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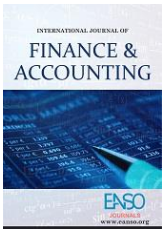

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Original Article

The Paradox of Taxation and Development in Ivory Coast: An Empirical Inquiry into High Tax Burdens amidst Low Development Outcomes

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ARDL, GDP, GDP per Capita Growth, Taxes on Income, Profits and Capital Gains, Ivory Coast.

ABSTRACT

This study investigates the complex interplay between government fiscal policy and economic growth in Kenya, focusing particularly on the balance between fiscal multipliers and the crowding-out of private investment. Using a quantitative approach, the research applies Local Projection Methods (LPM) to estimate the size and timing of fiscal multipliers and employs Vector Autoregressive (VAR) models to assess the extent to which public borrowing influences private sector investment. The analysis utilises time-series data spanning from 2000 to 2023, sourced from authoritative institutions such as the Kenya National Bureau of Statistics, the Central Bank of Kenya, the World Bank, and the International Monetary Fund. The results reveal that fiscal multipliers in Kenya are moderate in magnitude, with government spending raising GDP by approximately 0.25% in the short run, increasing to nearly 0.60% over a longer horizon. Notably, capital investments—especially in infrastructure and education—demonstrate significantly stronger multiplier effects compared to recurrent expenditure, which shows only limited influence on growth. The study also uncovers a pronounced crowding-out effect whereby heightened public borrowing leads to increased interest rates, thereby constraining private investment, particularly when public debt levels are high. Furthermore, the effectiveness of fiscal interventions is found to vary according to macroeconomic conditions, emphasising the importance of maintaining fiscal prudence. These findings highlight the critical need for strategic fiscal management, prioritising productive public investments alongside sustainable debt practices, to enhance economic growth and foster inclusive development in Kenya.

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INTRODUCTION

Taxation is a critical instrument for mobilising domestic resources, financing public services, and promoting long-term economic development (OECD, 2014). In theory, countries with higher tax revenues are expected to achieve stronger development outcomes due to increased government capacity to invest in infrastructure, education, health, and social protection. However, in many developing countries, this relationship is not always evident. Ivory Coast provides a striking example of this disconnection, where, despite being one of the countries with the highest personal income tax rates globally, reaching up to 60% (PwC, 2023), key development indicators remain worryingly low.

Over the past two decades, Ivory Coast has recorded tax revenues consistently exceeding 15% of GDP (World Bank, 2023), aligning with internationally recommended thresholds for sustainable development. Yet, persistent underdevelopment remains a defining feature of the country's economic landscape. It ranks low on the Human Development Index and faces challenges such as poor public infrastructure, high poverty rates, and limited access to essential services (UNDP, 2023). This paradox of high taxation coexisting with low development outcomes raises important questions about the effectiveness and developmental impact of the Ivorian tax system.

The core problem this study investigates is the mismatch between high tax burdens and weak development outcomes in the Ivory Coast. While traditional economic theory posits that tax revenues enhance state capacity and public investment (Musgrave & Musgrave, 1989), the Ivorian case suggests that revenue generation alone is insufficient. Potential explanations for this paradox include inefficient public spending, weak governance, low transparency, and an over-reliance on regressive tax instruments that may suppress private sector growth (Moore, 2008; Fjeldstad & Heggstad, 2012).

The study is therefore timely and significant. It empirically examines whether high-income taxation in the Ivory Coast translates into meaningful economic development, using GDP per capita growth as the main development indicator. The rationale lies in the urgent need to assess not just how much tax is collected, but how effectively it is transformed into development outcomes. As African countries seek to strengthen domestic resource mobilisation and reduce aid dependence (UNECA, 2019), understanding this paradox is crucial for evidence-based tax policy reforms that balance revenue goals with inclusive growth.

LITERATURE REVIEW

Globally, taxation is recognised as a fundamental tool for resource mobilisation, governance, and development. According to OECD (2014), well-designed tax systems can stimulate inclusive growth and reduce inequality by financing essential public services and infrastructure. However, the relationship between taxation and development is not always linear. Bird & Zolt (2005) argue that while high-income countries have achieved strong

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developmental outcomes with relatively high tax-to-GDP ratios, many developing nations have failed to achieve similar results despite increasing tax efforts. This divergence is often attributed to differences in state capacity, institutional quality, and efficiency of public expenditure (Besley & Persson, 2013).

In Sub-Saharan Africa, several countries have intensified domestic revenue mobilisation in response to declining foreign aid and increasing public spending demands. However, the effectiveness of taxation in translating into economic development remains mixed. Moore (2008) notes that in many African states, taxation is perceived more as a tool of extraction than development. Studies by Fjeldstad & Heggstad (2012) and the IMF (2018) highlight the prevalence of regressive tax systems, limited accountability in revenue use, and poor service delivery, which often undermine the legitimacy of tax regimes and weaken the social contract.

Empirical evidence also shows that tax revenue alone is insufficient to drive development unless complemented by sound fiscal governance. For instance, Ndulu et al. (2007) emphasise that without transparent and efficient public spending, high tax burdens may crowd out private investment and hinder economic growth. The mismatch between tax effort and development outcomes in countries such as Nigeria, Ghana, and Kenya illustrates this concern, raising questions about the structure, administration, and developmental use of taxes in Africa.

Ivory Coast presents a compelling case of the taxation and development paradox. With a top marginal personal income tax rate of 60% (PwC, 2023) and tax revenues above 15% of GDP (World Bank, 2023), the country has one of the highest tax burdens in Sub-Saharan Africa. Yet, it remains ranked among the lower-tier nations in terms of the Human Development Index (UNDP, 2023), and continues to face chronic underdevelopment in health, education, and infrastructure. Studies specific to Ivory Coast are limited, but IMF (2020) and World Bank (2022) reports indicate challenges such as inefficient public investment, tax evasion, and weak administrative capacity. The disconnect between tax revenue and development outcomes signals the need for empirical studies focused on the effectiveness of taxation in promoting sustainable growth.

The study is anchored in Musgrave's Theory of Public Finance, which posits that taxation should serve three core functions: resource allocation, income redistribution, and economic stabilisation (Musgrave & Musgrave, 1989). According to this theory, when taxes are appropriately designed and utilised, they can support equitable development and macroeconomic stability. However, in developing countries, the redistributive and developmental functions are often undermined by weak governance, corruption, and poor fiscal management.

Additionally, the Social Contract Theory provides a political economy lens, suggesting that taxation should foster accountability and reciprocal obligations between the state and citizens (Moore, 2008). When taxpayers perceive that their contributions do not yield public benefits, trust in government erodes, potentially reducing compliance and weakening fiscal legitimacy. The conceptual framework guiding the study assumes a causal relationship between taxation (independent variable) and economic development (dependent variable). Taxation is measured by taxes on income, profits, and capital gains (% of revenue), while development is proxied by GDP per capita growth (annual %).

DATA AND METHODS

We adopt a quantitative explanatory research design, aimed at empirically assessing the relationship between taxation and economic development in the Ivory Coast. The design is appropriate for establishing causal inferences and testing the validity of the taxation and development

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paradox using time-series econometric modelling (Gujarati & Porter, 2009). The focus is on examining both the short-run and long-run effects of high tax burdens on development outcomes, specifically GDP per capita growth.

Secondary macroeconomic data sourced from the World Bank's World Development Indicators (WDI) for the period 2001 to 2024 was used. The key variables are: GDP per capita growth (annual %), used as a proxy for economic development. The independent variable is taxes on income, profits, and capital gains (% of total revenue), representing the tax burden. While the original data is reported annually, it is transformed into a quarterly frequency using interpolation techniques. This transformation increases the number of observations, thereby enhancing degrees of freedom and the power of statistical tests in time-series analysis (Lütkepohl, 2005). Quarterly data enables a more nuanced analysis of dynamic relationships over time and supports the estimation of models that require a larger sample size, such as the ARDL model.

Since our research relies on macroeconomic secondary data covering the entire national economy, no conventional sampling procedure is applied. Instead, a census approach is adopted, where all available observations within the 2001-2024 period are used. This eliminates sampling bias and ensures that results are representative of Ivory Coast's macroeconomic environment over time.

We employ the Autoregressive Distributed Lag (ARDL) bounds testing approach, developed by Pesaran et al. (2001), to examine the short-run and long-run relationships between the variables. The ARDL model is preferred for its flexibility in handling time-series data that is integrated at different orders, i.e., I(0) or I(1), but not I(2). It also accommodates small-sample properties, making it ideal given the moderate number of quarterly observations derived from the annual data (Nkoro & Uko, 2016). The general ARDL (p, q) model used is specified as:

$$\Delta GDP\_Y_t = \sum_{i=1}^{p} \beta_i \Delta GDP\_Y_{t-i} + \sum_{j=1}^{q} \gamma_i \Delta Taxes\_Y_{t-j} + \lambda_1 GDP\_Y_{t-1} + \lambda_2 Taxes\_Y_{t-1} + \varepsilon_t \quad \text{.....(1)}$$

Where;

Δ denotes the first difference operator

GDP_Y_t is GDP per capita growth (annual%)

$Taxes\_Y_t$ is taxes on income, profits, and capital gains (% of revenue)

ε_t is the white noise error term (Wooldridge, 2013).

The analysis follows several econometric steps: Stationarity tests using Augmented Dickey-Fuller (ADF) tests are applied to determine the order of integration of the variables (Dickey & Fuller, 1979). Model estimation using the ARDL model is conducted to capture short-run dynamics and long-run equilibrium relationships. Diagnostic tests such as normality (Jarque-Bera), serial correlation (Breusch-Godfrey), and heteroskedasticity (White test) are performed to validate the robustness of the model.

The choice of the ARDL model is grounded in its advantages for empirical macroeconomic analysis in developing country contexts. Unlike traditional cointegration techniques (e.g., Johansen), ARDL does not require pre-testing for exact integration levels and allows for the inclusion of lags based on model selection criteria (AIC, SIC). This makes it suitable for small-sample, time-series data with mixed integration orders (Pesaran et al., 2001). The use of interpolated quarterly data further enhances model efficiency and allows for capturing more frequent fluctuations in tax and growth dynamics.

RESULTS AND THEIR DISCUSSION

Descriptive statistics (Appendix 1) for the key variables, based on 93 quarterly observations (transformed from annual data for 2001-2024), are presented. GDP per capita growth (GDP_Y) shows a mean of 3.86%, with values ranging from 0.42% to 8.57%. The distribution is approximately

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symmetric (skewness = 0.27), and the Jarque-Bera probability (0.25) suggests normality.

Taxes on income, profits, and capital gains (Taxes_Y) have a mean of 22.14%, with a minimum of 10.14% and a maximum of 27.72%. The distribution is negatively skewed (–1.51) and leptokurtic (kurtosis = 5.40), indicating a left-skewed distribution with fat tails. The Jarque-Bera test is significant (p = 0.00), suggesting deviation from normality, possibly due to fiscal policy shocks or administrative reforms over time.

Stationarity of GDP per capita growth and taxes on income, profits, and capital gains data is tested using the Augmented Dickey-Fuller (ADF) test (Appendix 2-5). Results indicate that both series are non-stationary at levels (p > 0.05), implying the presence of unit roots. However, after first differencing, both series became stationary (p < 0.05) (Gujarati & Porter, 2009; Dickey & Fuller, 1979). This transformation ensures that the statistical properties of the series remain constant over time, thus avoiding spurious regression results (Enders, 2014).

Inferential statistics are summarised as follows:

Results of the ARDL model (Appendix 6)

$$\widehat{GDP\_Y_t} = 0.703779GDP\_Y_{t-1} + 0.406910Taxes\_Y_t - 0.392855Taxes\_Y_{t-1} \quad \ldots\ldots\ldots (2)$$

Hence,

$$\hat{\beta}_{ARDL} \begin{bmatrix} 0.703779 \\ 0.406910 \\ -0.392855 \end{bmatrix}$$

ARDL model estimation reveals significant insights into the dynamic relationship between taxation and economic development in the Ivory Coast. The lagged value of GDP per capita growth (GDP_Y(-1)) is positive and statistically significant, suggesting strong growth persistence over time. This implies that past economic performance significantly influences present growth trajectories, underscoring the momentum effect inherent in macroeconomic dynamics (Barro, 1991).

Notably, the contemporaneous effect of tax revenue (Taxes_Y) on GDP per capita growth is positive and statistically significant (coefficient = 0.406910) in the short run. This indicates that higher tax revenues initially stimulate economic growth, likely through increased public investment in infrastructure, education, and other development-oriented expenditures. This result aligns with Musgrave's theory of public finance, which posits that taxation plays a vital role in mobilising resources for public goods provision and macroeconomic stabilisation (Musgrave & Musgrave, 1989).

However, the lagged taxes on income, profits, and capital gains variable (Taxes_Y(-1)) is found to be negative and statistically significant (coefficient = -0.392855). This implies that while tax revenues may boost economic activity in the immediate term, their prolonged effects can become detrimental. This adverse long-run impact may be attributed to the distortionary consequences of high tax burdens, such as reduced private sector investment, consumption suppression, and increased informality, particularly in contexts characterised by inefficiencies in public service delivery and fiscal mismanagement (Bird & Zolt, 2005; Tanzi & Zee, 2000).

The adjusted R-squared value of 0.520589 indicates that approximately 52% of the variation in GDP per capita growth is explained by the model, reflecting a moderate explanatory power of the selected variables. Durbin-Watson statistic of 1.803078 falls within acceptable bounds, suggesting the absence of significant first-order autocorrelation in the residuals (Gujarati & Porter, 2009).

Although the normality test (Appendix 7) reveals that residuals are not normally distributed, this does not invalidate the model, given the robustness of ARDL estimators in large samples. Additionally, other diagnostic tests, including those for serial correlation (Appendix 10) and heteroskedasticity

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(Appendix 11), indicate no major violations, confirming the reliability of the estimated coefficients. Furthermore, the cointegration test (Appendix 8) supports the existence of a long-run equilibrium relationship among the variables (Pesaran et al. 2001), while the dynamic multiplier graph (Appendix 9) illustrates the transitory positive and eventual negative responses of GDP to tax shocks over time.

Mixed signs and temporal shifts in the effect of taxation confirm the existence of what we term the "taxation and development paradox." In the short term, increased taxation facilitates public spending and growth, but in the long run, persistent high tax burdens, if not matched with governance reforms and fiscal efficiency, can stifle economic development (Besley & Persson, 2013).

Our finding partially aligns with Bird & Zolt (2005) and Besley & Persson (2013), who assert that the developmental utility of taxation depends critically on the quality of governance and expenditure effectiveness. In well-managed economies, taxes serve as a foundation for inclusive growth; in contrast, in settings with weak institutions, taxes may act as an economic drag.

Regionally, our results mirror observations by Moore (2008) and Fjeldstad & Heggstad (2012), who argue that in Sub-Saharan Africa, taxation often lacks developmental payoff due to weak accountability and fiscal inefficiencies. Specifically, in Ivory Coast, IMF (2020) reports have consistently pointed to inefficiencies in tax administration and public investment management, corroborating our empirical finding of long-term adverse tax effects.

Our study offers a distinct empirical contribution by employing quarterly data spanning over two decades (2001-2024), providing a granular and dynamic analysis often absent in existing literature, which typically relies on annual or cross-country datasets. Our findings emphasise that the tax and development paradox in Ivory Coast is both temporal and structural; initial tax-induced gains are not self-sustaining unless underpinned by fiscal discipline, transparency, and institutional reforms (Tanzi & Zee, 2000; IMF, 2020).

LIMITATIONS

While our study provides meaningful insights into the taxation and development paradox in Ivory Coast, several methodological and data-related limitations are acknowledged. These limitations may have influenced the precision and generalizability of the study's findings.

We relied exclusively on secondary data from the World Bank's World Development Indicators, which, although authoritative, does not capture informal taxation, tax evasion, or regional disparities in tax incidence (Keen, 2012; Joshi et al., 2014). The focus on taxes on income, profits, and capital gains, while significant, omits other critical tax categories such as consumption, trade, and property taxes, which also affect development outcomes (Moore, 2008).

Moreover, to increase the degrees of freedom, annual data was interpolated into quarterly time series. While this methodological step is supported in econometric literature for small-sample time-series estimation (Lütkepohl, 2005), it may introduce measurement error or obscure actual economic fluctuations that quarterly data would otherwise capture (Stock & Watson, 2015).

The final dataset, consisting of 93 quarterly observations, remains moderate in size and may constrain the power of certain statistical tests. This is particularly relevant in time-series models where lagged values and diagnostic tests can reduce degrees of freedom, thereby increasing standard errors and reducing the reliability of long-run estimates (Gujarati & Porter, 2009).

We employed the ARDL bounds testing approach, which is appropriate for small samples and mixed-order integration (Pesaran et al. 2001). However, the ARDL model is limited in capturing nonlinear

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dynamics or asymmetric effects of taxation, which have been increasingly observed in fiscal policy studies (Bleaney et al. 2001). Additionally, the model assumes structural stability throughout the period, which may not hold in a country like the Ivory Coast that has experienced episodes of political instability and economic reform (IMF, 2020). The absence of structural break adjustments may bias the long-run relationship between taxation and development.

Furthermore, GDP per capita growth was used as the sole proxy for economic development. While standard in macroeconomic analysis, this indicator may not fully reflect multidimensional aspects of development, such as health, education, and quality of life (Sen, 1999; UNDP, 2023). As a result, some nuances of taxation and development paradox may be understated.

Finally, this is a single-country case study, focused exclusively on the Ivory Coast. While the findings offer important country-specific insights, they may not be generalizable to other contexts with different institutional frameworks, tax structures, or governance capacities (Bird & Zolt, 2005). Broader comparative studies using panel data could offer more generalizable conclusions.

CONCLUSION

We set out to critically examine the taxation and development paradox in Ivory Coast, a country characterised by one of the highest personal income tax rates globally, yet simultaneously burdened by persistent underdevelopment. Drawing on time-series data and empirical modelling, we interrogated the assumption that increased tax revenue necessarily translates into meaningful economic progress.

Our overarching insight is that the developmental potential of taxation is not solely a function of revenue mobilisation, but fundamentally a question of fiscal governance, allocative efficiency, and institutional capacity (Moore, 2008; Fjeldstad & Heggstad, 2012). In contexts where public resources are poorly managed, high tax burdens may constrain economic development, particularly if the tax system is perceived as extractive rather than developmental. The paradox, therefore, lies not in taxation per se, but in the disconnect between revenue generation and developmental delivery mechanisms (Bird & Zolt, 2005).

Additionally, our findings suggest that the effect of taxation on development is dynamic and time-sensitive, supporting the view that short-term fiscal injections can spur growth only if followed by consistent and transparent public investment (Besley & Persson, 2013). Without such investment, long-run economic benefits may erode, especially when taxation places disproportionate pressure on the formal economy or discourages productive enterprise (Keen, 2012).

Our study reinforces a critical policy imperative: domestic resource mobilisation must be accompanied by credible reforms in public sector management and tax accountability. In the absence of such reforms, tax systems risk undermining public trust, reducing compliance, and exacerbating inequality (Joshi et al. 2014).

In sum, taxation and development paradox in Ivory Coast is not an anomaly, but a manifestation of deeper systemic constraints that hinder the transformative role of fiscal policy. Addressing this paradox demands a paradigm shift from revenue-centered taxation to development-focused fiscal architecture, one that aligns tax policy, expenditure management, and inclusive governance.

RECOMMENDATIONS

Drawing from our empirical findings and the broader discourse on taxation and development, this section outlines key recommendations in three domains: policy, programme implementation, and research. These are grounded in the core insight that high taxation in the absence of efficient, accountable, and pro-development public spending contributes to the taxation and development paradox in the Ivory Coast.

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The government should reorient tax policy away from excessive reliance on income and corporate taxes and adopt a more progressive and diversified tax mix. A balanced combination of direct and indirect taxes anchored in fairness and simplicity can reduce economic distortions while protecting lower-income groups (Bird & Zolt, 2005; IMF, 2020). Enhancing the efficiency of tax incentives is also critical to avoid revenue leakages that do not yield meaningful investment or development outcomes.

To close the gap between revenue collection and development outcomes, there must be improvements in public expenditure governance, budget transparency, and citizen participation in fiscal processes (Moore, 2008; UNDP, 2023). A performance-based budgeting system and rigorous expenditure tracking can ensure that tax revenues are used for impactful and pro-poor investments.

Policymakers should promote mechanisms that link taxation directly to visible development benefits, such as earmarking portions of tax revenues for education, health, or infrastructure in underserved regions. Strengthening the social contract between taxpayers and the state can increase compliance and reduce resistance to taxation (Joshi et al., 2014).

Government, through the Ivorian Revenue Authority, should continue to modernise tax administration systems through digital platforms, taxpayer identification systems, and data analytics. This will enhance revenue mobilisation while reducing administrative costs, leakages, and opportunities for corruption (Fjeldstad & Heggstad, 2012).

Programmes funded by tax revenues should prioritise rural infrastructure, SME development, education, and healthcare, especially in regions disproportionately affected by poverty. Targeted programmes ensure that fiscal policies are aligned with development goals and reduce the risk of regressive tax impacts (OECD, 2014).

Given decentralisation efforts, local governments should be empowered to generate and manage their revenues transparently. This requires capacity-building programmes in local tax administration, financial reporting, and accountability systems (World Bank, 2022).

There is a need for micro-level research into how different tax instruments affect households, businesses, and sectors. Such studies can uncover hidden regressivity or distortions that macro-level analyses may overlook (Keen, 2012).

Future studies could employ nonlinear and threshold models to investigate whether there are critical levels of taxation beyond which economic growth is negatively affected. This would provide a deeper understanding of optimal tax rates for development (Bleaney et al., 2001).

Research that integrates variables such as corruption indices, government effectiveness, or public service delivery performance can better explain the mediating factors in the taxation and development relationship. This could inform institutional reforms and governance strategies (Besley & Persson, 2013).

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APPENDICES

Appendix 1: Descriptive Statistics

	GDP per capita growth (annual %) GDP_Y	Taxes on income, profits and capital gains (% of revenue) TAXES_Y
Mean	3.858947	22.14403
Median	3.789372	22.65699
Maximum	8.573224	27.72358
Minimum	0.42196	10.136
Std. Dev.	2.006464	3.859372
Skewness	0.265909	-1.511041
Kurtosis	2.339985	5.402656
Jarque-Bera	2.783998	57.75972
Probability	0.248578	0
Sum	358.8821	2059.395
Sum Sq. Dev.	370.3826	1370.317
Observations	93	93

Appendix 2: Unit Root Test, GDP per Capita Growth [GDP_Y] (in Level)

Null Hypothesis: GDP_Y has a unit root
Exogenous: None
Lag Length: 9 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.883115	0.3306
Test critical values:	1% level	-2.593121	
	5% level	-1.944762	
	10% level	-1.614204	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP_Y)
Method: Least Squares
Date: 06/21/25 Time: 11:43
Sample (adjusted): 2003Q3 2024Q1
Included observations: 83 after adjustments

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Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP_Y(-1)	-0.005886	0.006665	-0.883115	0.3801
D(GDP_Y(-1))	0.920003	0.084419	10.89806	0.0000
D(GDP_Y(-2))	0.004084	0.109319	0.037359	0.9703
D(GDP_Y(-3))	0.004084	0.109319	0.037359	0.9703
D(GDP_Y(-4))	-0.954822	0.109362	-8.730828	0.0000
D(GDP_Y(-5))	0.859142	0.117775	7.294758	0.0000
D(GDP_Y(-6))	0.001714	0.108900	0.015738	0.9875
D(GDP_Y(-7))	0.001714	0.108900	0.015738	0.9875
D(GDP_Y(-8))	-0.451691	0.109015	-4.143375	0.0001
D(GDP_Y(-9))	0.386040	0.083742	4.609895	0.0000

R-squared	0.819960	Mean dependent var	-0.023038
Adjusted R-squared	0.797764	S.D. dependent var	0.550041
S.E. of regression	0.247357	Akaike info criterion	0.156617
Sum squared resid	4.466550	Schwarz criterion	0.448043
Log likelihood	3.500408	Hannan-Quinn criter.	0.273696
Durbin-Watson stat	1.982269		

Appendix 3: Unit Root Test, GDP per Capita Growth [GDP_Y] (in First difference)

Null Hypothesis: D(GDP_Y) has a unit root
Exogenous: None
Lag Length: 8 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.234822	0.0253
Test critical values:	1% level	-2.593121	
	5% level	-1.944762	
	10% level	-1.614204	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(GDP_Y,2)
Method: Least Squares
Date: 06/21/25 Time: 11:44
Sample (adjusted): 2003Q3 2024Q1
Included observations: 83 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP_Y(-1))	-0.245092	0.109669	-2.234822	0.0284
D(GDP_Y(-1),2)	0.170074	0.108344	1.569763	0.1207
D(GDP_Y(-2),2)	0.170074	0.108344	1.569763	0.1207
D(GDP_Y(-3),2)	0.170074	0.108344	1.569763	0.1207
D(GDP_Y(-4),2)	-0.788517	0.108473	-7.269259	0.0000
D(GDP_Y(-5),2)	0.071372	0.083247	0.857360	0.3940
D(GDP_Y(-6),2)	0.071372	0.083247	0.857360	0.3940

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D(GDP_Y(-7),2)	0.071372	0.083247	0.857360	0.3940
D(GDP_Y(-8),2)	-0.381572	0.083464	-4.571689	0.0000

R-squared	0.698664	Mean dependent var	0.019137
Adjusted R-squared	0.666088	S.D. dependent var	0.427427
S.E. of regression	0.246989	Akaike info criterion	0.143147
Sum squared resid	4.514268	Schwarz criterion	0.405431
Log likelihood	3.059396	Hannan-Quinn criter.	0.248518
Durbin-Watson stat	1.984071		

Appendix 4: Unit Root Test, Taxes on Income, Profits and Capital Gains [TAXES_Y] (in Level)

Null Hypothesis: TAXES_Y has a unit root
Exogenous: None
Lag Length: 5 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.116827	0.7170
Test critical values:	1% level	-2.591813	
	5% level	-1.944574	
	10% level	-1.614315	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TAXES_Y)
Method: Least Squares
Date: 06/21/25 Time: 11:44
Sample (adjusted): 2002Q3 2024Q1
Included observations: 87 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TAXES_Y(-1)	0.000188	0.001612	0.116827	0.9073
D(TAXES_Y(-1))	0.885469	0.075649	11.70497	0.0000
D(TAXES_Y(-2))	-9.41E-05	0.091503	-0.001029	0.9992
D(TAXES_Y(-3))	-9.41E-05	0.091503	-0.001029	0.9992
D(TAXES_Y(-4))	-0.605719	0.091503	-6.619655	0.0000
D(TAXES_Y(-5))	0.490953	0.076008	6.459215	0.0000

R-squared	0.769235	Mean dependent var	0.155463
Adjusted R-squared	0.754990	S.D. dependent var	0.645839
S.E. of regression	0.319681	Akaike info criterion	0.623483
Sum squared resid	8.277852	Schwarz criterion	0.793546
Log likelihood	-21.12153	Hannan-Quinn criter.	0.691962
Durbin-Watson stat	1.995293		

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Appendix 5: Unit Root Test, Taxes on Income, Profits and Capital Gains [TAXES_Y] (in First difference)

Null Hypothesis: D(TAXES_Y) has a unit root
Exogenous: None
Lag Length: 4 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.065460	0.0025
Test critical values:	1% level	-2.591813	
	5% level	-1.944574	
	10% level	-1.614315	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TAXES_Y,2)
Method: Least Squares
Date: 06/21/25 Time: 11:45
Sample (adjusted): 2002Q3 2024Q1
Included observations: 87 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TAXES_Y(-1))	-0.226004	0.073726	-3.065460	0.0029
D(TAXES_Y(-1),2)	0.112951	0.074117	1.523943	0.1314
D(TAXES_Y(-2),2)	0.112951	0.074117	1.523943	0.1314
D(TAXES_Y(-3),2)	0.112951	0.074117	1.523943	0.1314
D(TAXES_Y(-4),2)	-0.492674	0.074117	-6.647225	0.0000

R-squared	0.542887	Mean dependent var	-0.028424
Adjusted R-squared	0.520589	S.D. dependent var	0.458917
S.E. of regression	0.317752	Akaike info criterion	0.600663
Sum squared resid	8.279246	Schwarz criterion	0.742382
Log likelihood	-21.12886	Hannan-Quinn criter.	0.657729
Durbin-Watson stat	1.997259		

Appendix 6: Auto Regressive Distributed Lag (ARDL) Model Results

Dependent Variable: D(GDP_Y)
Method: ARDL
Date: 06/21/25 Time: 09:08
Sample: 2001Q3 2024Q1
Included observations: 91
Dependent lags: 1 (Automatic)
Automatic-lag linear regressors (1 max. lags): D(TAXES_Y)
Deterministics: Restricted constant and no trend (Case 2)
Model selection method: Akaike info criterion (AIC)

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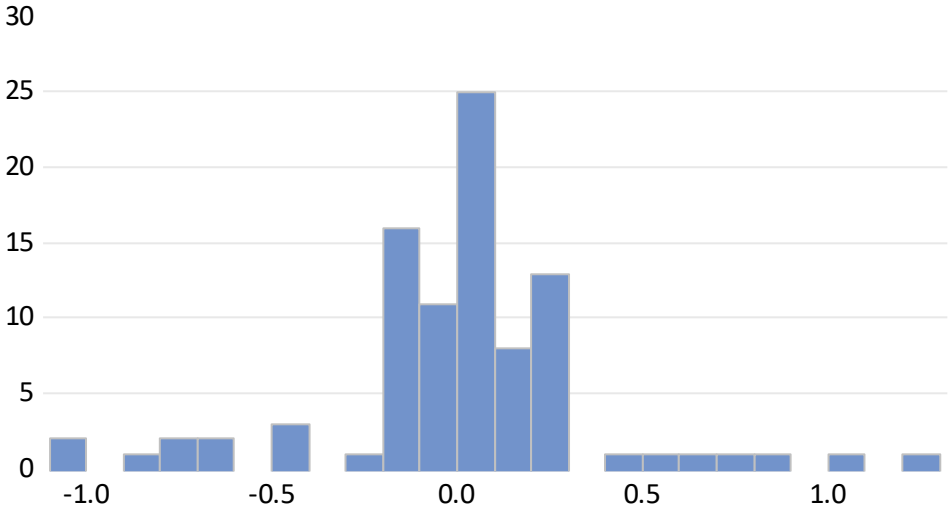
Number of models evaluated: 2
Selected model: ARDL(1,1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
D(GDP_Y(-1))	0.703779	0.073351	9.594720	0.0000
D(TAXES_Y)	0.406910	0.082191	4.950763	0.0000
D(TAXES_Y(-1))	-0.392855	0.084272	-4.661778	0.0000
C	-0.007534	0.040773	-0.184786	0.8538

R-squared	0.568934	Mean dependent var	-0.014136
Adjusted R-squared	0.554069	S.D. dependent var	0.560433
S.E. of regression	0.374246	Akaike info criterion	0.915154
Sum squared resid	12.18523	Schwarz criterion	1.025522
Log likelihood	-37.63953	Hannan-Quinn criter.	0.959681
F-statistic	38.27501	Durbin-Watson stat	1.803078
Prob(F-statistic)	0.000000		

*Note: p-values and any subsequent test results do not account for the model selection.

Appendix 7: Normality of Residuals



Series: Residuals
Sample 2001Q3 2024Q1
Observations 91

Mean	4.76e-17
Median	0.010386
Maximum	1.272470
Minimum	-1.069923
Std. Dev.	0.367956
Skewness	0.100472
Kurtosis	5.890461
Jarque-Bera	31.83158
Probability	0.000000

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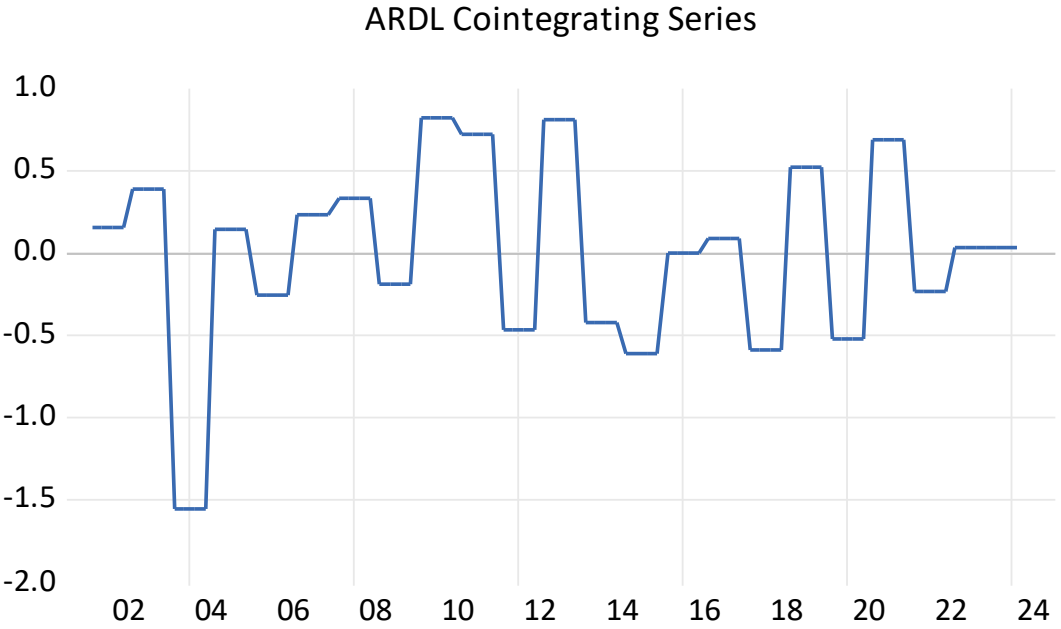
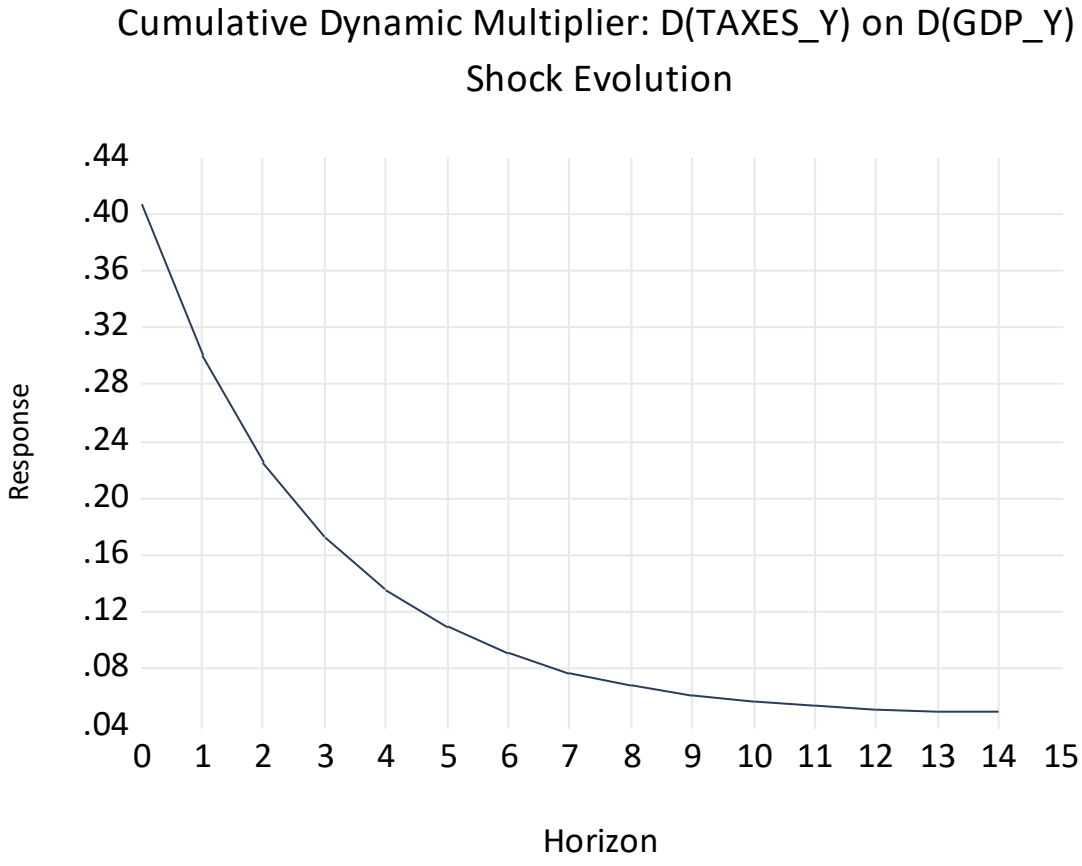
Appendix 8: ARDL Diagnostics, Cointegrating Relation



Appendix 9: ARDL Diagnostics, Dynamic Multiplier Graph



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Appendix 10: Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:
Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.329249	Prob. F(2,85)	0.2701
Obs*R-squared	2.759838	Prob. Chi-Square(2)	0.2516

Test Equation:
Dependent Variable: RESID
Method: ARDL
Date: 06/21/25 Time: 09:31
Sample (adjusted): 2001Q3 2024Q1
Included observations: 91 after adjustments
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(GDP_Y(-1))	-0.175591	0.132301	-1.327208	0.1880
D(TAXES_Y)	0.013262	0.082370	0.161000	0.8725
D(TAXES_Y(-1))	0.034897	0.086802	0.402030	0.6887
C	-0.010128	0.041130	-0.246238	0.8061
RESID(-1)	0.260481	0.163757	1.590655	0.1154
RESID(-2)	0.146573	0.142260	1.030319	0.3058

R-squared	0.030328	Mean dependent var	4.76E-17
Adjusted R-squared	-0.026712	S.D. dependent var	0.367956
S.E. of regression	0.372838	Akaike info criterion	0.928313
Sum squared resid	11.81568	Schwarz criterion	1.093864
Log likelihood	-36.23825	Hannan-Quinn criter.	0.995103
F-statistic	0.531700	Durbin-Watson stat	2.044134
Prob(F-statistic)	0.751689		

Appendix 11: Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	0.462368	Prob. F(3,87)	0.7093
Obs*R-squared	1.428111	Prob. Chi-Square(3)	0.6990
Scaled explained SS	3.191812	Prob. Chi-Square(3)	0.3630

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 06/21/25 Time: 09:29
Sample (adjusted): 2001Q3 2024Q1
Included observations: 91 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.

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C	0.129387	0.032735	3.952565	0.0002
D(GDP_Y(-1))	-0.053270	0.058890	-0.904569	0.3682
D(TAXES_Y)	-0.039863	0.065988	-0.604095	0.5474
D(TAXES_Y(-1))	0.063189	0.067658	0.933953	0.3529

R-squared	0.015694	Mean dependent var	0.133904
Adjusted R-squared	-0.018248	S.D. dependent var	0.297760
S.E. of regression	0.300465	Akaike info criterion	0.475988
Sum squared resid	7.854281	Schwarz criterion	0.586356
Log likelihood	-17.65747	Hannan-Quinn criter.	0.520515
F-statistic	0.462368	Durbin-Watson stat	2.214721
Prob(F-statistic)	0.709284		

