Tax Effort and Capacity in Developing Countries: Unravelling the impact of the informal economy

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Abstract

This study focuses on estimating the tax effort in 25 selected African countries and its implications for economic development. The findings aim to assess the level to which a country's tax mobilisation is constrained by its inability to utilize available tax capacity for funding public spending. Additionally, comparing the tax effort among countries offers insight into appropriate tax mixes for addressing budgetary imbalances and debt management strategies. Analysing taxable capacity and tax capacity using panel data from the year 2000 to 2021, the paper employs stochastic frontier techniques (SF) for estimation. Due to data limitations and covariates challenges, it employs OLS, FE and dynamic GMM techniques for robust check. Key results show that per capita income trade openness, remittances, FDI, and manufacturing positively influence tax revenue, while agriculture, informal economy, population, corruption control and voice accountability have a negative and significant impact on tax effort. The findings highlight the significance of governance improvements and economic structural reforms for revenue mobilization in African countries. The study offers insights into fiscal behaviour patterns in African economies and recommends necessary reforms for fiscal responsibility.

Key words: Tax effort, tax capacity, tax frontier, informal economy, inefficiency.

JEL (H0: H2, H21, C23, C51)

1. Introduction and background of the study

A country's economic development relies heavily on the efficacy of its tax system. A well-mobilized tax system is crucial for the country's capacity to pay its public debt and finance its essential infrastructure projects. It also serves as a crucial revenue base to fund the country's economic development. Assessments of tax estimates are often conducted to measure the influence of government size on economic progress and other related factors. Research on state policymaking has revealed that a state's economic resources are a primary determinant of policy choices. This paper attempt to investigate the impact of the informal sector on tax mobilisation effort and create a tax effort index for 25 selected African economies. The revenue mobilisation ability does not only hinge on the economic structure, but also the political disposition of the country. The country's ability to mobilise revenues is contingent on a social contract between the state and the public. The extent to which the state succeeds in tax collection shows how strong or weak is such a contract is in that country.

There are two major approaches used in estimating tax effort previously. Namely, the regression analysis approach, which uses regression analysis to explain variation across different entities, (see Lotz and Morss, 1967; Bahl, 1971; Chelliah, 1971; Reddy, 1975; Dwivedi, 1980 and Oommen, 1987). The second approach is the representative tax system, which attempts to choose potential bases of specific taxes, which means for every tax, a suitable base is identified, and a representative set of tax rates is created (see Thimmaiah, 1979; Chelliah and Sinha, 1982; William et al., 1997). Furthermore (Gupta, 2007; Attiya and Umaima, 2012; Le et al., 2012; and Khwaja and Iyer, 2014) have analysed revenue performance in the short run using panel data analysis.

This paper provides a conceptual and empirical analysis of taxable capacity and tax effort in 25 African countries for the 2000-2021 period using a stochastic frontier method (Fenochietto, Pessino, 2013; Langford and Ohlenburg, 2016; Mawejje and Sebudde, 2019). The estimated tax index mirrors the variance in the taxable capacity of a country.

Tax potential represents the highest achievable level of tax revenue for a specific country, considering its economic structure, social dynamics, institutional settings and demographic factors. Tax effort on the other hand is the degree to which actual tax revenue is feasible to reach potential, stated as a percentage (Bird, 2004; Majjewe and Sebudde, 2019). (Tual Minh Le et al., 2012) define taxable capacity as the estimated tax-to-GDP ratio, which is measured empirically by considering a country's specific macroeconomic, institutional and demographic indicators. The

results obtained here will help policymakers to discern which countries are close to their tax capacity and which are below their tax capacity; and therefore have scope to increase their tax revenue. This study makes use of predicted tax ratio as a proxy for potential tax revenue.

This paper is unique in that, it tracks tax effort and tax capacity at a total level and related tax revenue and revenue potentials to its informal economy, and other covariates such as institutional features and other fiscal and monetary policy strength in these countries using Stochastic frontier approach (SFA) (Kumbhakar et al., 2015). Previous analysis by (Fenochietto, Pessino, 2013; Ndiaye and Korsu, 2014; Majjewe and Sebudde, 2019) do not include covariates such as the informal economy index, remittances, and debt to GDP ratio, foreign aid, which are included in this study. Moreover, this paper differs from those of Majjewe and Sebudde (2019) and Fenochietto and Pessino (2013) with regards to data used and the period. This approach is valuable because it will help to establish the exact extent to which the informal economy influences tax effort in countries with a larger segment of its economy in the informal sector. To ensure the accuracy of the results in Stochastic frontier analysis (SFA), appropriate panel data robust tests such as GMM, dynamic fixed effect are estimated as well (Clark et al.,2013; Blundell et al., 2000) are included.

This study compliments the literature in various ways. To begin with, it monitors the overall tax capacity and tax efforts while also establishing a connection with tax revenues and revenues potentials to their informal economy, fiscal, and monetary policy strength in these countries. Second following Alesina et al. (2003) and Ade et al. (2018) work on the institutional role in tax mobilization studies, various institutional measures are incorporated in revenue performance estimates. Third, the study introduces several controls such as remittance inflows, commodity debt to GDP ratio, and foreign aid besides other commonly used covariates; thereby analysing their influence on tax capacity. Last, a consorted effort is apportioned to obtain consistency of estimates by employing an array of different methodologies, which correct for econometrics limitations such as endogeneity, multicollinearity, heteroscedasticity, and instrumental variables choices challenge.

In summary, the envisioned contribution of the paper is to extend the existing tax research by analysing tax effort and tax capacity at an aggregate level using the stochastic frontier approach with the aim to establish the extent to which macroeconomics covariates and institutions matter in tax mobilization. The inclusion of the informal economy significantly enhances the explanatory

capability of the utilized model for assessing the factors contributing to variations in the tax ratios among countries (Joshi et al., 2014; Resnick, et al., 2020; Rogan, 2019).

A larger value of the tax effort index shows that a certain country is amassing more tax than expected, given its edifice and prevailing economic and social technologies. Previous literature shows that tax effort and tax capacity are useful tools to judge whether reforms on tax collection should be carried out, accounting for disparity in income levels, demographics and institutions according to respective countries. There is a gap in the literature on tax capacity and tax effort for African economies. Naape et al. (2021) is the latest paper on tax effort. However, the paper solely focuses on South Africa using a time series analysis. Most literature about tax mobilization focuses on colonial legacies and political institutions and ignores the role of other factors such as informal sector, remittances, mineral rents, foreign aid, and dynamism of the state in building other infrastructure necessary to increase tax mobilization. Here, the consorted effort expended in establishing the role political and institutional determinants plays in the determination of tax capacity and tax effort in African economies. This study acknowledges the influence of corruption control, governance, and regulatory quality in the effort of revenue mobilization since such factors impact the ability of tax entities to collect taxes (Alesina et al., 2003).

The rest of the paper is structured as follows: the second section presents a brief discussion of the Literature review and theoretical framework, while section 3 covers the data. The methodology adopted in this paper to estimate results is discussed in section 4. The empirical results and related discussions are presented in the fifth section. The sixth section discusses the sensitivity analysis of the results. The paper concludes in the last section.

2. Literature review

Developing countries face the imperative of increased expenditure on essential sectors like education, public infrastructure, and health, driving the need to expand their tax base (Bird et al., 2008; Piancastelli et al., 2020; Gupta et al., 2022). However, the literature on revenue mobilisation methods for these purposes is underdeveloped (Martin et al., 2009). While studies have determined tax effort and capacity across emerging and developed countries, these general trends offer limited guidance for African economies, which remain underdeveloped and heavily reliant on aid, remittances and borrowing (Naape and Mohanye, 2021; Mawejje et al., 2019). Despite the fact that, the informal sector has been on an upward trajectory in many African countries (El Badaoui

and Magnani, 2020). Few studies have explored the influence of informal economy has in tax mobilisation efforts in Africa (Mpofu, 2021).

Makate, Mahonye and Mandishara (2018) explored the impact of debt on Sub-Saharan Africa's growth, revealing that foreign debt often exceeds sustainable thresholds (Pattillo et al., 2002). Taxable capacity, defined by Moreno-Donson and Rojchaichaninthirn (2012), is assessed through regression-based tax-to-GDP ratios. The tax effort index, as defined by Stotsky et al. (1997) and Gaspar et al. (2016), gauges the effectiveness of tax collection relative to GDP and taxable capacity. An index exceeding unity indicates efficient tax base utilisation, while one below unity signifies untapped revenue potential. Gaspar et al. (2016) emphasise that tax capacity is pivotal for a country's viability and sustainable economic growth. As African countries strive for self-sufficiency, understanding and optimising tax effort and capacity are crucial for their development trajectories. The search for mechanism to broaden the tax for development purposes is an ongoing process and this paper endeavour to contribute in that end.

Lotz and Morss (1970) introduced inter-country tax effort comparisons by examining variations in actual and estimated tax ratios. Bahl (1971) delved deeper into subsequent tax effort studies, emphasizing that differences in openness play a significant role in tax collection variations among developing countries, possibly even more so than variations in per capita GDP. Chelliah, Baas and Kelly (1975) developed a tax effort index using different blends of explanatory variables. Moreover, Tait, Gratz and Eichengreen (1979) provide further estimation techniques of tax index. A discussion paper by Piancastelli, (2001) looks at an estimation of tax effort in both developing and developed countries from 1985 to 1995. Meda, (2015) used various approaches to estimate the tax gap in South Africa by defining a tax gap as the difference between potential revenue inferred from macroeconomic data and actual tax collection. He asserts that the tax gap is a quantitative indicator of an efficient tax system; he concludes that the diagnosis and evaluation of efficiency in tax collection are key factors for the prioritisation of scarce resource allocation. Moreover, in terms of roles of institutions, Alm and Torgler (2006), study the role of tax morale in the US and Europe, and conclude that citizens of more democratic countries have a high propensity to pay tax.

By comparing the efficacy of revenue collection across countries in diverse income groups, (Tuan, et al., 2012; Zee, 1996) show that, the tax-to-GDP ratio tends to produce a distorted picture, because of differences in institutional settings, economic structures, and demographic trends. (Le Moreno-Dodson and Rojchaininthorn, 2008) suggest that the tax system exerts a significant impact

on investment decisions. Furthermore, higher tax revenues are vital to lower external donor assistance reliance in low-income countries. (Feger and Asafu-Adjaye, 2014) show that tax collection in sub-Saharan Africa (SSA) only amounts to 15% of GDP. An effective tax system encourages good governance, strengthens nation building and promotes government transparency. Using tax effort and tax capacity, (Tuan, Dodson and Bayranktar, 2012) constructed a benchmark upon which they could rank different economies in four distinct classifications, namely:

i. low tax collection, low tax effort
ii. high tax collection, high tax effort
iii. low tax collection, high tax effort
iv. high tax collection, low tax effort

A tax effort of one corresponds with an index of the ratio between the share of the taxable capacity and actual tax collection in income. A country with a low tax collection is reflected in its having a low tax effort index, or it could have a high tax collection, which is reflected in its high tax effort index. Bahl (1971) argues that a country with a tax effort below unity implies that that country's tax effort is lower attained relative to other countries, but does not necessarily suggest that it has attained a higher tax ratio. Chelliah et al. (1975) state that a modest comparison of tax ratios is only appropriate for comparisons of the relative levels of taxes of different countries. Mixed results can be obtained because of measurement errors or insufficient data points during estimation. However, any conclusion on tax performance grounded on such assessment fails to account for the fact that some countries might choose to charge lower taxes and therefore provide lower social services or have a small public sector. Thus, a country could decide to have a lower effort on purpose, not because it lacks the ability to pursue a high tax ratio. Bird (1976) notes that individual countries are distinctive in terms of political, economic, and institutional characteristics, which generalized those variations and tend to provide less evocative information than they will obscure. The financial crisis of 2008-2009 and Covid-19 pandemic in 2019 resulted in an increase in the budget deficits and forced governments to look for new avenues to increase revenue sources to fund public expenditures and minimise the deficit with minimal adverse effects on economic activities. (Hinrichs, 1966 and Musgrave, 1969) stress the importance of tax structural features such as import tariffs, which are easy to utilise to meet fiscal needs. (Bird, 1989) cites the administrative capacity limitations imposed on taxation in developing countries.

Kaldor (1963) emphasizes that the success of global tax reform hinges on political will as an essential requirement. Bird (2004) extends this notion, asserting that a nation's tax system reflects its political institutions, which are effective tax systems thriving in politically stable environments with strong institutions. Piancastelli (2001) study identifies corruption control, regulatory quality, and uncertainty as key determinants of tax revenue across countries, with weaker corruption controls leading to lower tax revenues. Easterly and Levine (2002) study involving 72 countries highlights the significance of factors such as the rule of law property rights, financial systems, and reduced corruption in determining economic success beyond resources and government policies. Institutions' role in shaping incentives for favourable economic outcomes is underscored by (North, 1991; Acemoglu et al., 2001). Gupta et al. (2022) find that fragile Sub-Saharan African nations exhibit lower short-term tax buoyance due to weak institutions. Rodrik and Subramanian (2003) conclude that institution quality supersedes all else in influencing income outcomes.

While official development assistance (aid) and foreign direct investments contribute to development, they can create budgeting uncertainty in the public sector (Junquera-Varela et al., 2017). Recognising the need to reduce aid dependence, international donors stress expanding the tax base for long-term sustainability (Mascagni et al., 2014). To enhance tax mobilisation in African countries, the IMF and World Bank recommend measures like VAT management improvement, taxing the digital economy directly, and broadening VAT regulations (Akpen, 2022; Onuoha and Gillwald, 2022). Suggestions also include adopting digital tax collection technologies, raising property tax, expanding excise taxes, and addressing loopholes exploited by multinational entities for tax base loss (Meagher, 2018; Sebele-Mpofu, 2020; Mashiri and Schwartz, 2021). These strategies aim to strengthen revenue resources, mitigate aid-related uncertainty, and foster economic independence.

Tax mobilisation serves four key purposes. First, it generates capital for fiscal needs. Second, it enhances institutional efficiencies. Third, it establishes state legitimacy and reduces reliance on donor funding. Fourth, it promotes civic engagement, state accountability and discourse (Daude, Gutoerrez and Melguizo, 2013). Challenges to tax mobilisation in developing countries include abuse of tax incentives and exemptions (Oguttu, 2018), as well as corruption, low tax morale, and weak governance (Sebele-Mpofu and Korera, 2021). Factors contributing to limited tax collection in developing countries include heavy reliance on agricultural sector, a sizable informal sector, the growing untaxed digital economy, and multinational corporations' use of transfer pricing

strategies. A Recent study by Piancastelli and Thirlwall (2020) reveals that over half of the studied developing countries exhibit a tax effort below unity. For countries aiming to bolster social safety nets amidst larger informal sectors, revenue mobilisation remains a significant challenge (Cody, 2018). An ILO report of 2018 shows that 85.8% of African employment lies within the informal sector.

Dom and Miller (2018) assert that revenue mobilization in SSA is sporadic. Other scholars highlight problems of effective tax mobilization as revenue instability, tax evasion, political instability, economic challenges, policy incredibility, and institutional flaws (Carrillo et al., 2017; Gwaindepi, 2021). Moreover, Nandelenga and Odour (2020) suggest that African countries face economic challenges, weak institutions problem, mistrust towards government and demoralized taxpayer problem. Levin (2021) identifies weak tax system in Sub-Saharan Africa and urges for the requisite for a well-designed tax system that fosters a structural transformation process that supports job creation. Few authors emphasize the need for efforts towards the improvements of administrative structures and for the fiscal capacity to be designed in a matter those carters to each country social environment, political, and economic. In terms of transfer pricing legislation enforcement, Sebele et al. (2022) point to the lack of tax management and implementation capabilities, lack of tax agreements and unproductive dispute resolution mechanisms as well as poor audit frameworks.

Digital economy can play a role in tax mobilization effort in developing countries. Emergent of new technologies opens new frontiers for tax mobilization for developing countries. Governments often lag behind the designing of a mechanism of collecting taxes in new emerging markets. The digital economy is no different. Bunn, Asen and Enache (2020) and Onuoha and Gillward (2022) argue that 21 million people are involved in e-commerce in Africa. Bunn et al. (2020), Ganter (2021) and Kelbese (2020) highlight the difficulty faced by African countries in collecting taxes in the digital economic sector. Singh (2018) asserts that under-developed countries lost in surplus of US $500 billion in tax revenues annually. Developing countries in Africa need to deepen efforts to tax the economy through digital mechanisms such as digital service taxes (DSTs), value-added tax and withholding taxes.

In case of the literature on tax mobilisation within the Southern African Development Community (SADC) various researchers explore region. Ade, Rossouw and Gwatidzo (2018) highlight the significance of Foreign direct investment (FDI) inflows in influencing tax collection.

However, their analysis overlooks the role of institutions and the informal sector in revenue generation. Naape and Mahonye (2021) analyse South Africa's tax effort, using time series, finding positive and a significant relationship between GDP per capita, FDI and inflation; while population growth, trade openness, and agriculture negatively impacts tax effort. Ndiaye and Korsu (2014) show that literacy rate positively influence various tax groups, with financial deepening affecting trade and indirect tax positively, and agricultural output affecting direct and indirect taxes negatively. Brun and Diakite (2016) employ the stochastic frontier model to assess overall tax effort, noting higher effort in low-income countries, and attributing tax ineffectiveness to policy choices.

Addison and Levin (2012) link high tax-to-GDP ratios to increased trade, small agriculture sector, smaller population and peaceful conditions. Garikai (2009) explores tax buoyancy in SADC, finding adverse effects of financialisation, external donor assistance growth, and fiscal deficit expansion. Gupta (2007) establishes that trade openness; per capita income, foreign aid, and institutional stability significantly influence revenue performance. Stotsky and WoldeMarian (1997) find that countries with higher tax shares tend to exhibit great tax effort, although this consistency varies. Tanzi (1987) finds a positive and significant relationship between tax revenue share and per capita GDP. Chelliah, Baas and Kelly (1975) and Tait, Gatz, and Eichengreen (1979) relate tax share to various factors, with mining showing a positive association, agriculture a negative one, and exports being insignificant. These studies collectively contribute insights into the complexities of tax mobilisations within the African context.

Table 1. Determinants of Tax capacity and Tax effort in empirical literature

Categories	Variables	Positive relation	Negative relation	Non- significant
		(Source's)	*(Source's)*	Relation Inconclusive
Macro-Economic	**Trade**	Naape & Mahonye, (2021), Khwaja M. S. and Iyer, I. (2014), Le T.M, Moreno-Dodson, B, Bayraktar. N (2012), Aizenman and Jinjarak (2009), Norregaard and Khan(2007), Piancastelli (2001), Rodrik, (1998), Lotz and Morss (1967), Chelliah(1971), Hinrich (1965)		
	Per Capita	Moreno_Dodson, B.L, Bayraktar.N (2012),Gupta,(2007),Piancastelli (2001), Bahl,(1971,1972),Hinrich(1965), Chelliah(1971)	Tait(1976/1972)	Lotz and Morss (1967)
	Agriculture	Minh.T, Moreno_Dodson, B.L, Bayraktar, N. (2012), Davoodi and Grigorian(2007),Chelliah(1971)	Fenochietto et al (2010, 2013),Piancastelli (2001), Tanzi, (1992), Leuthold(1991) , Tait(1972/1976),	Khwaja and Indira Iyer (2014), Piancastelli(2001),Tait (1972/1976),
	Foreign Aid		Thornton (2014), Ahmed & Mohammad(2010) Gupta et al.(2003)	
	FDI	Ndiaye and Kursu (2014)		
	PE		Fenochietto and Pessino (2013)	
Demographic	**Population**	Zerriaa et al. (2017),Dragos, (2014)	Le,T.M, Moreno_Dodson.B, Bayraktar .N. (2012). Bird et al. (2004)	
Historical Event	**Colonial policy**	Feger and Asafu-Adejiye (2014)		
Institutional Quality	**Corruption Control**	Khwaja and Indira Iyer (2014), Fenochietto and Pessino (2013)	Tuan Minh Le, Blanca Moreno_Dodson, Nihal Bayraktar (2012), Bird et al (2004) Tanzi and Davoodi (1997)	
	Voice accountability	Torgler and Schneider (2007), Gupta, 2007,Piancastelli, M. (2001), Bird, et al. (2004), Ghura, 1998, Tanzi and Davoodi (1997);		
	Inflation	Fenochietto and Pessino (2013)		

2.1 Theoretical Framework.

Tax effort, introduced by Lotz and Morss (1967) and expanded by subsequent researchers, notably Bahl (1971) and Stotsky and WoldeMariam (1997), assesses a country's ability to utilize its taxable

capacity. This static measure of tax performance related to actual tax collection to taxable capacity, tracked at regular intervals. It is estimated using a regression model based approach, where the actual tax ratio is divided by the predicted ratio, yielding the tax ratio as an indicator of taxable capacity. Accuracy hinges on the precision of the model and the quality of data employed (Mertens, 2003). Tax effort evaluates a country's tax revenue mobilisation, incorporating tax and other broader economic, institutional and political indicators. A tax effort suggests that revenue is collected optimally, while a tax effort below one signifies untapped potential. Institutions play a significant role in the performance of the economies. However, if an economy begins with a larger share of informal sector, such informality tends to constraints the economic growth of the economy. This means informality constraint have a pervasive influence upon the long run character of the economies (North, 1991).

3. Data

This paper uses secondary data from the International Monetary Fund (IMF) and World Bank's World Development Indicators (WDI). The data collected is based on homogeneous data availability. The dataset is a panel data of 25 countries, from the year 2000 to 2021. Panel data correct for sample selection bias, arising from variables (Baltagi, 2013; Andre, 2017). The variables collected are as follows: Total tax as a % of GDP defined as the tax revenues collected from taxes on payroll taxes, income and profits, social security contributions, taxes levied on goods and services, taxes on the ownership and transfer of property, and other taxes. A trade openness variable is constructed by adding imports as a percentage of GDP to exports as a percentage of GDP. The share of agriculture as a percentage of GDP is the net output of a sector after accounting for output and intermediate inputs. GDP per capita, which is a logarithm, function of per capita GDP in constant US$. Population is the number of individuals ages 15-64 in the respective countries in log form. Remittances are personal remittance flows, paid in US dollars.

Informality is estimated in two ways, first, it is computed indirectly as the informal output as a percentage of official GDP. Second, it is measured directly from surveys such as labour force, household, opinion, or the firm's surveys. Informality is a market based and legal production of goods and services that are hidden from the public authorities for monetary, regulatory or institutional reasons (Schneider, Buehn and Montenegro, 2010). Two indices are used to proxy the informality. The Multiple Indicators Multiple Causes (MIMIC) model (Schneider, Buehn and

Montenegro, 2010) and the General dynamic equilibrium model (DGE) (Elgin and Oztunali, 2012; Ihrig and Moe, 2004; Orsi et al., 2014). Elgin et al. (2021), provide an exhaustive coverage of the two indices both in terms of their strengths and in terms of limitations. Foreign aid is the total number of foreign financial assistance to recipient countries in terms of capital, equipment and technology. The corruption index is the institutional variable proxy, which takes values of -2.5 for the lowest, and 2.5 for the highest. Similarly, voice accountability is another proxy for the institution, which has the same values as the corruption index. Before taking the logarithm of both institutional variables, a value of 2.5 is added to it and divided by 5. Debt is the external debt stocks as percentage of GNI and PE is government expenditure on education, total percentage of GDP, and AID is the net official development assistance and official aid received. Per capita is per capita GDP in constant 2015 US$. Inflation is the aggregate inflation rate in percentage for each country.

Due to problems of missing data, only countries with a complete dataset of variables are used. The choice of countries' data is undertaken randomly to avoid selectivity bias but also according to data availability. Utilising logarithmic form for all variables reduces data variance, resulting in improved goodness of fit for the estimated equations as argued by Piancastelli et al. (2020). Table 9 in the annexure lists the countries used in this paper.

4. Methodology

Tax effort and tax capacity are usually determined using either income approach representative tax system, or aggregate regression approach. The following studies make use of the income approach and aggregate regression approach to estimate tax effort (Bahl 1972; Rao .H 1993; Tanzi and Davoodi, 1997; Tanzi and Zee, 2000; Paincastelli, 2001; Bird, Vazquez and Torgler, 2004; Purohit, 2006; Le, Moreno- Dodson and Rojchaininthorn, 2008; Tuan Minh Le, et al., 2012; Feger and Asafu-Adejiye, 2014). This approach is perceived to be insufficient because it is based on the assumption that the only source of variation in tax is emanates from income and does not encompass other possible determinants. For representative tax system, it involves the presence of valid proxies for the tax base separate to each tax type in order to estimate tax measurements of each tax group (Purohit, 2006; Crotty, 2008). Mikesell (2007) provides broad list of limitations of the representative tax system. Among them, is the challenge with estimating using (OLS) in that the estimators obtained exclude the effect of heterogeneity that may exist among countries. The uniqueness of countries is contained in the disturbance term (ε_{it}). The consequence of individual

differences among countries being contained in the error term is that the disturbance term will be correlated with independent variables in the model and by implication, $cov(v_t, v_s) = \rho, t \neq s$, (Gujarati, 2008). The implication of the correlation between error term and other independent variables is that the coefficient estimated will be biased and inconsistent, due to a possible heterogeneity effect not captured in Ordinary Least Square (OLS). The most popular used approach is the aggregate expenditure approach, which embodies a set of independent indicators to explain the differences in interregional tax revenue (Berry and Fording 1997; Gupta, 2007; Davoodi and Grigorian, 2007).

This paper uses Fenochietto and Pessino (2010, 2013), Mawejje and Sebudde (2019) and Piancastelli et al. (2020), stochastic frontier model, where T_{it} represents Tax Revenue and Y_{it} represents GDP to estimate the estimation of tax effort. The difference between the regression model and SFA is in the way the disturbance term is derived. In the regression model, the error term, which captures inefficiency and can be negative or positive, showing a state, can be deviated from the mean of the estimated revenue by underperforming or over performing. In the SFA analysis, the non-negative factor of the error term guarantees that a unit can accomplish optimal output at maximum, and the actual revenue cannot exceed the potential revenue (Fenochietto and Pessino, 2010; Cyan, Martinez-Vazquez and Vulovic 2013). Tax effort is the ratio of actual tax collection to national income.

$$\frac{T_{it}}{Y_{it}} = \alpha_0 + \beta x'_{it} + \varepsilon_{it} \quad (1)$$

Where x_{it} is the vector of all explanatory indicators used in empirical analysis going forward, as stated in the equation below, and ε_{it} is the error term.

4.1 Stochastic Frontier approach to tax effort and tax capacity (a brief background)

The stochastic frontier paradigm redefines the traditional production function by considering optimal allocation in production as a testable limitation (Sickles and Zelenyuk, 2019). Aigner, Lovell, and Schmidt (1977) introduced the production stochastic frontier model, but its applications vary depending on the assumptions about the inefficient and distribution terms. Schmidt and Sickles (1984) highlighted shortcomings of the cross-sectional stochastic frontier, including the lack of a reliable estimator for efficiency and the need for parametric assumptions. To address this, Schmidt and Sickles (1984) extended the model to a panel data framework, and

later made time-variant by Cornwell et al. (1990) while avoiding the violation of distributional assumptions.

Kumbhakar (1990) and Battese and Coelli (1992) employed maximum likelihood to correct distribution assumptions. Greene (2005a, b), Chen et al. (2011), Colombi et al. (2014), Belotti, and Ilardi (2018) innovated on these models, differentiating unobserved individual differences from technical efficiency. Greene (2005a, b) proposed a panel data model, estimating it using fixed effects and distinguishing short-term inefficiency from unobserved individual heterogeneity. However, it only captures short-term inefficiency. Kumbhakar et al. (2014) and Colombi et al. (2014) extended Greene's model to account for persistent efficiency, linked to economic policy decisions, while transient efficiency relates to tax administration efficiency. These approaches address the issue of conflation between unobserved individual effects and technical inefficiency. The evolving models provide insights into production inefficiency, capturing both short-term and long-term factors shaping the firm's performance (Brun and Diakite, 2016).

Tax frontier estimation is the same as production frontier estimation, but with two key differences. While production involves labour and capital as inputs, tax estimation employs variables such as per capita GDP, public expenditure on education, remittances, and foreign direct investments. Ambiguity surrounds treating inflation, corruption, and voice accountability as input. Unlike production, where the difference from the frontier signifies inefficiency, in tax estimation, the gap between actual revenue and tax capacity denotes technical and policy related inefficiencies. The stochastic frontier tax function extends regression models based on production functions. It incorporates GDP per capita, education and institutions in the estimation of tax effort. A stochastic panel approach addresses challenges encountered in the normal panel data (Kumbhakar et al., 2014; Wang, 2002) while incorporating institutional aspects as discussed by Alesina et al. (2003) and La Porta et al. (1999). Notably, the SFA enables one to estimate both persistent and transient efficiencies in tax effort estimation, a feature absent in prior approaches.

4.2 Stochastic frontier models with corruption control, voice accountability and inflation as determinants of inefficiency.

The stochastic frontier model's versatility allows the study of drivers of technical inefficiency. This study incorporates exogenous factors like inflation and institutional variables (corruption and voice accountability) into the model, recognising their impact on tax revenue. This extension

introduces a parametric inefficiency distribution linked to exogenous indicators' pre-truncated average and variance. While Cornwell et al. (1990) consider efficiency determinants, issues arise in detecting both covariate effects on inefficiency and production levels in fixed effect models. Kumbhakar et al. (1991) nonlinearly model inefficiency causes, while Caudill et al. (1995) and Wang (2002) parameterize inefficiency variance. Alvarez et al. (2006) propose a scaling approach, to influence production unit efficiency. This paper applies similar innovations to tax mobilisation analysis, yielding uniform inefficiency distribution across units regulated by disturbance, with varying magnitude across units and time.

The Battese and Coelli (1995)'s 2-stage estimation approach is estimated in this paper. Where the first part comprises the determination of the stochastic tax frontier and estimation of technical inefficiency in tax collection relative to the maximum predicted tax collection. The inefficiency term is a linear function of a set of independent variables containing state characteristics. What sets the stochastic frontier paradigm apart from the standard average production model paradigm is its distinct, non-symmetrical dual-error structure that consists of a typical idiosyncratic error component, as well as an extra one-sided non-negative error element. The former addresses factors like measurement inaccuracies, model misrepresentations, and the stochastic nature of production. Meanwhile, the latter is intended to capture technical inefficiency, which leads to the reduction of actual output from its highest attainable level.

The distribution of the inefficient term is truncated normal by assumption. The stochastic frontier model for the panel is stated as follows:

$$Y_{it} = \exp\left(X_{it}\beta + v_{it} - u_{it}\right) \quad (2)$$

$v_{it} \sim N(0, \sigma_v^2)$ and $u_{it} \sim N(0, \sigma_u^2)$ and both are individually and independently identified.

Where Y_{it} captures the owner tax revenue for ith (i=1,2… N) state at tth (t=1, 2, 3... T) time; X_{it} is (1 x K) vector of values of function of indicators, which influences tax revenue and other independent variables, β is a (K x 1) vector of unknown parameters. Moreover, the disturbance term is disintegrated into two parts v_{it}, u_{it}, where u_{it} is the nonnegative error term, representing the time changing technical inefficiency term. u_{it} is attained by truncating the normal distribution with mean $Z_{it}\delta$ and variance σ^2. v_{it} is the statistical disturbance term with symmetric distribution, which could be negative or positive. Green (2003) argues that using a single sided error term equation makes the problem difficult to estimate. The theoretical problem is that any measurement error in the dependent variable must be embodied in the error term.

$Y_{it} = f\ (X_{it}\beta)$ captures the deterministic part of the frontier, where the addition of v_{it} disturbance term to make it the stochastic frontier, which means v_{it} captures the macroeconomic factors that are outside the state control. The gap of actual output from the optimal output is captured through u_{it} , termed as technical inefficiency. The inefficiency derived here is treated as an independent factor Q_{it}, which is specified as follows $u_{it} = Q_{it}\delta + C_{it}$.

Where C_{it} is a random variable, defined by the truncation of normal distribution with a mean of zero and variance σ^2. The underlying estimation method is the maximum likelihood technique. Technical efficiency of the i^{th}state at t^{th} time is termed as $e^{-u_{it}}$. The following hypotheses will be tested:

(i) Technical inefficiency term is not influenced by independent factors, hence $H_0: \delta = 0$

(ii) Technical inefficiency term is not random; hence $H_0: \lambda = 0.\ where\ \lambda = \frac{\sigma_u}{\sigma_v}$

The aim is to predict and measure inefficiency impacts. To achieve that, tax effort is defined as the ratio between actual tax revenue and the corresponding stochastic frontier tax revenue (tax capacity). This measure of tax effort has values between zero and one.

$$TE_{it} = \frac{\exp\ (\alpha + \beta^T x_{it} + v_{it} - u_{it})}{exp(\alpha + \beta^T x_{it} + v_{it})} = \exp\ (-u_{it})$$

$$x_{it} = f(TOP_{it}\ , GDPP_{it}\ , GDPP^2{}_{it}\ , POP_{it}, AID_{it},\ REMI_{it}, AGRI_{it}, COR_{it}, VA_{it}, MAN_{it}, DEBT_{it}, PE_{it}\ , IE_{it}, MI_{it},\ \ INF_{it}) \quad (3)$$

$TE_{it} = \frac{T_{it}}{GDP_{it}}$ is total tax revenues collection as a percentage of GDP.

Thus, the estimated model is as follows:

$$\ln\left(\frac{T_{it}}{GDP_{it}}\right) = \alpha_0 + \alpha_1 lnTOP_{it} + \alpha_2 lnGDPP_{it} + \alpha_3 lnGDPP^2{}_{it} + \alpha_4 lnPOP_{it} + \alpha_5 lnAID_{it} + \alpha_6 lnREMI_{it} + \alpha_7 lnAGRI_{it} +$$

$$\alpha_8 lnCOR_{it} + \alpha_9 lnVA_{it} + \alpha_{10} lnMAN_{it} + \alpha_{11} lnDEBT_{it} + \alpha_{11}\ lnPE_{it} + \alpha_{12}\ lnIE_{it} + \alpha_{13}\ lnMI_{it} + \alpha_{14}\ lnINF_{it} + \varepsilon_t \quad (4)$$

After estimating the parameter of the model, the expected level of technical inefficiency is obtained by computing $E[u] = \sqrt{\frac{2}{\pi\sigma_u}}$, subsequently, the expected level of efficiency is given by $E[e^{-u}] \approx 1 - E[u]$. Table 2 lists the variables used in equation (4).

Table 2. Description of model variables

Variable	Definition	Source
Dependent variable		
lnTTAX	Total tax revenues as % of GDP	World Bank (WDI)
Independent variables		
lnTOP	Trade openness (average of import and exports)	World Bank (WDI)
lnAGRI	Agricultural output as % of GDP	World Bank (WDI)
lnINF	Consumer price index	World Bank (WDI)
lnPOP	total population of people of age between age 15-64	World Bank (WDI)
lnVA	Voice accountability	World Bank (WDI)
lnCOR	Corruption control	World Bank (WDI)
lnGDPP	Per capita income as % of GDP	World Bank (WDI)
lnGDPP2	Square of per capita income as % of GDP	World Bank (WDI)
lnMAN	Manufacturing output as % of GDP	World Bank (WDI)
lnREMI	Remittances inflows (total in US $)	World Bank (WDI)
lnDEBT	Total external debt as % of GDP	World Bank (WDI)
lnAID	Total foreign donor assistance as % of GDP	World Bank (WDI)
lnPE	Total public expenditure in education as % of GDP	World Bank (WDI)
lnFDI	total foreign direct investment as % of GDP	World Bank (WDI)
lnIE/lnDGE	Informal sector index (MIMIC/DGE)	World Bank (WDI)
lnMI	Mineral rents as % of GDP	World Bank (WDI)

5. Results discussion

Table 2 provides a snapshot of the data used for empirical analysis in this paper, which include the mean, standard deviation, maximum and minimum of the variables used. Some countries are not included in the estimation because of missing observations. As explained in the previous data section, all data is collected from the World Bank database (WDI). All values are in unit forms initially and tax revenue, whereas population is the number of individuals ages 15-64 in the respective countries. Trade openness is the sum of imports and exports for all countries in the study as a percentage of GDP. Agriculture is value added for all agricultural output as a percentage of GDP. Inflation is the annual inflation in percentage form. The corruption index is the institutional proxy, which takes values of -2.5 for the lowest, and 2.5 for the highest. Similarly, voice accountability is an index, which has the same values as the corruption index. Before taking the logarithm of both institutional variables, a value of 2.5 is added to it and divided by 5.This correct

for some values becoming zero or undefined when the logs is applied. Remittance is personal remittances flow in US dollars.

All variables are transformed in log form before estimating the results. The data is collected from 2000 to 2021. Most countries have no observation for many variables before the year 2000. The average tax revenue as a percentage of GDP is 2.82 percent, while agriculture as a percentage of GDP is 2.403 per cent. The corruption control per average is -0.85 units. Trade openness is 3.58 percent per average and the population is 16.18 percent. All variables have a standard deviation below their mean. Tax, population, corruption, voice accountability, debt and foreign aid are negatively skewed. However, trade openness, inflation, per capita, manufacturing and remittances are positively skewed. In terms of kurtosis, trade openness, population, corruption index, per capita GDP, manufacturing, and public expenditure on education are all normally distributed. Tax, inflation, remittances, and aid have thick tails. Their distributions are peaked. Agriculture, per capita and voice accountability have a flat distribution with thin tails.

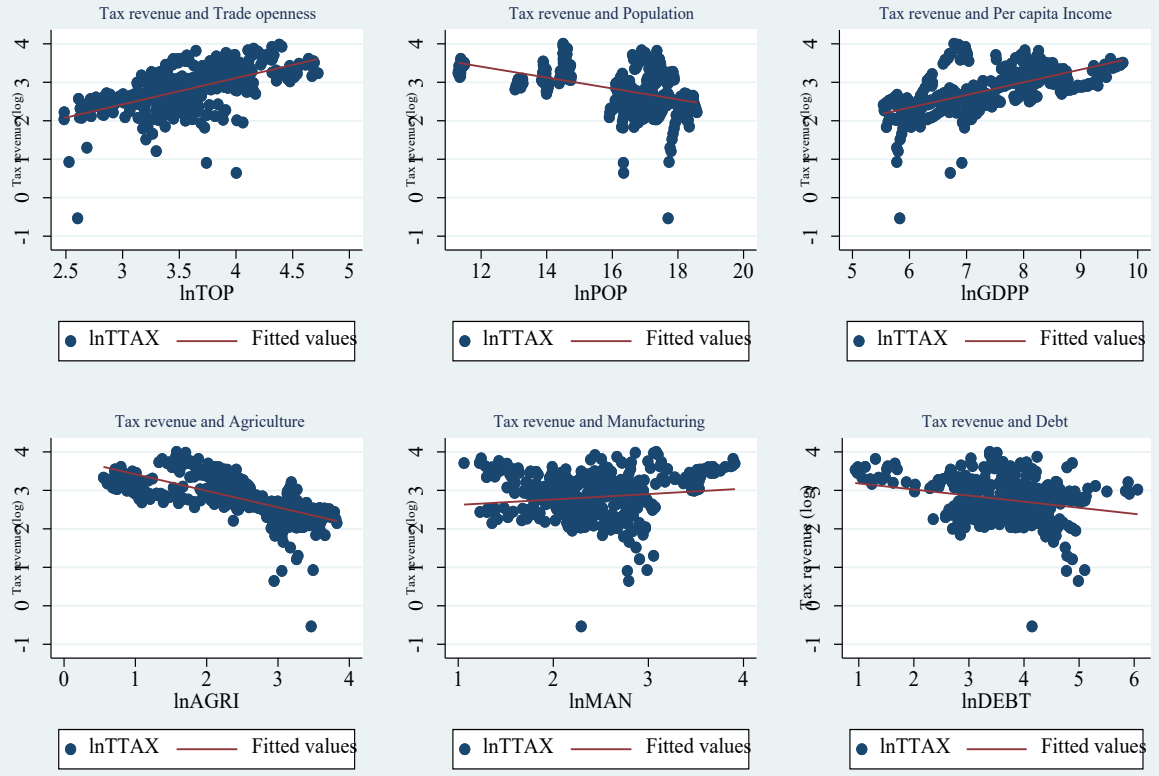
Table 3. Descriptive statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max	p1	p99	Skew.	Kurt.
lnTTAX	513	2.816	.533	-.535	4.003	1.301	3.875	-.748	6.074
lnTOP	510	3.581	.445	2.484	4.723	2.611	4.655	.042	2.875
lnAGRI	549	2.403	.846	.543	3.826	.656	3.746	-.484	2.298
lnINF	507	1.88	1.138	-2.891	7.875	-1.001	5.283	.152	6.023
lnPOP	550	16.182	1.731	11.304	18.605	11.335	18.499	-1.003	3.372
lnVA	525	-.902	.366	-1.802	-.362	-1.649	-.37	-.375	1.892
lnCOR	525	-.854	.298	-1.578	-.19	-1.532	-.312	-.364	2.643
lnGDPP	550	7.442	1.019	5.542	9.74	5.607	9.652	.045	2.106
lnGDPP2	550	56.418	15.246	30.71	94.877	31.437	93.159	.274	2.288
lnMAN	540	2.44	.523	1.061	3.91	1.298	3.758	.184	3.079
lnREMI	492	17.827	1.56	12.552	21.734	13.342	21.161	.179	3.068
lnDEBT	506	3.634	.83	.937	6.063	1.187	5.843	-.467	4.199
lnAID	546	20.054	1.43	10.82	22.778	16.243	22.33	-1.145	5.837
lnPE	402	1.544	.398	.095	2.582	.434	2.408	-.409	3.521
lnFDI	525	.91	1.066	-3.198	4.058	-1.898	3.266	-.43	3.844
lnIE	456	3.627	.221	3.057	4.148	3.067	4.117	-.037	3.274
lnMI	375	3.211	2.504	-4.92	7.313	-3.402	7.097	-.694	2.703

Table 2 provide descriptions of all the variables in the sample.

Figure 1, shows that tax revenue is positively correlated with trade openness, per capita GDP, and manufacturing, while population, agriculture and debt are negatively correlated with tax revenue as percentage of GDP. There are notable outliers in the all variables plots.

Figure 1:Tax revenues against other variables



Data Source:WDI, Author's own compilation

Figure 2, indicates that there is a positive relationship between tax revenue and foreign direct investment, expenditure on education, remittances, and mineral rent. Similarly, foreign aid, and the informal economy index are all negatively correlated with tax revenue.

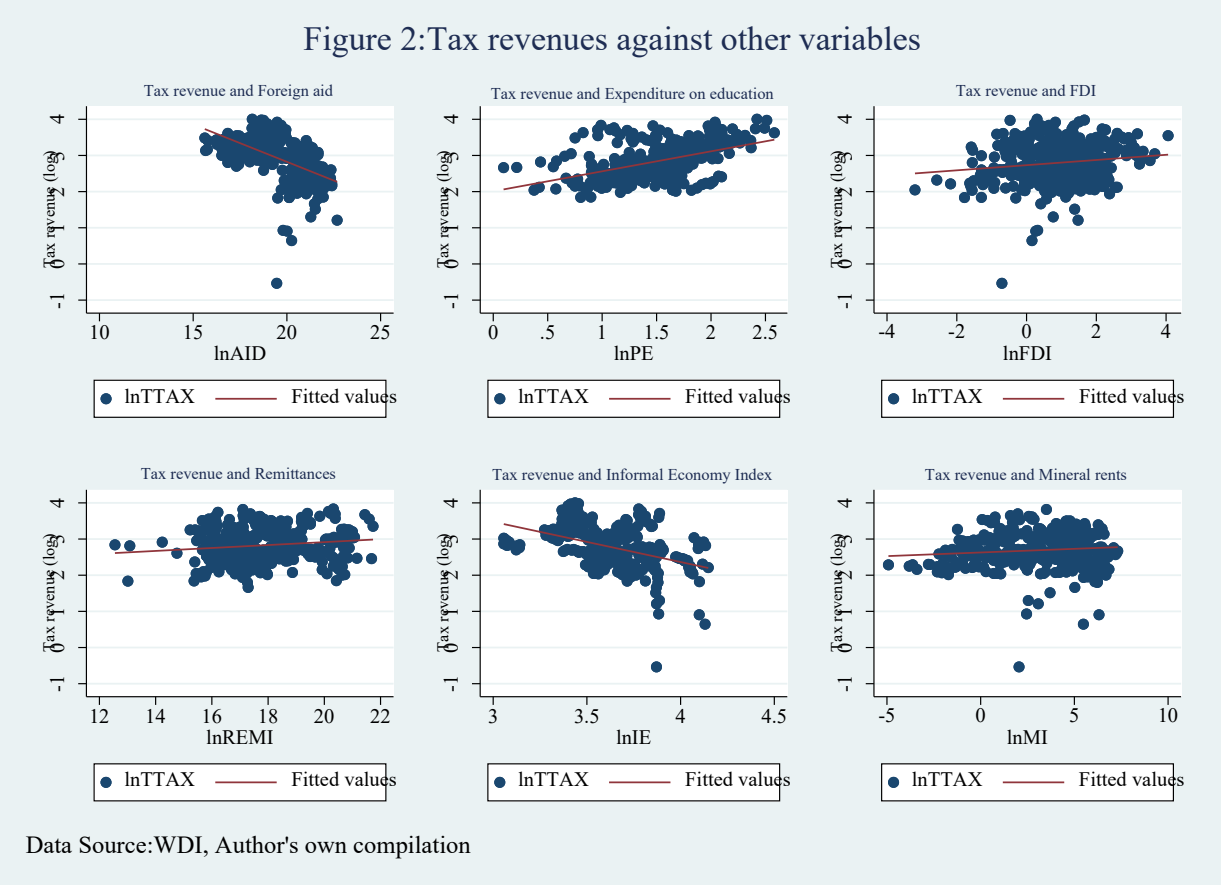


Figure 1. Tax revenues plot against other variables

Table 4, provides a pairwise correlation of all variables. Tax is positively correlated with trade openness, voice accountability, corruption index, per capita GDP, and its square, manufacturing, remittances, and public spending on education. Agriculture, inflation, population, debt, and aid are all negatively correlated with tax revenues. Notably, Trade openness, agriculture, per capita GDP and its square and aid are highly correlated with tax with a value above 0.50. The log of per capita GDP is negatively correlated with agriculture. Similarly, agriculture is highly correlated with the square of the log of per capita GDP. The log of per capita GDP is also highly correlated with the log of population and foreign aid.

Table 4. Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
(1) lnTTAX	1.000																
(2) lnTOP	0.574*	1.000															
(3) lnAGRI	-0.683*	-0.567*	1.000														
(4) lnINF	-0.222*	-0.121*	0.186*	1.000													
(5) lnPOP	-0.464*	-0.737*	0.558*	0.225*	1.000												
(6) lnVA	0.203*	0.297*	-0.406*	-0.170*	-0.386*	1.000											
(7) lnCOR	0.386*	0.365*	-0.463*	-0.316*	-0.633*	0.612*	1.000										
(8) lnGDPP	0.633*	0.510*	-0.819*	-0.265*	-0.510*	0.320*	0.495*	1.000									
(9) lnGDPP2	0.621*	0.519*	-0.824*	-0.262*	-0.530*	0.329*	0.506*	0.997*	1.000								
(10) lnMAN	0.140*	-0.010	-0.061	-0.094	0.030	-0.170*	-0.050	0.141*	0.129*	1.000							
(11) lnREMI	0.140*	-0.139*	-0.284*	-0.020	0.321*	0.025	-0.141*	0.205*	0.199*	-0.053	1.000						
(12) lnDEBT	-0.244*	0.095	0.175*	0.000	-0.061	0.108	-0.114	-0.257*	-0.257*	-0.223*	-0.106	1.000					
(13) lnAID	-0.538*	-0.669*	0.631*	0.133*	0.828*	-0.223*	-0.467*	-0.613*	-0.631*	-0.124*	0.144*	0.180*	1.000				
(14) lnPE	0.480*	0.256*	-0.254*	-0.207*	-0.268*	0.202*	0.368*	0.264*	0.248*	0.200*	-0.200*	-0.097	-0.242*	1.000			
(15) lnFDI	0.138*	0.397*	-0.065	-0.008	-0.245*	0.175*	0.185*	0.040	0.051	-0.271*	0.064	0.222*	-0.069	-0.062	1.000		
(16) lnIE	-0.448*	-0.283*	0.509*	0.176*	0.310*	-0.462*	-0.580*	-0.565*	-0.589*	-0.166*	-0.038	0.228*	0.398*	-0.354*	0.059	1.000	
(17) lnMI	0.100	0.305*	-0.307*	0.012	-0.076	0.076	0.054	0.260*	0.251*	-0.046	0.342*	-0.082	-0.007	-0.022	0.213*	0.189*	1.000

**** p<0.01, ** p<0.05, * p<0.1.* Table 2 provide descriptions of all the variables in the sample.

The results for the tax frontier are shown in Table 5. All coefficients have the anticipated signs in the 4 models and many of them are statistically significant. The results indicate that nations operating in proximity to their tax frontier tend to have elevated income levels than others. The per capita income variable which proxy for the level of development and hence a potentially higher tax base is positive and statistically significant, corroborating the assumption that tax effort rises with level of development (Bird, 1976; Castro and Camarillo, 2014). For each one percent increase in per capita, tax revenue will increase by 2.95, 3.96, 3.05 and 3.93 percent respectively Steenekamp (2007). According to (Besley and Persson, 2013), the degree of development plays a pivotal role in enabling governments to generate sufficient revenue for funding public expenditures, given that increasing per capita income often stimulates urbanisation and the non-agricultural sector. This implies that, the more the country develops, a larger share of activities fall in the formal sector, increasing the potential taxable base of the economy. This finding is consistent with the greater part of the empirical evidence on the determinants of tax revenue performance (Lotz and Morss, 1967; Coulibaly and Gandhi, 2018; Terefe and Teera, 2018). When one control for the nonlinearity nature of per capita GDP by including per capital income squared, the variable is negative, suggesting that the nonlinear association between per capita GDP and tax effort exists. This means that, there is an inflection point in terms of the impact per capita GDP has on tax effort, thus there is an optimal point where per capita income becomes ineffective in tax mobilisation efforts. For every one percent increase in the square of per capita, tax revenues decline by 0.19, 0.27, 0.20, and 0.25 percent. These results are in line with, among others, those of Fenochietto and Pessino (2013), and Langford and Ohlenburg (2016), Mawejje et al. (2019), who find similar non-linear influence of per capita income.

Concerning structural variables and sector structure of GDP, results suggest that countries that have a big share of agricultural GDP tend to have a lower tax potential. The agriculture variable has the expected sign and is highly significant. For many countries, prevalence of the agricultural sector is linked with informality, low income, and low productivity, making taxation difficult for those countries (, Gupta, 2007; Mawejje and Munyambonera, 2016). For each one percent increase in agriculture value added (lnAGRI), tax revenues (lnTAX) will decrease by 0.10 percent. Lack of robust infrastructure for tax collection and agriculture subsidies can be attributed to the negative sign between agricultural output and tax revenue. Moreover, countries that operate far below their tax frontier have a larger share of the agricultural sector as a share of GDP (see

Mkandawire, 2010; Chelliah, Baas and Kelly, 1975; Atsan, 2017 and Terefe and Teera 2018). This means that countries whose agricultural sector is large are likely to struggle in mobilising sufficient tax revenues. Edward and Tabellini (1991), argue that countries with a large agricultural sector are more prone to tax evasion in comparison to those in the manufacturing sector. The difficulty of rebating tax from the agricultural sector is observed in every model estimated. However, agriculture is only negative and statistically significant in three models.

Results show that public expenditure in education is negatively associated with higher tax effort. The coefficient on public education spending is negative for all estimation techniques and statistically insignificant. These results are inconsistent with other studies which showed that expenditure on human capital enhances productivity and therefore results in a country having a higher level of tax effort (Fenochietto and Pessino, 2013; Langford and Ohlenburg, 2015,2016; Mawejje and Sebudde, 2019). In addition, a direct effect of higher education levels may be to raise citizens' appreciation of how and why to pay taxes. This finding could be a signal of a weak social contract dynamic between the government and the people where progress in social sector spending is expected to result in better compliance attitudes as argued by (Ali et al., 2014).

In case of trade openness, which also captures the extent of the country's development. The more developed a country, the more it trades with the rest of the world and the more likely it is to generate more tax revenues than other surrounding countries which are close (Coulibaly and Gandhi, 2018; Terefe and Teera, 2018). The coefficient on trade openness is positive in all models and statistically significant. For every one-percentage increase in trade openness, tax revenues will increase by 0.23, 0.21, 0.23 and 0.35 percent respectively. The results show that countries whose a large share of the economic is in export and imports, tend to have a higher tax effort. Rasheed (2006) results corroborate these findings for Pakistan data as well. The results are consistent with previous studies such as those of (Gupta, 2007; Le et al., 2012; Mawejje and Sebudde, 2019).

In case of manufacturing, the results show that manufacturing is positively associated with higher tax potential for only one model (column 4) in table 4. Every one percent increase in manufacturing led to a 0.13 increase in tax revenues. Simbachawene (2018) finds similar results for manufacturing in the study of determinants of tax revenue in Tanzania. In addition, Ahmed et al. (2010), find similar results in their study of tax buoyancy of developing countries. The importance of manufacturing's contribution to the GDP reflects the common significance observed in sectoral share variables. This likely encompasses various pertinent factors that influence tax

collection. It points towards more concentrated, intricate, and organized business activities that are better suited for effective tax collection, as suggested by Langford and Ohlenburg (2015). For the other 3 models, the results show a negative association between manufacturing and tax frontier, but not significant results. This could be ascribed to tax evasion, tax grace and tax collection costs, which are prevalent in developing countries (Edwards and Tabellini, 1991; Feger, 2014). Most developing countries tend to grant tax exemptions to foreign investors in order to attract capital inflow and it is likely to an adverse impact on tax revenue collection (Simbachawene, 2018).

The results also show that many countries still have underdeveloped financial sectors. The informal sector is negatively associated with the tax effort. For every one percent increase in informal sector, tax revenue decreases by 0.70, 1.40, 0.78 and 1.06 percent respectively. These results are in line with those of (Berdiev and Saunoris, 2016) who argue that a less developed financial sector is negatively associated with a shadow economy, which implies that with a larger informal economy, it is hard to administer taxes, and therefore it provides potential negative effects for tax revenue mobilisation. Moreover, studies by (Beck et al., 2014; Alm et al., 2018) show that financial constraints are associated with the informal economy. The policy implication here is that, the pervasiveness of the informal sector tends to undermine the social contract between the public and the state, and that such countries characterised by a larger informal sector will struggle to build their fiscal space given the significant size of the informal sector in their economy.

The measure of donor assistance is positively related with tax revenue performance across all models. For every one percent increase in foreign aid, tax revenue increases by 0.06, 0.11, 0.06 and 0.63 percent. This implies that donors aid stimulates consumption and productivity and therefore, it is likely to increase government tax revenues. These results are in line with previous studies, shows that higher donor assistance stimulates development and therefore, broadens the tax base of the country. (Ayenew, 2016) finds similar results in a time series study of Ethiopian tax mobilization. However, literature such as those of Clements et al. (2003) and Benedek et al. (2014) argue that countries, which rely on aid assistance, tend to face different incentives in collecting their taxes compares to those that receive little or no aid. Some countries will have little to no incentives since they have aid support. (Boukbech et al., 2018, Terefe, and Teera, 2018) assert that foreign aid can be a deterrent to tax collection efforts and therefore likely to affect tax revenue collection efforts adversely. Potential negative influence for the over reliance on aid as a source of revenue includes Dutch disease and conditionality. This could undermine state accountability and

state-public relations. Morrissey (2015) highlights the ongoing debate about the association between grants and tax revenues. Earlier studies show that grants tend to crowd out tax revenue collection (Benedek et al., 2014). Yet, recent literature has challenged Benedek et al. (2014) assertion, providing evidence that grants have a positive impact on tax collection (see Clist and Morrissey, 2011; Mascagni, 2016; Clist, 2016), and that grants support enhances efficiency reforms that foster higher tax revenue effort.

With regards to foreign direct investment flows into the country, the results shows that FDI is related, with higher tax potential on the three models. For every one percent increase in the FDI flow, tax revenue increases by 0.04 percent based on the three models (column, 1, 2 and 3) in table 4. The increase in financial flows can result in an increase in economic productivity through investments. The findings of Ndiaye and Korsu (2014), Langford, and Ohlenburg (2015) align with this outcome, underscoring financial deepening as a pivotal catalyst for tax revenue. A well-established financial sector facilitates the influx of credit into productive endeavours, consequently elevating both business and individual income. This phenomenon contributes to the expansion of the tax base. Within this context, Ndiaye and Korsu (2014) propose that augmenting the level of monetization simplifies tax collection and augments tax revenue. Bayu (2015) finds the negative relationship between manufacturing and tax revenue in Ethiopia, contrary to the finding for this paper. Moreover, Ade et al. (2018) find that the FDI is positive and significant in determining tax revenue in SADC countries for the period of 1990-2010, which is consistent with this paper's findings. These results support Wood (2008) findings, who proposed a novel way to increase tax revenues by coupling international aid to tax effort. He proposed that for each dollar raised in taxes, donors would collectively agree to give fifty cents extra in aid up to a fifty percent upper limit of the ratio of aid to taxation. This would provide a strong incentive for countries with an aid to tax ratio below that limit to mobilise more taxation.

The results show that corruption is negatively associated with tax revenue performance in the model, which includes it as a constitutional quality proxy. The coefficient of corruption is only negative and significant for one model (column 4) in Table 4, where for every one percent increase in corruption events in a country, tax revenue decreases by 0.28 percent. This result is consistent with literature showing that the quality of institutions, corruption and voice accountability are important predictors of tax effort. (Langford and Ohlenburg, 2015; Baum et al., 2017; Bird et al., 2008) argue that corruption and bribery are negatively associated with tax revenue performance.

The outcome presented by (Tanzi and Davoodi, 1997 and Ayenew, 2016) supports the idea that the quantity of institutions plays a crucial role in the facilitation of tax collection. This is in line with the findings of the current study, particularly concerning aspects such as voice accountability and corruption control. Moreover, Cukierman el at. (1989) and Langford and Ohlenburg (2015) emphasize the role of political system in tax mobilization challenges faced by different countries. In case of voice accountability, the coefficient is positive but not significant for all models considered.

The results are mixed in terms of inflation. The signs are positive and negative across the four models. However, all the coefficients are statistically insignificant. Tanzi (1997) asserts that policy reform put forward to lower inflation and therefore, foster structural reforms, are often met with resistance from the government because the state stands to lose seigniorage revenues. This could explain the insignificance of inflation in explaining tax revenue. However, the small and negative coefficient associated with inflation implying that a significant increase in the consumer price index (CPI), indicative of macroeconomic instability hinders the ability to generate tax revenue. These results are inconsistent with those of Langford and Ohlenburg (2016) who shows that inflation is negatively associated with poor tax performance.

In term of population, the results show that population is negatively associated with the tax frontier. However, despite all coefficient being negative, only one of them is statistically significant, column 2. For every one percent increase in population, tax revenue will decrease by 0.24 percent. Aizenman and Jinjarak (2009) argue that the probable consequence of an increased population may explain the negative correlation between population density and the easiness of tax collection.

When considering the influence of personal remittances flows on the tax frontier, the results have the correct signs, but they are only statistically significant for one model. A one percent increase in remittances flows will result in a 0.02 percent increase in tax revenues. The implication of this result is that a country can take advantage of remittance inflows by forming policies, which provide incentives for people to remit more. Pasara and Zuze (2021) find that the share of remittance flows significantly influences income tax revenues in Zimbabwe. They assert that increase in remittance inflows have a potential to generate more taxes through income and consumption tax. Ebeke (2021) finds remittances significantly increase both the level and the

stability of government tax revenue ratio in recipient countries with a VAT system in place, for developing countries' data.

The results show that, external debt is negatively associated with tax revenue under two considerations, and positively associated with other considerations. However, the coefficients are all statistically insignificant for all models. The results are consistent with those of Gupta et al. (2022) who assert that central government debt has a negative influence on tax buoyancy, even though it is not statistically significant in this instance.

In the case of mineral rents, the coefficient is positive and statistically significant, when voice accountability is used as an institutional proxy. However, when corruption is used instead, the result is insignificant. For every one percent increase in mineral rent, tax revenues increase by 0.10 percent. However, mineral rent as a source of tax revenue is susceptible to price volatility, term of trade, Dutch diseases and limited incentives for skills investment and education (Bornhorst et al., 2009). Countries, which rely on mineral rent as a source of revenue, are faced with problems such as rent seeking behaviour corruption, either political elites or foreign investors capture often majority of revenue from mineral resources, and they are likely not to contribute substantially to the tax base of the country Langford and Ohlenburg (2015).

Regarding sensitivity tests for model inefficiency, the value of mu (μ) is statistically different from zero. This suggests that the presumed truncated normal distribution for inefficiency is suitable for models 1, 2 and 3. The sigma value, indicating the average total variation across time in the model, is statistically significant. This indicates that there is ample variation in the tax performance variable throughout the sample period for the three models (columns 1, 2 and 3). The gamma coefficient, larger and statistically significant, differs from zero. This demonstrates that an array of inputs into the model is responsible for a significant portion of the overall variance in tax revenue performance. The eta coefficient is positive and significant, implying that the inefficiencies in tax mobilization tend to increase over time.

Table 5. Tax Revenue stochastic frontier (Battese and Coelli, 1992)

	model1	model2	model3	model4
Trade Openness	0.232***	0.210***	0.227***	0.345***
	(4.36)	(3.94)	(4.06)	(6.20)
Agriculture	-0.0989*	-0.0911*	-0.0917*	0.0135
	(-1.83)	(-1.84)	(-1.62)	(0.32)
Population	-0.0772	-0.236**	-0.0942	-0.0608
	(-1.47)	(-3.22)	(-1.89)	(-1.94)
GDP per capita	2.948***	3.964***	3.048***	3.933***
	(6.11)	(6.68)	(6.33)	(5.72)
Sq. GDP per capita	-0.191***	-0.270***	-0.197***	-0.250***
	(-5.89)	(-6.61)	(-6.05)	(-5.54)
Manufacturing	-0.0555	-0.0589	-0.0439	0.125**
	(-1.08)	(-0.95)	(-0.79)	(2.78)
Personal remittances	0.0200*	0.0171	0.0180	-0.00259
	(2.11)	(1.78)	(1.83)	(-0.26)
External debt stocks	-0.0282	0.0214	-0.0301	0.00273
	(-1.46)	(1.12)	(-1.57)	(0.15)
Net official development assistance	0.0605**	0.110***	0.0600**	0.0625**
	(3.06)	(4.89)	(2.99)	(2.83)
Government expenditure on education	-0.0108	-0.0446	-0.00285	-0.000281
	(-0.29)	(-1.25)	(-0.07)	(-0.01)
Foreign direct investment	0.0389***	0.0372***	0.0386**	0.0204
	(3.35)	(3.32)	(3.25)	(1.64)
Informal Economy Index(MIMIC)	-0.699*	-1.377***	-0.782**	-1.057***
	(-2.48)	(-4.50)	(-2.76)	(-7.44)
Inflation	0.0111	-0.00256	0.0104	-0.00496
	(1.15)	(-0.29)	(1.08)	(-0.52)
Voice and Accountability	0.0520	0.0947		
	(0.81)	(1.61)		
Mineral rents		0.0131*		-0.00136
		(2.11)		(-0.20)
Control of Corruption			-0.165	-0.278**
			(-1.57)	(-3.24)
Constant	-5.824*	-4.520	-5.914**	-10.33***
	(-2.42)	(-1.66)	(-2.64)	(-4.03)
Inefficiency				
Sigma	-2.406***	-2.187***	-2.543***	-0.162
	(-6.44)	(-5.56)	(-7.12)	(-0.03)
Gamma	2.047***	2.670***	1.884***	4.578
	(4.58)	(5.93)	(4.35)	(0.92)
mu	0.647***	0.953***	0.579***	-3.045
	(4.22)	(5.08)	(3.44)	(-0.17)
eta	0.0103*	0.00736**	0.0112*	0.0250***
	(2.45)	(2.61)	(2.29)	(3.82)
Observations	225	182	225	182

t statistics in parentheses. $^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$: Source: author self-computed.

Table 6 shows the tax effort, tax revenue, tax potential and per capita GDP for all countries included in the sample. The largest average tax potential for the sample is 55.02 percentage points

of GDP against the average tax revenue of 22.74 percent for South Africa. The lowest average tax potential is 8.56 percentage points of GDP against 6.86 percent for DRC. The results show larger disparities between tax revenues and tax potentials across countries. Despite a substantial heretogeneity in individual countries' outcomes, the results show that countries that operate closer to their tax frontier have higher income levels (Algeria, Angola, Cabo Verde, Mauritius, Seychelles and Namibia). Lesotho and Malawi tax frontier is closer to one, but have very lower levels of income. Countries with lower income level are associated with lower tax revenues (Bornhorst et al., 2009; Crivelli and Gupta, 2014, Mawejje, 2019).

Total tax revenue as a percent of GDP is the highest in Lesotho (42.9), Algeria (33.5), Angola (31.3), Seychelles (29.2), Namibia (28.7), Eswatini (25.9), Botswana (24.7), South Africa (22.7), Morocco (21.7), and Tunisia (20.8). Congo DRC (6.90) and Madagascar (8.90) have the lowest total tax revenue. Tax effort is highest in Angola, Cabo Verde, Lesotho, Mauritius, Namibia and Malawi all with 0.98. The lowest tax effort is South Africa (0.41), Tunisia (0.48), Zambia (0.44) and Kenya (0.38). No country has tax effort above one, thus we can conclude that all countries are below their tax potential. A tax effort above one means that countries are collecting tax revenue above their target, while those below one still have scope to strengthen their tax collection, since their collection effort is below capacity. The results are consistent with those found by (Gupta, 2000; Mawejje et al., 2019; Piancastelli et al., 2020). These findings contradict the findings of Leuthold (1991) study concerning Senegal having low a tax effort. Besides, economic, demographic, social and institutions issues, differences in tax effort reflect country specific policy choices. South Africa for example has a high income and robust institutions, but has an estimated tax effort of 0.41. At the same time, Malawi with a very low-income level of $338 is operating closer to its tax frontier of 0.98. A possible explanation for these tax performance variations could be that tax mix varies a lot across countries. Overall, tax capacity and tax effort appears to have substantial power in explaining the variation in tax revenue trends in different African economies.

Even though many countries have tax effort below one for an extended period, it cannot be said exhaustively that the cause is due to poor tax collection, other attributes such as business cyclicality can be the cause of under-capacity and not poor collection mechanism. Furthermore, it can only be said firmly that tax effort has been below capacity for the period, but further investigation is required to discern the source of such variation in tax effort from year to year. The variation can either be due to tax rate change year-to-year to conform to national average rates for

that year or a mere increase in tax base for that year. Both the tax effort and tax capacity index are comparable over time only to the extent that a change in the index between two periods indicates that a country tax capacity (effort) relative to the national average has change between those periods.

Table 6. Estimates of Tax potential and tax effort

Country	Tax effort	Tax revenue	Potential	Per Capita GDP
Algeria	0.969	33.481	34.542	3857.020
Angola	0.984	31.333	31.835	2631.811
Botswana	0.673	24.706	36.709	5709.084
Cabo Verde	0.984	19.357	19.668	2664.488
Congo, Dem. Rep.	0.801	6.859	8.561	410.745
Egypt, Arab Rep.	0.528	13.511	25.602	3165.632
Eswatini	0.915	25.867	28.284	3194.235
Ethiopia	0.710	11.026	15.535	494.604
Ghana	0.550	10.044	18.266	1475.808
Kenya	0.380	11.964	31.466	1381.780
Lesotho	0.984	42.859	43.546	958.132
Madagascar	0.687	8.917	12.971	460.279
Malawi	0.984	11.633	11.820	338.928
Mauritius	0.984	17.777	18.062	8122.833
Morocco	0.766	21.731	28.377	2523.874
Mozambique	0.615	14.744	23.970	484.614
Namibia	0.984	28.732	29.193	4108.955
Rwanda	0.656	12.394	18.884	604.686
Senegal	0.543	14.797	27.257	1205.700
Seychelles	0.984	29.239	29.708	13352.580
South Africa	0.413	22.743	55.021	5795.531
Tanzania	0.577	10.506	18.211	810.645
Tunisia	0.479	20.831	43.459	3614.624
Zambia	0.435	14.821	34.069	1127.139
Zimbabwe	0.817	13.438	16.444	1289.139

Source: author self-computed

In summary, these findings validate prior analyses by confirming a notable and meaningful correlation between tax revenue as a percentage of GDP and informality. These findings underscore the importance of African countries persisting with tax reform efforts to enhance the adaptability of their systems to changes in income levels. Nevertheless, mainly, developing countries will gain substantially if they can transform a larger share of their economy from informal to formal, which is easy to tax. At the same time, policymakers in Africa need to

supplement their endeavours to boost tax revenue with initiatives aimed at enhancing the quality of expenditures.

5.1 Robust check

Table 9 in the annexure, presents other Driscoll and Kraay model (DK), fixed effect model and system GMM estimations. From the outset, assumption that the error terms of a panel model are cross-sectional independent is usually not appropriate (Pesaran, 2004). Countries share some form of mutual dependence between the cross-sectional units, for example imports and exports. Ordinarily, covariance matrix estimators do not control for cross sectional dependency. Mistakenly overlooking cross sectional correlation in the estimation of panel can result in severely biased statistical inference. To ensure the credibility of the results, the Driscoll and Kraay (DK) panel regression method refines the standard error estimation for coefficient estimates to account for possible residual interdependence. This refinement involves applying a New-West type correction to the series of cross-sectional averages of the moment conditions. By modifying the disturbance term in this manner, the consistency of the covariance matrix estimator is preserved, regardless of the cross-sectional dimension. DK introduces a nonparametric covariance matrix estimator that yields standard errors resilient to various form of spatial and temporary dependence, making them robust and appropriate for heteroscedasticity. When Driscoll and Kraay (1998) estimated a method which controls for heteroscedasticity, autocorrelation with MA(q) and cross sectional dependency, this study conclude that Agriculture, population, manufacturing, foreign direct investment, public spending on education, corruption, voice accountability, informal economy, mineral rent, and inflation were all significant and maintain the anticipated sign.

Estimating using fixed effects is similar to DK model for certain indicators, with exception to trade openness, per capita income, square of per capita income, remittances, external donor assistance, foreign direct investment, the informal economy, and mineral rents which are all-significant and have the expected sign. However, public spending on education becomes negative under this specification. Moreover, voice accountability becomes positive as well contrary to the DK model and the theory expectation. The system GMM model, which deals with the endogeneity problem, does perform poorly for this dataset. Only trade openness is positive and significant in explaining the tax revenue.

To test heteroscedasticity, Breusch-Pagan/Cook-Wesberg test is performed, which gives the

chi (2) of 2.20, and probability of 0.138, hence we reject the null hypothesis of constant variance in error term and conclude the presence of heteroscedasticity in the model. To check multicollinearity test, variance inflation for all variables are below 5, with exception to per capita income and the square of per capita income which are highly correlated. To test for auto correlation in panel data, Woodridge test is used, which gives a F-value of 18.06, with a p-value of 0.005, therefore we reject the null hypothesis and conclude that, there is autocorrelation in the panel sample.

Table 7, where χ^2 value and p-value for the test indicates that the error term is overall not normally distributed, that is both Kurtosis and Skewness are those of the normal distribution. The findings of the test strongly rejects that the residuals have a skewness of zero and a kurtosis of three, respectively. Therefore, the hypothesis that both skewness and kurtosis jointly have a normal distribution is rejected.

Table 7.Normality test

Skewness and Kurtosis tests for Normality					
Joint					
Indicator	Observations	Pr(Skewness)	Pr(Kurtosis)	Adj chi (2)	Prob (chi2)
residuals	201	0.0771	0.9836	3.16	0.2060

The Ramsey RESET test for omitted variables is performed, which gives an F-value of 10.21 with a probability of 0.000, therefore, the null hypothesis is rejected, and the model has omitted variables. The test results show that the chosen linear functional form model is an appropriate model. For model selection between fixed effect and Random Effect, the Hausman test is performed which gives a Chi (2) value of 23.16, with a probability of 0.04. The null hypothesis is reject and fixed effect is used for estimation.

Since the sample in this paper has a larger N and small T, to test whether the residuals are independent across cross-sections, the parametric technique proposed by Pesaran (2004) is performed. The test gives a value of -1.50 and a probability of 0.133, therefore, fails to reject the null of no cross-sectional dependence. A modified Wald test for group-wise heteroscedasticity in fixed effect is performed to test for presence of heteroscedasticity, the chi (2) value of 626.69 with a probability of 0.00 is found, therefore, the null hypothesis of no heteroscedasticity is rejected. Table 10 in the annexure, present results when the Dynamic General Equilibrium (DGE) is used

to proxy informality instead. The results shows that, DGE is a poor proxy for informality in the selected sample. All other variables maintain the expected sign and the level of significant as those obtained when MIMIC is used to proxy the informality.

6. Conclusion

Overall, the analysis suggests several conclusions. First, macroeconomic effect, demographic indicators, and institutional variables play an important role in determining tax revenue collection in selected African economies. Second, among the 4 regression analyses performed, the Informal economy, GDP per capita, trade, remittances, foreign aid flow, manufacturing, public spending in public education spending, foreign direct investment, population, voice accountability and corruption control are all statistically significant with the expected signs. All countries have tax effort below one, signifying room for improvement in tax mobilization in the respective countries. The robust test results collaborate those estimates in the paper. This finding suggests that improvement in governance; small share of informal sector, trade openness and manufacturing, foreign direct investments, remittances inflows, small share of agriculture sector are desirable tools in revenue mobilization in African economies. For the 25 years studied, most countries have had a tax effort below one for at least 5 years, which signal potential room for improvement. African countries will need to diversify away from the agricultural sector and the informal activities, which are the largest proportion of employment, but with less to no tax revenue potential. These findings are noteworthy, since their sample period starts from 2000 to 2021, which is outside the examined time span of previous, similar studies, and since majority of previous studies use OLS regression rather than stochastic panel data estimation, which is correct for major specification biases encountered in previous studies. The possible ways developing countries can increase their tax revenues is either by exploring new ways to tax new economic activities such digital economy, build capacity to be able to tax the informal sector. Invest more in building the capacity of tax authorities, both in tax collection, compliance, and governance. Ultimately, a salient characteristic of an effective tax system encompasses its capacity to generate sufficient government revenue at minimum cost.

For countries with tax effort less than unity, the policy implications are clear. Consorted efforts are needed to broaden the tax base, apply, and enforce rates of tax, which bring more stable revenues with the traditional tenets of taxation: administrative convenience, equity, and efficiency.

Furthermore, countries could put in place policies, which promote industrial development, which can results in growing manufacturing sector that is easy to tax. The future paper will explore the role electoral cycles plays in the dynamic of tax efforts in developing economies.

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Annexure

Table 8. List of countries in the study

1	Algeria	14	Egypt, Arab Rep.
2	Angola	15	Eswatini
3	Botswana	16	Ethiopia
4	Cabo Verde	17	Ghana
5	Congo, Dem. Rep.	18	Kenya
6	Lesotho	19	Madagascar
7	Malawi	20	Mauritius
8	Morocco	21	Mozambique
9	Namibia	22	Rwanda
10	Senegal	23	Seychelles
11	South Africa	24	Tanzania
12	Tunisia	25	Zambia
13	Zimbabwe		

Table 9. Regression results for DK, FE and system GMM

VARIABLES	DK-CR	DK-VA	FE-CR	FE-VA	System GMM-CR	System GMM-VA
lnTOP	-0.0137	0.0645	0.160**	0.154**	0.277	0.441*
	(0.105)	(0.0963)	(0.0596)	(0.0587)	(0.257)	(0.245)
lnAGRI	-0.134**	-0.179***	-0.153	-0.157	-0.171	0.113
	(0.0498)	(0.0529)	(0.112)	(0.111)	(0.803)	(0.744)
lnPOP	-0.0904**	-0.0752*	-0.178	-0.200	-14.94	-0.204
	(0.0418)	(0.0360)	(0.189)	(0.176)	(16.82)	(3.838)
lnGDPP	0.0693	0.386	4.144***	4.223***	-10.73	2.397
	(0.681)	(0.590)	(1.024)	(1.118)	(21.84)	(9.687)
lnGDPP2	0.00119	-0.0223	-0.281***	-0.289***	2.119	-0.127
	(0.0485)	(0.0426)	(0.0660)	(0.0733)	(2.824)	(0.734)
lnMAN	0.216***	0.203***	-0.162	-0.159	1.412	0.716
	(0.0589)	(0.0561)	(0.127)	(0.126)	(1.154)	(0.606)
lnREMI	-0.00200	0.0116	0.0265*	0.0259*	0.0440	0.00601
	(0.0150)	(0.0173)	(0.0146)	(0.0147)	(0.0412)	(0.0138)
lnDEBT	-0.0241	-0.0309	0.0346	0.0426	1.340	-0.0800
	(0.0503)	(0.0529)	(0.0269)	(0.0298)	(1.678)	(0.267)
lnAID	0.0378	0.0551	0.145***	0.132***	-0.475	0.0755
	(0.0437)	(0.0453)	(0.0369)	(0.0353)	(0.625)	(0.239)
lnPE	0.261**	0.271***	-0.0617*	-0.0623**	-5.296	0.394
	(0.0966)	(0.0916)	(0.0294)	(0.0279)	(6.492)	(1.798)
lnFDI	0.0843**	0.0689**	0.0387**	0.0412***	-0.0412	-0.00418
	(0.0325)	(0.0270)	(0.0138)	(0.0133)	(0.0356)	(0.0307)
lnIE	-0.394***	-0.315**	-1.519**	-1.667**	38.82	-2.844
	(0.102)	(0.116)	(0.612)	(0.611)	(49.06)	(11.99)
lnMI	0.0158*	0.00750	0.0143*	0.0191**	-0.0259	0.00196
	(0.00885)	(0.0110)	(0.00774)	(0.00770)	(0.0321)	(0.0276)
lnINF	-0.0322*	-0.0271*	-0.00295	-0.00495	-0.204	-0.00498
	(0.0167)	(0.0145)	(0.00971)	(0.00970)	(0.234)	(0.0546)
lnCOR	-0.143**		-0.0181		1.770	
	(0.0628)		(0.123)		(2.097)	
lnVA		-0.166**		0.142**		0.507
		(0.0581)		(0.0644)		(1.241)
L.lnTTAX					-2.049	0.306
					(3.036)	(0.452)
Constant	3.727	1.421	-7.132	-5.944	93.91	0
	(2.631)	(2.320)	(4.820)	(4.848)	(109.3)	0
Observations	182	182	182	182	182	182
R-squared	0.715	0.725	0.675	0.686		
No of groups	18	18				

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1

Table 10. Tax Revenue stochastic frontier with DGE (Battese and Coelli, 1992)

	model1	model2	model3	model4
Trade openness	0.223***	0.212***	0.369***	0.203***
	(3.90)	(3.91)	(6.47)	(3.66)
Agriculture	-0.110*	-0.128*	-0.0121	-0.128*
	(-2.07)	(-2.26)	(-0.28)	(-2.26)
Population	-0.169*	-0.0592	-0.0657	-0.0743
	(-2.47)	(-1.17)	(-1.78)	(-1.52)
GDP per capita	3.556***	2.853***	2.224**	2.874***
	(4.81)	(5.49)	(2.78)	(5.60)
Sq. GDP per capita	-0.229***	-0.179***	-0.137**	-0.179***
	(-4.66)	(-5.20)	(-2.64)	(-5.28)
Manufacturing	-0.0460	-0.0553	0.180***	-0.0508
	(-0.67)	(-0.93)	(3.65)	(-0.87)
Personal remittances	0.0133	0.0193	-0.00530	0.0184
	(1.28)	(1.94)	(-0.51)	(1.83)
External debt stock	-0.00195	-0.0396	-0.0318	-0.0425
	(-0.08)	(-1.74)	(-1.61)	(-1.87)
Net official development assistance	0.115***	0.0673**	0.0539*	0.0687***
	(4.73)	(3.28)	(2.30)	(3.37)
Government expenditure on education	-0.0823*	-0.0354	-0.00346	-0.0318
	(-2.13)	(-0.90)	(-0.08)	(-0.81)
Foreign direct investment	0.0490***	0.0443***	0.0301*	0.0447***
	(4.21)	(3.87)	(2.21)	(3.90)
Informal Economy Index (DGE)	-0.140	-0.178	-0.505***	-0.204
	(-0.63)	(-1.00)	(-4.23)	(-1.16)
Mineral rents	0.00139		-0.0160*	
	(0.22)		(-2.06)	
Inflation	-0.00365	0.00906	-0.00926	0.00882
	(-0.35)	(0.84)	(-0.82)	(0.82)
Voice and Accountability	0.0510	0.0449		
	(0.82)	(0.69)		
Control of Corruption			-0.203*	-0.107
			(-2.06)	(-1.04)
Constant	-9.349**	-7.932**	-5.615	-7.862**
	(-2.66)	(-3.14)	(-1.76)	(-3.24)
Sigma	-2.347***	-2.558***	-2.030	-2.660***
	(-5.54)	(-7.98)	(-1.58)	(-8.74)
Inefficiency				
Gamma	2.338***	1.806***	2.517	1.676***
	(4.65)	(4.58)	(1.80)	(4.40)
mu	0.929***	0.677***	-0.196	0.647***
	(4.61)	(3.68)	(-0.25)	(3.64)
eta	0.00733*	0.00670	0.0354***	0.00676
	(2.20)	(1.56)	(3.49)	(1.50)
Observations	181	221	181	221

t statistics in parentheses. Source: author self-computed

$^{*}p < 0.05$, $^{**}p < 0.01$, $^{***}p < 0.001$