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Impact of Macroeconomic Instability and Regulatory Policy Uncertainty on Tax Revenue Mobilization in African Oil-Exporting Countries: Evidence from CS-ARDL Analysis

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Abstract **Original Research Article**

Purpose: This paper examines the effects of macroeconomic instability and regulatory policy uncertainty on tax revenue mobilization in African oil-exporting countries within a period spanning from 1990 to 2023.

Design/methodology/approach - The study adopts the Cross-Sectional Autoregressive Distributed Lag (CS-ARDL) approach to evaluate both the long-run and short-run dynamics. Eight African oil-exporting countries were analyzed with an interaction term to examine the compounded effects of macroeconomic instability and regulatory policy uncertainty.

Findings: The findings suggest that macroeconomic instability and regulatory policy uncertainty reduce tax revenue in both the short and long run, with interaction between the two variables amplifying the negative effect. On the other hand, oil rents, financial development, and government expenditure enhance revenue mobilization consistently.

Research limitations/implications - The findings are limited to eight oil-exporting countries and may not generalize to non-oil economies. Other African countries need to be studied in the future, along with additional institutional and governance factors.

Practical implications: improvement in tax revenue collection requires stable macroeconomic conditions, predictable regulatory policies, and enhanced financial and institutional frameworks.

Social implications: Increased tax revenue mobilization fosters the delivery of public services and economic development, enhancing welfare in resource-dependent countries.

Originality/value – This study represents one of the first attempts at an explicit analysis of how the combined role of macroeconomic instability and regulatory policy uncertainty affects tax revenue mobilization, controlling for cross-sectional dependence and slope heterogeneity, thereby presenting robust and context-specific evidence.

Keywords: Tax revenue mobilization, Macroeconomic instability, Regulatory Policy uncertainty, CS-ARDL.

1. Introduction

Tax revenue mobilization remains the cornerstone of fiscal sustainability in African oil exporters, many of these economies perform well below their potential. According to the World Bank (2023), non-resource tax revenues average 15 to 17% of GDP in Sub-Saharan Africa, contrasted with an OECD benchmark level of 34%. However, the performance is indeed even weaker in oil-exporting countries, including Nigeria, Angola, Congo, and Gabon, due to procyclical expenditure, narrow tax bases, and overdependence on volatile hydrocarbon earnings. In fact, the IMF (2024) warns that the persistent instability of core macroeconomic aggregates-including inflation, exchange rate, and output-erodes the tax systems and weakens compliance, thus undermining the revenue-raising capacities of governments.

Macroeconomic instability influences tax revenue mobilization through those channels emphasized in the tax-base erosion mechanism, which explains that high inflation, unstable output, and exchange-rate volatility shrink taxable income and distort consumption patterns, thereby destabilizing tax projections (Atolagbe & Abiodun, 2021; Queku et al., 2024). Instability also increases informality and weakens tax morale, thereby reducing governments' capacity to widen the tax base (Shivanda & Obwogi, 2018). This theoretical mechanism suggested that stable macroeconomic environments increase predictability, raise investment, and lead to strengthened taxpayers' willingness to remain within the formal tax net.

Apart from that, institutional quality also has to do with shaping both the macroeconomic environment and outcomes in tax mobilization. Evidence from studies by the African Development Bank reveals that weak institutions, manifested in corruption, weak rule of law, low bureaucratic quality, and weak regulatory frameworks, weaken tax effort (Bah, 2024; Nikiema & Zore, 2025). In reality, the institutional governance mechanism stipulates that effective institutions will ensure an increase in administrative efficiency, thereby strengthening tax enforcement, reducing leakages, building taxpayer trust, and hence raising revenue performance (Zallé, 2022; Meddeb et al., 2025). The low institutional quality, along with unstable macroeconomic conditions, therefore amplifies uncertainty and diminishes revenue generation capacity, especially in oil-dependent economies characterized by rent-seeking and volatility.

A related concern is the increasing importance of regulatory policy uncertainty, including unpredictability in tax laws, ambiguous fiscal frameworks, and inconsistent regulations. This type of uncertainty increases transaction costs, compliance rates decrease, and profit-shifting or avoidance is encouraged. Based on the mechanism of the policy credibility and fiscal contract, when governments constantly change or fail to enforce rules on taxation consistently, taxpayers voluntarily reduce compliance on the premise that governance cannot effectively use such revenues. This finding is in line with Tolossa & Melese (2024) and Lompo (2024). Regulatory uncertainty has been a serious constraint to sustainable revenue mobilization in oil-exporting economies whose fiscal policy constantly changes with various oil price shocks.

Despite the significance of these relationships, there are considerable literature gaps. Most of the available studies focus on isolated macroeconomic variables such as inflation, GDP growth, exchange rates, and trade openness (Atolagbe & Abiodun, 2021; Ihuarulam et al., 2021; Onakoya et al., 2020). None of the studies previously reviewed explicitly focus on the aspect of macroeconomic instability-that is, combined dynamic fluctuations and volatility across key macroeconomic indicators-and how it interlinks with regulatory policy uncertainty to shape tax revenue outcomes within oil-exporting African countries. Also, most of these studies tend to ignore cross-sectional dependence and slope heterogeneity despite strong economic and institutional linkages between African economies (Garg et al., 2025; Đurović Todorović et al., 2024).

These gaps highlight the need for a comprehensive framework that can jointly analyze macroeconomic instability along with regulatory policy uncertainty, thereby accommodating cross-country spillovers and

heterogeneous structural features. The cross-sectionally augmented autoregressive distributed lag model presents a methodological strength in this regard because it accounts for interdependence, heterogeneity, and short-run and long-run dynamics all at once.

Addressing this gap, this study provides valuable policy lessons that could enhance tax systems in oil-exporting African economies. These include enhancing macroeconomic stability, reducing regulatory unpredictability, and improving institutional governance that could broaden the tax base, reduce leakages, and improve compliance, thereby minimizing fiscal risks from resource dependence. These reforms are imperative for countries desiring to diversify their sources of revenue and attain long-term fiscal soundness.

2. Literature Review

2.1. Theoretical Frameworks

Several theoretical perspectives explain why macroeconomic instability and regulatory policy uncertainty influence tax revenue outcomes. From the tax-base or tax-handle perspective, a stable macroeconomic environment enhances the measurability and predictability of the tax base, while volatility in inflation, output, and exchange rates erodes real incomes, discourages formal sector participation, and complicates revenue forecasting. The resource-curse and rentier-state theories further illustrate that reliance on oil rents reduces the long-term incentives for states to build strong tax institutions, encourages patronage politics, and fosters institutional weakness, all of which undermine tax effort (Ndikumana & Abderrahim, 2010; Zallé, 2022). Complementing these, the institutional governance framework has emphasized that better governance-more specifically, transparency, rule of law, and administrative efficiency-improves tax enforcement and compliance and, in turn, tax revenue mobilization (Bah, 2024; Timba, Eto'o & Meka'a, 2025). Another useful lens is provided by the policy-credibility and regulatory instability perspective, which holds the view that unpredictable or frequently changing regulatory regimes increase compliance costs and deter investment, and create uncertainty among taxpayers over the stability of the tax system. As Tolossa and Melese (2024) illustrate, modernized and predictable administrative systems strengthen compliance, while Garg et al. (2025) argue that regulatory unpredictability serves as a motive for firms to delay investment or shift activity to informal channels. These theories collectively suggest that macroeconomic instability reduces the taxable base and tax predictability, while regulatory policy uncertainty further reduces voluntary compliance and investment, thereby restricting tax revenue mobilization in oil-exporting economies.

2.2. Empirical Review

Empirical evidence supports the great importance of macroeconomic conditions in determining tax revenue performance. A number of such studies across Sub-Saharan Africa indicate that GDP growth, inflation, trade openness, and exchange-rate movements have significant impacts on tax receipts, as hostile macroeconomic conditions tend to be correlated with poor revenue performance (Atolagbe & Abiodun, 2021; Ihuarulam, Sanusi & Oderinde, 2021; Onakoya et al., 2020). Queku et al. (2024) further illustrate the role that the macroeconomic environment plays in the level of tax performance in African economies. Most studies in this area tend to treat these variables in levels or means, rather than sources of instability. More direct analyses of volatility indicate that macroeconomic instability is more harmful compared to the levels of macroeconomic indicators, because higher instability reduces predictability, increases administrative burdens, and encourages informal economic activities (Shivanda & Obwogi, 2018; Bati, 2025). Similarly, reports from the IMF (2022) and AfDB (2022) also highlight the destabilizing effects of frequent external shocks and commodity-price volatility on fiscal systems, particularly in oil exporters.

While the number of empirical studies into the impact of regulatory policy uncertainty is narrower than that for other areas of uncertainty, these studies suggest that inconsistent and unpredictable

regulatory regimes undermine tax performance. For example, Tolossa and Melese (2024) emphasize the value of predictable and technologically enhanced administrative procedures in bolstering collection efficiency. Lompo (2024) and Adeosun et al. (2025) illustrate how financial and institutional development have facilitated tax mobilization, partly through the reduction of uncertainty in regulatory administration. Directly relevant research on policy unpredictability is relatively scarce, but studies of tax policy reversals, ambiguous enforcement procedures, and ad hoc regulatory changes do reveal a consistent pattern of lower tax effort since uncertainty discourages formalization and compliance. Examples include Sodji (2024) and Jemiluyi & Jeke (2023). These studies suggest that regulatory uncertainty erodes the tax base by raising compliance costs and encouraging firms to operate beyond formal tax systems.

Institutional quality has also been consistently investigated, and the available evidence has identified consistent relationships between stronger governance structures, such as higher bureaucratic efficiency, a more robust rule of law, and lower corruption, and higher levels of mobilization of tax revenue. Bah (2024) finds that institutional quality significantly enhances tax effort in Sub-Saharan Africa. Timba, Eto'o, and Meka'a (2025) also point out that gains in governance yield substantial gains in tax mobilization across African economies. Zallé (2022) shows how natural resource dependence tends to amplify corruption and reduce non-resource tax revenue, further reinforcing the relevance of institutions in resource-rich settings. In addition, Nikiema and Zore (2025) demonstrate that institutional quality exerts a stabilizing role by dampening volatility in tax revenue collection, implying that strong institutions mitigate the adverse impact of macroeconomic instability.

2.3.Gaps in the Literature and Contribution of the Study

Despite the voluminous literature on the determinants of tax in Africa, there are still some important gaps in previous studies. First, most prior studies have focused on macroeconomic variables in their static form—such as inflation levels or GDP growth rates—and avoided macroeconomic instability, which is a more direct representation of volatility and unpredictability of tax administration and revenue flows. Very few studies have treated instability as a separate variable, even though this factor is quite relevant to oil-exporting economies where volatility is endemic. Secondly, regulatory policy uncertainty has remained largely unexplored, despite the fact that investors are wary of the losses associated with bases that are subject to unpredictable changes in tax regulations, administrative procedures, and fiscal policies. Thirdly, very few studies have examined how macroeconomic instability and regulatory policy uncertainty jointly affect taxes, or how institutional quality conditions or moderates these relationships. Lastly, several of the existing empirical studies are based on estimation techniques that do not take adequate consideration of cross-country interdependence, unobserved common shocks, and heterogeneity in long-run responses. This study fills these gaps in several ways: using the macroeconomic instability measure, constructing proxies for regulatory policy uncertainty, and applying the CS-ARDL method in order to capture country-specific dynamics while controlling for cross-sectional dependence. The study provides fresh insights into how instability and uncertainty interact with institutional conditions to determine tax revenue mobilization in African oil-exporting economies.

3. Methodology

This study uses a quantitative, longitudinal panel research design to examine how macroeconomic instability and the uncertainty of regulatory policy influence tax revenue mobilization in the eight leading African oil-exporting economies, namely, Nigeria, Angola, Algeria, Libya, Egypt, Republic of Congo, Gabon, and Equatorial Guinea. The choice of a panel econometric approach is motivated by the interest in capturing both time-series dynamics and cross-country heterogeneity inherent in the oil-dependent African economies. Since there is a greater likelihood of cross-sectional dependence due to shared external shocks such as oil-price volatility,

global financial cycles, and OPEC market conditions, the CS-ARDL model has been employed in the study, which yields robust and efficient estimates when there is cross-sectional dependence and slope heterogeneity. The analysis covers the period 1990–2023, based on data availability from internationally recognized databases.

3.1. Data Sources and Variables Measurement

This research employs annual secondary data from eight major African oil-exporting countries, namely Nigeria, Angola, Algeria, Libya, Egypt, Congo Republic, Equatorial Guinea, and Gabon, over the period 1990–2023. Data are sourced from the World Bank's World Development Indicators (WDI) and Worldwide Governance Indicators (WGI), offering consistent, comparable coverage across the macroeconomic, governance, and oil-market variables. The dependent variable is Tax Revenue Mobilization (TRM), represented by total tax revenue as a percentage of GDP. The major explanatory variables include Macroeconomic Instability (MI) and Regulatory Policy Uncertainty (RPU). Whereas the former captures volatility in inflation, exchange rates, output growth, and fiscal deficits, the latter captures deviations regarding regulatory quality, policy reforms, and institutional ruptures. Control variables, including oil prices, trade openness, financial development, population size, and government effectiveness, have been added to the model to isolate the MI and RPU effects.

3.1.1. Deriving regulatory policy uncertainty, and macroeconomic instability

Regulatory policy uncertainty (RPU) reflects uncertainty related to regulatory agencies, the legal system, and political environment assessed using the indexes of regulatory quality, rule of law, and political stability. Macroeconomic instability (MI) shows volatility of the economic environment, such as inflation, exchange rates, inflows of FDI, money supply, trade, and export/import prices. Both are volatility measures estimated with the GARCH (1,1) model, which is efficient for conditional heteroscedasticity estimation, yielding composite indexes for RPU and MI, respectively (Hansen & Lunde, 2003; Reschenhofer, 2013). Equation 1 depicts the functional form of GARCH (1,1) used in the estimation of these volatility-based indexes:

$$\rho_t^2 = \varphi + \sigma\mu_{t-1}^2 + \gamma\rho_{t-1}^2 \qquad (1)$$

From equation (1), the volatility data of a variable at time t is denoted by ρ_t^2 , φ is the intercept and σ and γ are the respective coefficients of the ARCH and GARCH terms of the model. These derived data are further used for constructing the regulatory policy uncertainty and macroeconomic instability indexes.

3.1.2. Principal Component Analysis

The study constructs RPU and MI using Principal Component Analysis, which derives weights from eigenvectors of components explaining most variation, hence more efficient as compared to equal weighting or expert opinion as posited by Sendhil et al. (2018). PCA is widely adopted in previous studies such as Anarfo et al. (2019); Abaidoo & Agyapong (2022b, 2023); Ahamed & Mallick (2019). Using indexes with variables in different units, a data normalization procedure is applied, as indicated in Equation (2):

$$N_{q,it} = \frac{(Ymax_{q,i} - Y_{q,it})}{(Ymax_{q,i} - Ymin_{q,it})} \qquad (2)$$

From equation (2), N_q, denotes the normalized data point for variable q (q is either inflation volatility, exchange rate volatility, FDI volatility, trade volatility, money supply volatility, import price volatility, or export price volatility) at year t, for country i. $Ymax_{q,i}$ and $Ymin_{q,i}$ represent the maximum and minimum data points, respectively, for variable q, and $Y_{q,it}$ denotes datapoint for variable q, for country i at year t. For the regulatory policy uncertainty index, because the base variables (rule of law, regulatory quality and political stability) are constructed by the World Bank at an equal scale, the variables do not have to go through the normalization process. For the jth term of an index, the sum of the weights up to the nth variable is given by equation (3) below:

$$\sum_{n=1}^{n} M_j = m_1 + m_2 + m_3 \ldots\ldots\ldots + m_n \qquad (3)$$

According to equation (3), M_j is the sum of the weights of the jth term of an index, whereas $m_1 + m_2 + m_3 \ldots\ldots\ldots + m_n$ is the PCA-generated weights of the variables for the construction of the index. The index of the jth term is therefore calculated using equation (4):

$$Index_{p,j} = \frac{(X_{q1}m_1 + X_{q2}m_2 + X_{q3}m_3 \ldots\ldots X_{qn}m_n)}{\sum_{n=1}^{n} M_j} \quad (4)$$

From equation (4), $Index_{p,j}$ represents the jth term of composite index p, where p denotes either regulatory quality index, or macroeconomic instability. X_{q1} , ..., qn represent the datapoints (normalized for macroeconomic instability) for the jth term, while the remaining terms follow the definitions per equation (4).

Table I: PCA Results for Regulatory Policy Uncertainty and Macroeconomic Instability Indexes

Index	Variables	KMO	Bartlett's Test (χ^2, p-value)	Component 1 Loading	Component 2 Loading	Eigenvalue (Comp. 1)	% Variance Explained (Comp. 1)	PCA Weight
Regulatory Policy Uncertainty Index	Rule of Law	0.742	χ^2 = 218.54, p < 0.001	0.812	0.210	2.31	76.9%	0.36
	Regulatory Quality			0.845	0.115	—	—	0.38
	Political Stability			0.790	0.318	—	—	0.34
Macroeconomic Instability Index	Inflation Volatility	0.701	χ^2 = 196.82, p < 0.001	0.781	0.302	2.67	66.8%	0.27
	Exchange Rate Volatility			0.823	0.214	—	—	0.29

FDI Volatility	0.758	0.318	—	—	0.25
Money Supply Volatility	0.804	0.276	—	—	0.28

Table 1 presents the PCA results for the Regulatory Policy Uncertainty and Macroeconomic Instability Indexes. Relatively high KMO values (0.742 and 0.701) and highly significant Bartlett's tests ($p < 0.001$) confirm that the data are suitable for PCA. The first component of the Regulatory Policy Uncertainty Index has an eigenvalue of 2.31 and explains 76.9% of the variance, with strong loadings for the rule of law, regulatory quality, and political stability, all above 0.79. Correspondingly, the PCA weights fall within a narrow range of 0.36–0.38 and reflect a balanced contribution of each variable.

In the case of the Macroeconomic Instability Index, the first component has an eigenvalue of 2.67 and explains 66.8% of variance, with high loadings for inflation volatility, exchange rate volatility, FDI volatility, and money supply volatility, within the range of 0.758 and 0.823. The weights from PCA, ranging between 0.25 and 0.29, indicate that each variable contributes meaningfully to the index. The findings from PCA therefore confirm both indexes as statistically valid and internally consistent, hence suitable for further empirical analysis.

3.2. Model Specification

Two panel-data econometric models are specified and estimated using the CS-ARDL framework to empirically analyze the effect of macroeconomic instability and regulatory policy uncertainty on tax revenue mobilization in African oil-exporting countries.

3.2.1. Model without Interaction Term

In this respect, the baseline model assesses the independent effect of MI and RPU on TRM, conditioned by controls like GDPPC, OILR, TRADE, INFL, FDI inflows, and GOVEXP. According to the literature, a stable regulation and high-quality institution contribute to increasing the effectiveness of collection (Bah, 2024; Timba et al., 2025; Nikiema & Zore, 2025; Garg, Mittal, & Garg, 2025), whereas macroeconomic instability can lower tax compliance and undermine fiscal capacity (Bati, 2025; Lompo, 2024; Atolagbe & Abiodun, 2021).

The functional form is:

$$TRM = f(MI, RPU,\ OILR, FD, GEX) \quad (5)$$

The econometric (log-linear) form is:

$$lnTRM_{it} = \alpha_{it} + \beta_1 MI_{it} + \beta_2 lnRPU_{it} + \beta_3 lnOILR_{it} + \beta_4 lnFD_{it} + \beta_5 lnGEX_{it} + \mu_{it} \quad (6)$$

Where: TRM = tax revenue mobilization; MI = macroeconomic instability index; RPU = regulatory policy uncertainty; OILR = Oil rents (% of GDP); FD = financial development; GEX = government expenditure.

3.2.2. Model with Interaction Term

In addition, an interaction term is introduced to investigate whether regulatory policy uncertainty interacts with the effect of macroeconomic instability on tax revenue mobilization. This is in line with studies such as Zallé (2022), Nnyanzi et al. (2018), and Vincent and Evans (2025) that showed how institutional and regulatory frameworks act to either dampen or heighten macroeconomic and fiscal outcomes.

The functional form is:

$$TRM = f(MI, RPU, MI * RPU, OILR, FD, GEX) \quad (7)$$

The econometric form is:

$$lnTRM_{it} = \alpha_{it} + \beta_1 MI_{it} + \beta_2 lnRPU_{it} + \beta_3 MI * RPU_{it} + \beta_4 lnOILR_{it} + \beta_5 lnFD_{it} + \beta_6 lnGEX_{it} + \mu_{it} \quad (8)$$

Here, **β3** captures the moderating effect of regulatory policy uncertainty on the association between macroeconomic instability and tax revenue mobilization. A positive coefficient infers that stable and predictable regulatory policies alleviate the adverse effects of macroeconomic instability on revenue collection.

3.3 Econometric Strategy

With the possibility of dependence across the African economies, the application of simple panel estimators is likely to result in violations of the consistency assumption. These econometric issues are overcome in the present research by estimating the CS-ARDL model of Pesaran (2006). The model provides for inter-temporal slope/period heterogeneity, cross-country dependence, and non-stationary data. All these features render the model highly applicable to the African context.

3.3.1 Test of CS dependency and Slope Homogeneity

In the analysis of a sample of countries and the use of panel data, there may be common associations and common shocks, especially when there is a regional or international connection (Chandio et al, 2022). The proof is offered through Pesaran (2007) using the cross-section dependence analysis as follows:

$$Cross\ dependency = \sqrt{\frac{2G}{N(N-1)} \sum_{i=1}^{N-1} \sum_{j=i+1}^{N} \check{F}_{ij}} \quad (9)$$

Where μ_{ij} denotes the ordinary least squares estimation of φ_{it} . The slope homogeneousness procedure proposed by Pesaran and Yamagata (2008) is employed to capture country-specific disparities across the unit of the cross-section, which includes estimating two test statistics ($\tilde{\Delta}$ and $\tilde{\Delta}$ adj) under the null hypothesis of homogeneous slope coefficients, typically represented as follows:

$$\hat{\Delta} = (n)^{\frac{1}{2}}(k2)^{-\frac{1}{2}}\left(\frac{1}{n}\hat{s} - K\right) \quad (10)$$

$$\hat{\Delta}_{adj} = (n)^{\frac{1}{2}}\left(\frac{2K(t-k-1)}{1+t}\right)^{-\frac{1}{2}}\left(\frac{1}{n}\hat{s} - 2K\right) \quad (11)$$

In this context, $\tilde{\Delta}$ as well $\hat{\Delta}_{adj}$ as denote the statistics for slope homogeneousness as well as biased-adjusted slope homogeneousness, respectively. The demonstration of CSD facilitates the implementation of second-generation econometric techniques in the following stages of analysis.

3.3.2 Unit Root Test

In statistics, the unit root test is used to ascertain a time series variable's unit root and non-stationary state. Depending on the test applied, the null hypothesis suggests a unit root, whereas the alternative hypothesis generally indicates explosive root, trend stationarity, or stationarity. For this analysis, the CS augmented Dickey-Fuller (CADF) test by Pesaran (2007) and the CS augmented Im, Pesaran, and Shin (CIPS) test were employed. The formula below was used to compute the unit root test statistic:

$$\Delta y_{it} = \delta_i + \rho_i y_{i,t-1} + y_i g_t + \epsilon_{it} \quad (12)$$

The t-statistic calculated yields the following CIPS unit root test statistic:

$$CIPS = \frac{1}{N}\sum_{i=1}^{N} t_i(N,T) \quad (13)$$

Where Δy stands for the corresponding mean of the first and lag differences, represented by the symbol $t_i(N,T)$. These warrants are conducting a panel cointegration analysis.

3.3.3 Test for cointegration

To determine whether the series are cointegrated, the study employed the Westerlund and Edgerton (2007) approach. The cointegration bootstrap method was chosen, as it is more stable than conventional cointegration techniques by focusing on systemic rather than residual dynamics. This panel cointegration test has several benefits over first-generation tests because it is founded on the LM test of stationarity. The assessment is defined as:

$$H_G = \frac{1}{N}\sum_{I=1}^{N} S\partial_{ij}\frac{\hat{\alpha}_i}{\hat{\emptyset}_i} \quad (14)$$

$$H_P = \frac{1}{N}\sum_{i=1}^{N}\frac{1}{K_e} \quad (15)$$

Where the least square sum of ∂_i is represented by $\hat{\alpha}_i$, and the sum of the lagged covariance of $\Delta\widehat{K}_{it}$ is evaluated in the sequence K defines. Hence, $H_1: \delta i = \delta < 0$, whereas the panel checks whether the null hypothesis is $H_G \; and \; H_P$ denote the statistics for the group.

3.3.4 Panel Estimation

The CS-ARDL model was selected because it has a higher capability than traditional regression analysis in addressing issues of endogeneity, changing slopes, and cross-sectional dependence (Chudik et al., 2017). Founded on Pesaran's (2006) panel ARDL modeling strategy and rendering the lagged dependent variable weakly exogenous, this method effectively addresses unobserved common components. Notably, it lessens sample selection bias and provides robust estimates in panels with n smaller than t, independent of the integration ordering of the variables, which also includes the error correction term (ECT), long- and short-term dynamics, and cross-sectional averages for each variable's long- and short-term effects.

$$\begin{aligned}\Delta y_{it} = {} & \pi_i + \delta_i\big(y_{i,t-1} - \emptyset_i' X_{i,t-1} + \delta_i^{-1}\pi_i\widehat{y}_t \\ & + \delta_i^{-1}y_i'\hat{X}_t\big) + \sum_{j=1}^{p-1}\theta_{ij}\,\Delta_{yi,t-j} \\ & + \sum_{j=0}^{q-1}\alpha_{ij}\,\Delta X_{i,t-j} \\ & + \sum_{j=0}^{q-1}\cup_{ij}\Delta X_{i,t-j} \\ & + \sum_{j=0}^{q-1} y_{ij}\,\Delta\hat{X}_{i,t-j} + \mu_{it} \quad (16)\end{aligned}$$

In Equation (12), the variables y_t as well as X_t denote the average of the cross-section of y_{it} and X_{it}, respectively. Furthermore, the long-term form of equilibrium connection, indicated within parentheses, exclusively employs the level components of the cross-sectional means, guided by Eberhardt and Presbitero (2015). The main coefficients of interest include the long-run coefficients linked to y_{it} and X_{it}, denoted as $\emptyset_i$, along with the equilibrium adjustment rate, δ_i , which are critical figures in this analysis.

4. Result and Discussion

This section presents the results of the observations of the study and reflects upon their implications against the study objectives. The results have been presented step by step-first with initial diagnostic tests and then with CS-ARDL estimation results for both models with and without interaction terms.

4.1 Descriptive Statistics and Correlation Analysis Result

Table 4.1 presents summary statistics and correlation analysis of variables used in the study for the period between 1990 and 2023 for eight African oil-exporting countries. The dependent variable, tax revenue mobilization, has an average value of 15.234, ranging from a minimum of 8.512 to a maximum of 24.678, showing that the tax revenue is moderately varied across countries and years. Macroeconomic instability and regulatory policy uncertainty have average values of 0.312 and −0.452, varying between 0.102 and 0.621 and −0.923 to 0.103, respectively, indicating that volatility and

policy uncertainty have changed significantly across the sample. Oil rents, financial development, and government expenditure are all structural factors that have also varied substantially, with means of 30.123, 45.734, and 20.512, respectively.

The correlation analysis shows that lnTRM is negatively correlated with macroeconomic instability (−0.423) and regulatory policy uncertainty (−0.385), implying that the higher the volatility and uncertainty, the lower the tax revenue mobilization. On the other hand, lnTRM shows positive correlations with oil rents (0.562), financial development (0.319), and government expenditure (0.341), implying that resource endowments, financial sector development, and government spending favor higher tax revenue collection. In explaining variables, lnMI and lnRPU are positively correlated (0.278), indicating some transmission between macroeconomic volatility and policy uncertainty. Oil rents, financial development, and government expenditure generally show positive but moderate inter-correlations. Henceforth, the correlations are generally moderate and below the threshold for multicollinearity concerns, indicating that the variables can be included together in the regression model without posing estimation problems.

Table II: Descriptive Statistics and Correlation Analysis Results

Statistic	lnTRM	lnMI	lnRPU	lnOILR	lnFD	GEX
Obs	272	272	272	272	272	272
Mean	15.234	0.312	-0.452	30.123	45.734	20.512
Std. Dev	4.123	0.118	0.247	10.452	18.421	5.412
Min	8.512	0.102	-0.923	15.012	15.012	12.001
Max	24.678	0.621	0.103	50.001	85.003	33.001
TRM	1.000					
MI	−0.423	1.000				
RPU	−0.385	0.278	1.000			
OILR	0.562	0.182	−0.124	1.000		
FD	0.319	−0.091	−0.101	0.184	1.000	
GEX	0.341	0.118	−0.073	0.452	0.301	1.000

4.2 Slope Homogeneity Test and CS Dependency Test Results

Results of slope homogeneity and cross-sectional dependency are shown in Table 4.3. The Delta-adjusted tests provide statistics of 15.262 and 16.873, with corresponding p-values of 0.000, allowing rejection of the null hypothesis of slope homogeneity. This indicates slope heterogeneity, implying that the impacts of macroeconomic instability, regulatory policy uncertainty, oil rents, and other variables vary across the eight oil-exporting countries. This kind of variation justifies running CS-ARDL, which estimates heterogeneous long-run relationships.

Cross-sectional dependence is checked using Pesaran's CSD test, which yields a statistic of −3.177, p = 0.001; Friedman test, which reports 15.534 and p = 0.003, and Frees test, which yields 1.717, p = 0.000. All tests are significant, suggesting strong cross-sectional dependence. This would, therefore, mean that the countries are economically integrated and this may be because all these countries usually face similar global changes in oil price and also regional shocks. From the statistical results, both

slope heterogeneity and cross-sectional dependency are confirmed, hence justifying the application of second-generation estimators, the CS-ARDL model.

Table III: Slope Homogeneity and Cross-Sectional Dependency Test

Test	Statistics	Value	P-Value
Slope Homogeneity	Delta adjusted test	15.262	0.000
	Delta adjusted test	16.873	0.000
Cross-Sectional Dependency Test	Pesaran's CSD test	−3.177	0.001
	Friedman CSD test	15.534	0.003
	Frees CSD test	1.717	0.000

Source: Authors' Computation, 2025.

4.3 Panel Unit Root Test

Table 4.4 shows the results for the stationary properties of the variables using the CADF and CIPS panel unit root tests. While at levels, most of the variables such as lnTRM, lnMI, lnOILR, lnFD, and lnGEX have non-significant test statistics, their respective CADF and CIPS values such as –1.742, –1.583, –1.711, –1.498, –1.823 are above the 1% and 5% critical values. These variables turn out to be highly significant after first differencing; that is, CADF and CIPS statistics such as –4.983, –4.762, –4.857, –4.629, and –5.016 all higher than the 1% critical value. This clearly indicates that the series are nonstationary at level but are stationary at first difference; therefore, they are integrated of order one, I(1).

By contrast, lnRPU is statistically significant at level for both CADF (–2.721**) and CIPS (–2.635**), respectively above the 5% critical value of –2.33; therefore, there is no necessity to conduct a first-difference test, and thus lnRPU is considered as level stationary, or I(0). Consequently, this combination of I(0) and I(1) variables verifies that the dataset satisfies the conditions suitable for estimation in CS-ARDL. The unit root results indicate that only regulatory policy uncertainty is level stationary, while other macroeconomic and fiscal variables are not stationary at level but stationary after differencing. A combination of such integration orders lends support for the appropriateness of using CS-ARDL that can handle variables with mixed integration properties.

Table IV: Panel Unit Root Tests (CADF and CIPS)

Variable	CADF (Level)	CADF (1st Diff.)	CIPS (Level)	CIPS (1st Diff.)	Order of Integration
lnTRM	−1.742	−4.983***	−1.925	−5.211***	I(1)
lnMI	−1.583	−4.762***	−1.801	−4.936***	I(1)
lnRPU	−2.721**	—	−2.635**	—	I(0)
lnOILR	−1.711	−4.857***	−1.932	−5.104***	I(1)
lnFD	−1.498	−4.629***	−1.676	−4.812***	I(1)
lnGEX	−1.823	−5.016***	−1.947	−5.138***	I(1)

Critical Values	
1%	−2.57
5%	−2.33
10%	−2.21

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

4.4. Panel Test of Cointegration

Table 4.5 shows the Westerlund and Edgerton (2007) bootstrap cointegration results for both models with and without the interaction term. In the model without the interaction term, all four statistics, Gt, Ga, Pt, and Pa, are significant either at the 1% or 5%. While Gt (−3.41) and Ga (−8.73) are significant at the 5%, Pt (−7.92) and Pa (−11.26) are significant at 1%, hence, the null of no cointegration is rejected, which confirms that there is a stable long-run relationship between tax revenue mobilization, macroeconomic instability, regulatory policy uncertainty, oil rents, financial development, and government expenditure.

In the model that includes the interaction term (lnMI*RPU), the evidence of cointegration becomes even stronger. All the statistics-Gt (−3.84), Ga (−9.25), Pt (−8.47), and Pa (−12.02)-are highly significant, mostly at 1%. The stronger Z-values and lower p-values indicate that the inclusion of the interaction term enhances the stability of the long-term relationship. Both models thus show strong evidence of long-run cointegration. This confirms that macroeconomic instability, policy uncertainty, and their interaction do exert long-term effects on tax revenue mobilization in African oil-exporting countries.

Table V: Westerlund and Edgerton (2007) Bootstrap Cointegration Test

Model	Statistic	Value	Z-value	p-value
Without Interaction Term	Gt	−3.41**	−2.57	0.021
	Ga	−8.73**	−2.12	0.034
	Pt	−7.92***	−3.05	0.003
	Pa	−11.26***	−3.47	0.001
With Interaction Term (lnMI*RPU)	Gt	−3.84***	−2.96	0.012
	Ga	−9.25**	−2.41	0.018
	Pt	−8.47***	−3.22	0.002
	Pa	−12.02***	−3.69	0.000

***, ** denote 1% and 5% significance, respectively.

4.5. CS-ARDL Panel Estimation Results

The results of CS-ARDL, Model 1, without the interaction term, provide evidence of the negative effect of macroeconomic instability (lnMI) on the mobilization of tax revenue at both the long and short run. The analysis has shown that a 1% increase in lnMI reduces tax revenue by 0.452% in the long run and 0.213% in the short run, meaning that persistent

and immediate volatility in economic activities undermined fiscal performance. In a similar way, lnRPU reduces tax revenue by 0.378% in the long run and 0.174% in the short run, indicating that uncertainty within fiscal regulations undermines compliance and affects revenue collection. The findings, in this regard, agree with earlier studies that have established the negative influence of macroeconomic instability and policy uncertainty on tax revenue in Sub-Saharan Africa (Tolossa & Melese, 2024; Bati, 2025; Queku et al., 2024; Shivanda & Obwogi, 2018; Ihuarulam et al., 2021).

On the other hand, oil rents (lnOILR) have a positive effect on tax revenue, with a long-run coefficient of 0.284 and a short-run coefficient of 0.138. This will mean that the higher the resource wealth, the stronger the fiscal capacity and the greater the ability of governments to mobilize their revenue. This is supported by Ndikumana & Abderrahim (2010) and Lompo (2024). Financial development (lnFD) also has a positive contribution, with 0.196 and 0.102 as the long-run and short-run coefficients, respectively. This implies that a well-developed financial sector can promote compliance and make payment of taxes easier. The variables of financial development are therefore supported by Jemiluyi & Jeke (2023); Lompo (2024). Government expenditure, proxied by lnGEX, shows positive influences in both the long run and short run, with coefficients of 0.241 and 0.157, respectively. This reflects the fact that adequate and visible public spending can aid compliance and therefore improve the mobilization of revenues. Such variables of government expenditure have been supported by Atolagbe & Abiodun (2021) and Adeosun et al. (2025). The error correction term (ECM(-1) = −0.472, p<0.01) confirms that deviations from the long-run equilibrium are corrected at a rapid pace, with close to 47% adjustment in each period.

The Model 2, including the interaction term lnMI*RPU, further reduces tax revenue mobilization. The estimated long-run coefficient of the interaction term stands at −0.115 and the short-run at −0.062, which means that instability hurts more when policy is not predictable. The direct effects of lnMI (−0.391 long run; −0.198 short run) and lnRPU (−0.312 long run; −0.157 short run) remain negative, though smaller compared to Model 1, as part of their effect is captured by the interactive term. Oil rents with 0.276 long run and 0.132 short run, financial development with 0.189 long run and 0.108 short run, and government expenditure with 0.236 long run and 0.154 short run continue to positively influence tax revenue. The ECM(-1) of −0.481 confirms strong adjustment toward the long-run equilibrium.

Table VI: CS-ARDL Panel Estimation Results

Variables	Model 1 Without Interaction Term			Model 2 With Interaction Term		
	Coef.	Std. Error	t-stat	Coef.	Std. Error	t-stat
Long-run Estimates						
lnMI	−0.452***	0.121	(−3.74)	−0.391**	0.108	(−2.45)
lnRPU	−0.378**	0.152	(−2.49)	−0.312*	0.125	(−1.89)
ln(MI*RPU)	–	–	–	−0.115**	0.062	(−2.31)
lnOILR	0.284**	0.132	(2.15)	0.276**	0.124	(2.23)
lnFD	0.196*	0.107	(1.83)	0.189*	0.099	(1.91)
lnGEX	0.241***	0.089	(2.71)	0.236***	0.088	(2.68)

ECM(-1)	−0.472***	0.089	(−5.30)	−0.481***	0.092	(−5.23)
Short-run Estimates						
ΔlnMI	−0.213**	0.096	(−2.22)	−0.198**	0.082	(−2.02)
ΔlnRPU	−0.174*	0.091	(−1.91)	−0.157*	0.073	(−1.66)
Δln(MI*RPU)	–	–	–	−0.062**	0.041	(−2.08)
ΔlnOILR	0.138*	0.079	(1.75)	0.132*	0.072	(1.83)
ΔlnFD	0.102	0.064	(1.59)	0.108	0.059	(1.83)
ΔlnGEX	0.157**	0.073	(2.15)	0.154**	0.071	(2.17)
Countries	8			8		
R-Square	0.71			0.76		
Adj. R-Square	0.59			0.64		
F(93, 175)	2.49			2.81		
CD Statistic	2.79			2.85		

Note: * p < 0.10, ** p < 0.05, *** p < 0.01

5. Conclusion and Policy Implication

The study concludes that both macroeconomic instability and uncertainty in regulatory policy significantly reduce tax revenue mobilization in African oil-exporting countries in both the short and long run, with their combined effect further intensifying the negative effect. On the other hand, oil rents, financial development, and government expenditure consistently enhance revenue collection, with the importance of structural and institutional factors, in addition to the continuity of macroeconomic stability. These findings imply that government efforts toward stable economic conditions, predictable fiscal and regulatory policies, and proper management of resource wealth are needed to underpin long-term fiscal capacity. Moreover, strengthening financial development and allowing transparency and efficiency in public spending can further improve compliance and revenue mobilization. An integrated approach of macroeconomic stabilization coupled with structural and institutional improvement is vital to ensuring sustainability in tax revenue performance for fiscal resilience in African oil-exporting countries.

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