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Estimating and comparing tax efforts among selected East African Community member States

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Abstract
The East African countries tax ratio is less than internationally recognized level of 20 percent of Gross Domestic Product (GDP). This makes it difficult for the region to realize the intended development projects. To boost tax performance, the study sought to identify the determinants of tax ratio to GDP among selected East African countries. The study also investigates tax effort of the selected countries in the region. To achieve this, the study uses a pragmatic fixed effects-based approach to approximate the decomposition of inefficiency. The results show that GDP per capita, manufacturing share in GDP, broad money share in GDP. The results also reveal that Kenya, Uganda, Tanzania, Burundi and Rwanda have a tax effort of less than unit. Rwanda and Kenya are found to have a tax effort of 0.98 and 0.97 respectively. Burundi is found to have a tax effort of 0.95. Uganda and Tanzania have a tax effort of 0.88 and 0.81 respectively. Based on these findings the study recommends that East African governments should promote the manufacturing growth and formalizing the sector through industrial parks, special economic zones and simplify the tax regimes for the small-scale manufacturers. The governments should digitalize tax systems fully in order to reduce tax evasion, leakages and transaction costs. The digitalization can be in form of e-filing, mobile tax payment and e-invoicing.

Keywords: Tax effort, tax capacity, revenue mobilization, East African Community, fiscal efficiency, stochastic frontier analysis, institutional performance

Introduction

Synonymous with other countries across the globe, developing nations are striving to achieve sustainable development financing, placing domestic revenue mobilization at the forefront of policy agendas. However, macroeconomic and institutional conditions restrict the amount of taxes any nation can reasonably raise. A plausible question would therefore be, how much extra revenue can a country raise through taxation at a given time, and what factors influence this maximum capacity. Tax capacity refers to the highest attainable level of tax revenue under prevailing economic and institutional conditions. On the other hand, tax effort is the ratio of actual tax revenue to tax capacity and indicates how effectively a government is utilizing its full potential. Although tax-to-GDP ratio is a common metric for assessing revenue performance, it presents an incomplete picture. A low ratio could stem from a constrained economic base or from inefficiencies in harnessing that base. Disentangling these two components is critical for designing effective fiscal reforms. The existing literature employs diverse approaches to measure tax effort, including traditional econometric methods and stochastic frontier (SF) analysis. The first strand of research relies on linear regression models, which assess a country's tax performance by comparing actual revenues to predicted values. However, these estimates do not represent maximum tax capacity, as tax effort exceeds one whenever actual collection surpass the regression prediction. As a result, their usefulness for policy guidance is limited. In contrast, the SF approach more effectively captures the concept of potential by estimating the maximum level of tax revenue a country could achieve, given its own characteristics relative to peer countries in the sample. The East African Community (EAC) presents a compelling case study. Member states share similar economic structures characterized by large informal sectors, agricultural dependence, and emerging industrialization, yet exhibit notable variations in their tax-to-GDP ratios. Conventional wisdom often attributes these differences to varying levels of economic development. However, preliminary evidence suggests that administrative efficiency and institutional quality play an equally, if not more, important role.

In this paper, we empirically investigate tax effort among the East African countries based on study adopted a pragmatic fixed effects-based approach to approximate the decomposition of inefficiency as proposed by Kumbhakar *et al.* (2014) [17]. The approach disentangles country-specific fixed effects from the persistent and time-varying tax effort. This is unlike earlier studies that are based on specifications where country heterogeneity for instance geography, cultural attitudes and tax moral is treated as a persistent trend. This means that earlier models suffer from the problem of model misspecification and therefore tend to yield a downward bias in estimating tax effort. To show the need to isolate the two issues, consider two countries that have similar characteristics. The first country may have higher tax revenue as a result of having favourable trade. However, this may not mean the other country is inefficient in tax collection but due to its less advantageous trade position.

The results showed that GDP per capita, manufacturing sector and broad money are important determinant of tax ratio among the selected East African countries. A pragmatic fixed effects-based approach to approximate the decomposition of inefficiency showed that the selected East African countries were not fully efficient with regards to tax

collection. This was revealed by tax effort of less than unit for the five countries. Rwanda was found to have a tax effort of 0.98 followed by Kenya at 0.957 The third country was Burundi with tax effort of 0.95. Uganda and Tanzania were the least countries in terms of tax collection by having tax effort of 0.85 and 0.81 respectively.

The rest of the paper is structured as follows. The second section presents a brief review of related empirical literature. The third section illustrates the methodology that was used. Section 4 illustrates the empirical finding. Section 5 illustrates the conclusion and recommendations of the study.

Literature Review

The empirical literature on tax performance is broadly divided into two main branches, encompassing the traditional regression techniques that identify the determinants of tax revenue, and another that employs Stochastic Frontier Analysis (SFA) to estimate tax effort by distinguishing between a country's tax capacity and its efficiency in achieving it.

The first branch stretches back to the seminal work of Lotz and Morss (1967) [20] and applies linear regression models to identify the macroeconomic and structural determinants of tax-to-GDP ratios. A wide consensus has emerged around a core set of variables that define a country's tax capacity. These include the level of economic development, consistently proxied by GDP per capita (Fox & Gurley, 2005; Gupta, 2007; Tanzi, 1987) [11, 14, 24], and the sectoral composition of the economy, with a high dependence on agriculture typically associated with lower tax ratios due to informality (Jewell *et al*., 2005) [15]. Although complex, the degree of trade openness is another critical factor as it can generate customs revenue but may be eroded by trade liberalization (Agbeyegbe *et al*., 2006; Baunsgaard & Keen, 2010) [1, 10]. Subsequent studies expanded this framework to include socio-institutional determinants such as education levels (Cyan *et al*., 2013) [9], income distribution (Bird *et al*., 2014; Gupta, 2007) [7, 14], as well as the measures of institutional quality and informality (Grigorian & Davoodi, 2007) [13]. This past literature firmly established that factors such as governance, rule of law, and corruption are important in achieving high levels of tax collection (Bird *et al*., 2008; Le *et al*., 2012) [6]. Drummond and Wendell (2012) [10] provide a comprehensive review of these determinants.

However, this traditional approach is more focused on estimating the average level of tax collection within the context of a given set of economic conditions. The predicted value from such a regression is often interpreted as tax capacity, with tax effort calculated as the ratio of actual revenue to this prediction. Langford and Ohlenburg (2015) [18] pinpoint a core limitation by arguing that this method provides little information on a country's ability to raise additional revenues, given that effort can exceed one; hence, making its interpretation as "inefficiency" less intuitive.

Such a limitation informed the development of the second branch of literature, which utilizes Stochastic Frontier Analysis (SFA). Unlike traditional regression, the SFA approach is designed to estimate a “true" tax potential, the maximum feasible revenue given a country's economic structure and characteristics. This approach is advantageous in that tax effort, measured as the ratio of actual collection to this stochastic frontier, ranges between 0 and 1, directly representing the degree of efficiency in revenue mobilization and the potential room for improvement.

The first literature pioneering the SFA approach was authored by Jha *et al.* (1999) [16] for Indian states. The SFA method has been widely applied globally, as seen in studies focusing on Indonesia by Alfirman (2003) [2], another on the Mexican context by Castaneda & Pardinas (2012) [8], West African states by Ndiaye & Korsu (2014) [22], and Brazil by Antonio & Postali (2015) [3]. A study by Pessino and Fenochietto (2013) [23] employed SFA on a large panel of developed and developing countries, moving beyond cross-sectional analysis.

Although the SFA approach has some advantages, its application has been met with some criticism due to its methodological challenges and inconsistencies. A primary issue is the misspecification of handling unobserved country-specific heterogeneity, such as the historical tax culture, geography, and stable institutional features. Early panel SFA models, like the basic formulation of Battese and Coelli (1992) [4], assumed a deterministic trend for inefficiency, conflating these time-invariant fixed effects with persistent inefficiency. This conflation produces a downward bias in inefficiency estimates, which leads to overestimation of tax effort due to the mistaking of inherent national characteristics for efficient performance.

Later studies, such as those using the True Random Effects (TRE) model (Greene, 2005a; McNabb *et al*., 2021) [12, 21] attempted to address this by incorporating all time-invariant effects as heterogeneity. However, this approach swings to the opposite extreme, often overestimating inefficiency as it underestimates tax effort by classifying government-controllable but persistent institutional factors, such as long-standing governance quality, as unchangeable heterogeneity. The impact of these choices is dramatic, with McNabb *et al*. (2021) [21] showing that the average tax effort estimate can swing from 0.41 under an ordinary random effects model to 0.84 under the TRE specification.

A further critical limitation of traditional and SFA studies is the omission of key policy variables, most notably tax rates as Pessino and Fenochietto (2013) [23] established that models that omit statutory rates can yield puzzling results, such as surprisingly low tax effort estimates for advanced economies with low VAT rates like in Singapore and Korea; and implausibly high estimates for developing nations with high rates like the case of Belarus and Bolivia. This indicates that a significant portion of tax effort or capacity may reflect differences in policy choices on tax rates, leading to inaccurate assessments and flawed policy recommendations.

The existing literature on tax effort remains limited within the East African Community (EAC) context, with most studies focusing on individual countries or relying on traditional deterministic models. This study addresses the dual methodological and contextual gaps highlighted above. First, it contributes to the methodological literature by applying a robust empirical strategy that avoids the misspecification of earlier models. The choice and the

application of the Fixed Effects (FE) panel model is deliberate and effectively controls for all time-invariant, country-specific heterogeneity such as historical legacies and geographic constraints. This allows us to isolate the time-varying components of tax performance, providing a clearer, less biased measure of taxable capacity based solely on observable economic determinants. This approach ensures that the subsequent calculation of tax effort is not confounded by fixed national characteristics, offering a more accurate measure of controllable efficiency.

Second, while the study acknowledges the importance of tax rates as a policy variable, our focused regional analysis of the EAC provides a natural control for this omitted variable bias. The EAC member states have made significant strides in harmonizing their tax policies, including aligned VAT standards and a common external tariff. This regional integration creates a more homogeneous policy environment than global samples, meaning that differences in statutory rates are less likely to drive the variations in tax effort observed between Kenya, Tanzania, Rwanda, Uganda, and Burundi. This unique context allows for a more confident attribution of disparities in tax effort to differences in administrative efficiency and compliance rather than divergent policy choices. Therefore, this study provides a novel and refined analysis of tax effort in the EAC using a pragmatic fixed effects-based approach to approximate the decomposition of inefficiency as proposed by Kumbhakar *et al*. (2014) [17].

Methodology

This study aims to estimate and compare tax effort across the East African Community (EAC). The analysis proceeds in two stages where tax capacity for each country was estimated first; a subsequent step involving calculating tax effort as the ratio of actual revenue to this estimated capacity.

The model specification is derived from our prior analysis of tax ratio determinants in the EAC (Nzula, 2025), which established a robust set of macroeconomic and structural drivers. The core econometric model is specified as follows:

$$Y_{it} = \alpha_0 + \alpha_1 X_{it} + V_{it} - u_{it} \quad \text{.....1}$$

where Yit represents the natural logarithm of tax revenue to GDP ratio of country i at time t; Xit is the vector of variables that determine tax collection of country i at time t; uit represents the extent to which a country fails to reach its potential tax revenue given the underlying conditions. It captures the level of inefficiency. It is assumed that Vit and uit are uncorrelated across observations. The inefficiency term represents a one-sided error for all countries, illustrating the difference between their actual tax performance and the theoretical frontier. The literature has developed various approaches for identifying this inefficiency component. We apply the stochastic frontier model of Kumbhakar *et al*. (2014) [17] that disentangles the one-sided inefficiency term into time-varying inefficiency (uit), persistent inefficiency ηi, and country heterogeneity β_0:

$$Y_{it} = \alpha_0 + \beta_i + \alpha_1 X_{it} + V_{it} + \eta_i - u_{it} \quad \text{.....2}$$

The analysis aims at measuring tax effort as the ratio between actual and the corresponding stochastic frontier tax revenue predicted from Equation (2):

Our estimation strategy is built around the reduced form representation of the SF model
discussed in the previous section:

$$\ln TRGDP_{it} = \beta_0 + \beta_1 GDPPC_{it} + \beta_2 \ln MANU_{it} + \beta_3 \ln TRADEOP_{it} + \beta_4 \ln AGRIC_{it} + \beta_5 \ln M2_{it} + \beta_6 \ln INF_{it} + \sigma_i + \mu_{it} \quad \text{.....3}$$

Where TRGDP is the Tax Revenue to GDP ratio, GDPPC is GDP per capita, a measure of economic development and the ability to pay taxes, MANU is the natural log of the manufacturing share of GDP, representing an easily taxable, formal sector, TRADEOP is the natural log of trade openness (exports + imports as a % of GDP), a source of customs duties, AGRIC is the natural log of the agricultural share of GDP, a typically hard-to-tax, informal sector, M2 is the natural log of broad money supply, a proxy for financial deepening and monetization, INF is the inflation rate, which can erode the real value of tax collections, EXCRATE is the exchange rate, controlling for external sector effects, σi is the standard random error term, U (it) is a non-negative error term representing technical inefficiency.

We utilize a balanced panel dataset from 2013–2023 for five EAC member states: Kenya, Tanzania, Rwanda, Uganda, and Burundi. Data for all variables are sourced from the World Development Indicators (WDI) and International Financial Statistics (IFS) databases. These sources were selected to ensure standardized, internationally comparable data, which is a critical requirement for robust cross-country analysis.

This study adopted a pragmatic fixed effects-based approach to approximate the decomposition of inefficiency as proposed by Kumbhakar *et al*. (2014) [17]. Specifically, the country-specific fixed effects are interpreted as the proxies for persistent inefficiency and the within-period residuals treated as time-varying inefficiency. Though this approach does not completely implement the Generalized True Random Effects model, it adopts the conceptual framework that is proposed by Kumbhakar *et al*. (2014) [17] to differentiate between persistent and time-varying inefficiency components.

Empirical findings

Before estimating stochastic frontier, model described in Section 3, we follow the recommendation of Kumbhakar *et al*. (2014) [17] and conduct a likelihood-ratio (LR) test on the existence of inefficiency. We estimate our baseline specification, disentangling country-specific effects from time-varying and persistent inefficiencies. Table 1 summarizes the estimation results of the frontier and inefficiency models.

Table 1: Fixed Effects Panel Results

Random-effects GLS regression	Number of obs		=	55
Group variable: country_id	Number of groups		=	5
R-squared:	Obs per group:			
Within = 0.3064	min		=	11
Between = 0.8985	avg		=	11.0
Overall = 0.6881	max		=	11
	Wald chi2(6)		=	105.88
corr (u_i, X) = 0 (assumed)	Prob > chi2		=	0.0000
Natural log of Tax ratio in GDP	Coefficient	Standard Error	z	P>z
Natural log of agricultural share in GDP	0.18	0.145	1.27	0.205
Natural log of manufacturing share in GDP	0.08	0.040	2.04	0.042
Natural log of Broad Money	0.23	0.0396	5.77	0.000
Natural log of inflation	-0.01	0.013	-0.99	0.323
Natural log of trade Openness	0.14	0.0530	2.72	0.007
Natural log of GDP per Capita	0.16	0.055	2.90	0.005
Constant	3.02	0.762	3.96	0.000
sigma_u	0.086			
sigma_e	0.046			
rho	0.779 (fraction of variance due to u_i)			

The coefficients of natural logs of manufacturing share in GDP, broad money, per capita GDP are statistically significant at a 5 percent level and have the expected signs. In particular, the level of economic power, manufacturing, and broad money are important determinants of East African countries' tax performance. The results are in line with Langford and Ohlenburg (2015) [18] and Murunga *et al.* (2016) studies that found similar results.

From the above results, tax effort was obtained. Figure 1 presents tax effort for each country of study.

Fig 1: Tax Effort for the Selected East Africa Community member countries.

That red line is at 1.0 showing the optimal frontier, that is full efficiency in tax collection. However, from Figure 1, it is observed that all the countries considered in the study had a shortfall in effort. This is evident by all their tax efforts being less than 1. The country that was found to be relatively efficient in tax performance was Rwanda which had a tax effort of 0.98. Kenya had a tax effort of 0.97. It was followed by Burundi at 0.95, Uganda at 0.85 and Tanzania at 0.81.

Conclusion and Recommendations

In this study we bring new evidence on the countries' tax effort, making a contribution to the existing literature. This is through applying pragmatic fixed effects-based approach to approximate the decomposition of inefficiency as proposed by Kumbhakar *et al.* (2014) [17]. The approach stands out as superior due to disentangling country specific effects from persistent and time-varying components of tax effort. This assists to mitigate the misspecification bias of the previous studies.

Our findings suggest that the level of economic performance, manufacturing and broad money are essential in influencing a country's tax effort. The study also points out that the selected East African countries are yet to reach efficiency levels with regards to tax collection. This was informed by tax effort of less than unit for the selected East African countries.

The study therefore recommends that East African governments should promote the manufacturing growth and formalizing the sector through industrial parks, special economic zones and simplify the tax regimes for the small-scale manufacturers. The governments should also support local value chains in light industries so as to expand the taxable base and increase employment in the formal sector. The governments should also target GDP per capita expansion through investing in education, infrastructure and innovation. Such action can enhance productivity and income levels. In order to improve tax collection, the East African community countries should digitalize tax systems fully in order to reduce tax evasion, leakages and transaction costs. The digitalization can be in form of e-filing, mobile tax payment and e-invoicing

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