability (Regime 1), they may have a neutral or slightly beneficial effect under more stable conditions (Regime 2). This supports the hypothesis of a regime-dependent impact and highlights the need for adaptive interest rate policies.

Exchange Rates and Tax Revenue

In Regime 1, the exchange rate is positively correlated with tax revenue in Nigeria, consistent with Gaalya's (2024) study in Uganda. In contrast, Regime 2 exhibits a negative association, supporting the findings of Rutto (2020), who identified a similar trend in Kenya. This contrasting behavior indicates that the exchange rate’s impact on tax revenue is highly dependent on the prevailing economic regime. Policymakers should therefore consider the broader macroeconomic context when formulating tax strategies related to exchange rate fluctuations, as rigid policies may not be effective across varying economic conditions.

Real GDP Growth and Tax Revenue

Across both regimes, real GDP growth demonstrates a positive and statistically significant relationship with tax revenue, with the effect being more pronounced in Regime 1. These findings are in agreement with Mardan and Stimmel Mayr (2020), who found a strong link between GDP growth and tax revenue in advanced economies. The results imply that economic expansion is a key driver of increased tax collections in Nigeria, regardless of the specific regime. This contradicts the hypothesis that the effect of GDP on tax revenue is regime-dependent, instead indicating a consistent relationship across different

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economic environments. For policymakers, this emphasizes the importance of fostering economic growth as a strategy to boost fiscal performance Sulaiman et al. (2021).

Current Account Balance and Tax Revenue

In Regime 1, the current account balance has a positive and statistically significant impact on tax revenue, supporting earlier findings by Sulaiman et al. (2021), who observed strong links between external balances and fiscal outcomes in other developing countries. This suggests that during periods of economic expansion, increased trade activity and higher output contribute to greater tax collections. Conversely, in Regime 2, the relationship turns negative, implying that during economic downturns or external shocks, deteriorating current account positions may hinder tax revenue performance. These results support the hypothesis that the impact of the current account balance on tax revenue is regime-specific and emphasize the need for responsive fiscal planning that accounts for changing external economic conditions.

CONCLUSION

This study examined the influence of macroeconomic variables on tax revenue performance in Nigeria from the first quarter of 2000 to the third quarter of 2023. Using the Markov Switching Model, the analysis assessed how the impact of these variables differs across periods of economic expansion (regime 1) and contraction (regime 2). The findings reveal that inflation has a negative, statistically insignificant effect on tax revenue during periods of economic growth (regime 1), and a positive but similarly insignificant impact during downturns (regime 2). This suggests that inflation does not have a consistent or significant influence on tax revenue, and its effect varies depending on the broader economic context—supporting the notion of a regime-dependent relationship.

Interest rates exhibit a significant and negative effect on tax revenue during periods of growth (regime 1), but a positive and insignificant impact during recessions (regime 2). This indicates that tax revenue is more sensitive to interest rate fluctuations in stable economic conditions, whereas during economic downturns, other factors likely exert a stronger influence. These results reinforce the importance of recognizing regime-dependent behavior when designing fiscal and monetary policies. Exchange rate coefficients are positive in regime 1 and negative in regime 2, though both are statistically insignificant. This implies that exchange rate movements do not have a direct or substantial influence on tax revenue performance in either regime. The variability in direction, however, points to the influence of regime-specific dynamics, consistent with a regime-dependent framework. Real GDP growth (RGDP) shows a strong, positive, and statistically significant effect on tax revenue in both regimes, with the effect being more pronounced in regime 1. This indicates that economic growth plays a consistently vital role in enhancing tax revenue, regardless of the prevailing economic regime. These results challenge the hypothesis of a regime-dependent influence of GDP growth on tax revenue, suggesting instead a stable and positive relationship across economic cycles.

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In summary, the study provides strong empirical evidence that the effects of macroeconomic variables on tax revenue in Nigeria are largely regime-dependent, with notable variations in their influence across different economic conditions. Policymakers should take these findings into account when formulating tax and macroeconomic policies, particularly by prioritizing economic growth, managing interest rate impacts during stable periods, and adapting fiscal strategies to changing external conditions.

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