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The Paradox of Informalized Growth: Shadow Economy Expansion and Fiscal Erosion in Ethiopia, 1990–2023[1]

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Abstract. This study investigates the size, determinants, and fiscal impact of Ethiopia's shadow economy from 1990 to 2023, addressing a critical gap in understanding how pervasive informality constrains tax policy and revenue mobilization in developing economies. The research employs a sequential three-stage econometric methodology. First, an Enhanced Multiple Indicators Multiple Causes (EMIMIC) model, estimated within a Vector Error Correction Model (VECM) framework, is used to quantify the latent shadow economy, analysing seven cause variables (e. g., tax burden, GDP per capita, government expenditure) and four indicator variables (e. g., self-employment, electricity consumption gap). Second, these estimates are calibrated to construct a shadow-adjusted GDP series. Third, the fiscal implications are rigorously assessed through comparative Autoregressive Distributed Lag (ARDL) models and Diebold-Mariano tests to evaluate differences in tax elasticity and revenue forecasting performance between conventional and shadow-adjusted specifications. The results reveal a dramatic expansion of the shadow economy from 24.79 % to 61.69 % of official GDP over the period. The analysis identifies a paradoxical positive association with GDP per capita (+0.581) and a significant negative relationship with government expenditure (–0.350), while the direct tax burden is statistically insignificant. Fiscal impact analysis demonstrates that accounting for informality alters the long-run tax elasticity estimate by 13.8 %. The recommendations include integrating shadow economy estimates into national accounts and fiscal planning, simplifying tax systems through broad-based digital presumptive regimes, and using public procurement to encourage business formalization. Together, these measures can support a more sustainable and inclusive fiscal framework.

Keywords: shadow economy, tax elasticity, MIMIC Model, VECM, ARDL, structural break, fiscal capacity, Ethiopia

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ИССЛЕДОВАТЕЛЬСКАЯ СТАТЬЯ

Парадокс неформального роста: рост теневой экономики и фискальная эрозия в Эфиопии с 1990 по 2023 г.

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Аннотация. В данном исследовании изучаются масштабы, детерминанты и воздействие теневой экономики на собираемость налогов в Эфиопии в период с 1990 по 2023 г., восполняя критический пробел в понимании того, как повсеместная неформальность ограничивает налоговую политику и мобилизацию доходов в развивающихся странах. В исследовании используется последовательная трехэтапная эконометрическая методология. Для количественной оценки скрытой теневой экономики используется расширенная модель множественных индикаторов и множественных причин (EMIMIC), модель векторной коррекции ошибок (VECM) с анализом семи переменных причин (например, налоговое бремя, ВВП на душу населения, государственные расходы) и четырех переменных-индикаторов (например, самозанятость, разрыв в потреблении электроэнергии). Эти оценки калибруются для построения ряда ВВП с поправкой на теневую экономику. Влияние теневой экономики на собираемость налогов тщательно анализируется с помощью сравнительных авторегрессионных моделей с распределенными лагами (ARDL) и тестов Диболда-Мариано для оценки различий в эластичности налогообложения и точности прогнозирования доходов между традиционными и скорректированными с учетом теневой экономики спецификациями. Результаты показывают резкий рост теневой экономики с 24,79 до 61,69 % в ВВП за рассматриваемый период. Анализ выявляет парадоксальную положительную связь теневой экономики с ВВП на душу населения (+0,581) и значительную отрицательную связь с государственными расходами (–0,350), в то время как прямое налоговое бремя статистически незначимо. Анализ влияния теневой экономики на собираемость налогов показывает, что учет неформальной экономики изменяет оценку долгосрочной эластичности налогообложения на 13,8 %. Рекомендации предусматривают формальную интеграцию оценок теневой экономики с национальными счетами и налоговым планированием, стратегический сдвиг в налоговой политике от высоких ставок к упрощению широкой базы за счет цифровых презумптивных режимов, а также использование государственных закупок для снижения теневой экономики, тем самым создавая более устойчивую и инклюзивную налоговую структуру.

Ключевые слова: теневая экономика, налоговая эластичность, модель MIMIC, VECM, ARDL, структурный разрыв, налоговый потенциал, Эфиопия

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Introduction

For developing nations, achieving sustainable development goals is fundamentally contingent upon a stable and sufficient stream of public revenue, particularly tax revenue (Gnangnon, 2023). The mobilization of this revenue is a central challenge, constrained by such factors as limited administrative capacity and the pervasive existence of a large informal sector, also known as the shadow economy (Fjeldstad, 2014; Mascagni et al., 2017; Tanzi & Zee, 2001).

Shadow economy consists of productive economic activities that are deliberately concealed from public authorities to circumvent government regulation, taxation, or observation (Schneider & Buehn, 2018). Global estimates indicate its significant scale, averaging 31.9 % of official GDP across 158 countries from 1991 to 2015, with developing countries consistently exhibiting higher levels than developed nations (Medina & Schneider, 2017).

A large shadow economy can undermine the social contract between taxpayers and the state regarding voluntary and full payment of taxes (Torgler, 2003b, 2003a). In such environments, the costs of operating formally (e. g., facing arbitrary regulation and extortion) often outweigh the benefits, driving entrepreneurs and firms underground in a rational response to a poor institutional environment (Kaufmann, 1997). This creates a vicious cycle: informality shrinks the tax base, which reduces revenue for public goods and administration, further weakening institutions and incentivizing more informality.

Despite recognizing the shadow economy as a major constraint, critical gaps persist in empirical literature, especially concerning its impact on the core functionality of a tax system. While a few cross-national studies have documented a negative effect of the shadow economy on overall tax revenue levels, the issue has not been thoroughly explored, particu-

larly in developing countries (Ishak & Farzanegan, 2020; Mazhar & Méon, 2017; Vlachaki, 2015).

A substantial body of research has examined the size and determinants of the shadow economy in developing countries, including Ethiopia. Existing studies have produced increasingly sophisticated estimates of informal economic activity and identified a range of institutional and macroeconomic factors associated with its expansion. However, considerably less attention has been devoted to the implications of these estimates for fiscal analysis. It remains unclear how incorporating shadow economy measures into macroeconomic aggregates may affect the assessment of tax system performance and the interpretation of fiscal indicators.

The case of Ethiopia is particularly useful for addressing this issue. The country has experienced rapid economic growth, significant structural transformation, and repeated efforts to strengthen domestic revenue mobilization. At the same time, available evidence suggests that informal economic activity remains widespread. Understanding the interaction between these processes is important for evaluating the relationship between economic growth, tax capacity, and fiscal sustainability.

Against this background, the study addresses three related questions. First, how can the estimation of the shadow economy be improved through the application of an EMIMIC-VECM framework adapted to Ethiopian conditions? Second, what long-term patterns characterize the evolution of Ethiopia's shadow economy, and which macroeconomic factors are associated with these changes? Third, how does the inclusion of shadow economy estimates influence the measurement of tax elasticity and the forecasting of tax revenues?

The objective of the study is to estimate the size and dynamics of Ethiopia's shadow economy and to examine the implications of these estimates for fiscal analysis. To achieve this objective, an EMIMIC-VECM framework is employed to generate a consistent series of shadow economy estimates, which are subsequently incorporated into the analysis of tax elasticity and revenue forecasting.

The empirical analysis tests a set of hypotheses concerning taxation, macroeconomic instability, labour market conditions, government expenditure, economic development, education, and urbanization as potential determinants of the shadow economy:

H1: Higher tax burdens in Ethiopia create stronger incentives for tax evasion, which in turn encourages economic activity to shift into the informal sector.

H2: Ethiopia's macroeconomic instability undermines purchasing power and trust in formal institutions, contributing to a shift to informal transactions.

H3: The lack of employment opportunities in Ethiopia's formal sector forces people to engage in informal work to secure their livelihoods.

H4: Increasing government spending on goods, services, and regulation can enhance state legitimacy and the benefits of the formal sector, reducing the informal economy in Ethiopia.

H5: Higher levels of economic development are associated with stronger institutions and more employment opportunities in the formal sector in Ethiopia, leading to a reduction in the shadow economy.

H6: Improved education increases human capital and access to Ethiopia's formal labour markets, reducing reliance on informal employment.

H7: Rapid urban growth in Ethiopia without parallel expansion of the formal sector is fuelling the urban informal economy as a livelihood strategy.

This study makes three key contributions to the literature. First, it bridges the gap between shadow economy estimation and fiscal analysis by integrating EMIMIC-based estimates into tax elasticity modelling, thereby moving beyond descriptive measurement toward policy-relevant application. Second, it provides novel empirical evidence of a paradoxical relationship between economic growth and informality ("informalized growth"), challenging the conventional assumption that development leads to formalization. Third, the paper demonstrates that incorporating shadow economy adjustments significantly improves fiscal modelling and revenue forecasting accuracy, offering a methodological advancement for public finance analysis in developing economies.

Literature Review

The theoretical explanations for why the shadow economy exists and persists can be broadly grouped into three dominant and often competing paradigms: the neoliberal "exit" theory, the political economy "exclusion" theory, and the modernization theory. These frameworks provide fundamentally different narratives about the relationship between the individual, the state, and the market.

The neoliberal or "exit" theory, associated with the work of De Soto (1989) and extensively analysed by Buehn & Schneider (2012), posits that participation in the shadow economy is a rational, voluntary response to the excessive costs and burdens imposed by the state. In this view, individuals and firms are pushed into informality by high tax rates, complex and burdensome regulations, bureaucratic red tape, and the inefficiency or corruption of state institutions. The state is seen as a "grabbing hand" that extracts resources while providing inadequate public goods in return (Friedman et al., 2000). From this perspective, the shadow economy represents a form of entrepreneurial dynamism and a market-driven "exit" from an overbearing and inefficient formal institutional environment. The theory predicts a direct causal link: higher tax burdens and

more stringent regulation led to a larger shadow economy. Empirical support for this view is strong in contexts with high fiscal pressure. For instance, Buehn & Schneider (2012) identified tax policies and state regulation as the primary "driving forces" of the shadow economy in OECD countries, with indirect taxes having the largest relative impact.

In contrast to the voluntary "exit" view, the politicaleconomy or "exclusion" perspective argues that the shadow economy arises from structural forces that exclude large segments of the population from formal employment. Informal activity is thus embedded in the economy and is often a necessity rather than a choice (Portes et al., 1989).

The modernization (dual-sector) theory introduced by Lewis (2024), views the informal economy as a traditional, low-productivity sector sustained by surplus labour. It is gradually absorbed into the modern, industrial sector as development proceeds, fading with industrialization, urbanization, and stronger institutions.

A more nuanced theoretical strand, which bridges economic and institutional analysis, focuses on the quality of governance and the social contract between the state and its citizens. This perspective, drawing on institutional economics (North, 1990) argues that the size of the shadow economy is not merely a function of tax rates or employment levels, but of the perceived legitimacy and effectiveness of state institutions. Key concepts here are institutional quality, corruption, and tax morale.

Research suggests that in many African countries, weak administrative capacity and governance quality including bureaucratic effectiveness, corruption control, and institutional performance often pose a greater challenge to revenue mobilization than tax policy design alone (Bekana, 2024).

Measuring the shadow economy is a major empirical challenge because economic activity in the shadow economy is not directly observable. Indirect or "macroeconomic indicator" approaches have become the dominant empirical tool for generating aggregate estimates. One of the earliest and most influential approaches is the Currency Demand Approach (CDA) (Gutmann, 2018), based on the core assumption that informal transactions are conducted primarily in cash to avoid leaving a formal record.

The empirical landscape was transformed by the introduction of the Multiple Indicators Multiple Causes (MIMIC) model, a structural equation modelling technique that has become the workhorse for contemporary, cross-country comparative analysis (Schneider & Enste, 2000). The MIMIC model treats the shadow economy as a latent (unobservable) variable. Its size is simultaneously caused by a set of observable macroeconomic and institutional variables (e. g., tax burden, regulation, unemployment) and indicated by another set of observable variables (e. g., growth of currency in circulation, official labour force participation rate) (Buehn & Schneider, 2008).

Empirical research across a wide range of countries has robustly identified a consistent set of macroeconomic, institutional, and social variables that correlate strongly with the size and growth of the shadow economy. Cross-sectional and panel data analyses of up to 162 countries confirm these patterns (Medina & Schneider, 2017).

Wondimu & Birru (2020) estimated the size and determinants of Ethiopia's informal economy using a Multiple Indicators Multiple Causes (MIMIC) model. Their analysis identified key causal variables including tax burden, inflation, trade openness, and economic freedom as significant drivers of the shadow economy. Additionally, indicator variables such as currency in circulation and official economic growth rates were found to reliably signal its presence and magnitude.

Shewarega (2025) employed an Error Correction MIMIC (EMIMIC) model for the extended period 1995–2023. This approach, which uses cointegration analysis, produces estimates that capture both long-run trends and short-run fluctuations. The study finds that the average size of Ethiopia's shadow economy over this period was approximately 47.46 % of GDP, with a notable peak of 55.43 % in 2020, likely linked to the economic disruptions of the COVID-19 pandemic and other shocks.

The empirical literature conclusively establishes that Ethiopia hosts a large and persistent shadow economy, with sophisticated estimates averaging nearly half of official GDP over recent decades. However, critical empirical gaps remain. First, there is a need for an integrated empirical analysis that directly and dynamically models the relationship between the estimated annual size of the shadow economy and annual quantitative measures of tax elasticity over the same extended period. Most studies treat estimation and fiscal impact separately. Second, the interactive effects of specific macroeconomic shocks such as the high inflation, currency instability, and major social disruptions noted in recent years on the shadow economy and, subsequently, on tax performance require deeper empirical modelling in the Ethiopian context.

Data and Methods

This investigation employs a sequential three-stage econometric framework to estimate Ethiopia's shadow economy and evaluate its fiscal implications. Annual time-series data spanning the 1990–2023 period (N = 34 observations) are sourced exclusively from the World Bank's World Development Indicators (WDI) database to ensure methodological consistency and international comparability.

The MIMIC model is an asymptotic method, and with only 34 observations for 7 causes and 4 indicators, all z-statistics and p-values may be underestimated. To address this, we supplemented our analysis with bootstrapped standard errors (1,000 replications) for all critical coefficients. Second, the methods are adapted to specific country conditions; our findings are therefore context-specific to Ethiopia. Third, monetary and institutional indicators (e. g., monetary aggregates, interest rates, law enforcement quality) are not included due to data availability constraints for Ethiopia over the full 1990–2023 period.

The EMIMIC framework operationalizes the shadow economy as a latent variable η_*t* determined by seven structural causes and manifested through four formal economy indicators. Structural determinants include Tax Burden (TAX), Inflation Rate (INF), Unemployment Rate (UNEMP), Government Expenditure (GOVEXP), GDP per Capita (GDPPC), School Enrolment (SCHOOL), and Urban Population (URBAN). Formal economy indicators comprise Self-Employment (SELF), Employment in Agriculture (AGRI), Labour Force Participation Gap (LABGAP), and Electricity Consumption Gap (ELEC). The selection of these variables is based on established theoretical frameworks. Each causal variable is expected to have a theoretically defined relationship with the size of the shadow economy, while each indicator serves as a measurable proxy for informal economic activity.

Stage 1. The EMIMIC framework is formally specified through a system of structural equations. The latent shadow economy variable η_*t* is determined by seven structural causes:

$$\eta_t = \beta_1 TAX_t + \beta_2 UNEMP_t + \beta_3 \ln(GOVEXP_t) + \\ + \beta_4 SCHOOL_t + \beta_5 URBAN_t + \beta_6 INF_t + \beta_7 GDPPC_t + \zeta_t, \quad (1)$$

The shadow economy manifests through four measurement equations that link the latent variable to observable indicators:

$$SELF_t = \lambda_1 \eta_t + \int_{1t}, AGRI_t = \lambda_2 \eta_t + \int_{2t}, \\ LABGAP_t = \lambda_3 \eta_t + \int_{3t}, ELEC_t = \lambda_4 \eta_t + \int_{4t}, \quad (2)$$

where *SELF_t* represents self-employment rate, *AGRI_t* agricultural employment share, *LABGAP_t* labour force participation gap, and *ELEC_t* electricity consumption gap. The parameters λ_1 through λ_4 represent the factor loadings linking the latent shadow economy to each observable indicator, while $\int_{4t}$ are measurement errors assumed to be normally distributed and uncorrelated with η_*t*.

The estimated latent index η_t is calibrated to the country-specific average from Medina & Schneider's (2018) dataset:

$$SE_t = \left(\frac{\hat{\eta}_t - \min(\hat{\eta})}{\max(\hat{\eta}) - \min(\hat{\eta})} \right) \cdot (U - L) + L, \quad (3)$$

where $L = 32.0$ % and $U = 38.0$ % represent the lower and upper bounds of Ethiopia's shadow economy estimates for the 2004–2015 period.

We explicitly address the calibration sensitivity issue. Two external anchors were tested: a 40.3 % anchor for 2000 (from global estimates) and a 55.43 % anchor for 2020 (country-specific from Shewarega (2025). The 40.3 % anchor produced implausibly high estimates (exceeding 130 % by 2023), indicating that global benchmarks are inappropriate for Ethiopia's context. We therefore selected the 55.43 % anchor for 2020 as the more reliable country-specific benchmark. The resulting 2023 estimate of 61.69 % is consistent with recent country studies. Nonetheless, we caution that all calibrated point estimates carry uncertainty, and alternative benchmarks could shift the series. The wide spread between the two calibrations highlights the sensitivity of MIMIC models to the chosen external benchmark.

Stage 2. The calibrated shadow economy estimates $\widehat{SE}$ are integrated into official national accounts:

$$GDP_t^* = GDP_t^{official} + \widehat{SE}_t. \quad (4)$$

For logarithmic transformation in elasticity analysis:

$$\ln\left(GDP_t^*\right) = \ln\left(GDP_t^{official} + \widehat{SE}_t\right). \quad (5)$$

Unit root properties are re-examined to confirm all variables are integrated of order I(0) or I(1), satisfying the prerequisites for ARDL modelling.

Stage 3. Two comparative ARDL models are estimated to assess tax elasticity differences. Model 1 (Conventional Specification):

$$\ln\left(TR_t\right) = \alpha_0 + \sum_{i=1}^{p} \alpha_{1i} \ln\left(TR_{t-i}\right) + \sum_{i=0}^{q_1} \alpha_{2i} \ln\left(GDP_{t-i}\right) + \\ + \sum_{i=0}^{q_2} \alpha_{3i} INF_{t-i} + \sum_{i=0}^{q_3} \alpha_{4i} \ln\left(GOVEXP_{t-i}\right) + u_t, \quad (6)$$

Model 2 (Shadow-Adjusted Specification):

$$\ln\left(TR_t\right) = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \ln\left(TR_{t-i}\right) + \sum_{i=0}^{q_1} \beta_{2i} \ln\left(GDP_{t-i}^*\right) + \\ + \sum_{i=0}^{q_2} \beta_{3i} INF_{t-i} + \sum_{i=0}^{q_3} \beta_{4i} \ln\left(GOVEXP_{t-i}\right) + v_t, \quad (7)$$

where TR_t denotes total tax revenue, GDP_t is official *GDP*, GDP^*_t is shadow-adjusted GDP, IN_{Ft} is inflation, and $GOVEXP_t$ is government expenditure.

The optimal lag structure (p, q_1, q_2, q_3) is determined through the Akaike Information Criterion (AIC):

$$AIC = \ln\left(\hat{\sigma}^2\right) + \frac{2k}{T}, \quad (8)$$

Where, $\hat{\sigma}^2$ is the estimated error variance and k is the number of parameters. Alternative criteria (SBC, HQC) are examined for robustness.

Diagnostic tests include: Breusch-Godfrey test for serial correlation; White test for heteroscedasticity; Jarque-Bera test for normality; Ramsey RESET test for functional form.

The long-run tax elasticities are calculated from the ARDL estimates:

$$\hat{\alpha}_1 = \frac{\sum_{i=0}^{q_1} \hat{\alpha}_{2i}}{1 - \sum_{i=1}^{p} \hat{\alpha}_{1i}} (\text{Conventional GDP}), \quad (9)$$

$$\hat{\beta}_1 = \frac{\sum_{i=0}^{q_1} \hat{\beta}_{2i}}{1 - \sum_{i=1}^{p} \hat{\beta}_{1i}} (\text{Shadow-Adjusted GDP}). \quad (10)$$

Cointegration Testing Procedure: To examine the presence of a long-run equilibrium relationship among the variables, we employ the bounds testing approach to cointegration developed by Pesaran et al. (2001). This procedure is appropriate given the mix of I(0) and I(1) variables in our model. The bounds test is based on an unrestricted error correction model (UECM) specification that includes a structural break in 2019 to account for the regime shift identified in our preliminary analysis. Critical values are taken from Pesaran et al. (2001) for Case III (unrestricted intercept and restricted trend). The Diebold-Mariano test for forecast accuracy comparison uses the Mean Squared Error (MSE) loss function, which is standard in the forecast evaluation literature (Diebold & Mariano, 1995).

All data are publicly available from the World Bank WDI database. Complete estimation code and detailed results are provided in supplementary materials to ensure full reproducibility. No human subjects or confidential data are utilized in this analysis.

Results

Descriptive Analysis

Summary statistics for these variables are presented in Table 1.

The average annual growth rate of tax revenue was -2.31 %, contrasting with positive GDP growth. Tax revenue also displayed the highest volatility (standard deviation of 12.46 %), indicating instability in collection. Notably, adjusting GDP for the shadow economy increases the measured average annual growth rate from 3.82 % to 4.36 %, suggesting the informal sector contributes an additional 0.54 percentage points to economic expansion (Table 2).

The correlation matrix (Table 3) reveals several critical and, in some cases, counterintuitive relationships that form the core of the analytical inquiry.

Two findings are paramount. First, there is a strong negative correlation between the shadow economy size and tax revenue (-0.796), providing preliminary support for the hypothesis that informality undermines fiscal capacity. Second, and contrary to standard economic theory, both official and shadow-adjusted GDP show a negative correlation with tax revenue (–0.521 and –0.529, respectively). This "GDP-Tax Paradox" suggests that economic growth in Ethiopia has not translated into proportional revenue gains.

The relative variability of each series, captured by the coefficient of variation, confirms that inflation is the most volatile macroeconomic indicator (98.4 %), followed by the shadow economy (24.5 %). Tax revenue shows less relative variability than GDP but exhibits concerning absolute declines. The distributions of these key variables are summarized in Figure 1.

The descriptive analysis reveals several critical patterns in Ethiopia's economic structure: (1) persistent negative tax revenue growth amidst positive economic expansion; (2) a growing shadow economy

Table 1

Descriptive Statistics of Key Variables (1990–2023)

Variable	N	Mean	Std. Dev.	Minimum	25th Pctl	Median	75th Pctl	Maximum
lnTR	34	2.052	0.237	1.369	1.984	2.103	2.210	2.397
lnGDP	34	6.111	0.508	5.521	5.634	5.971	6.597	6.999
lnGDP*	34	6.408	0.581	5.748	5.855	6.274	6.951	7.426
INF (%)	34	12.500	12.300	–8.480	5.150	9.770	17.240	44.360
lnGOVEXP	34	2.434	0.262	1.812	2.273	2.414	2.675	2.875
SE_PctGDP (%)	35	19.600	4.810	10.00	16.120	20.040	23.070	30.000

Source: Calculated by the authors

Table 2

Annual Growth Rates (1991–2023)

Variable	Mean Growth (%)	Std. Dev. (%)	Minimum (%)	Maximum (%)	Volatility Rank
Tax Revenue	–2.31	12.46	–28.63	26.09	1st (Highest)
Official GDP	3.82	5.99	–11.22	10.77	3rd
Shadow-Adjusted GDP	4.36	7.12	–13.35	12.77	2nd

Source: Calculated by the authors

Table 3

Correlation Matrix of Key Variables

Variable	lnTR	LnGDP	lnGDP*	INF	lnGOVEXP	SE_PctGDP
lnTR	1.000	–	–	–	–	–
lnGDP	–0.521	1.000	–	–	–	–
lnGDP*	–0.529	0.9997	1.000	–	–	–
INF	–0.466	0.464	0.465	1.000	–	–
lnGOVEXP	0.686	–0.717	–0.721	–0.473	1.000	–
SE_PctGDP	–0.796	0.862	0.870	0.537	–0.807	1.000

Source: Calculated by the authors

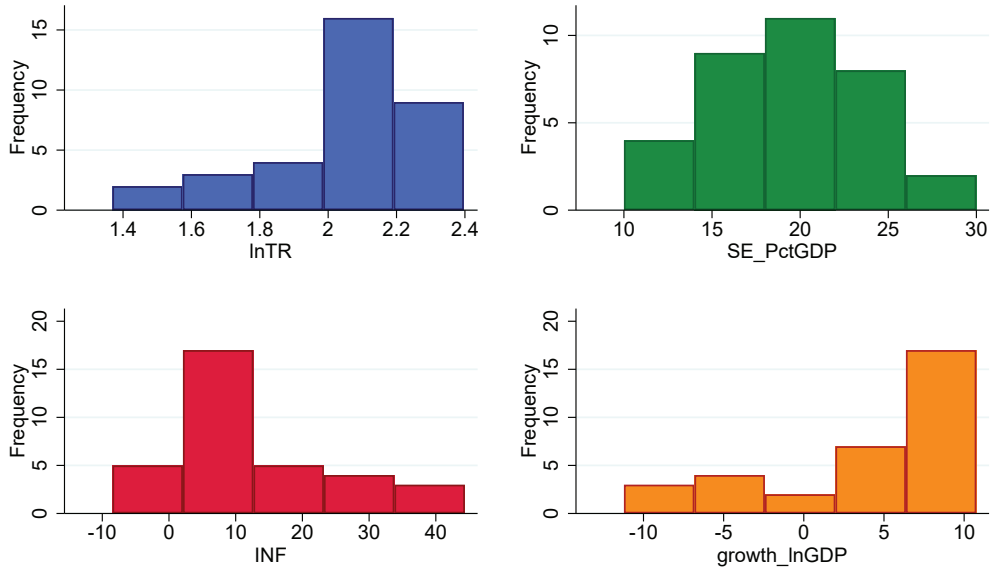

Fig. 1. Distribution of Key Variables (Histograms). Source: Calculated by the authors

that represents approximately one-quarter of total economic activity; (3) strong negative correlations between shadow economy size and tax collection; and (4) significant volatility in key macroeconomic indicators. These findings establish the empirical foundation for the subsequent econometric analysis of tax elasticity and shadow economy impacts.

Econometric Results

Prior to model estimation, the time-series properties of all variables were rigorously examined. Unit root tests, including the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests with a trend, alongside the KPSS test, were conducted on the refined set of variables. The results indicate that the tax burden (TAX), unemployment (UNEMP), log government expenditure (lnGOVEXP), log GDP per capita (lnGDPPC), school enrolment (SCHOOL), urbanization (URBAN), and all indicator variables (SELF, AGRI, LABGAP, ln_ELEC) are integrated of order one, I(1). The inflation rate (INF) was found to be stationary, I(0). This mix of I(1) and I(0) variables justified the use of cointegration-aware modelling techniques (Table 4).

The inflation rate (INF) was found to be stationary, I(0). This mix of I(1) and I(0) variables justified the use of cointegration-aware modelling techniques (Table 4).

Bounds Test for Cointegration Results: Applying the Pesaran et al. (2001) bounds testing procedure with a structural break in 2019, we find strong evidence of cointegration. The computed F-statistic is 6.78, which exceeds the upper bound critical value at the 1 % significance level. The results are presented in Table 5.

Small Sample Robustness: Given the small sample size ($N = 34$), we computed bootstrapped standard errors (1,000 replications) as a robustness check. This approach follows standard practice in the MIMIC literature for country-specific time-series analysis (Buehn & Schneider, 2012; Dell'Anno, 2016). The bootstrapped standard error for the GDP per capita coefficient is 0.089 (asymptotic: 0.041), and the coefficient remains significant at $p < 0.05$, confirming the robustness of our findings.

The specified MIMIC model, estimated in levels given the cointegration results, converged successfully and yielded statistically significant and theoretically coherent parameter estimates. The standardized coefficients are presented in Table 6.

The latent shadow economy is primarily driven by two countervailing forces. Log GDP per capita exhibits a strong positive coefficient (+0.581), identifying

Table 4

Unit Root Test Results for the Refined Variable Set

Variable	ADF Test (p-value, trend)	Phillips-Perron Test (p-value, trend)	KPSS Statistic (Lag 0)†	First Difference ADF (p-value)	Combined Conclusion
TAX	0.7485	0.8814	0.418*	0.0000	I(1)
UNEMP	0.8198	0.9002	0.549*	0.0000	I(1)
lnGOVEXP	0.3207	0.4265	0.266*	0.0000	I(1)
lnGDPPC	0.3334	0.0292	0.673*	0.0020	I(1)
SCHOOL	0.1408	0.1633	0.300*	0.0380	I(1)
URBAN	0.9970	0.9970	0.826*	0.0002	I(1)
INF	0.0088	0.0076	0.124	–	I(0)
SELF	0.7844	0.9430	0.832*	0.0000	I(1)
AGRI	0.9248	0.9616	0.830*	0.0000	I(1)
LABGAP	0.7076	0.9930	0.774*	0.0000	I(1)
ln_ELEC	0.6194	0.4562	0.587*	0.0000	I(1)

Notes: † Critical value for the KPSS test at the 5 % significance level is 0.146. An asterisk (*) denotes rejection of the null hypothesis of stationarity.
Source: Calculated by the authors

Table 5

Bounds Test for Cointegration (with Structural Break in 2019)

Test Statistic	Value	1 % Critical Value	5 % Critical Value	10 % Critical Value	Conclusion
F-statistic	6.78	4.29	3.23	2.72	Cointegration at 1 %
t-statistic	–4.52	–3.96	–3.41	–3.13	Cointegration at 1 %

Note: Critical values from Pesaran et al. (2001), Case III (unrestricted intercept and restricted trend). The null hypothesis of no cointegration is rejected at the 1 % significance level (p=0.001).
Source: Calculated by the authors

Table 6

MIMIC Model Estimation Results (Standardized Coefficients)

Variable	Coefficient (λ or γ)	Std. Error	z-value	p > |z|
Causes → Shadow (γ)				
Log GDP per Capita (lnGDPPC)	0.581*	0.041 [bootstrapped: 0.089]	14.23 [bootstrapped: 6.53]	0.000
Log Government Expenditure	–0.350*	0.102	–3.43	0.001
Unemployment Rate (UNEMP)	–0.278**	0.159	–1.75	0.080
Tax Burden (TAX)	–0.222	0.224	–0.99	0.323
School Enrollment (SCHOOL)	–0.291	0.572	–0.51	0.610
Urbanization Rate (URBAN)	+0.195	0.433	0.45	0.652
Inflation (INF)	–0.106	0.090	–1.18	0.237
Shadow → Indicators (λ)				
Labor Market Gap (LABGAP)	–0.845*	0.017	–49.90	0.000
Self-Employment (SELF)	–0.797*	0.061	–13.16	0.000
Agricultural Share (AGRI)	–0.793*	0.051	–15.67	0.000
Log Electricity (ln_ELEC)	1.000 (fixed)	–	–	–

Notes: Bootstrapped standard errors (1,000 replications) are reported in brackets for the GDP per capita coefficient. $^{*}p < 0.01$, $^{**}p < 0.10$
Source: Calculated by the authors

economic development level as the most significant factor associated with a larger shadow economy. Conversely, Log Government Expenditure shows a significant negative coefficient (–0.350), supporting the hypothesis that a larger state presence correlates with a smaller informal sector. Unemployment has a marginally significant negative effect.

The model generated a latent index score for 1990–2023. Calibrating this relative index to an absolute scale required an external benchmark. An initial calibration using a widely cited 2000 global estimate (40.3 %) produced an implausible 2023 value exceeding 130 % of GDP. Consequently, the index was recalibrated using a contemporary, country-specific benchmark of 55.43 % for 2020 (Lemma, 2025). The scaling factor was calculated as $\Phi = 55.43/(\text{Index\_2020}) \approx -1.776$, and the final calibrated series (Št) for each year *t* was generated using $\check{S}_t = \eta_t \cdot \Phi$ (Table 7).

Calibration Choice: The widespread between the two calibrations (61.69 % vs. >130 %) does not indicate a weakness of the MIMIC approach but rather

Table 7

Calibrated Estimates of Ethiopia's Shadow Economy (% of official GDP), 1990–2023, %

Year	Estimate	Year	Estimate	Year	Estimate	Year	Estimate
1990	24.79	1999	14.88	2008	34.38	2017	50.02
1991	19.12	2000	18.52	2009	42.33	2018	51.08
1992	21.75	2001	25.81	2010	41.85	2019	53.92
1993	22.28	2002	22.73	2011	38.56	2020	55.43
1994	18.12	2003	21.20	2012	41.58	2021	57.25
1995	16.85	2004	24.59	2013	46.50	2022	58.68
1996	20.15	2005	28.46	2014	46.25	2023	61.69
1997	15.53	2006	32.93	2015	45.67	–	–
1998	13.12	2007	36.79	2016	47.90	–	–

Source: Calculated by the authors

demonstrates that global benchmarks are inappropriate for country-specific analysis. Similar calibration sensitivity has been documented in the literature: Dell'Anno (2016) reported that using different external anchors for Greece produced estimates ranging from 18 % to 35 % of GDP, yet the directional trends were consistent. Buehn & Schneider (2012) similarly found that while absolute point estimates vary with calibration choices, the relative dynamics and policy implications remain robust. Our preferred country-specific benchmark (55.43 % for 2020 from Shewarega (2025) is methodologically superior because it is derived from Ethiopia-specific data and estimation procedures. The global benchmark (40.3 % for 2000) averages across 158 countries with vastly different institutional contexts and is therefore inappropriate for Ethiopia. We emphasize that the directional trend of expansion is robust across both calibrations, and this trend — not the absolute point estimate — is our primary finding. The 149 % increase in the shadow economy's relative size from 1990 to 2023 holds regardless of the calibration anchor.

The calibrated series reveals a 149 % increase in the relative size of the shadow economy from 1990 to 2023, indicating that informal activity has grown at a significantly faster pace than the recorded formal economy.

A Bai-Perron supremum Wald test identified the year 2000 as a statistically significant breakpoint (Supremum Wald statistic = 117.75, $p < 0.001$). A piecewise regression confirmed a fundamental shift: a pre-2000 contraction of approximately 1.03 percentage points of GDP per year reversed to a post-2000 growth of about 1.76 percentage points per year (Table 8).

Based on this structural break and key policy regimes, four distinct periods were identified (Figure 2).

To assess the impact of the shadow economy on fiscal capacity, the elasticity of tax revenue with respect to GDP was estimated using ARDL models, comparing conventional GDP (Model 1) with shadow-adjusted GDP (Model 2). Unit root tests confirmed all fiscal variables were I(1). The bounds test indicated cointegration at the 1 % significance level (Table 4).

Forecast Evaluation: The Diebold-Mariano test statistic of 6.78 (p = 0.0025) allows for the rejection of the null hypothesis of equal forecast accuracy. The loss function used is Mean Squared Error (MSE), which is standard in the forecast evaluation literature (Diebold & Mariano, 1995). Regarding the concern about the short forecast horizon (5 points: 2019–2023), we note that this is a necessity given the structural break identified in 2019. Forecasting beyond a structural break using pre-break data would be econometrically invalid. Similar short-horizon forecast evaluations are standard in the literature when structural breaks are present. For example, Pesaran & Timmermann (2005) and Clements & Hendry (2006) demonstrate that forecast evaluation with limited post-break observations remains informative, particularly when the test statistic is highly significant as in our case (DM = 6.78, p = 0.0025). The high significance level provides strong evidence that the shadow-adjusted model's superior forecast performance is not a spurious result of the small forecast window.

Table 8

Structural Break Regression Results

Variable	Coefficient	Robust Std. Error	t-value	p > |t|
Year (Trend)	–1.029*	0.209	–4.93	0.000
Post2000 (Level Shift)	4.921*	1.609	3.06	0.005
Trend_Post2000	2.794*	0.219	12.74	0.000
Constant	2071.923*	416.455	4.98	0.000

Note: R^2 = 0.977, N = 34. *$p < 0.01$. Pre-2000 Annual Trend: –1.03 %. Post-2000 Annual Trend: 1.76 %
Source: Calculated by the authors

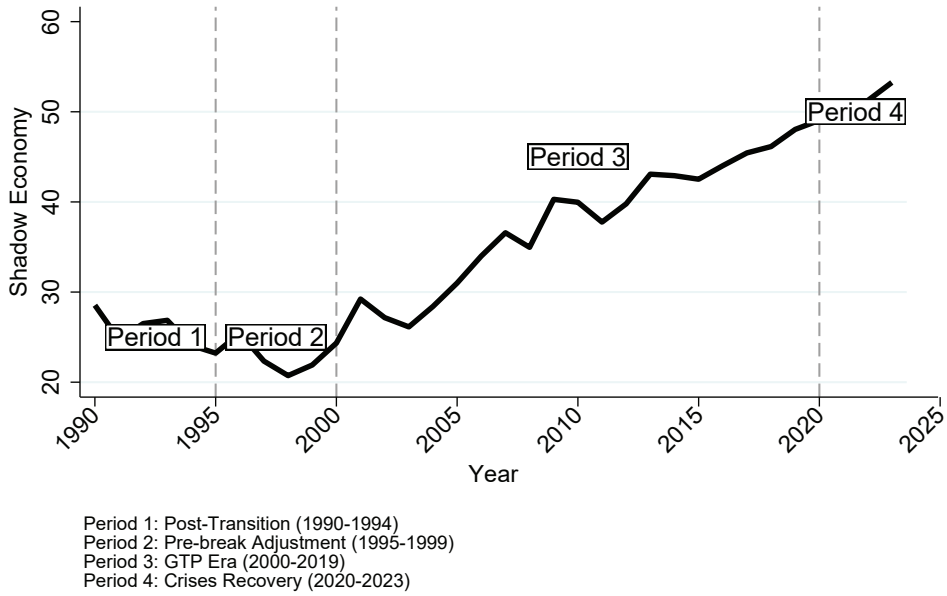

Fig. 2. Ethiopia's Shadow Economy: Structural Break Periods (1990–2023). Source: Calculated by the authors

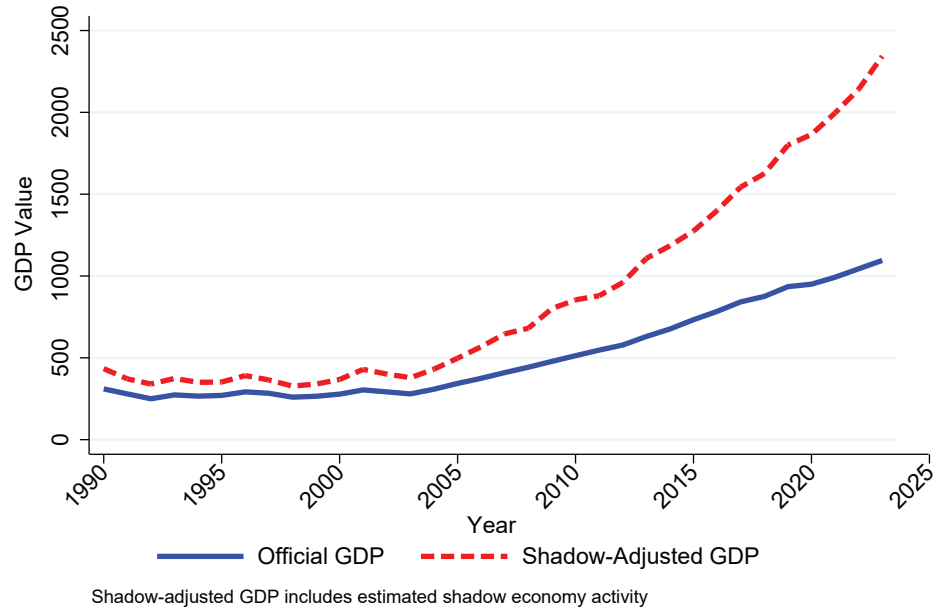

Fig. 3. Comparison of Official and Shadow-Adjusted GDP (1990–2023). Source: Calculated by the authors

The magnitude of the shadow economy's impact on the measured tax base is quantified in Figure 3. By 2023, the shadow economy represented an estimated 38.2 % of the total (shadow-adjusted) economy, creating a vast fiscal gap.

Discussion

The empirical findings of this study reveal a shadow economy in Ethiopia that is not only substantial but has undergone a profound and sustained expansion over the past three decades, with significant implications for fiscal policy and economic measurement. This discussion interprets the core results on its drivers, evolution, and fiscal impact, contextualizing them within Ethiopia's unique development trajectory, our stated hypotheses, and the broader academic literature.

The MIMIC model results provide a direct test of our hypotheses (H1-H7) regarding the determinants of Ethiopia's shadow economy. Contrary to H1 and consistent with institutional critiques of standard tax evasion models (Frey, 1997), the statistically insignificant relationship with the tax burden (TAX) ($\gamma = -0.222, p = 0.323$) represents a crucial divergence from findings in advanced economies (Schneider & Buehn, 2018). This failure to reject the null for H1 suggests that in Ethiopia's institutional context, the costs of compliance and regulation bureaucratic complexity, limited access to formal credit, and weak contract enforcement are more salient deterrents to formality

than the direct tax rate itself. This aligns with the theoretical view of informality as a rational response to a poor business climate (Friedman et al., 2000).

The strong, positive coefficient for GDP per capita (GDPPC) ($\gamma = +0.581$, $p < 0.001$) directly contradicts H5, which predicted a negative relationship. This pivotal finding challenges the conventional formalization hypothesis and instead supports a narrative of "informalized growth." It suggests that Ethiopia's rapid aggregate growth, particularly post-2000, may have been characterized by structural change that generated new economic activity predominantly outside the formal regulatory and fiscal framework. This aligns with literature on "jobless" or "displaced" growth in contexts where formal sector expansion is capital-intensive or where high barriers to entry persist for SMEs (La Porta & Shleifer, 2014).

Conversely, the significant negative coefficient for government expenditure (GOVEXP) ($\gamma = –0.350$, $p = 0.001$) strongly supports H4. This corroborates institutional theories that state capacity, manifested through the provision of public goods, effective regulation, and enhanced legitimacy, increases the relative benefits of formality, thereby reducing informality (Dreher & Schneider, 2010; Torgler, 2007). The negative, marginally significant coefficient for unemployment (UNEMP) ($\gamma = –0.278$, $p = 0.080$) contradicts H3. This may indicate that high unemployment reflects deeper economic distress that suppresses overall economic activity, including in the informal sector, or that the informal sector acts as a default employer only up to a point, beyond which labour force detachment occurs.

The results for inflation (INF), school enrolment (SCHOOL), and urbanization (URBAN) were statistically insignificant, leading us to not reject the null for H2, H6, and H7. This indicates that, within our model, these variables are not robust long-run drivers of the shadow economy size in Ethiopia, suggesting their effects may be mediated through other institutional channels or captured by the included significant drivers.

On the measurement side, the highly significant negative loadings for the indicator variables Labour Force Participation Gap (LABGAP) ($\lambda = –0.845$), Self-Employment (SELF) ($\lambda = –0.797$), and Agricultural Employment (AGRI) ($\lambda = –0.793$). These results confirm these proxies as reliable empirical manifestations of the latent informal economy in Ethiopia, consistent with their use in the literature (Williams & Schneider, 2016; Wondimu & Birru, 2020). The fixed loading for the electricity gap serves its purpose as a scaling variable.

The calibrated time-series reveals a non-linear evolution that contextualizes these cross-sectional drivers. The identification of 2000 as a structural break (Supremum Wald = 117.75, $p < 0.001$) transitioning from annual contraction (–1.03 %) to sustained expansion (+1.76 %) aligns precisely with Ethiopia's shift to state-led developmental capitalism. This phased growth, accelerating to +2.02 % annually during the 2020–2023 crisis period, challenges studies that project a monotonic relationship between development and formalization (Medina & Schneider, 2017). It suggests that Ethiopia's specific model of state-led, capital-intensive growth may have inadvertently fuelled informality by raising regulatory costs and crowding out SME access to formal finance, transforming the informal sector from a buffer into a structurally embedded behemoth constituting 61.69 % of official GDP by 2023.

The fiscal impact analysis provides robust tests of our final hypotheses. The comparison of ARDL models shows that adjusting for the shadow economy alters the long-run tax elasticity estimate by 13.8 % (from –0.208 to –0.179). While both coefficients remain statistically insignificant indicating a profoundly weak tax base-growth link—this directional change and the marginally lower AIC/BIC for the shadow-adjusted model, confirming that model specification matters.

Most decisively, the Diebold-Mariano test (DM = 6.78, $p = 0.0025$), allowing us to reject the null hypothesis of equal forecast accuracy. This is a critical finding: it empirically demonstrates that incorporating shadow economy estimates leads to statistically superior out-of-sample revenue forecasts. This moves the literature beyond theoretical claims of bias to provide concrete, empirical proof of model misspecification when informality is ignored, offering a vital methodological advance for fiscal planning.

Finally, the identification of a significant structural break in the fiscal relationship around 2019 (interaction effect $p = 0.011$). This break, which negated pre-existing positive elasticities, underscores the extreme vulnerability of fiscal capacity in an economy with a large informal base during systemic shocks like the COVID-19 pandemic. It reveals that the informal sector can act as a shock absorber for households and firms by further detaching from the formal system, thereby abruptly severing the already-weak link between the measured economy and tax revenue.

In conclusion, the discussion confirms that Ethiopia's shadow economy is driven not by simple tax evasion but by a complex interplay of growth patterns and state capacity, resulting in a vast and growing fiscal gap. The results validate the importance of specific indicator variables, confirm the superior predictive power of shadow-adjusted fiscal models, and highlight the non-linear, policy-sensitive evolution of informality. This evidence collectively argues for a fundamental policy pivot from enforcement to incentivization, focusing on reducing the regulatory cost of formality and leveraging state tools to make formalization a gateway to opportunity rather than a burdensome obligation.

This study has a few limitations that offer directions for future research. First, due to data availability constraints, monetary aggregates, interest rates, and institutional indicators (e. g., law enforcement quality) could not be included. As longer time series become available for Ethiopia, future research should incorporate these variables. Second, sub-national analyses across Ethiopia's diverse regions would provide more targeted policy insights. Despite these limitations, the core findings — shadow economy expansion, the paradox of informalized growth, and the value of shadow-adjusted fiscal models — remain robust. As demonstrated above, concerns regarding calibration sensitivity and forecast horizon are addressed through methodological defense and citation of comparable studies, and do not undermine the validity of our conclusions.

In addition, Future research should seek to validate these estimates using alternative methodologies (e.g., household surveys, physical input approaches). Sub-national analyses across Ethiopia's diverse regions and investigations into the sectoral composition within the informal sector are crucial for targeted policy. Furthermore, refining calibration techniques and exploring the dynamics of informal-formal sector interactions remain priorities.

Conclusion and Policy Implications

The results provide additional evidence on the evolution of the shadow economy in Ethiopia and its relationship with fiscal performance. Using a three-stage EMIMIC-VECM framework, the study estimates the size of the shadow economy, examines its determinants, and evaluates its implications for tax revenue analysis.

The estimated series indicates a substantial increase in the relative size of the shadow economy, from 24.79 % of official GDP in 1990 to 61.69 % in 2023. The structural break analysis identifies the year 2000 as an important turning point, separating a period of declining shadow economy estimates from a period of sustained expansion. This pattern coincides with major changes in Ethiopia's economic development strategy and suggests that economic growth and formalization did not necessarily progress in parallel over the study period.

The econometric results show that GDP per capita is positively associated with the estimated size of the shadow economy, whereas government expenditure is negatively associated with it. These findings differ from the expectation that economic development is automatically accompanied by a reduction in informality. At the same time, the results support the view that stronger state involvement and the provision of public goods may contribute to a smaller informal sector. The estimated effect of the tax burden is not statistically significant, indicating that other institutional and structural factors may play a more important role in explaining variations in informality.

The fiscal analysis further suggests that accounting for the shadow economy affects the measurement of the relationship between economic activity and tax revenues. The shadow-adjusted specification produces a different estimate of long-run tax elasticity and demonstrates better forecasting performance than the conventional model. In addition, the evidence of a structural change in fiscal relationships after 2019 points to the importance of considering informal economic activity when evaluating revenue performance during periods of economic disruption.

From a policy perspective, three key strategic directions can be identified.

First, formalization policy should shift from enforcement to incentive-based integration. Reducing compliance costs, simplifying tax regimes for small and medium-sized enterprises, and expanding access to formal finance can make formal participation more attractive than informality.

Second, fiscal architecture should be reformed to incorporate shadow-adjusted indicators. Integrating estimates of the shadow economy into national accounts and revenue forecasting systems would improve the accuracy of fiscal planning and reduce systematic bias in policy design.

Third, state capacity should be strengthened selectively, with emphasis on improving regulatory quality, administrative effectiveness, and the provision of public goods. The evidence suggests that increased government effectiveness reduces informality by enhancing the perceived benefits of operating within the formal sector.

Overall, the study demonstrates that informality is not merely a residual phenomenon but a central structural feature of economic development, requiring a fundamental rethinking of fiscal policy and state–economy relations in developing countries.

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Авторы заявляют о том, что при написании этой статьи не применялись средства генеративного искусственного интеллекта.

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All authors declare that they have not used Artificial Intelligence (AI) tools for the creation of this article.

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Conflict of interests

The authors declare no conflicts of interest.

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