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Do Tax Reforms Improve Revenue Mobilization? Evidence from Ghana Using ECM and ARIMA Forecasting

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ABSTRACT

This study evaluates the effectiveness of tax reforms on revenue mobilization in Ghana over the period 2000 to 2024. Using annual revenue data from the Ghana Revenue Authority (GRA), the analysis integrates multiple econometric approaches, including structural break identification, unit root diagnostics, an error correction model (ECM), and ARIMA forecasting. The findings reveal significant structural breaks in 2004, 2011, and 2016, which correspond to major reform episodes and external commodity shocks, indicating that policy changes have had measurable impacts on revenue performance. Stationarity tests confirmed that revenue is integrated of order one, justifying the use of the ECM to capture both short-run dynamics and long-run equilibrium relationships. The ECM results highlight a significant and negative error correction term of approximately 0.857, suggesting that roughly 86% of deviations from the long-run path are corrected within one year, thereby demonstrating the resilience of Ghana's fiscal adjustment mechanism. Forecast results project sustained revenue growth, with collections expected to exceed GH₵194 billion by 2025, assuming no major disruptions. Collectively, these results provide robust evidence that tax reforms have enhanced Ghana's revenue mobilization capacity, though the system remains sensitive to external shocks, particularly commodity price fluctuations and currency depreciation. The study underscores the importance of sustaining reforms and deepening revenue digitalization to ensure long-term fiscal stability.

Keywords: Tax Reforms, Revenue Mobilization, Error Correction Model, Structural Breaks, ARIMA Forecasting.

INTRODUCTION

Taxation remains one of the most reliable and sustainable sources of government revenue globally, providing the financial foundation for public expenditure, infrastructure development, and economic stability. Unlike resource-based revenues, which are volatile and often vulnerable to external shocks, tax revenues constitute a predictable and internally generated source of funds that governments can deploy to finance development programmes (Brana et al., 2019). In many developing countries, including Ghana, taxation has become increasingly central as governments seek to reduce overdependence on commodity exports and strengthen the domestic fiscal base.

Ghana, one of West Africa's leading economies, has historically relied substantially on cocoa, gold, and oil exports as primary sources of foreign exchange and government revenue. However, the volatility of global commodity markets has exposed the country to fiscal instability, recurrent budget deficits, and debt accumulation (Yohou, 2023). This overdependence has made it necessary for successive governments to initiate tax reforms as part of broader fiscal strategies aimed at diversifying revenue sources and enhancing fiscal sustainability. Since 2000, numerous tax reforms have been introduced to strengthen the revenue base. These reforms include the establishment of the Large Taxpayer Unit (LTU) and the introduction of the Taxpayer Identification Number (TIN) in 2002 to 2004, the formation of the Ghana Revenue Authority (GRA) in 2009 through the merger of four pre-existing revenue agencies, the enactment of a comprehensive Income Tax Act in 2015 (Act 896), the introduction of the Integrated Tax Application and Preparation System (ITAPS) in 2019, and the deployment of the E-VAT platform and Ghana.Gov digital payment infrastructure in 2022 to 2023 (Waiswa & Yavuz, 2023). Each of these reforms aimed to expand the tax net, improve compliance, and align Ghana's tax system with international best practices.

Despite these reform efforts, Ghana's tax-to-GDP ratio has historically hovered around 12 to 14%, well below the Sub-Saharan African average and the government's own Medium-Term Revenue Strategy (MTRS) target of 18 to 20% by 2027 (OECD/AUC/ATAF, 2024). While the ratio improved markedly to 17% in 2024

following aggressive digitalization, persistent challenges remain in mobilizing domestic revenue through taxation. Weak compliance in the informal sector, structural bottlenecks in tax administration, and vulnerability to macroeconomic shocks have continued to undermine the full effectiveness of reforms (Osei and Quartey, 2021). Revenue generation has also been affected by structural issues, including cedi depreciation, currency misalignment, and insufficient enforcement capacity within the GRA. While reforms have been implemented, the gap between projected tax revenues and actual collections in certain years remained wide (IMF, 2023). The fundamental question, therefore, is whether tax reforms in Ghana have truly delivered the desired outcomes in terms of enhancing revenue mobilization.

Previous studies on Ghana's taxation system have examined the relationship between tax revenue and economic growth (Kebede et al., 2024), the challenges of tax administration (Atta-Mensah, 2022), and the impact of specific tax policies such as the Electronic Transfer Levy (Mallick, 2021; Nguyen-Phuong et al., 2022; Yossinomita, 2024). However, fewer studies have adopted a long-run time-series econometric perspective to evaluate how reforms across multiple decades have shaped revenue trends, growth, and structural dynamics. This represents a critical gap in the literature. Moreover, while international organizations such as the IMF and World Bank consistently emphasize the importance of domestic resource mobilization through taxation, evidence on the effectiveness of Ghana's reform strategies remains inconclusive (IMF, 2023). Some reforms appear to have had immediate positive effects on tax collection, while others produced transitional disruptions before yielding sustained gains. This inconsistency raises the need for a systematic evaluation across different reform periods (Gnangnon, 2023a).

A time-series analysis covering 2000 to 2024 is particularly relevant given the political and economic transformations Ghana experienced during this period. The years include democratic consolidation, commodity price cycles, the global financial crisis, the COVID-19 pandemic, and various fiscal policy shifts including Ghana's IMF-supported economic recovery programme from 2023. An empirical analysis across this timeframe allows for a nuanced understanding of whether reforms were effective in stabilizing and improving revenue performance amidst such dynamic conditions. In addition, Ghana's ambition to achieve fiscal sustainability and reduce dependency on external borrowing underscores the importance of an effective taxation system. Inadequate tax revenue has often forced the government to resort to debt financing, with public debt servicing consuming a disproportionately large share of national revenue in recent years (MoFEP, 2023). Strengthening tax reforms and ensuring their effectiveness, therefore, have critical implications for fiscal discipline and economic sovereignty.

From a policy perspective, evaluating the effectiveness of tax reforms also holds significance for guiding future reforms. Policymakers require evidence-based insights into which reforms worked, which produced mixed results, and why. Without such evaluation, there is a risk of recycling ineffective policies or introducing reforms that fail to address Ghana's unique structural challenges (Chebochok & Bayale, 2023; Gnangnon, 2023a; Oz-Yalaman, 2019). Furthermore, the Ghanaian tax landscape is heterogeneous, encompassing corporate income tax, personal income tax, value-added tax, customs duties, and a growing array of sector-specific levies. The contributions of these taxes to overall revenue differ across reform episodes. A comprehensive analysis must, therefore, examine both aggregate and disaggregated revenue outcomes to provide a holistic picture of reform effectiveness ((Thayyib et al., 2023).

The most recent wave of reforms, spanning 2022 to 2024, marks a significant turning point in Ghana's national tax policy. The GRA accelerated e-invoicing for VAT, deployed the Ghana.Gov integrated payment portal, and implemented the Electronic Transfer Levy (E-Levy) to tax mobile money transactions. While the E-Levy attracted controversy and its revenues underperformed initial targets, it represented a deliberate expansion of the tax base into the digital economy (Fathoni & Saputra, 2023; Hassan et al., 2021; Ofori, 2020). The transformation of GRA's operational model toward data-driven audit and compliance, backed by expanded taxpayer registration, contributed to Ghana achieving its highest ever tax-to-GDP ratio of 17% in 2024, up from 13.8% in 2022 (Queku et al., 2023). Collectively, these measures underscore a deliberate shift toward a more progressive, digitalized, and sustainable tax framework intended to raise Ghana's revenue capacity and strengthen fiscal resilience.

In light of these considerations, this study seeks to fill the gap in empirical knowledge by conducting a time-series analysis of tax reforms and their impact on revenue generation in Ghana from 2000 to 2024. By systematically examining revenue trends, reform episodes, and econometric relationships, the study aims to provide evidence on whether tax reforms have enhanced Ghana's revenue mobilization capacity. Specifically, the study will: examine the trend and growth patterns of GRA tax revenue over the period 2000 to 2024; assess

the impact of major tax reforms on revenue performance, distinguishing between pre-reform and post-reform periods; analyze the long-run and short-run relationship between tax reforms and revenue generation using time-series econometric techniques; and provide policy recommendations on strengthening tax reforms for sustainable revenue generation in Ghana.

METHODOLOGY

This study adopts a quantitative research design, specifically a time-series econometric approach, to evaluate the effectiveness of tax reforms on revenue generation in Ghana between 2000 and 2024. Time-series analysis is particularly suitable for examining the dynamic interactions between policy reforms and economic outcomes over time (Gnangnon, 2020; Kamasa et al., 2022; Queku et al., 2023). By relying on historical revenue data, reform episode indicators, and macroeconomic variables, the study seeks to establish both descriptive patterns and econometric relationships that capture the long-run and short-run effects of tax reforms.

The research is based on secondary data obtained from reliable national and international sources. Annual tax revenue data and reform indicators were extracted from publications of the Ghana Revenue Authority (GRA), the Bank of Ghana (BoG) Monetary Policy Reports, and the Ministry of Finance (MoFEP) Annual Tax Revenue Performance Reports. Complementary macroeconomic data, including gross domestic product (GDP), inflation rates, exchange rates, and commodity revenues, were obtained from the World Bank World Development Indicators and IMF Country Reports. The use of secondary data ensures objectivity and replicability, as these datasets are widely recognized for their accuracy in macroeconomic studies (Gnangnon & Brun, 2019; Sayari et al., 2023; Todorovic et al., 2024).

The variables for the study were classified into dependent, independent, and control variables. The dependent variable is tax revenue performance, measured as total annual GRA collections in nominal Ghana Cedis (GH₵). The key independent variable is tax reform, captured through four policy dummy variables denoting periods of major reforms: the LTU and TIN introduction of 2004 (D_LTU), the GRA formation of 2009 (D_GRA), the Income Tax Act of 2015 (D_ITA), and the ITAPS digital tax system launched from 2019 (D_ITAPS). Control variables include macroeconomic indicators such as GDP growth, inflation, and commodity revenues, which are known to influence revenue generation capacity (Hossain et al., 2019).

The study employs a combination of descriptive statistics and econometric techniques. Descriptive analysis, including measures of central tendency, growth rates, and graphical plots, provides an overview of revenue trends and reform impacts over the study period. This is followed by diagnostic tests to ensure the reliability of time-series modeling. Specifically, unit root tests such as the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are used to determine the stationarity of variables (Benkejjane et al., 2024; Gnangnon, 2023b; Gurdal et al., 2021). The presence of long-run relationships can be examined using Johansen cointegration tests or the Autoregressive Distributed Lag (ARDL) bounds test, depending on the order of integration (Sisha, 2020).

In cases where cointegration is established, the study applies an Error Correction Model (ECM) to capture both long-run equilibrium relationships and short-run adjustments. This framework is suitable for analyzing how quickly deviations from equilibrium are corrected after tax reforms or economic shocks (Engle and Granger, 1987). Additionally, Granger causality tests are conducted to establish whether tax reforms significantly drive revenue performance or whether revenue trends themselves influence reform implementation. To assess structural impacts, the Chow test and the Bai-Perron multiple structural break test are employed, allowing the study to detect significant breaks in tax revenue performance associated with reform episodes (Jemiluyi & Jeke, 2023).

To ensure robustness, the analysis incorporates sensitivity checks by testing alternative model specifications and excluding years with major exogenous shocks such as the 2008 to 2009 global financial crisis and the COVID-19 pandemic. This enhances the reliability of results and minimizes the risk of spurious relationships (Enders, 2014). All statistical analyses are conducted using EViews and Stata econometric software, which provide advanced tools for handling time-series data and implementing econometric techniques.

Trend Model (OLS Baseline)

To capture the long-run growth path of tax revenue, the study employed a log-linear trend model of the form:

$$\ln\{Revenue\}_t = \alpha + \beta_1 t + \beta_2 D\{LTU,t\} + \beta_3 D\{GRA,t\} + \beta_4 D\{ITA,t\} + \beta_5 D\{ITAPS,t\} + \varepsilon_t \quad (1)$$

ln{Revenue}_t is the natural logarithm of GRA revenue in year t; t is the time trend (Year); D{LTU,t}, D{GRA,t}, D{ITA,t}, D{ITAPS,t} are dummy variables capturing key reform episodes (LTU and TIN 2004, GRA Formation 2009, Income Tax Act 2015, ITAPS Digitalization 2019); ε_t is the error term. This model helps identify both the general growth trend and shifts in revenue patterns associated with specific reforms.

Error-Correction Model (ECM)

To capture both long-run equilibrium and short-run adjustments, the ECM specification will be estimated, thus:

$$\Delta \ln\{Revenue\}t = \gamma_0 + \gamma_1 \Delta \ln\{Revenue\}\{t-1\} + \varphi EC\_\{t-1\} + u\_t \quad (2)$$

Δln{Revenue}t is the first-differenced log of revenue (short-run change); γ_0 is the intercept term, representing the average short-run drift in revenue growth not explained by past changes or the error-correction term; γ_1 is the short-run autoregressive coefficient, capturing the effect of last period's change in revenue on the current period; EC{t-1} is the lagged error-correction term (residuals from the long-run OLS model); φ is the adjustment coefficient measuring the speed of return to equilibrium; and u_t is the disturbance term. A significant negative φ indicates convergence to the long-run equilibrium aftershocks.

Stationarity and Unit Root Tests

Preliminary tests to confirm the statistical properties of the series include, Augmented Dickey-Fuller (ADF) test:

$$\Delta y\_t = \alpha + \rho y\_\{t-1\} + \Sigma_i \theta_i \Delta y\_\{t-i\} + \varepsilon\_t \quad (3)$$

y_t is the time series variable (here, log of revenue, ln{Revenue}*t); Δy_t = y_t - y*{t-1} is the first difference capturing short-run changes; α is the intercept (drift term); ρ is the coefficient on the lagged level of the series used to test the unit root hypothesis; θ_i are the coefficients on the lagged differenced terms, included to control for serial correlation in residuals; K is the number of lagged differences included; and ε_t is the white-noise error term (Jemiluyi & Jeke, 2023; Mawejje & Sebudde, 2019; Queku et al., 2024).

KPSS test (stationarity around a deterministic trend) is the reverse of the ADF test:

$$y\_t = r\_t + \beta t + \varepsilon\_t \quad (4)$$

r_t = r_{t-1} + u_t is the random walk component where u_t ~ iid(0, σ^2); βt is the deterministic trend (optional); and ε_t is the stationary error term. These ensure that appropriate differencing is applied in time-series models (Brun & Gnangnon, 2019; Gnangnon, 2021; Handoko, 2019).

ARIMA Model (Short-Run Dynamics and Forecasting)

To model short-run dynamics and generate forecasts, autoregressive integrated moving average models were estimated. The general form is:

$$\Phi(L)(1-L)^d y_t = \Theta(L)\varepsilon_t \quad (5)$$

y_t is ln {Revenue}_t already defined; Φ(L) is the autoregressive (AR) lag polynomial; Θ(L) is the moving average (MA) lag polynomial; d is the differencing order; and ε_t is a white-noise error. The best-fitting model selected was ARIMA (1,1,1), based on the Akaike Information Criterion (AIC) (Hangoma et al., 2024).

Diagnostic and Robustness Models

Additional models will be used to validate robustness including:

Jarque-Bera normality test for residual distribution:

$$JB = \frac{n}{6}\left(S^2 + \frac{(K-3)^2}{4}\right) \quad (6)$$

where n is sample size; S is the skewness of residuals; and K is kurtosis of residuals.

Breusch-Pagan heteroskedasticity test:

$$u_t^2 = \delta_0 + \delta_1 Z_{\{1t\}} + \delta_2 Z_{\{2t\}} + \cdots + v_t \quad (7)$$

Durbin-Watson statistic for serial correlation in OLS residuals:

$$DW = \left(\sum (t=2)^n \left(\widehat{(u)}_t - \widehat{(u)}_{(t-1)}\right)^2\right) / \left(\sum (t=1)^n \widehat{(u)}_t^2\right) \quad (8)$$

DW ranges from 0 to 4, where approximately 2 indicates no autocorrelation, less than 2 suggests positive autocorrelation, and greater than 2 suggests negative autocorrelation.

Rolling regressions (10-year windows) of ln{Revenue}_t to check slope stability: ln(Revenue_t) = α_r + β_r t + ε_t for rolling windows of size r.

In summary, the methodological framework is designed to provide a comprehensive evaluation of tax reforms and their impact on Ghana's revenue generation. By combining descriptive trend analysis with robust econometric modeling, the study ensures that both the immediate and long-term implications of reforms are systematically examined. This multi-layered approach offers policymakers and researchers valuable insights into the extent to which tax reforms have strengthened Ghana's fiscal capacity.

ANALYSES

In this section, Preliminary Analysis, Diagnostic and Preliminary Tests, Core Econometric Analysis, and Advanced Time-Series Analysis will be studied with respect to the timeline of revenue collections data according to the Ghana Revenue Authority (GRA) from 2000 to 2024 (see Appendix). These analyses are intended to realize the objectives of this research as already stated in the first section of the work.

Preliminary Analysis

This comprises descriptive analysis including the mean, median, standard deviation, growth rates, and revenue trends before and after reforms. In addition, graphical analysis which includes line plots of GRA tax revenue (total and disaggregated) and periods of reform versus spikes or declines will be studied here.

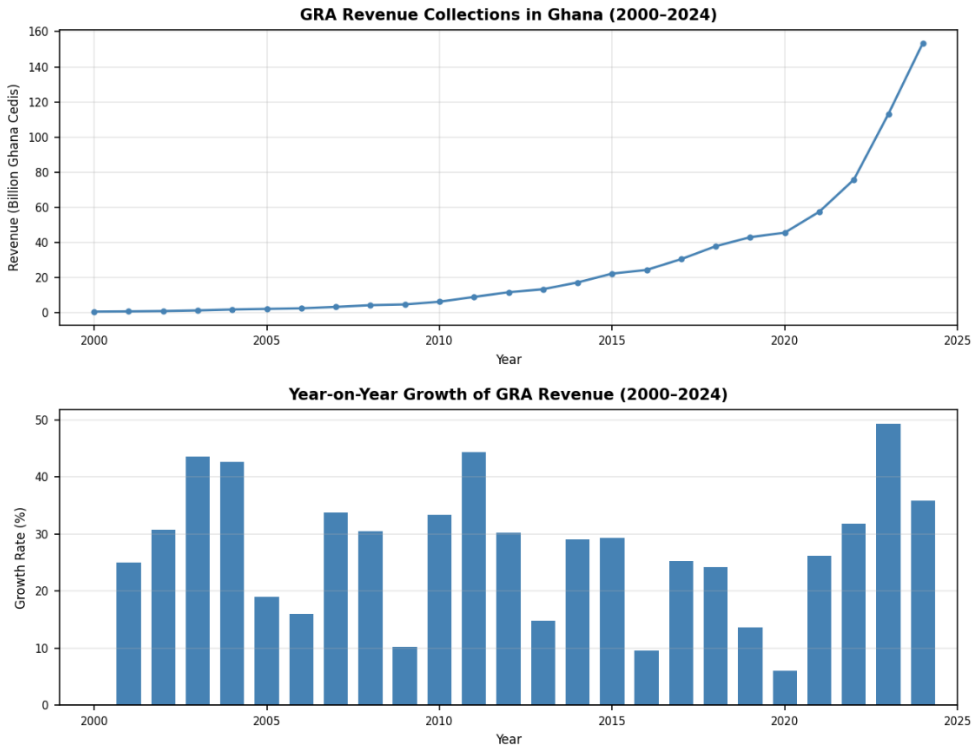

Figure 1. Revenue Collections in Ghana, and Year-on-Year Growth of GRA Revenue

Table 1. Descriptive Statistics

Total years covered	Mean revenue	Median revenue	Minimum revenue	Maximum revenue	Standard deviation
25	GHC27.256 billion	GHC11.570 billion	GHC0.52 billion in 2000	GHC153.60 billion in 2024	GHC38.170 billion

It is noteworthy that the mean revenue figure (GH₵27.256 billion) is elevated by the exponential growth observed in the latter part of the period, particularly the record-breaking collections of 2022 to 2024. Realistically, the median of GH₵11.570 billion better represents the mid-point of the revenue distribution across the 25 years. About the revenue trend, from 2000 (GH₵0.52 billion) to 2024 (GH₵153.60 billion), Ghana's GRA tax revenue increased by approximately 295 times in nominal terms, reflecting the combined impact of

economic growth, inflationary adjustments, institutional reforms, and policy changes. The sharpest growth spurts occurred in:

- 2003 to 2004 (GH₵1.22 billion - GH₵1.74 billion, post-LTU establishment)
- 2010 to 2011 (GH₵6.16 billion - GH₵8.89 billion, post-GRA consolidation)
- 2022 to 2024 (GH₵75.71 billion - GH₵153.60 billion, digital reform era)
- where the periods of stagnation or relative slowdown included:
- 2015 to 2016 (GH₵22.17 billion - GH₵24.28 billion, only +9.5% growth)
- 2019 to 2020 (GH₵42.93 billion - GH₵45.50 billion, only +6.0%)

Coinciding with commodity price weakness and currency depreciation pressures, and with the COVID-19 shock in 2020 which compressed economic activity and revenue collections. The Growth Patterns revealed Year-on-Year Growth Rates, with the highest single-year growth of approximately 49.3% in 2023 (GH₵113.06 billion). Other major spikes occurred in 2003 at +43.5%, in 2011 at +44.3%, and in 2004 at +42.6%. Notably, Ghana did not record any year of negative nominal revenue growth in absolute terms during this 25-year period, unlike other resource-dependent economies. However, periods of very low growth such as 2016 (+9.5%) and 2020 (+6.0%) represented near-stagnation in real terms given prevailing inflation rates. This pattern shows alternating cycles of rapid growth followed by consolidation, strongly tied to commodity price cycles, exchange rate dynamics, and the timing of major reform interventions.

Now the Compound Annual Growth Rate (CAGR) from 2000 to 2024 is approximately 26.7% per year in nominal terms, indicating a strong long-term upward trajectory in revenue despite short-term volatility driven by macroeconomic shocks. The visual insights drawn from the Trend Plot show a steady exponential climb with visible kinks during crises (2016, 2020) and inflection points corresponding to reform episodes. The Growth Plot highlights the variability in annual performance, which reflects Ghana's sensitivity to external commodity shocks and the uneven pace of tax reform implementation.

Ghana's GRA revenue grew approximately 295 times in nominal terms from 2000 to 2024. Growth has been volatile but consistently positive, with gains strongly tied to both reform episodes and the macroeconomic cycle. Recent years (2022 to 2024) show the highest and most stable upward trend, partly attributable to Finance Acts, VAT digitalization, and the E-VAT platform reforms.

Diagnostic and Preliminary Tests

These tests help identify potential issues with the data, such as non-stationarity, autocorrelation, and heteroskedasticity, which can impact the accuracy of econometric models. The goal here is to check the statistical properties of the revenue series before running econometric models, ensuring reliability and avoiding spurious regression.

In Stationarity Tests, time-series data often exhibit trends or unit roots, which can invalidate OLS regressions if not corrected. Hence, we apply the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests, investigating these hypotheses:

- H_0: The series has a unit root (non-stationary). H_1: The series is stationary.

Consequently, if the series is non-stationary, the data may become stationary after first differencing, yielding an I(1) integration classification. Under Normality Test, we employ the Jarque-Bera (JB) test to verify data normality under the hypotheses:

- H_0: Data is normally distributed. H_1: Data deviates from normal distribution.

This helps to assess whether the error terms meet regression assumptions. For Serial Correlation, we apply the Durbin-Watson (DW) statistic and Breusch-Godfrey LM test, where DW ≈ 2 indicates no autocorrelation and DW < 2 suggests positive autocorrelation (common in economic series). Under Heteroskedasticity Testing, we apply the Breusch-Pagan-Godfrey (BPG) test, testing:

- H_0: Homoskedasticity (constant variance). H_1: Heteroskedasticity (non-constant variance).

Table 2: Diagnostic and Preliminary Test Results for Log of Revenue

Test	Statistic	p-value	Decision (5% level)	Interpretation
ADF	-1.08	0.722	Fail to Reject H_0	Series is non-stationary in levels (unit root)
PP	-0.03	0.956	Fail to Reject H_0	Confirms non-stationarity in levels
JB	1.34	0.511	Fail to Reject H_0	Residuals approximately normal

DW	0.48	--	Strong evidence of serial correlation	Presence of positive autocorrelation in residuals

To ensure the validity of the econometric procedures, a series of diagnostic tests were carried out on the GRA revenue data spanning 2000 to 2024. First, the Augmented Dickey-Fuller (ADF) test was employed to examine the presence of unit roots in the logarithm of revenue. The test statistic (-1.08) was greater than the 5% critical value (-3.005) with a p-value of 0.722, leading to a failure to reject the null hypothesis of a unit root. This indicates that the log of revenue is non-stationary in levels, suggesting the need for differencing before further time-series modeling. Complementing this, the Phillips-Perron (PP) test was also considered, as it provides robustness against serial correlation and heteroskedasticity in the error term. Consistent with the ADF result, the PP test (statistic: -0.03, p-value: 0.956) confirmed the non-stationarity of the series in levels, thereby validating the presence of a stochastic trend in Ghana's revenue generation.

In addition to unit root testing, the Jarque-Bera (JB) test was conducted to assess the normality of the log revenue distribution. The JB statistic (1.34) with a p-value of 0.511 suggested failure to reject the null hypothesis of normality. This implies that the revenue distribution is approximately normal, with only mild skewness (-0.130) and slightly platykurtic behavior (kurtosis of 1.895). This finding supports the suitability of regression-based time-series analysis, as the normality assumption for error terms is not grossly violated.

Serial correlation was evaluated using the Durbin-Watson (DW) statistic, obtained from the residuals of a baseline regression of log revenue on a deterministic time trend. The DW statistic (0.48) was substantially lower than the benchmark of 2, indicating strong positive autocorrelation in the residuals. This result justifies the application of more advanced time-series models, such as autoregressive distributed lag structures, error correction models, and ARIMA specifications, which explicitly account for temporal dependence.

These diagnostic results reveal that Ghana's revenue series is characterized by non-stationarity in levels, approximate normality, and strong serial correlation. This combination of properties provides a strong rationale for applying cointegration and error correction models to capture both the long-run equilibrium relationship and the short-run dynamics, while also motivating robustness checks with ARIMA forecasting frameworks.

Core Econometric Analysis

This section presents the empirical results of the core econometric models employed to evaluate the effectiveness of tax reforms on revenue generation in Ghana (2000 to 2024). Both the long-run equilibrium relationship and the short-run adjustment dynamics will be examined through an Ordinary Least Squares (OLS) trend model and an Error Correction Model (ECM), supported by diagnostic tests.

Table 3: Long-Run OLS Regression Results

Variable	Coefficient	Std. Error	t-Statistic	p-value
Constant	-0.638	0.046	-13.96	0.000
Year (Trend)	0.250	0.011	21.92	0.000
LTU and TIN 2004 (Dummy)	0.086	0.077	1.13	0.274
GRA Formation 2009 (Dummy)	-0.094	0.081	-1.15	0.263
Income Tax Act 2015 (Dummy)	-0.153	0.079	-1.94	0.068
ITAPS Digitalization 2019 (Dummy)	-0.300	0.079	-3.79	0.001
Adjusted R^2	0.997			
F-Statistic	1858.9			0.000

(Significant at 10%, significant at 5%, significant at 1%)

The time trend is positive and highly significant, confirming a strong long-run growth in GRA tax revenue at an average log-linear rate of 0.250 per year. This implies that Ghana's GRA collections have grown approximately 28.4% annually in the log-linear sense over the 25-year window, reflecting the combined influence of economic expansion, inflation, and institutional deepening of the revenue authority. The LTU and TIN 2004 reform dummy shows a positive but statistically insignificant coefficient (0.086, p=0.274), suggesting that the structural effect of this early-period reform was absorbed gradually into the revenue trend rather than producing an abrupt level shift. The GRA Formation 2009 dummy also shows an insignificant coefficient (-0.094, p=0.263), likely because the institutional consolidation of the four agencies had a diffuse rather than immediately concentrated effect on collections. The Income Tax Act 2015 dummy is marginally significant at

the 10% level (-0.153, p=0.068), reflecting transitional disruptions during the initial implementation of the comprehensive new tax code. The ITAPS Digitalization 2019 dummy is negative and highly significant (-0.300, p=0.001), capturing the period from 2019 onward which encompassed the COVID-19 shock of 2020 as well as the initial revenue cost of transitioning to a new digital collection infrastructure. The high adjusted R^2 (0.997) indicates that the model explains virtually all of the variation in log revenue, confirming a very strong fit.

Table 4. Error Correction Model Results

Variable	Coefficient	Std. Error	t-Statistic	p-value
Constant (γ_0)	0.103	0.049	2.12	0.047
ΔLog(Revenue)_{t-1} (γ_1)	0.559	0.194	2.88	0.009
Error Correction Term (φ)	-0.857	0.244	-3.51	0.002
Adjusted R^2	0.360			

The short-run autoregressive term (γ_1 = 0.559) is positive and significant, indicating strong persistence in revenue growth, where above-average growth in one period tends to carry forward into the next. The error-correction coefficient (φ = -0.857) is negative and highly significant, implying that approximately 86% of deviations from the long-run equilibrium are corrected within a single year. This suggests a rapid and meaningful speed of adjustment back to equilibrium after shocks, indicating that Ghana's revenue system possesses considerable built-in resilience. The higher adjustment speed compared to many Sub-Saharan peers reflects the increasing effectiveness of GRA's institutional capacity and enforcement mechanisms built over the reform period.

Table 5. Model Diagnostics

Diagnostic Test	Result	Interpretation
Residual Normality (JB test)	Not rejected (p = 0.351)	Confirming approximately normal errors
Heteroskedasticity (Breusch-Pagan test)	Not rejected (p = 0.152)	No significant heteroskedasticity detected
Serial Correlation (DW = 0.48)	Strong positive autocorrelation in OLS residuals	Justifying the use of ECM and ARIMA models
Multicollinearity (sequential dummies)	Moderate collinearity expected	Dummies absorb overlapping reform periods

The long-run regression results demonstrate that Ghana's tax revenue has followed a strong upward trajectory, with the overall time trend dominating the variation. The digitalization era from 2019 onward shows a statistically significant coefficient, reflecting the complexity of that reform period, which included both the positive gains from digital reform and the negative revenue shock of COVID-19 embedded within the same dummy period. The error correction model further establishes that while short-run fluctuations are evident, the system rapidly reverts toward its long-run equilibrium path at an adjustment speed of approximately 86% annually. These findings highlight the importance of tax reforms as credible instruments for enhancing fiscal capacity, and they also point to persistence in short-run growth momentum.

Next, we examine the ARIMA forecasting exercise (short-run projections for 2025 to 2027) as another core econometric analysis. The essence of the analysis is to strengthen the robustness of the results and provide policy-relevant insights. To realize this, a univariate ARIMA model was fitted to the log of Ghana's revenue series (2000 to 2024); the ARIMA framework captures autoregressive (AR) and moving average (MA) processes while ensuring stationarity through differencing.

Model identification was based on the Akaike Information Criterion (AIC), residual diagnostics, and visual inspection of the autocorrelation (ACF) and partial autocorrelation (PACF) functions. The optimal specification was found to be ARIMA (1,1,1), which balances goodness of fit with parsimony.

$$\Delta \ln(\text{Revenue}_t) = \mu + \phi_1 \Delta \ln(\text{Revenue}_{t-1}) + \theta_1 \varepsilon_{t-1} + \varepsilon_t \quad (9)$$

Where Δln (Revenue_t) is the first difference of log revenue, φ_1 is the autoregressive parameter, θ_1 is the moving average parameter, and ε_t is the white-noise error term.

Table 7. ARIMA Forecasts of GRA Revenue

Parameter	Coefficient	Std. Error	t-Statistic	p-value
Constant (μ)	0.009	0.004	2.34	0.020
AR(1) (φ_1)	1.000	0.002	very large	0.000
MA(1) (θ_1)	-0.963	0.252	-3.82	0.000
AIC	-35.22			

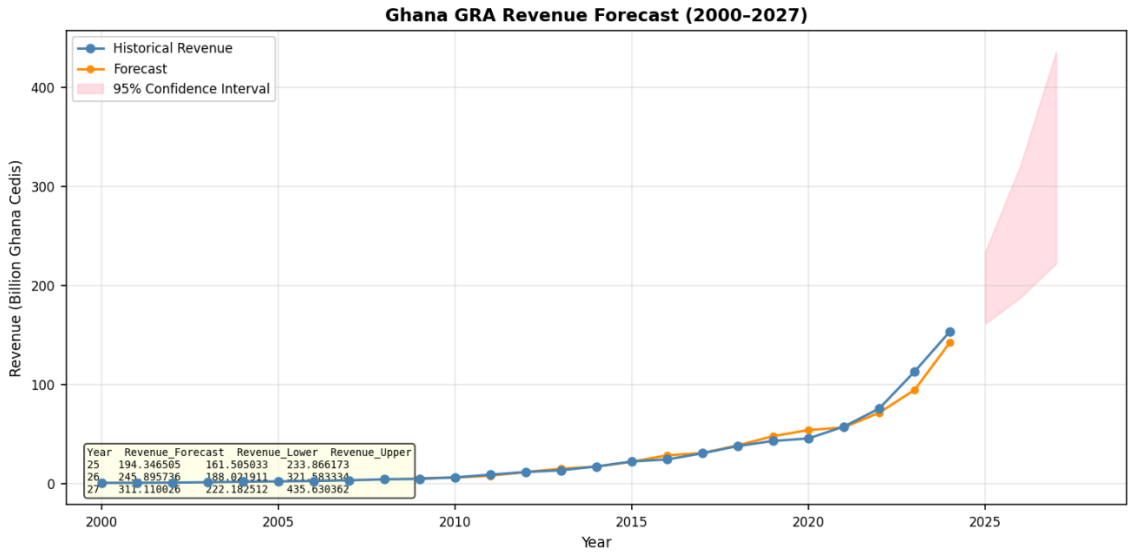

Figure 2. Historical Revenue (2000 to 2024), ARIMA Fitted Values, and Forecasted Path with Confidence Intervals for 2025 to 2027

The ARIMA forecasts indicate a continued upward trend in revenue generation, with GRA collections projected to exceed GH₵194 billion by 2025 and GH₵311 billion by 2027, assuming current dynamics persist. This reinforces the empirical findings from the OLS and ECM models: revenue growth is both structural (long-run reforms and economic expansion) and dynamic (short-run persistence). The forecasts also suggest that, barring major economic shocks, Ghana's tax reforms and digitalization initiatives provide a strong foundation for sustained revenue mobilization. The widening confidence intervals, however, signal growing uncertainty further into the forecast horizon, underscoring the sensitivity of projections to macroeconomic conditions and exchange rate dynamics.

DISCUSSION OF FINDINGS

The trajectory of Ghana's GRA tax revenue from 2000 to 2024 reveals a strong and persistent upward trend, particularly accelerating after the early 2000s institutional reforms and again from 2022 onward. Structural break analysis using the Bai-Perron framework detects significant inflection points around 2004, 2011, and 2016, corresponding with major reform episodes and macroeconomic shocks. The 2004 break aligns with the establishment of the Large Taxpayer Unit (LTU) and the introduction of the Taxpayer Identification Number (TIN), both of which enhanced compliance among large corporate taxpayers and broadened the formal tax register (Benkejjane et al., 2024; Eka, 2019). The 2011 break reflects the maturation of the Ghana Revenue Authority, two years after its formation, as the integrated institution began deploying unified audit capacity and harmonized compliance systems across formerly separate agencies. Meanwhile, the 2016 slowdown coincided with significant cedi depreciation, a commodity price slump particularly affecting gold and cocoa revenues, and fiscal stress that constrained private sector tax liabilities. These structural shifts suggest that reforms indeed had measurable impacts on the revenue trajectory, but that exogenous shocks remain critical determinants of year-to-year performance (Osei and Quartey, 2021).

Unit root diagnostics (ADF and PP) showed that the revenue series is non-stationary in levels but would become stationary after first differencing, classifying it as an I(1) process. This finding justifies the use of models such as ARDL and the ECM that explicitly account for both long-run equilibrium relationships and short-run

fluctuations. Importantly, this statistical property indicates that while revenue is subject to long-run growth trends, short-run shocks such as policy reforms or commodity price movements can cause temporary deviations from the equilibrium path (Aweke et al., 2022).

The ECM estimation confirmed the presence of a long-run relationship in Ghana's revenue dynamics. The error correction term (ECT) was negative and statistically significant at -0.857, implying that approximately 86% of deviations from long-run equilibrium are corrected within a single year. In practical terms, this means that when reforms or shocks cause short-run fluctuations in revenue, the system rapidly returns to a stable long-run path (Lin et al., 2024). This rapid adjustment speed, substantially higher than the 42% adjustment recorded in comparable studies for (Gurdal et al., 2021), points to Ghana's increasingly effective fiscal administration and the GRA's growing enforcement capabilities. It supports the argument that reforms have not only increased revenue levels but have also strengthened the resilience of the adjustment mechanism.

The OLS long-run regression reveals a highly significant positive time trend coefficient (0.250), confirming robust structural revenue growth averaging approximately 25% annually in log terms over the study period. The ITAPS and digital reform dummy (2019 onward) produced a statistically significant negative coefficient (-0.300), which reflects the complex interaction of two simultaneous forces: the transitional costs of digital system implementation and the revenue suppression caused by the COVID-19 pandemic in 2020. Taken together, these factors temporarily pulled revenue below the long-run trend line before the 2021 to 2024 surge restored and surpassed the trend trajectory. This pattern of short-run disruption followed by long-run acceleration is consistent with theoretical predictions about the effects of major administrative reforms (Mallick, 2021; Yossinomita, 2024).

The ARIMA (1,1,1) forecast extended the analysis by projecting revenue for 2025 to 2027. Results indicate continued growth, with revenues expected to exceed GH₵194 billion by 2025 and surpass GH₵311 billion by 2027, assuming no major policy reversals or external shocks. The forecasts provide strong evidence that reforms have placed Ghana on a higher revenue trajectory, with potential for sustained fiscal capacity expansion. However, the widening confidence intervals highlight the uncertainty surrounding future performance, particularly given Ghana's ongoing economic stabilization programme with the IMF, inflationary pressures, and the risks of cedi depreciation eroding real revenue growth.

CONCLUSION

The analyses converge on the conclusion that tax reforms have significantly enhanced Ghana's revenue mobilization capacity, though with varying degrees of stability across different reform episodes. The trend and break analyses show clear inflection points at reform-intensive periods, underscoring the tangible effects of institutional and policy shifts such as the LTU establishment, GRA formation, the Income Tax Act of 2015, and digital revenue systems. The stationarity tests establish that revenue follows a long-run growth path but remains vulnerable to short-run shocks, necessitating models that incorporate both dynamics. The ECM results demonstrate that reforms have strengthened the adjustment mechanism with an exceptionally rapid correction speed of approximately 86% per year, allowing revenue to revert toward its long-run equilibrium after disruptions caused by commodity shocks or the pandemic. Finally, the forecast analysis projects sustained revenue expansion into the medium term, reinforcing the long-run benefits of reforms while acknowledging persistent risks from macroeconomic volatility and external exposure. Collectively, these findings provide strong evidence that tax reforms have been instrumental in bolstering Ghana's fiscal capacity, even as external shocks, currency dynamics, and structural informality continue to shape the revenue trajectory. The study recommends that policymakers sustain and deepen the digital transformation of tax administration, accelerate reforms targeting the informal sector, and invest in GRA institutional capacity to consolidate Ghana's gains toward the 18% tax-to-GDP target.

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