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DETERMINANT OF TAX REVENUE EFFORT IN SUB-SAHARAN AFRICAN COUNTRIES: A STOCHASTIC FRONTIER ANALYSIS

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ABSTRACT

The main objective of this paper was empirically examined the trend and its drivers of tax revenue effort in Sub- Saharan African countries using panel data and stochastic frontier analysis techniques inter alia:- random effect, fixed effect, half-normal, exponential-normal, and truncated-normal analysis for a period of 2000 to 2018. The estimation result shows that tax effort is positively and significantly related to openness, Share of agriculture sector, external debt, share of the construction sector, population growth, age dependency, corruption and GDP per capita and negatively and significantly related with a share of the service sector, official development assistance, foreign direct investment, population density, literacy and official exchange rates. In general, depending on the choice of analysis technique, both supply- side factors and demand - side factors are highly affected tax revenue effort and before designing tax policy, therefore, those concerned bodies be going to first determine their tax revenue effort.

Contribution/Originality: This study uses the new estimation methodology of stochastic frontier analysis to examine tax revenue effort in 23 Sub-Saharan African countries over 19 year's panel data set from 2000-2018 and the paper's primary contribution finding is that economic, demographic, policy and institutional factors have a significant effect on tax revenue effort.

1. INTRODUCTION

Interest in rising revenue overall performance has received extended momentum in the late years across several growing countries (AfDB, 2010a; Drummond, Daal, Srivastava, & Oliveira, 2012). This has been on account of enlarged funding wishes for supplier delivery, issues over debt property, and waning donor guide throughout several countries. Whereas the overall revenue performance has now not been alert to general value growth, it's not clear that explicit sectors of the economic system are responding or not. A clearer understanding of sector-specific tax elasticity's will provide higher policy choices for raising tax revenue performance.

To date, several developing nations nonetheless face drawn back in elevating government revenue to the level needed for marketing of economic processes. A tainted tax performance, in phrases of raising financial gain may end up from either deficiencies in tax structure policy or associate inadequate effort to gather, on the role of the government, every of that are influenced by employing a mixture of matters. Underlying the abstract line of reasoning that the yield of the legal arrangement may be a feature of the tax bases in the securities industry, the

costs used to those bases, and also the opportunity of amassing any distinctive levy are a feast of several components. In other words, as Eshag (1983) states that the particular quantity of taxation accumulated depends solely partially on the taxation manageable of the countries, the taxation targets set by mistreatment the authorities, and also the ability of governments to exercise to accumulate tax. Given these, the success of the authorities in exploiting the tax manageable and in achieving the taxation goal can deem a spread of various factors, that embrace, the economic structure, the conventional stage of improvement (reflected in per capita earnings and stages of attainment, urbanization, communication, etc.), the executive and political constraints on the business enterprise system, social-political values, endemic institutional arrangements, fashionable needs for state outlay and alternative factors that state of affairs normal disposition to pay taxes. It's probable that these factors engage in an exceedingly distinctive manner, at special times, and in one-of-a-kind countries, as an end product of that their effect in an exceedingly inequality in tax revenues between nations (Teera & Hudson, 2004).

Several studies show that variables among others, such as per capita GDP, the sector wise composition of output, the degree of trade openness, the ratio of foreign aid to GDP, the ratio of overall debt to GDP, and a measure of the informal economy plays an important role in determining the revenue potential and effort of an economy of a given country (Addison & Levin, 2012; Agbeyegbe, 2004; Richard M Bird, Martinez-Vazquez, & Torgler, 2008; Chelliah, 1971; Gerardo & Diana, 2014; Gupta, 2007; Le, Blanca, & Je, 2008; Lotz & Morss, 1970; Ndiaye & Korsu, 2014; Pessino & Fenochietto, 2010; Tanzi, 1992).

However, the extant paper examines the tax revenue potential and effort in developed country context and even those prior studies there have been few studies comprehensively examining economic, demographic, policy and institutional factors in one study in general and in Sub-Saharan African countries in particular. Therefore, this paper was comprehensively examined economic, demographic, policy and institutional factors for tax revenue effort in Sub-Saharan African countries by using stochastic frontier analysis for the time span of 2000 to 2018 G.C.

The remaining part of the study is organized as follows. Section 2 discusses the theoretical and empirical literature in this area. The methodological framework, data/sample and estimation technique are presented in Section 3. The empirical results of the stochastic frontier analysis to determine tax revenue effort is presented in Section 4 and the last section 5 present conclusions and recommendation the study.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

Tax effort is a measure of the ratio of the share of the actual tax collection as a percentage of GDP to the predicted taxable potential of a traditional regression or stochastic frontier model. Leuthold (1991) described tax effort as a country's effort to collect its tax revenue provided the tax handles available. Tax effort is the extent to which a country makes use of its taxable potential, according to Gillis (1989). Thus, it is the ratio of actual tax revenues to taxable potential. In other words, the tax effort can be measured by dividing the tax burden by the taxable potential (Le et al., 2008). Stotsky and Asegedech (1997) explained that the tax effort index is the ratio of the actual tax share of the predicted (or potential) tax share.

Several studies show that variables among others, such as per capita GDP, the sector wise composition of output, the degree of trade openness, the ratio of foreign aid to GDP, the ratio of overall debt to GDP, and a measure of the informal economy plays an important role in determining the revenue effort of any economy (Addison & Levin, 2012; Agbeyegbe, 2004; Richard M Bird et al., 2008; Chelliah, 1971; Gupta, 2007; Le et al., 2008; Lotz & Morss, 1970; Ndiaye & Korsu, 2014; Pessino & Fenochietto, 2010; Tanzi, 1992).

Chelliah (1971) states that the tax share to explanatory variables such as mining share; non-mineral export ratio and agriculture share play an important role in determining the revenue potential and effort of any economy. In a related study covering developing countries (Tanzi, 1992) finds that half of the variation in the tax ratio is explained by per capita income, import share, agriculture's share and foreign debt share. Leuthold (1991) finds a positive impact from trade, share and Stotsky and Asegedech (1997) find that both agriculture and mining share are

negatively related to the tax ratio, while the export share and per capita income has a positive effect. Ghura (1998) also concludes that the tax ratio rises with income and degree of openness, and with the share of agriculture in GDP.

The degree of external indebtedness of a country is also examined as a factor that affects tax revenue potential and effort of an economy (Gupta, 2007). To generate necessary foreign exchange to service the debt, a country may choose to reduce imports that lead to lower import tax otherwise the country may choose to increase import tariffs or other taxes to generate a primary budget surplus for debt servicing. The composition of aid has an important effect on tax revenue potential and effort; for example, concessional loans are associated with higher domestic revenue mobilization, while grants have the opposite effect (Gupta, Benedict, & Alexender, 2004). Similarly, Mbatia (2018) a study on the effect of foreign aid dependency on taxation revenue in 42 Sub-Saharan Africa countries for the period covering 1990-2014, results show that both concessional loans and grants have a negative effect on taxation revenue when all countries are pooled, and similarly for low-income and lower-middle income levels. On the contrary, studies such as Tanzi (1992) and Eltony (2002) found that foreign debt is positively related to resource mobilization.

The effect of trade liberalization is considered as important determinant that occurs primarily through a reduction in tariffs, then one expects losses in tariff revenue, however revenue may increase provided trade liberalization occurs through tariffication of quotas, eliminations of exemptions, reduction in tariff peaks and improvement in customs procedure (Keen & Alejandro, 2004). Several studies have found that there is a positive relationship between trade openness and the size of the government (Bird, 2007; Gupta, 2007; Le et al., 2008). Rodrik (1998) also concludes that as societies seem to demand (and receive) expanded roles for the government in providing social insurance in more open economies are subject to external risks. In the same notion, the study of Agbeyegbe (2004) study of Trade Liberalization, Exchange Rate Changes, and Tax Revenue using a panel of 22 countries in Sub-Saharan Africa, over 1980-1996 finding indicates that trade liberalization is linked to higher tax revenue and trade tax revenue, while there is some limited evidence that it is linked to weaker income tax revenue. The also find that the exchange rate is not in general strongly linked to revenues, while inflation shows a strong and a negative link to total tax revenue.

The study of Gerardo and Diana (2014) on the determinants of tax revenue in OECD countries over the period 2001-2011 results show that gross domestic product per capita, the industrial sector, and civil liberties have positive impact on the tax revenue, while the agricultural sector and the share of foreign direct investment in gross fixed capital formation have a negative impact. The lagged value of the dependent variable enters positively into the equation and its effect is larger in high income countries. The study also encounter tax effort and tax gap and find that they are stable over time, but diversification across countries, regardless of the level of development of the economies.

The study of Pessino and Fenochietto (2010) on the determinant of countries' tax effort, result indicate that, there is a positive and significant relationship between tax revenue as percent of GDP and the level of development (per capita GDP), trade (imports and exports as a percent of GDP) and education (public expenditure on education as a percent of GDP). The study also demonstrates the negative relationship between tax revenue and inflation (CPI), income distribution (GINI coefficient), the ease of tax collection (agricultural sector value added as GDP per cent), and corruption.

The study of Ndiaye and Korsu (2014) on tax effort in ECOWAS countries, over the period 2000 to 2010, the results show that literacy rate has a positive effect on all the categories of tax considered, financial depth has a positive effect on indirect tax and trade tax, agricultural share of GDP has a negative effect on direct and indirect tax, and openness of the economies to import and GDP per capita have positive effects on trade tax. The results of the tax effort estimation show that all the ECOWAS countries are below their tax capacities, though with differences in magnitude across tax type and countries.

Addison and Levin (2012) study of the determinants of tax revenue in Sub-Saharan Africa uses an unbalanced panel data set of 39 countries over the period 1980-2005, results significantly suggest that the overall tax to GDP ratio is higher in more open and less agricultural dependent economies, less populous and peaceful countries. The introduction of VAT also has a significant positive impact on the total tax-GDP ratio. The study also finds that relationships between the effect of openness and per-capita GDP on the trade-tax GDP ratio, the size of the agricultural sector and foreign aid affects the direct-tax GDP ratio negatively and a peaceful environment has a significant positive impact.

Cheeseman and Griffiths (2005) on their study of increasing tax revenue in sub-Saharan Africa the case of Kenya, the result indicates that policies have had mixed results. They indicate that, the reduction in tariffs has been successful, as increased imports have so far more than compensated for the reduction in tariffs and resulted in an increase in trade tax revenue.

In their analysis of reassessing tax initiative in developing countries, Hermann and Michaël (2017) identify economic weakness as detrimental to tax while human assets increase tax. In addition, sub-Saharan African countries have shown an excellent vulnerability-adjusted tax effort compared to other countries. Low income and poor countries perform relatively better than the other classes in collecting taxes. As a result, an additional tax effort would certainly create distortions in the economy if it were not preceded by policies aimed at reducing vulnerabilities and increasing human capital. Financial support for vulnerable countries is still important to meet the financial needs that are already high tax effort.

The extant paper examines the tax revenue potential and effort in one sort of views that factors that influence it in developed country context. But, there have been few comprehensive empirical examination economic, demographic, policy and institutional factors in Sub- Saharan African countries. Therefore, this paper has a look at desires to comprehensively examine economic, demographic, policy and institutional factors for tax revenue tax revenue effort in Sub- Saharan African countries were considered for the time span of 2000 to 2018 and formulate the following hypothesis and the detail measurement and source of each variable described in Table 1.

H1: *Economic factors significantly affect country tax revenue effort.*
H2: *Demographic factors significantly affect country tax revenue effort.*
H3: *Policy factors significantly affect country tax revenue effort.*
H4: *Institutional factors significantly affect country tax revenue effort.*

3. RESEARCH METHODOLOGY

3.1. Data and Sample

In this paper secondary data were employed. The panel data covers 23 Sub-Saharan African countries having available data of 19 years from 2000 to 2018. The source of the data was taken from IMF International Financial Statistics (IFS), World Development Indicators (WDI), and World Bank database, World economic outlook (WEO), Transparency International (TP), African Economic Outlook (AEO) and International Countries Risk Guide (ICRG).

3.2. Models Specification

The basic model for stochastic frontier analysis first formulated by Aigner, Lovell, and Schmidt (1977) and Meeusen and Broeck (1977) subsequently modifier by Javid and Arif (2012); Khwaja and Iyer (2014); Kumbhakar, Lien, and Hardaker (2014); Brun and Diakite (2016) and Langford and Ohlenburg (2015) was the benchmark for this paper with modification via along with extra tax revenue effort variables primarily using random effect analysis, fixed effect analysis, half-normal analysis, exponential-normal analysis, and truncated-normal analysis. The following formula is the base line for tax effort

$$\frac{T}{Yit} = f(Xit; \beta). \xi it. e^{vit}$$

(1)

Where

- $\frac{T}{Yit}$ is the actual tax revenue to GDP ratio for country i at time t.

- $Xit,$ is an expression given to the production function normally in economics, but this context the vector

  of input X are to be transformed into tax revenues, in line with the parameter $\beta,$

- ξit is the tax effort for a country i at time t.

- e^{vit} represents the random shocks such as one off-windfalls, measurement errors and model specification.

Thus, the entire expression $\frac{T}{Yit} = f(Xit; \beta). \xi it. e^{vit}$ defines the stochastic tax frontier; specifies the tax

potential of the country, i at time t, and what the actual tax to GDP ratio would be if the effort ξit were equal to 1.

The general model specified in Equation 1 above can be further detailed as follows:

The production function component of the Equation 1 is assumed to take the form of Cobb-Douglas, i.e. linear in logs, as specified here below. In the definition of Qit= ln(T /Yit) where T is taxes and Y is GDP output. The following new definition is given by Defining Xit= ln(Xit), as an input vector of economic, demographic, policy and institutional factors, and by defining the term ' inefficiency' Uit =-ln (ξit).

$$Qit = \alpha + \beta'Xit + vit - uit$$

(2)

It is possible to more specify the model in Equation 2 by incorporating an observable heterogeneity, i.e.

environmental variables $(let\ it\ be\ Z)$ which are observable but not captured in the model as a direct input in to tax

collection, but that could influence tax potential, Tp, the level of tax effort, $Te,$ and inefficiency, TIe gives the

following specification (Battese & Coelli, 1995).

$$Qit = \alpha + \beta'Xit + \delta p'Zit, p + vit - uit$$

(3)

Where, $uit \sim N^{+}(\mu it, \sigma^2 u), \mu it = \delta e'zit, e$ and vit$\sim$N(0, σ^2v)

Here the specification $vit - uit$ is expressed as a composite error term that incorporates both the random

shock $vit,$ assumed to be normally distributed and independent of $uit,$ the strict positive inefficiency term. The

'inefficiency' term uit is assumed to be a truncated normal distribution. This 'inefficiency' is will be defined in terms

of lack of tax effort.

Table-1. Variable description.

Variable	Symbol	Expected sign	Description	Source
Dependent Variable				
Tax Revenue to GDO ratio	TR		Total tax revenue as percentage of GDP(excluding social contribution and natural resource)	World development indicators
Independent Variables				
Economic variables				
GDP Per capita (development level)	GDPPC	+	Real Gross Domestic product divided by total population	World development indicators
Openness/trade libralization	OPEN	+	Calculated as export + import divided by GDP	IMF International Financial Statistics
Share of Agriculture	SAG	-	Calculated as Agricultural value added divided by GDP	World development indicators
The share of Manufacturing industry	SMF	+	Calculated as a manufacturing industry Value added, divided by GDP	World development indicators
The share of Service industry	SSI	+	Calculated as a Service industry Value added, divided by GDP	World development indicators
Monetization	MN	+	Calculated as the ratio of broad money to GDP	World development indicators
Gini index	Gin	-	The Gini index measures the extent to which the distribution of income or consumption expenditure amongst individuals or households within an economy deviates from a perfectly equal distribution. A Gini index of 0 represents perfect equality, while an index of 100 implies perfect inequality.	World development indicators
Share of construction industry	SCI	-	Construction organizations share to GDP	World development indicators
Official exchange rate	OXR	-	Official exchange rate (LCU per US$, period average)	World development indicators
External debt	DBT	-	External debt, total debt service, interest percent of GDP	International Monetary Fund, World Economic Outlook Database and African Economic outlook(AEO)
Demographic variables				
Age dependency	AD	-	The age dependency ratio is the ratio of dependents--people younger than 15 or older than 64-- to the working-age population--those ages 15-64.	World Development Indicators
Population density	PD	+	Population density (people per sq. km of land area)	World Development Indicators
Urbanization	URB	+	Calculated as total urban population divided by total population	World development indicators
Population growth	PG	+	Population growth (annual %)	World development indicators
Literacy Rate	LR	+	Calculated as 100 minus illiteracy rate	World development indicators
Policy variables				

Foreign direct investment	FDI	+	Foreign direct investment, net inflows (% of GDP)	International Monetary Fund, International Financial Statistics
Inflation Rate	INF	-	Calculated as the percentage change in the consumer price index	World development indicators
Official development assistance	ODA	-	Net ODA received (% of GNI)	World development indicators
Institutional Quality varies (IQ)				
Corruption	CR	-	Corruption Perceptions Index	Transparency International
Bureaucratic quality	BQ	+	Measured by item scores extract from International Country Risk Guide political risk component.	International Country Risk Guide political risk component.
Democratic accountability	DA	+	Measured by item scores extract from International Country Risk Guide political risk component.	International Country Risk Guide political risk component.
Government stability	GS	+	Measured by item scores extract from International Country Risk Guide political risk component.	International Country Risk Guide political risk component.
Law & order	LO	+	Measured by item scores extract from International Country Risk Guide political risk component.	International Country Risk Guide political risk component.
Internal conflict	IC	-	Measured by item scores extract from International Country Risk Guide political risk component.	International Country Risk Guide political risk component.
Military in politics	MP	-	Measured by item scores extract from International Country Risk Guide political risk component.	International Country Risk Guide political risk component.
Religions tension	RT	-	Measured by item scores extract from International Country Risk Guide political risk component.	International Country Risk Guide political risk component.
Ethnic tension	ET	-	Measured by item scores extract from International Country Risk Guide political risk component.	International Country Risk Guide political risk component.
Instrumental variables				
TR-Lag	Lagged $\frac{T}{Y_{it}}$		Lag of tax revenue to GDP	WDI and Own computation
Agricultural land	AL		Agricultural land (sq. Km)	World development indicators
Basic sanitation	San		People using at least basic sanitation services (% of population)	World development indicators

Hence, the stochastic frontier is specified by $\alpha + \beta' x_{it} + \delta p' z_{it}, p + v_{it}$, specifies (log) tax ratio that a country i could achieve in time period t, in the absence of inefficiency, i.e. $u_{it} = 0$ or equivalently if effort $(\xi_{it}) = 1$.

The inefficiency term u_{it} varies across time in the country and is partly influenced by the observable factors $z_{it}, e.$ Finally, the distribution of the estimated stochastic frontier parameters, i.e. inefficiency (lack of effort, uit), stochastic error, vit and tax effort, ξ_{it}, all proof main specifications checked by using their respective descriptive

statistics (mean and standard deviation). Whether any given observed variation should be considered to be a direct input into the collection of tax revenues and thus included in vector x, to influence tax potential as an environmental variable TP, or to influence tax effort as a component of TE is often ambiguous. For example, the extent of corruption has been found in a number of empirical studies to have a significant negative impact on actual tax collection – but it is not clear where this should enter in a model for tax capacity: a reasonable case could be made for corruption entering in Equation 4 as an inward shift of the tax frontier, or as a determinant of effort. Such uncertainty rests on conceptual questions, as well as empirical ones; for example, if corruption were incorporated in TP and not TE, it would expect this to lead to lower estimates of tax capacity and accordingly-higher estimates for tax effort in higher-corruption countries – and imply a different interpretation of the meaning of 'effort'. More specifically for tax effort:

$$TEit = \frac{\text{Actual Collected tax for country it}}{\text{Tax revenue potential of country it}} \qquad (4)$$

Where:

$TEit$ =is tax revenue effort in country i at time t

After determining tax effort in this way, the next step is empirically examined which factor leads this effort.

$$TEit = \alpha i + \beta 1 lnEit + \beta 2 lnDit + \beta 3 lnPit + \beta 4 lnIQit + agland +$$

$$bsan + v\acute{\imath}t - uit \qquad (5)$$

$$TEit = \acute{a} + \beta 1 lnEit + \beta 2 lnDit + \beta 3 lnPit + \beta 4 lnIQit + agland$$

$$+bsanvit + \Theta i + vit - ui \qquad (6)$$

Where:

- $TEit$ =is tax revenue effort in country i at time t,

- αi =is the country i fixed effect,
- $lnEit$= is the natural logarithm of economic variables
- $lnDit$ =is the natural logarithm of demographic variables
- $lnPit$= is the natural logarithm of policy variables

- $lnIQit$ is the natural logarithm of institutional quality variables

- $\beta 1 = \beta 4$ are the slope parameter estimate of economic, demographic, policy and institutional quality variables respectively
- agland is agricultural land (sq. Km) used as an instrumental variable to solve endogeneity problem.
- bsan is People using at least basic sanitation services (% of population) used as an instrumental variable to solve endogeneity problem.
- θi is the random country effect.
- Vit= is the country's latent heterogeneity; the random shock

- uit is inefficiency' term

Equation 5 and Equation 6 represents fixed and random effect models respectively.

In view of the random effect relies on the unlikely assumption that the effects are not related to the explanatory variables. The choice of how to model unobserved time-invariant heterogeneity in stochastic frontier analysis (SFA) can have a substantive impact on the estimated size of inefficiency and hence, in the present context, on the size of countries' measured tax effort. In particular, country-specific characteristics that cannot be measured explicitly could be treated as differences in potential tax capacity; time-invariant aspects of inefficiency; or – perhaps most realistically – as some combination of the two.

The important distinction between fixed and random effect is whether or not the unobserved country effects are correlated with the regressors within the model. To manage for unobserved heterogeneity the use of the fixed effects models might be favored. Clark and Linzer (2015) reminder that even as the primary objection to the usage of random effect is that the converts may be correlated with the unit results, it does not imply that any correlation among the converts and the unit results imply that the constant results have to be favored because, except in first rate situations, there will continually be a few degrees of correlation between the covariates and the unit results. The preference consequently, relies upon on how a good deal bias is created by way of this correlation, and what kind of variance is delivered via using the fixed effect as opposed to the random effect.

The fixed and random effect models except that the inefficiency is time invariant and similarly in all likelihood to persuade estimation of any latent passes firm heterogeneity within the facts. This assumption within the real world isn't continually actually due to the fact if the time collection is lengthy; this is in all likelihood to be tricky. In most cases, there's no floor to assume that the company specific deviations are time invariant. Therefore, to minimize the dilemma of individual estimation methods, using blended methods of estimation gives more advantageous effects. Hence, to capture the unobserved heterogeneity and to determine the average predicted tax revenue effort, fixed and random effect might be used and to determine the best maximum effort of tax revenue, half-normal, exponential –normal and truncated normal distribution might be used.

4. RESULTS

4.1. Descriptive Statistics Results

Table 2 presents variables which included and examined in the models of tax revenue effort in this paper. The table result indicates that the average contribution to GDP per capita is 69.59%; the average contribution of the official exchange rate is 46.47%, the average contribution of age dependency is 41.55%, the average contribution of openness or trade liberalization is 40.29%, and etc. others less than 40% mean contribution. These indicate that from a given alternative GPD per capita has a greater contribution to the tax revenue collection and then tax revenue effort. The standard deviation tells regarding the scatters of the values and it can even be used for comparison functions. As an example the information presented in Table 2 shows that the official exchange rate (25.3%), Gini coefficient (15.9%) and literacy rate (14.9%) have a relatively larger spread than other variables. This is often clarified by differences in the sampled countries' economic development within the data set.

4.2. Assumption Test

4.2.1. Heteroskedasticity

The Breusch-Pagan / Cook-Weisberg test (chi2 (1) = 40.26, Prob > chi2 =   0.000) and IM-test decomposition by Cameron & Trivedi test (chi2 (252) = 403.16, Prob > chi2 =   0.000) resulted figure together with the null hypothesis and p-value suggest that the heteroscedasticity of the group estimate exists. This problem is solved by using strong standard errors for estimating coefficients. Similarly, in econometric analysis, the issue of serial correlation occurs when disturbances or error terms fail to fulfill the independence and identical distribution properties. To fix this issue, this study use the model of (a) Panel Corrected Standard Errors (PCSE) with panel-level heteroskedasticity and contemporaneous correlation across the panel Table 3, (b) stochastic Random effect

(SRE) Table 7, and (c) stochastic Fixed Effect (SFE) Table 8 model were used. All the model results indicate that heteroskedasticity and serial correlation problems have not occurred.

Table-2. Summary statistics of variables included.

Variable	Obs	Mean	Std. Dev.
lnTR	437	2.621	.439
lnGDPPC	437	6.959	1.174
lnOPEN	437	4.029	.765
lnSAG	437	2.908	.864
lnSMF	437	2.382	.816
lnSCI	437	3.245	.490
lnSSI	437	3.735	.340
lnDBT	437	3.787	.863
lnMN	437	2.718	1.257
lnGin	437	1.026	1.594
lnODA	437	2.386	1.444
lnINF	437	2.872	1.676
lnPG	437	1.404	.606
lnAD	437	4.155	1.016
lnURB	437	3.685	.499
lnPD	437	3.655	1.115
lnLR	437	.6274	1.494
lnFDI	437	1.549	1.141
lnOXR	437	4.647	2.537
log_CR	437	.0562	.249
log_GS	437	.102	.448

Table 3 result reveals that the Panel Corrected Standard Errors (PCSE), there is no autocorrelation of the error term. In this model, GDP per capita, openness, the share of the agricultural sector, the share of the manufacturing sector, the share of the construction sector, the share of the service sector, income inequality (Gini coefficient), population growth, age dependency, population density, the official exchange rate, agricultural land and basic sanitation are significant at 5% confidence level. These results are consistent results with the main specification of the model.

4.2.2. Endogeneity

As stated by Botlhole (2010) and Ali and Isse (2006) the use of instrumental variables usually minimizes the problem when an explanatory variable correlates with the error term. Two instrumental variables were applied to the model. The first is agricultural land, and the second is basic sanitation accessibility. Agricultural land area as an income instrument explained this option because large countries are often wealthy on average. Agricultural land may therefore be used to minimize the problem of endogeneity as instrumental variables. The subsistence-farm agriculture sector employs a large proportion of the population, which is over 60 percent of the total workforce, and is active in agriculture in Sub-Saharan Africa (Ali & Isse, 2006; Botlhole, 2010). The access to improved sanitation systems that refers to the percentage of the population using enhanced sanitation facilities derived from the dataset of World Bank development indicators. The theory is that economic growth depends on efficient health human resources. Health status, as Audibert, Combes, and Drabo (2012) said, is a major predictor of economic development. The inclusion and exclusion of these instrumental variable changes the results broadly across each model estimated (see Table 7, Table 8, Table 9, Table 10 and Table 11, model 2, 4, 6 and 8 for each table).

4.2.3. Multicollinearity

Multicollinearity, that may emerge when there appear to be an excessive correlation between two or greater explanatory variables each other. In order to check the presence of colliniarity or multicollinearity Pearson pairwise

correlation test was used and to resolve this problem, highly correlated explanatory variables are used in separate species. In the current study, Table 4 Pearson pairwise correlation results show that with exception of corruption and government stability (96.07%) correlation and GDP per capita and share of agriculture (69.22%) correlation, there was no problem of multicollinearity in tax revenue potential explanatory variables. Bird, Jorge, and Benno (2004) shows that variables with a correlation above 0.80 could certainly be troublesome and sometimes even smaller correlation levels could cause problems. To avoid the possibility of multicolliniraty using highly correlated explanatory variables entered in the model step by step specification was proposed by Bird et al. (2004) and Gupta (2007). Therefore, for tax revenue effort models, to alleviate this problem each model has eight (8) iteration as follows: model1 up to model4 result of each specification reveals that excluding share of the agricultural sector from the model and model 5 up to model 8 excluding GDP per capita and adding shares of the agricultural sector.

Table-3. Panel corrected standard errors (PCSE) with panel-level heteroskedasticity.

Variables	Coeff.	p
lnGDPPC	.102	0.000**
lnOPEN	.181	0.000**
lnSAG	.104	0.000**
lnSMF	.118	0.000**
lnSCI	−.126	0.041**
lnSSI	.558	0.000**
lnDBT	.004	0.824
lnMN	.013	0.205
lnGin	−.026	0.014**
lnODA	−.003	0.790
lnINF	−.002	0.744
lnPG	.193	0.000**
lnAD	−.088	0.000**
lnURB	−.047	0.233
lnPD	−.052	0.003**
lnLR	−.010	0.303
lnFDI	.003	0.835
lnOXR	−.024	0.000**
log_CR	− .072	0.707
log_GS	.217	0.065
log_AL	.056	0.000**
log_San	.191	0. 000**
_cons	−.491	0.349

Note: **significant at 5% confidence level. Panels correlated (balanced). Number of obs = 437. Autocorrelation: no autocorrelation. Estimated autocorrelations=0.Wald chi2 (22) = 4049.18. Prob > chi2 = 0.0000

Table-4. Test of multicolliniraty for variables included in tax revenue effort.

Variables	GDPPC	OPEN	SAG	SMF	SCI	SSI	DBT	MN	Gin	ODA	INF	PG	AD	URB	PD	LR	FDI	OXR	CR	GS
GDPPC	1.																			
OPEN	-0.073	1.																		
SAG	-0.692	-0.111	1.																	
SMF	0.08	-0.435	0.014	1.																
SCI	0.498	-0.260	-0.481	0.520	1.															
SSI	0.320	-0.324	-0.151	0.337	0.119	1.														
DBT	-0.296	-0.021	0.180	-0.003	-0.167	-0.293	1.													
MN	0.187	0.371	-0.175	-0.061	-0.081	0.074	-0.172	1.												
Gin	-0.057	-0.277	0.091	0.150	0.167	-0.088	0.089	-0.164	1.											
ODA	-0.596	0.156	0.510	-0.150	-0.347	-0.254	0.147	0.028	0.090	1.										
INF	-0.097	0.123	0.023	-0.030	-0.201	-0.035	0.094	0.089	0.052	0.108	1.									
PG	0.192	-0.821	0.031	0.314	0.240	0.186	0.087	-0.342	0.259	-0.243	-0.069	1.								
AD	-0.015	0.027	0.005	-0.063	0.013	-0.02	0.016	0.317	-0.091	0.319	0.064	-0.048	1.							
URB	0.372	0.037	-0.253	-0.032	0.216	-0.124	-0.047	-0.241	0.094	-0.365	-0.075	0.179	-0.312	1.						
PD	-0.339	-0.204	0.303	0.039	-0.193	-0.130	0.029	-0.036	0.067	0.359	-0.001	0.000	0.178	-0.244	1.					
LR	0.063	-0.144	0.025	0.059	0.060	0.131	-0.034	0.026	0.027	0.051	-0.020	0.147	0.102	-0.041	-0.000	1.				
FDI	-0.076	0.187	0.005	0.002	-0.170	-0.120	0.052	-0.057	-0.071	-0.034	0.103	-0.080	-0.094	0.145	-0.058	-0.030	1.			
OXR	-0.380	0.108	0.283	-0.336	-0.414	-0.160	0.084	0.072	-0.043	0.211	0.062	-0.066	0.021	-0.081	0.110	-0.000	-0.139	1.		
CR	0.053	-0.000	0.066	0.233	0.058	-0.003	0.034	-0.177	-0.059	-0.300	-0.202	-0.007	-0.571	0.061	-0.135	-0.070	0.345	-0.214	1.	
GS	0.032	-0.004	0.073	0.236	0.052	0.001	0.044	-0.179	-0.054	-0.299	-0.195	-0.015	-0.565	0.080	-0.138	-0.068	0.387	-0.223	0.9607	1.

With respect to institutional variables to minimize the problem of multicollinearity corruption entered in model1, model2, model5 and model6 of each specification by excluding government stability and then in model3, model4, model 7 and model 8 excluding corruption and add government stability. The estimation results based on this iteration strategy were significantly changed.

4.3. Empirical Results

4.3.1. Computation of Tax Effort Index

The tax effort index for any nation is usually calculated in the tax literature by the ratio of the actual tax amount to the ratio estimated. It primarily represents the variation in a nation's taxable ability. Different surveys have taken the same method to measure tax effort across a country like (Bird et al., 2004; Gupta, 2007) the ratio of actual ax collected to tax revenue forecast. This paper also calculates the tax effort in the same way as the estimated value of the revenue ratio, which measures the revenue potential of the country, while the ratio of actual to expected revenue is estimated the level of tax revenue effort as shown in Table 5. Here the computation of tax effort column 9 up to column 13 is the derivation of column 3 divided by column4 up to column 8 (that is a tax revenue effort column of each estimation technique is equal to actual tax revenue column 3 divided by tax revenue potential column of each estimation technique respectively). In most cases the estimates of tax effort (half-normal, exponential-normal and truncated-normal estimation) are moderately less than the random and fixed effect model. In part, this reflects the fact that the benchmark for revenue performance under the half-normal, exponential-normal and truncated-normal method is the best performance in the sample, while the benchmark in the fixed and random effect approach is the average in the sample.

Figure 1 and Table 5 shows that in all models the average actual revenue collection during the period of 2000 to 2018 for the sample of 23 sub-Saharan African countries is less than the forecast tax revenue collection, except for the fixed effect model in South Africa and slightly in Namibia. The result also indicates that on average during the study period the highest actual tax revenue collection countries from their potential let take truncated normal model tax revenue potential result as comparison are Namibia (29.05% actual and potential 35.63%), South Africa (27.34% actual and 33.96% potential) and Angola (19.30% actual and 35.04% potential), whereas the lowest one are Democratic Republic of the Congo(6.18% actual and 27.99% potential), Ethiopia(8.40% actual and 25.50% potential) and Sierra Leone (8.63% actual and 29.43% potential) . These show that on average, almost all of the sampled Sub-Saharan African countries collect their taxes, which is less than what could be collected. Tax revenue potential (the predicted value or the maximum potential value) was computed after running each estimation strategy. Economic, demographic, policy and institutional factors were the main reasons for these results. These variables were empirically investigated using stochastic frontier analysis with various estimation techniques. The results of stochastic random - effects specifications, fixed-effects specifications, normal/half-normal model, normal/exponential-normal model and normal/truncated-normal model is summarized in Table 7, Table 8, Table 9, Table 10 and Table 11 respectively.

The χ2 statistics for Wald test and F - statistics test on the null hypothesis that all the slope coefficients are equal to zero. The value of $χ^2$ statistics and F - statist are highly significant in all the specification, confirming that the overall fit of the models is quite satisfactory.

4.3.2. Comparison of Average Actual Tax Revenue, Potential Tax Revenue and Tax Effort

As stated in the statement of the problem, Sub-Saharan African countries in their tax effort is lower than their developed counterpart. The result of this study also confirms that none of the countries tested exceed their tax effort on average greater than1 from the world average index as shown in Table 5 and in Figure 1 below. Countries average tax effort such as, South Africans (89%), Namibia (87%), Kenya (64%), Mozambique (63%),

Angola (61%), Niger (61%), Togo (61%) and Uganda (61%) are comparatively better in terms of tax revenue effort than other countries surveyed, with an average revenue effort of more than 60% for the years 2000-2018.

In comparison to the sampled Sub-Saharan African countries, these countries have likely exploited their revenue potential to some degree. In comparison, there is a tax effort index of less than 40% in Ethiopia (36%), Madagascar (36%), Congo (36%), "Gambia (36%), Sierra Leone (35%), and Democrat Republic of the Congo (24%), which shows that their total potential revenue has still to be achieved. As in Table 6 presented all sampled sub-Saharan African countries were less than their output obtained. Figure 1 also presented below clearly stated that the level of countries ability of collection in comparison with their actual collection of potential revenues below 1 percent. It is due to economic, demographic, political and institutional factors that these countries tax effort lower than 1 from the index of international tax revenue effort. The main objective of this paper is therefore to empirically examine these factors, which lead to lower tax effort, among others, by means of different estimation techniques. Table 6 up to Table 11 shows the empirical results of this objective. The average values give the common impression of tax efforts in all countries, but a detailed analysis of countries in different regions and over time will provide a more detailed overview of tax trends.

Table 7 up to Table 11 estimation result reveals that the determinant factors of the tax revenue effort across a sampled 23 sub-Saharan African countries over a period of 2000 to 2018. The outcome of a random effect estimation shows that openness, the share of service sector, external debt, population growth, urbanization, government stability and partially in model7 share of the manufacturing sector have a positive and significant relationship with tax revenue effort, while share of the construction sector, official development assistance, age dependency, foreign direct investment and official exchange rate have a significant and negative relationship with tax revenue effort.

The estimation result of the fixed effect model shows that openness, the share of manufacturing sector and external debt have a significant and positive relationship with the tax revenue effort, whereas corruption has a negative and significant relationship with tax revenue effort. The analysis result of Table 9, Table 10 and Table 11 all most there is similar output. Because of half-normal and exponential –normal is a special case of truncated normal (Lee, 1983). The result indicates that tax revenue effort have a significant and positive relationship with GDP per capita, openness, the share of the agriculture sector, the share of the manufacturing sector, the share of the services sectors , monetization, population growth, urbanization and government stability, whereas, income inequality (Gini coefficient), official exchange rates, population densities , age dependence, corruption and the share of construction sector have a significant and negative relationship with the tax revenue effort. Positive and statistically significant per-capita GDP coefficients support the idea that the tax effort is growing with the level of development. These findings are consistent with Pessino and Fenochietto (2013); Langford and Ohlenburg (2015) as well as Mawejje and Sebudde (2019) among others. The results show that countries with increased trade (exports+ imports) as % of GDP have a higher tax effort. Generally speaking, countries that trade is more likely to achieve the highest tax effort than those that are closed. This signifies that the trade openness coefficient is positive and statistically significant in all models.

Table-5. Computation of tax effort Index

Country year		Actual Tax Revenue Ratio	Potential Tax Revenue					Tax Revenue Effort				
			Random Effect	Fixed Effect	Half Normal	Exponential Normal	Truncated Normal	Random Effect	Fixed Effect	Half Normal	Exponential Normal	Truncated Normal
Angola	2000-2018	19.30	27.94	30.12	35.04	30.48	35.04	0.69	0.64	0.55	0.63	0.55
Botswana	2000-2018	16.75	30.13	33.59	36.55	31.13	36.45	0.56	0.50	0.46	0.54	0.46
Cameroon	2000-2018	15.66	28.30	26.41	33.34	30.709	33.45	0.55	0.59	0.47	0.51	0.47
Democratic Rep. Congo	2000-2018	6.18	23.34	25.92	27.82	26.55	27.99	0.26	0.24	0.22	0.23	0.22
Republic of Congo	2000-2018	9.82	23.37	32.10	29.04	26.30	29.00	0.42	0.31	0.34	0.37	0.34
Côte d'Ivoire	2000-2018	14.51	27.56	29.19	32.35	29.56	32.56	0.53	0.50	0.45	0.49	0.45
Ethiopia	2000-2018	8.40	21.55	21.74	26.84	23.44	25.50	0.39	0.39	0.31	0.36	0.33
The Gambia	2000-2018	9.23	21.64	23.57	29.09	25.81	28.77	0.43	0.39	0.32	0.36	0.32
Ghana	2000-2018	16.16	27.32	30.73	31.26	29.23	31.28	0.59	0.53	0.52	0.55	0.52
Kenya	2000-2018	17.57	26.08	24.56	29.54	28.90	29.61	0.67	0.72	0.59	0.61	0.59
Madagascar	2000-2018	9.39	24.12	26.13	27.63	25.77	27.77	0.39	0.36	0.34	0.36	0.34
Malawi	2000-2018	15.13	26.73	23.37	31.11	28.98	31.26	0.57	0.65	0.49	0.52	0.48
Mali	2000-2018	13.07	25.82	25.75	30.54	28.11	30.57	0.51	0.51	0.43	0.46	0.43
Mozambique	2000-2018	18.11	26.89	26.92	30.28	29.17	30.46	0.67	0.67	0.60	0.62	0.59
Namibia	2000-2018	29.05	31.17	31.32	35.57	32.99	35.63	0.93	0.93	0.82	0.88	0.82
Niger	2000-2018	16.41	25.88	24.61	28.99	28.19	29.12	0.63	0.67	0.57	0.58	0.56
Sierra Leone	2000-2018	8.63	22.49	21.33	29.54	24.42	29.43	0.38	0.40	0.29	0.35	0.29
South Africa	2000-2018	27.34	32.66	22.36	34.88	34.27	33.96	0.84	1.22	0.78	0.80	0.81
Tanzania	2000-2018	10.81	23.50	23.85	28.19	25.80	28.32	0.46	0.45	0.38	0.42	0.38
Togo	2000-2018	17.01	27.25	22.40	31.58	29.09	31.35	0.62	0.76	0.54	0.58	0.54
Uganda	2000-2018	15.75	24.07	23.04	28.32	26.10	28.35	0.65	0.68	0.56	0.60	0.56
Zambia	2000-2018	15.02	27.93	27.51	31.02	30.29	31.03	0.54	0.55	0.48	0.50	0.48
Zimbabwe	2000-2018	15.77	27.16	26.36	29.73	29.65	29.74	0.58	0.60	0.53	0.53	0.53

Table-6. Comparison of average actual tax revenue, potential tax revenue and tax effort.

Country	year	Average Actual Tax Revenue Ratio	Average Potential Tax Revenue	Average Tax Effort
South Africa	2000-2018	27.34	31.63	0.89
Namibia	2000-2018	29.05	33.34	0.87
Kenya	2000-2018	17.57	27.74	0.64
Mozambique	2000-2018	18.11	28.75	0.63
Angola	2000-2018	19.30	31.72	0.61
Togo	2000-2018	17.01	28.33	0.61
Uganda	2000-2018	15.75	25.98	0.61
Niger	2000-2018	16.41	27.36	0.60
Zimbabwe	2000-2018	15.77	28.53	0.55
Ghana	2000-2018	16.16	29.96	0.54
Malawi	2000-2018	15.13	28.29	0.54
Cameroon	2000-2018	15.66	30.44	0.52
Zambia	2000-2018	15.02	29.56	0.51
Botswana	2000-2018	16.75	33.57	0.50
Côte d'Ivoire	2000-2018	14.51	30.24	0.48
Mali	2000-2018	13.07	28.16	0.47
Tanzania	2000-2018	10.81	25.93	0.42
Ethiopia	2000-2018	8.40	23.81	0.36
Madagascar	2000-2018	9.39	26.29	0.36
Republic of Congo	2000-2018	9.82	27.96	0.36
The Gambia	2000-2018	9.23	25.78	0.36
Sierra Leone	2000-2018	8.63	25.45	0.35
Dem. Rep. Congo	2000-2018	6.18	26.32	0.24

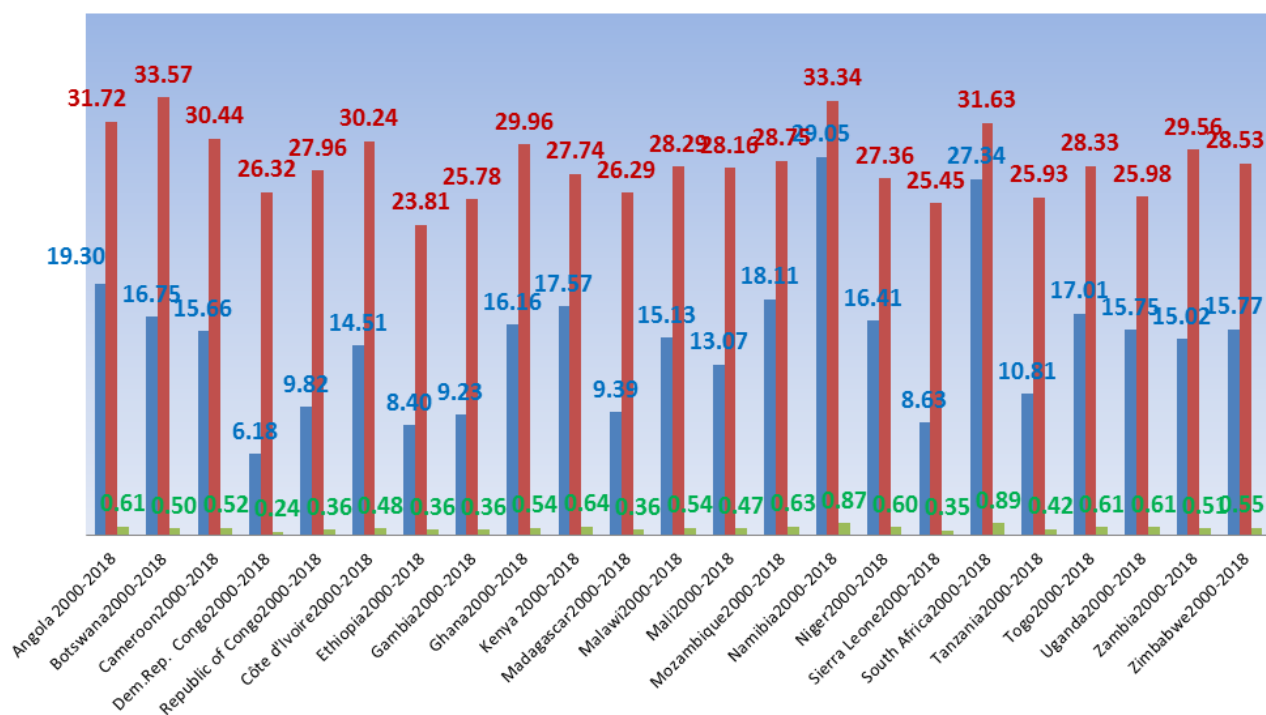Figure-1. Comparison of actual tax revenue, potential tax revenue and tax effort.

The share of agriculture, services in GDP, monetization is both significantly positive. In the case of institutional variables (such as (Cyan, Martinez-Vazquez, & Vulovic, 2013; Gupta, 2007; Pessino. & Fenochietto, 2013) corruption has a major adverse effect on the tax revenue effort. It may reflect its harmful effects on both

policy and administrative implementation choices. The negative impact of corruption affects the value of the state's ability to implement tax policy and reflect similar conclusions in Castaneda and Pardinas (2012). The stochastic frontier tax method of half-normal, exponential –normal and truncated normal, as becomes superficial, is an extension of the traditional regression model, based on the theoretical assumption that the production possibility frontier of taxation reflects the maximum amount of revenue that the government can achieve, taking into account several variables and potential revenue variations. In this respect, the advantage of the stochastic frontier analysis of (half-normal, exponential –normal and truncated normal) can be simply interpreted and a more transparently estimate of tax effort.

5. CONCLUSTION AND RECOMMENDATION

5.1. Conclusion

Interest in rising revenue overall performance has received extended momentum in the late years across several growing countries. The collection of tax revenues has long been regarded as a cornerstone central to every nation's growth and development. However, the collection of tax revenue in sub-Saharan Africa has historically been low, as governments rely heavily on foreign aid and debt financing to finance these vital public goods. As a consequence, the first step to understanding of public revenue systems in an agreement with the prevailing literature is to define and create certain typically agreed performance measurements and benchmarks. This paper uses, among other things, random effect estimates, fixed effect estimates, half-normal specifications, exponential and normal specifications, and truncated-normal specifications to determine the tax revenue effort as well as the determinants thereof.

The stochastic frontier analysis measures tax revenue effort in several different specifications and interprets the production frontier. This type of analysis helps to measure tax effort more empirically–and potentially more politics-relevantly. Then it can be used to generate a stochastic tax frontier that defines a maximum tax effort ratio for a certain number of determinants of inputs and environmental factors.

The tax revenue effort in sub-Saharan African countries is lower than that of their developed counterparts. Results show that the key factors in the tax effort are GDP per capita, openness, share of the agricultural sector, external debt and the share of the construction sector in economic factors, population growth and age dependence on demographic factors, and corruption due to institutional factors have a significant and positive relationship with tax effort, while the share of the service sector and the official exchange rate from economic factors, official development assistance and foreign direct investment from policy factors and population density from demographic factors have a significant and negative relationship to tax effort.

Based on the results, this paper concluded that both supply-side and demand-side factors are relevant to determine countries ' tax revenue effort. Therefore, a major effort remains to calculate the tax effort accurately and to stimulate discussion on the scope of tax reform for fiscal policy purposes. Hence, tax collections are identified fairly accurately in such efforts. Even though, practical estimation of the tax effort is a difficult task, but it is still important to recognize any country's potential tax gap.

5.2. Recommendation and Further Implication

This study result indicates that Sub-Saharan African countries have limits on extending the tax scope efficiently and reasonably, which in turn depends on the underlying taxable capacity and the initial tax collection level of the country. Although taxation is the most effective alternative to long-term funding of public spending, Sub-Saharan African countries typically experience a persistent gap between the amount of actual tax revenue and their potential. Not only this, but also the sampled Sub-Saharan African countries ' average tax effort lower than the world average effort index 1. Structural tax issues indicate that all countries need to adopt a long-term vision for tax reforms, and specific reform strategies cannot be "one-size-fits-all." Countries with low levels of actual

collection and low tax effort, for example, can have ample scope to increase revenues to reach their potential without aggravating economic distortions in the medium term.

On the contrary, a few low-income countries, placed in the situation of relatively low collection and high tax effort have restricted short-term potential to increase revenue without causing high collection costs (both enforcement and administration) and creating negative opportunities for the formal sector.

In the case of income reform, tax policies are of fundamental importance in all countries at vastly different levels of growth in addition to the structural factors. Furthermore, both the large-scale tax effects as well as the common pool nature of tax revenues make it difficult, in view of the resistance of the élites, to reach cooperative solutions. It is political, and hence practically challenging, to make fundamental changes to an established tax structure. Therefore, before designing tax policy those concerned bodies be going to first determine their tax revenue effort.

The results of the study are expected to contribute insights for an empirical model of a comprehensive examination of the determinants of tax revenue effort in Sub- Saharan African countries. Moreover, other research can also replicate this analysis or investigate how tax revenue effort is interlinked with tax revenue inefficiency is a potential future research avenue.

Table-7. Tax revenue effort under random effect estimation.

Variables	Model 1 Coef.	Model 1 P	Model 2 Coef.	Model 2 P	Model 3 Coef.	Model 3 P	Model 4 Coef.	Model 4 P	Model 5 Coef.	Model 5 P	Model 6 Coef.	Model 6 P	Model 7 Coef.	Model 7 P	Model 8 Coef.	Model 8 P
lnGDPPC	.0348	0.110	.032	0.168	.040	0.093	.042	0.117								
lnOPEN	.157	0.000**	.157	0.000**	.173	0.000**	.182	0.000**	.163	0.000**	.416	0.000**	.172	0.000**	.160	0.000**
lnSAG									.010	0.328	.007	0.744	.007	0.491	.005	0.613
lnSMF	.020	0.220	.020	0.233	.025	0.147	.028	0.105	.025	0.130	.082	0.021**	.027	0.113	.021	0.20
lnSCI	-.070	0.007**	-.070	0.008**	-.068	0.009**	-.069	0.009**	-.075	0.004**	-.149	0.008**	-.075	0.004**	-.073	0.007**
lnSSI	.084	0.017**	.086	0.016**	.100	0.004**	.107	0.002**	.076	0.026**	.100	0.172	.084	0.015**	.079	0.024**
lnDBT	.025	0.000**	.025	0.000**	.026	0.000**	.027	0.000**	.025	0.000**	.031	0.028**	.025	0.000**	.024	0.000**
lnMN	.003	0.535	.003	0.533	.001	0.796	.001	0.813	.004	0.467	.019	0.152	.002	0.744	.002	0.716
lnGin	-.005	0.160	-.005	0.167	-.005	0.135	-.005	0.121	-.004	0.190	-.000	0.965	-.004	0.171	-.004	0.202
lnINF	-.006	0.175	-.006	0.198	-.004	0.303	-.004	0.367	-.007	0.085	-.014	0.136	-.007	0.122	-.006	0.150
lnPG	.068	0.033**	.067	0.034**	.046	0.164	.033	0.323	.067	0.035**	.243	0.000**	.057	0.079	.071	0.026**
lnAD	-.025	0.007**	-.026	0.006**	-.017	0.063	-.017	0.065	-.027	0.005**	-.005	0.805	-.018	0.060	-.019	0.049**
lnURB	.040	0.027**	.040	0.031**	.038	0.038**	.037	0.043**	.045	0.013**	.077	0.043**	.042	0.021**	.041	0.027**
lnPD	-.005	0.621	-.002	0.809	-.009	0.430	-.007	0.539	-.004	0.719	.020	0.423	-.006	0.569	-.005	0.672
lnLR	.001	0.738	.001	0.746	.001	0.719	.001	0.704	.001	0.681	-.005	0.389	.001	0.690	.001	0.743
lnFDI	-.016	0.005**	-.016	0.005**	-.015	0.009**	-.014	0.011**	-.017	0.003**	-.037	0.002**	-.016	0.006**	-.016	0.005**
lnOXR	.001	0.760	.001	0.765	.001	0.994	-.001	0.971	.001	0.745	.002	0.768	.001	0.962	.001	0.969
log_CR	-.108	0.002**	-.112	0.002**					-.128	0.001**	-.080	0.313				
log_GS	.038	0.064	.039	0.058					.048	0.031**	.048	0.033**				
ln AL	.023	0.233			.028	0.328			.036	0.418			.025	0.184		
lnSan			-.005	0.801			-.014	0.526			.039	0.352			.010	0.620
_cons	-.584	0.020**	-.833	0.009**	-.507	0.050**	-.804	0.046**	-.392	0.099	-1.52 0	.030**	-.321	0.179	-.663	0.035**
F TEST	143.94	0.000**	141.77	0.000**	150.74	0.000**	157.62	0.000**	145.32	0.000**	127.36	0.000**	142.43	0.000**	130.35	0.000**
No. of obs.	437		437		437		437		437		437		437		437	

Note: **significant at 5% confidence level

Table-8. Tax revenue effort under fixed effect estimation.

Variables	Model 1 Coef.	Model 1 P	Model 2 Coef.	Model 2 P	Model 3 Coef.	Model 3 P	Model 4 Coef.	Model 4 P	Model 5 Coef.	Model 5 P	Model 6 Coef.	Model 6 P	Model 7 Coef.	Model 7 P	Model 8 Coef.	Model 8 P
lnGDPPC	.045	0.106	.034	0.270	.051	0.070	.040	0.196								
lnOPEN	.140	0.000**	.137	0.000**	.142	0.000**	.139	0.000**	.1451	0.000**	.137	0.000**	.147	0.000**	.140	0.000**
lnSAG									.002	0.791	.002	0.834	.005	0.567	.005	0.613
lnSMF	.036	0.033**	.036	0.033**	.035	0.043**	.035	0.042**	.041	0.016*	.039	0.021**	.040	0.020**	.038	0.026**
lnSCI	- 008	0.732	-.005	0.829	-.008	0.729	- .005	0.835	-.014	-0.575	-.008	0.742	-.016	0.531	-.009	0.707
lnSSI	.005	0.876	.005	0.877	.009	0.793	.008	0.796	.007	0.817	.002	0.933	.006	0.852	.001	0.971
lnDBT	.018	0.004*	.018	0.004**	.018	0.005**	.018	0.005*	.017	0.008**	.018	0.006**	.017	0.009**	.017	0.007**
lnMN	.001	0.757	.001	0.766	.001	0.953	.001	0.970	.001	0.847	.001	0.794	-.001	0.913	-.001	0.975
lnGin	-.001	0.786	-.001	0.737	-.001	0.793	- .001	0.742	-.001	0.791	-.001	0.726	-.001	0.820	-.001	0.749
lnODA	-.008	0.144	-.008	0.153	-.008	0.150	-.008	0.158	-.011	0.061	-.009	0.094	-.011	0.048**	-.010	0.081
lnINF	-.002	0.581	-.002	0.627	-.002	0.657	-.001	0.696	-.004	0.325	-.003	0.489	-.004	0.358	-.002	0.533
lnPG	.001	0.955	.003	0.913	.001	0.987	.002	0.942	.001	0.963	.004	0.905	.001	0.990	.003	0.927
lnAD	-.014	0.114	-.015	0.107	-.008	0.358	-.008	0.337	-.012	0.180	-.014	0.141	-.005	0.567	-.007	0.468
lnURB	.006	0.696	.007	0.688	.005	0.744	.006	0.734	.010	0.549	.009	0.602	.010	0.574	.009	0.623
lnPD	-.014	0.224	-.015	0.184	-.017	0.150	-.018	0.125	-.010	0.366	-.014	0.233	-.013	0.268	-.017	0.163
lnLR	-.001	0.697	-.001	0.729	-.001	0.702	-.001	0.727	-.001	0.697	-.001	0.764	-.001	0.714	-.001	0.780
lnFDI	-.009	0.100	-.009	0.080	-.008	0.141	-.008	0.114	-.009	0.099	-.010	0.070	-.008	0.153	-.009	0.111
lnOXR	-.003	0.289	-.004	0.270	-.004	0.216	-.004	0.203	-.004	0.269	-.004	0.241	-.004	0.185	-.005	0.166
log_CR	-.085	0.014**	-.084	0.014**					- .092	0.011**	-.088	0.015**				
log_GS					.029	0.142	.029	0.141					.031	0.146.	029	0.170
ln AL			.002	0.986			-.011	0.934			.040	0.757			.035	0.787
lnSan			.022	0.318			.023	0.294			.029	0.174			-.049	0.831
_cons	-.304	0.256	-.298	0.849	-.291	0.279	-.129	0.934	-.082	0.720	-.586	0.706	- .049	0.831	-.499	0.750
F TEST	4.73	0.000**	4.30	0.000**	4.47	0.000**	4.07	0.000**	4.56	0.000**	4.23	0.000**	4.27	0.000**	3.98	0.000**
No. of obs.	437		437		437		437		437		437		437		437	

Note: **significant at 5% confidence level

Table-9. Tax revenue effort under stochastic frontier half –normal model.

Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	Coef.	P	Coef.	P	Coef.	P	Coef.	P	Coef.	P	Coef.	P	Coef.	P	Coef.	P
lnGDPPC	.018	0.044**	.005	0.569	.018	0.045**	.004	0.622								
lnOPEN	.056	0.004**	.049	0.008**	.055	0.005**	.047	0.011**	2.781	0.000**	.053	0.004**	.060	0.002**	.051	0.006**
lnSAG									.986	0.010**	.024	0.023**	.019	0.077	.026	0.014**
lnSMF	.032	0.008**	.036	0.002**	.033	0.005**	.037	0.001**	.099	0.812	.026	0.024**	.018	0.121	.027	0.018**
lnSCI	-.020	0.344	-.038	0.071	-.020	0.327	-.039	0.064	.963	0.216	-.013	0.545	.014	0.506	-.013	0.556
lnSSI	.157	0.000**	.198	0.000**	.156	0.000**	.198	0.000**	7.351	0.000**	.210	0.000**	.179	0.000**	.210	0.000**
lnDBT	.003	0.649	.001	0.905	.003	0.682	.001	0.845	.241	0.395	.001	0.806	.003	0.637	.002	0.718
lnMN	.001	0.979	.001	0.771	.001	0.986	.001	0.790	.613	0.006**	.001	0.791	.006	0.315	.001	0.762
lnGin	-.014	0.001**	-.012	0.003**	-.014	0.001**	-.012	0.004**	-.468	0.002**	-.011	0.006**	-.013	0.002**	-.011	0.007**
lnODA	-.003	0.620	.000	0.994	-.003	0.559	-.000	0.920	-.577	0.010**	-.005	0.354	-.012	0.053	-.006	0.275
lnINF	-.003	0.399	-.002	0.576	-.003	0.335	-.001	0.651	-.083	0.558	-.003	0.421	-.002	0.477	-.002	0.491
lnPG	.085	0.000**	.087	0.000**	.083	0.000**	.084	0.000**	4.409	0.000**	.088	0.000**	.090	0.000**	.084	0.000**
lnAD	-.006	0.449	-.015	0.083	-.008	0.323	-.017	0.043	.200	0.519	-.017	0.044**	-.008	0.359	-.019	0.023**
lnURB	.005	0.756	.016	0.330	.006	0.719	.017	0.307	1.345	0.018**	.013	0.390	.005	0.750	.014	0.354
lnPD	-.014	0.031**	-.031	0.000**	-.015	0.027**	-.032	0.000**	-.528	0.026**	-.031	0.000**	-.015	0.026**	-.032	0.000**
lnLR	-.001	0.819	-.001	0.917	-.001	0.811	-.001	0.923	-.058	0.696	-.001	0.853	-.001	0.808	-.001	0.852
lnFDI	-.007	0.239	-.006	0.302	-.006	0.366	-.004	0.500	-.512	0.026**	-.004	0.454	-.005	0.425	-.001	0.770
lnOXR	-.010	0.000**	-.011	0.000**	-.011	0.000**	-.011	0.000**	-.570	0.000**	-.013	0.000**	-.013	0.000**	-.013	0.000**
log_CR	-.042	0.272	-.070	0.060					1.899	0.162	-.087	0.021**				
log_GS					.033	0.123	.051	0.015*						0.080	.063	0.003**
ln AL			.020	0.000**			.021	0.000**			.020	0.000**			.020	0.000**
lnSan			.051	0.000**			.052	0.000**			.057	0.000**			. 058	0.000**
_cons	-.414	0.056	-.206	0.316	-.386	0.069	-.169	0.410	-36.706	0.000**	-.379	0.078	.539	0.017	-.350	0.109
Wald chi2	249.98	0.000**	305.93	0.000**	251.83	0.000**	309.89	0.000**	370.98	0.000**	314.10	0.000**	250.97	0.000**	319.83	0.000**
No. of obs.	437		437		437		437		437		437		437		437	

Note: **significant at 5% confidence level

Table-10. Tax revenue effort under stochastic frontier exponential –normal model.

Variables	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6		Model 7		Model 8	
	Coef.	P	Coef.	P	Coef.	P	Coef.	P	Coef.	P	Coef.	P	Coef.	P	Coef.	P
lnGDPPC	.032	0.003**	.017	0.113	.032	0.002**	.017	0.105								
lnOPEN	.057	0.006**	.051	0.012**	.058	0.006**	.051	0.012**	.064	0.002**	.057	0.005**	.065	0.002**	.056	0.005**
lnSAG									.019	0.108	.027	0.019**	.021	0.086	.029	0.013**
lnSMF	.026	0.050**	.030	0.019**	.027	0.037**	.031	0.013**	.004	0.752	.014	0.249	.005	0.676	.016	0.207
lnSCI	-.038	0.101	-.060	0.010**	-.039	0.090	-.061	0.008**	.009	0.694	-.025	0.306	.010	0.678	-.025	0.306
lnSSI	.143	0.000**	.182	0.000**	.140	0.000**	180	0.000**	.178	0.000**	.205	0.000**	.176	0.000**	.203	0.000**
lnDBT	.005	0.515	.001	0.889	.005	0.522	.001	0.914	.007	0.398	.001	0.922	.007	0.410	.001	0.970
lnMN	.004	0.550	.002	0.705	.003	0.58	.002	0.731	.014	0.043**	.008	0.182	.014	0.044**	.008	0.182
lnGin	-.011	0.014**	-.009	0.038**	-.011	0.015**	-.009	0.042**	-.010	0.028**	-.008	0.071	-.010	0.033**	-.008	0.082
lnODA	-.001	0.942	.003	0.627	-.001	0.904	.002	0.674	-.012	0.086	-.005	0.439	-.013	0.061	-.006	0.358
lnINF	-.001	0.895	.005	0.243	-.001	0.804	.004	0.291	.001	0.809	.006	0.124	.001	0.933	.006	0.158
lnPG	.087	0.000**	.088	0.000*	.087	0.000**	.088	0.000**	.099	0.000**	.093	0.000**	.099	0.000**	.091	0.000**
lnAD	-.002	0.762	-.006	0.527	-.001	0.934	-.008	0.370	-.006	0.526	-.007	0.462	-.002	0.762	-.010	0.279
lnURB	.015	0.415	.004	0.818	.012	0.495	.001	0.915	.035	0.048**	.013	0.469	.032	0.069	.010	0.554
lnPD	-.010	0.164	-.027	0.001**	-.010	0.163	-.027	0.001**	-.010	0.157	-.027	0.000**	-.010	0.153	-.028	0.000**
lnLR	.001	0.856	-.001	0.892	.001	0.855	-.001	0.893	001	0.822	-.001	0.840	.001	0.819	-.001	0.838
lnFDI	-.012	0.081	-.011	0.101	-.011	0.110	-.010	0.156	-.013	0.064	-.010	0.146	-.012	0.109	-.008	0.259
lnOXR	-.009	0.005**	-.010	0.002	-.009	0.005**	-.010	0.001**	-.013	0.000**	-.012	0.000**	-.013	0.000**	-.012	0.000**
log_CR	-.037	0.372	-.007	0.846					-.040	0.338	-.007	0.855				
log_GS					.011	0.611	-.006	0.785					.008	0.721	.018	0.423
ln AL			.019	0.000**			.019	0.000*			.019	0.000**			.019	0.000**
lnSan			.058	0.000**			058	0.000*			.069	0.000**			.070	0.000**
_cons	-.468	0.033**	-.265	0.222	-.445	0.043**	-.235	0.281	-.647	0.006**	-.472	0.041**	-.621	0.009**	-.444	0.050**
Wald chi2	206.79	0.000**	255.13	0.000**	205.95	0.000**	255.12	0.000**	197.81	0.000**	260.21	0.000**	196.64	0.000**	261.22	.000**
No. of obs.	437		437		437		437		437		437		437		437	

Note: **significant at 5% confidence level

Table-11. Tax revenue effort under stochastic frontier truncated –normal model.

Variables	Model 1 Coef.	Model 1 P	Model 2 Coef.	Model 2 P	Model 3 Coef.	Model 3 P	Model 4 Coef.	Model 4 P	Model 5 Coef.	Model 5 P	Model 6 Coef.	Model 6 P	Model 7 Coef.	Model 7 P	Model 8 Coef.	Model 8 P
lnGDPPC	.020	0.041**	006	0.485	.019	0.044**	.005	0.544								
lnOPEN	.054	0.005**	.047	0.011**	.052	0.007**	.044	0.017**	.059	0.002**	.051	0.006**	.057	0.003**	.048	0.009**
lnSAG									.017	0.126	.023	0.031**	.019	0.092	.025	0.019**
lnSMF	. 032	0.008**	.035	0.002**	.033	0.006**	.036	0.002**	016	0.160	.025	0.028**	.017	0.137	.026	0.022**
lnSCI	-.020	0.346	-.038	0.075	-.020	0.333	-.038	0.069	.014	0.519	-.013	0.563	.015	0.499	-.012	0.574
lnSSI	.157	0.000**	.200	0.000**	.156	0.000**	.200	0.000**	.181	0.000**	.213	0.000**	.180	0.000**	.213	0.000**
lnDBT	.004	0.616	.001	0.928	.003	0.649	.001	0.868	.005	0.545	.001	0.843	.004	0.594	.002	0.753
lnMN	.001	0.959	.002	0.744	.001	0.974	.001	0.771	.006	0.324	.001	0.792	. 006	0.308	.001	0.760
lnGin	-.014	0.001**	-.012	0.003**	-.014	0.001**	-.012	0.003**	-.014	0.002**	- .011	0.005**	-.013	0.002**	-.011	0.006**
lnODA	-.002	0.734	.001	0.870	-.002	0.671	.001	0.954	-.010	0.104	-.004	0.431	-.011	0.074	-.005	0.344
lnINF	-.003	0.346	-.002	0.615	-.004	0.294	-.001	0.683	-.002	0.514	-.003	0.450	-.003	0.428	-.002	0.516
lnPG	.089	0.000**	.091	0.000**	.087	0.000**	.088	0.000**	.097	0.000**	.092	0.000**	.094	0.000**	.088	0.000**
lnAD	-.005	0.554	-.014	0.117	-.007	0.428	-.016	0.067	-.003	0.685	-.015	0.082	-.006	0.483	-.018	0.039**
lnURB	.002	0.910	.013	0.437	.002	0.893	.013	0.427	.0107	0.520	.010	0.541	.009	0.557	.010	0.513
lnPD	-.014	0.033**	-.031	0.000**	-.014	0.029**	-.032	0.000**	-.014	0.032**	-.032	0.000**	-.015	0.028**	-.033	0.000**
lnLR	-.001	0.797	-.001	0.934	.001	0.789	-.001	0.941	.001	0.785	-.001	0.874	.001	0.780	-.001	0.874
lnFDI	-.007	0.282	-.005	0.356	-.005	0.418	-.003	0.570	-.007	0.276	-.004	0.507	-.004	0.467	-.001	0.834
lnOXR	-.011	0.000**	-.011	0.000**	-.011	0.000**	-.012	0.000**	-.013	0.000**	-.013	0.000**	-.014	0.000**	-.013	0.000**
CR	- .051	0.181	-.080	0.031**					-.052	0.176	-.096	0.011**				
log_GS					.037	0.081	.055	0.008**					.042	0.045**	.067	0.002**
ln AL			.021	0.000**			.022	0.000**			.021	0.000**			.021	0.000**
lnSan			.051	0.000**			.052	0.000**			.057	0.000*			.058	0.000**
_cons	-.376	0.063	-.160	0.420	-.350	0.083	-.125	0.527	-.522	0.016**	-.329	0.121	-.499	0.021**	-.302	0.152
Wald chi2	264.03	0.000**	324.17	0.000**	265.97	0.000**	328.37	0.000*	261.52	0.000**	331.66	0.000**	264.42	0.000**	337.72	.000**
No. of obs.	437		437		437		437		437		437		437		437	

Note: **significant at 5% confidence level

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