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DETERMINANTS OF TAX CAPACITY AND TAX EFFORT IN SOUTHERN AFRICA: AN EMPIRICAL ANALYSIS

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ABSTRACT

Literature posits that numerous economic and institutional factors limit the amount of taxes that a country can raise. Against this background, the substantive aim of this study was to assess the determinants of tax capacity and tax effort in the SADC. A multi-step procedure was followed to estimate determinants of tax capacity and tax effort using stochastic tax function and unbalanced panel data for 13 SADC countries.[1] The study disentangled the error term to estimate the random effects separately from tax effort to capture the time-invariant country-specific effects. Further, tax effort was classified as persistent (long-run) and transient (short-run). The study was able to estimate the determinants of tax effort and to rank each member state or country according to its tax effort. The quantitative analysis indicate that financial deepening, economic development and trade openness influence tax capacity, while corruption and inflation influence tax effort. The SADC region has low persistent tax effort, implying that improving tax administration has superseded tax policy reforms. This result is augmented by the fact that tax legislation efforts were largely successful in tax administration but rather limited given tax policy.

KEYWORDS

Southern Africa; tax capacity; tax effort; SADC

Introduction

Background of the study

As part of its drive to promote regional integration, the SADC Secretariat facilitates and coordinates fiscal policy guidance about the macroeconomic convergence programme and the programme on cooperation on taxation for the region. In addition, the SADC Secretariat also seeks to facilitate the formulation and harmonization of the regions' fiscal policies and to align them with other regional and international benchmarks. Nevertheless, progress towards the coordination of tax regimes has been somewhat slow given the recent commitment by SADC member states towards the achievement of the Sustainable Development Goals (SDG's) and the African Union (AU) Agenda 2063. The Regional Indicative Strategic Development Plan (RISDP) identifies six potential sources of finance for development which include (i) public finance, (ii) official development assistance (ODA), (iii) debt relief, (iv) domestic savings, (v) foreign direct investment (FDI) and Portfolio Investment (FPI), and (vi) development finance and the development finance institutions network. In this regard, public finance, in particular, tax revenue remains an integral part of financing socio-economic development in the SADC region.

Literature review

Several studies have assessed the determinants of tax revenue performance in developing countries using the standard approach to explain how changes in economic structure, social and political conditions have affected tax revenue performance. (Teera 2003; Imam and Jacobs 2007; Mahdavi 2008; Mkandawire 2010; Morrissey and Clist, 2010; Botlhole 2011; Addison and Levin 2012; Dioda 2012). Using Stochastic Frontier Analysis (SFA), a considerably smaller pool of studies extended the standard approach further to examine the determinants of tax capacity and tax effort in both developed and developing economies. This was used to ascertain whether sample countries attained their tax capacity and to determine the corresponding tax effort (Le, Moreno-Dodson, and Bayraktar 2012; Fenochietto and Pessino 2013; Ndiaye and Korsu 2014; Langford and Ohlenburg, 2015; Brun and Diakite 2016; Yohou

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and Goujon 2017). Methodologically, the extension of the standard approach allows researchers to determine the extent to which a country can tax given its economic structure and therefore enables the estimation of how much more a country may hope to raise. In this regard, this leads to the identification of broad areas where tax policy efforts can be directed in addition to variables embedded in the economic structure.

There is limited empirical evidence of studies on the analysis tax capacity and tax effort in the SADC. However, research studies have been conducted concerning other aspects relating to tax revenue performance. Ade, Rossouw and Gwatidzo (2018) analysed the determinants of tax revenue performance using panel data from 15 countries over the period 1990–2010. One of the major contributions from Ade et al. (2018) was the attempt they made to model the impact of foreign direct investment (FDI) on tax revenue, particularly, the direction of causality. In another study, Garikai (2009) examined the determinants of tax buoyancy in the SADC using panel data for 14 countries over the period 1994–2005. In the same vein, Glenday and Hollinrake (2005) examined the nature of the tax capacity using panel data for 13 SADC member states over the period 1990–2001. This was done by examining the influence of various structural features of the SADC countries in explaining differences in tax yields to explain differences in tax efficiency of the VAT and sales taxes across the SADC Member States.

Despite the contributions of research on the drivers of tax performance in the SADC, the development of this paper is based on the belief that there is a need to defamiliarize existing theoretical and empirical contributions on tax design and tax policy to provide a practical guide to the development, effective monitoring and evaluation of tax systems in the SADC.

Data collection and data analysis

Data sources include World Development Indicators, African Development Indicators and African Economic Outlook. Table 1 shows a summary of the description of variables used in this study and the sources of data thereof.

Despite the existence of numerous developing countries in the world, this study focused on the SADC region to move to a more specified context. The selected sample comprises 13 member states of the SADC from which longitudinal/ panel data was derived for the period 2002–2016.

The appropriateness of using secondary data is justified by the existence of already documented reports and studies that would not require the collection of information on each country. This research extracted information that has already been collected by other institutions and researchers. Data is generally available and accessible and the sources of such information/data include archival material, government statistical material like central statistical office statistics and annual

Table 1. Description of variables and sources.

Variable	Measurement	Source of Data
Economic growth (pgdp)	GDP per capita (constant 2010, USD)	World development indicators (2018)
Openness (open)	Imports and exports of goods and services (% of GDP)	World development indicators (2018)
Inflation (infl)	Measured in consumer prices (annual %)	World development indicators (2018)
Foreign Aid (foraid):	The share of foreign aid to GDP (%)	World development indicators (2018)
Financial deepening (fid)	Measured as the ratio of broad money to GDP (%)	World development indicators (2018)
Population (pop)	Measured by the ratio of urban population to the total population (%)	World development indicators (2018)
Corruption (corr)	Measured by the control of corruption index.	World Governance Indicators (2018)
Government Effectiveness(geff)	An estimate that measures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies.	World Governance Indicators (2018)
Political instability (pol)	An estimate that measures perceptions of the likelihood of political instability/ politically motivated violence	World Governance Indicators (2018)

Source: Compiled by Authors

reports, scientific publications and data files from past research. This solidifies the rationale for using secondary data.

Assessing taxable capacity and tax effort in the SADC: design and methodology

It is important to note that there are endogenous and exogenous factors that influence a country's ability to reach its tax frontier or maximum level of tax. Because of providing practical solutions that may assist tax policymakers, this studied considered that governments only have control over endogenous factors, thus less attention was given to exogenous factors. Therefore, this study departs from assessing vulnerability as the policy implications are beyond the control of the government.

Stochastic frontier analysis (SFA)

Introduction to stochastic frontier models. The stochastic frontier models were simultaneously produced by Aigner, Lovell, and Schmidt (1977) and Meeusen and Broeck (Meeusen and van den Broeck 1977). The models focused on formulating and estimating technical efficiency in production functions. Hypothetically, every production function has a maximum level of output given a set of inputs. In this regard, the production function has a boundary or 'frontier' where deviations from it are interpreted as inefficiency. (Cornwell and Schmidt, 2008). Equation 1 illustrates a scenario where a firm seeks to maximize the production of an observable output (Y_i) while employing observable inputs (vector x_i) and marginal products (vector β).

$$Y_i = \alpha + \beta \mathbf{x}_i + v_i - u_i \tag{1}$$

In addition, v_i is a zero-mean, symmetric error while the salient feature of the model is a non-negative error, u_i, representing unobserved inefficiency. The deterministic portion of the specification represents the frontier of maximal output for a given set of inputs x_i. The symmetric error, v_i, causes the frontier to be stochastic. The one-sided inefficiency term, u_i, can only reduce output and represents departure from this frontier (.

The essence of applying stochastic frontier analysis in research is that it allows models with the frontier concept to be estimated to determine inefficiency. Although the stochastic frontier model was primarily used to estimate technical efficiency in production functions, for over 40 years its application has been extended to other areas such as taxation.

This section provides insight into how the model of this study was specified and took note of some of the methodological advances in Stochastic Frontier Models (SFMs). In this regard, this study attempted to reduce the shortcomings of previous models that failed to account for country heterogeneity, persistent efficiency and transient efficiency. Although the use of SFMs is common in studies that investigate tax effort in production, its relative application to tax revenue assessment is limited, particularly in Africa. Notably, the standard approach to assessing tax revenue fell short as it negated the role of tax effort and its determinants. Instead, the standard approach captured the effects in the disturbance term, thus being unable to extract policy implications relating to the extent of tax capacity and tax effort.

The first generation of SFMs added time-invariant tax effort (persistent efficiency). This major contribution arising from this was that the results had implications that permitted policymakers to restructure or reorient tax systems in the long run as empirical evidence could not account for the short-run. This led to the development of the second generation of SFMs that focused on disentangling persistent efficiency from time-varying/decaying tax effort (transient efficiency). This subsequently enabled researchers to provide empirical evidence to support long-run and short-run improvements to tax systems.

These methodological advances enabled this study to pursue a more elaborate inquiry on taxable capacity and tax effort in the SADC outside the domain of the standard approach that is largely abundant in the literature. Unlike the standard approach which is one dimensional, this study adopted a four-component panel data SFM with determinants of tax effort as described in Kumbhakar, Lien, and Hardaker (2014), Lai and Kumbhakar, (2016) as well as Kumbhakar, Parmeter, and Zelenyuk (2017). This gives this study an edge in providing more substance to proffering practical solutions to the SADC on how to improve their tax systems (if feasible).

Firstly, the study begins with a tax function and adds a new term for tax effort. This implies that the actual tax revenue is less than the maximum tax attainable. This study follows the panel version of the stochastic production frontier model by Aigner, Lovell, and Schmidt (1977). The specification of Aigner, Lovell, and Schmidt (1977) can be modified to represent a stochastic tax revenue function as follows:

$$Y_{it} = \alpha + \beta x_{it} + v_{it} - u_{it} \tag{2}$$

Where,

Y_{it}, represents the log tax revenue to GDP ratio for country i at time t;

$\mathbf{x}_{it}$, is the vector that represents variables affecting tax revenue for country i at time t;

β, is a vector of unknown parameters,

v_{it}, is the disturbance or error term. It is a random (stochastic) variable that captures aggregate effects of unobservable independent variables that are exogenous and beyond the control of the government; v_{it}can be positive or negative and so the stochastic frontier outputs vary on the deterministic part of the model. In essence, $\alpha + \beta \mathbf{x}_{it}$ represent the deterministic component, meanwhile, v_{it} reflects noise and u_{it} represents efficiency.

u_{it}, represents the relative level of efficiency that is required to produce the maximum level of tax collection. It is a non-negative random variable associated with country-specific factors that contribute to country i not attaining its tax capacity at time t. This represents the deviation of tax revenue from the tax frontier, which is caused by factors that are generally within the control of the government. Notably, $u_{it} = Z_{it}\delta$ where Z_{it} is the vector of variables that influence the tax effort of tax systems and δ is the vector of the unknown parameter to be estimated.

This study adopted the standard assumptions of zero mean, homoscedasticity and independence was assumed for elements of v_i. In addition, u_i's were assumed to be identically and independently distributed non-negative random variables, while v_i and u_i are independently distributed. Notably, this study incorporated distributional assumptions in the estimation of the parameters because of the presence of random errors in the model. In general, the probability distribution of errors takes the form of the half-normal (truncated at zero) distribution, exponential distribution as well as a gamma distribution.

The analysis sought to predict and measure efficiency effects by using the tax effort, defined as the ratio between actual tax revenue and the corresponding stochastic frontier tax revenue (tax capacity). Consequently, this measure of tax effort has a value between zero and one.

$$TE_{it} = \frac{T_{it}}{\exp\left(\propto + \beta^T \mathbf{x}_{it} + v_{it}\right)} = \frac{\exp\left(\propto + \beta^T \mathbf{x}_{it} + v_{it} - u_{it}\right)}{\exp\left(\propto + \beta^T \mathbf{x}_{it} + v_{it}\right)} = \mathbf{exp}(-u_{it}) \tag{3}$$

Choice of the functional form of the model

Bezat (2011) suggests that since SFA is a parametric approach, hypothetically there is a need to assume a specific functional form of the model. Bezat (2011) argues that if an inappropriate functional form is selected it would ultimately influence the outcome of estimated results from which practical advice would be based. Alternative production functions include Cobb-Douglas, Constant Elasticity of Substitution (CES), Translog, generalized Leontief, normalized quadratic and its variants (Bezat 2011). Nevertheless, Coelli et al. (2005) and Bezat (2011) assert that the Cobb-Douglas and Translog stochastic frontiers are the most common functional forms found in empirical studies on frontier analysis. In this regard, Bezat (2011) recommends that the Likelihood ratio test should be employed to select the most appropriate model. However, Umar, Girei, and Yakubu (2017) suggest that the choice of functional form for efficiency analysis should be based on convenience, meeting selection criteria premise on the value of variance-parameter and objectives of the study.

Muwanga (2017) suggests that the Cobb Douglas function is limited because of several restrictions which include the existence of presumptions of constant returns to scale and unitary elasticity of substitution between input pairs. However, the Translog function does not assume perfect or smooth substitution between inputs and accommodates the transition from a linear relationship between the output and the inputs to a non-linear one (Muwanga 2017). Therefore, the Translog function assumes stable but flexible non–unitary elasticities of substitution. Nevertheless, the usefulness of the Translog

functional form is limited by the explosion of the number of parameters due to the increase in the number of inputs, leading to harmful multicollinearity which demeans the precision of estimators (Muwanga 2017). This can be overcome by limiting the number of explanatory variables to those that are important to output behaviour or to increase the sample size. Against this background, Muwanga (2017) believes that the choice of functional form should be based on the theoretical consistency, domain applicability, flexibility, factual conformity and computation facility. In the context of assessing tax capacity and tax effort in the SADC, the choice between the Cobb Douglas function and the Translog specification was made using the Log-likelihood Ratio test. The test statistic is based on the likelihood ratio, which is the maximum value of the likelihood function for the restricted production function to the maximum value of the likelihood function for the unrestricted one. The null and alternative hypotheses are provided as follows:

$$H_0 : \beta_{ii} = \beta_{ij} = 0 \tag{4}$$

$$H_1 : \beta_{ii} \neq \beta_{ij} \neq 0 \tag{5}$$

Where H_0 and H_1 are the null and alternative hypotheses, while$\beta_{i's}$ and $\beta_{j's}$ are parameters of the restricted and unrestricted models respectively. The Log-likelihood test was as an appropriate method to compare the two models since the Cobb-Douglas function is nested in the Translog function. Rejection of the null hypothesis signifies that the Translog function is the appropriate model while failure to reject the null implies that the Cobb Douglas model is appropriate. Nevertheless, Muwanga (2017) argues that the requirement of selecting an appropriate functional form is rarely met by one form.

Specification of the model

The stochastic tax frontier model

In the context of this study, the Cobb–Douglas stochastic tax frontier was specified as follows:

$$\begin{aligned} lntgdp_{it} = {} & \beta_0 + \beta_1 lnpop_{it} + \beta_2 lnfid_{it} + \beta_3 lnpgdp_{it} \\ & + \beta_4 lnopen_{it} + \theta_i + \nu_{it} - (\tau_i + \varphi_{it}) \end{aligned} \tag{6}$$

This study employed the Likelihood ratio test to decide between the Cobb- Douglas stochastic frontier model and the Translog stochastic frontier model and selected. In this study, the variables employed in explaining tax capacity differ from those explaining tax effort in order to avoid estimation problems.

Dependent variable

Several studies have measured tax revenue capacity as the predicted ratio of tax revenue collection in GDP (Le, Moreno-Dodson, and Bayraktar 2012; Fenochietto and Pessino 2013; Ndiaye and Korsu 2014; Langford and Ohlenburg, 2015).

Explanatory variables for estimating tax capacity

Table 2 provides a summary of variables considered in this study. It is impossible to select all variables prescribed by literature; however, the dearth of data was a major constraint in the selection of some variables such as the literacy rate and the Gini coefficient.

The choice of explanatory variables in this study is centred on some elements of the tax base and other control variables that include factors of economic policy, social and political factors. This is consistent with the literature on the determinants of tax capacity (Le, Moreno-Dodson, and Bayraktar 2012; Fenochietto and Pessino 2013; Yohou and Goujon 2017). There is substantial theoretical and empirical literature that justifies the use of traditional variables and other factors.

Explaining tax effort

Persistent time efficiency is normally due to factors emanating from economic policy decisions while transient efficiency is often linked to tax administration efficiency (Brun and Diakite 2016). Table 3 shows a summary of exogenous variables which explain tax effort.

Descriptive/summary statistics

This section presents the summary of descriptive statistics of unbalanced panel data for 13 SADC member states. The use of unbalanced data was motivated by unavailability of data for some member states and missing entries in other instances. Although there was a possibility to fill in missing data points to yield balanced panel data, the degree

Table 2. Summary of explanatory variables for estimating tax revenue.

Description	Expected relationship with taxable capacity
GDP per capita (pgdp): Steenekamp (2007) asserts that the level of development is a critical factor for governments to raise adequate revenue to finance public spending. Hypothetically, rising per capita incomes tend to drive urbanization and non-agricultural activities (Besley and Persson 2013).	A positive relationship is expected. (Lotz and Morss 1967, Ghura 1998; Gupta 2007).
Openness (open): Measures the share of international trade in GDP and an indicator of liberalization in the economy (Ghura 1998). There is a high degree of monetization; meanwhile, it is relatively easy to collect (Stotsky and WoldeMariam 1997; Ghura 1998; Tanzi and Zee 2001; Addison and Levin 2012).	A positive relationship is expected.
Financial deepening (fid): Measured as the ratio of broad money to GDP. Tax revenue from financial deepening can reduce revenue volatility by increasing the private sector's ability to smooth its income in response to shocks (Aggrey, 2011).Taxes become easier to collect when the degree of monetization increases (Ndiaye and Korsu 2014).	A positive relationship is expected.
Population (pop): Measured by the ratio of urban population to the total population. The demand for government services increases with the increase in the urban population as public sector activities is concentrated in the cities. To satisfy the increase in demand for public services more tax revenue is required (Ndiaye and Korsu 2014)	A positive relationship is expected.
Foreign Aid (aid): Fjeldstad (2013) suggests that the motivation for donor assistance has been to strengthen tax systems in developing countries. However, critics argue that it has led to crowding out of tax revenue (Gupta et al., 2003; Ahmed and Mohammed 2010; and Thornton 2014).	This study expects a negative relationship between tax capacity and foreign aid.

Source: Authors' compilation from the literature review

Table 3. Summary of explanatory variables explaining tax effort in the SADC.

Description	Expected relationship with tax effort
Inflation (infl): Higher inflation rates may demoralize the public to pay taxes, while affecting the tax-paying capacity of the taxpayers (McMahon and Schmidt-Hebbel 2000; Agbeyegbe, Stotsky, and WoldeMariam 2004).	This study expects a negative relationship.
Corruption (corr): Bird, Martinez-Vazquez, and Torgler (2008), Ajaz and Ahmad (2010) and Besley and Persson (2013) hypothesize that if taxpayers feel that their country is rampant with corruption, then there is an increased likelihood of not complying with tax obligations. This in turn will constrain tax effort.	A negative relationship is expected between tax effort and corruption.
Government effectiveness (geff): Economic prosperity is linked to government effectiveness, hence this study believes that it is equally important in establishing efficient and effective tax systems.	A positive relationship is expected between government effectiveness and tax effort.
Political stability (pol): Reflects perceptions of the extent to which public power is exercised for private gain (World Bank Indicators, n.d). Political instability can influence behaviour towards tax evasion or tax avoidance as taxpayers respond to the injustices of the political economy. In this regard, political stability is expected to have a positive impact on tax effort.	A positive relationship is expected (Mutascu, Tiwari and Estrada, 2011; Ehrhart 2011; Besley and Persson 2013)

Source: Authors' compilation from the literature review

of missing entries was too large on some years. This counteracted the rationale of interpolation and extrapolation of data as they could not be kept a bay without igniting bias. As a result, this justifies the resolution to use unbalanced data which was used and evaluated against the following checkpoints:

(i) The presence of longitudinal data and the presence of fixed and/or random effects.
(ii) Consistency of the entities (countries); as such this study checked whether entities did not change during the period of research.
(iii) The time periods were checked for consistency where each period was taken as a year.
(iv) Each country was checked to ensure that not more than one observation occurred in a particular time period.

Table 4 shows the summary of statistics for tax revenue and other independent variables explored in this paper. The overall statistics are based on 183 observations and 171 observations for the size of the shadow economy variable (*sizshad*). However, Seychelles was excluded from this variable owing to

Table 4. Summary statistics.

Variable	Mean	Standard. Deviation	Minimum Value	Max value
tgdp	23.50465	9.556973	2.153343	56.5354
pop	39.67396	15.1844	14.786	67.933
fid	41.35784	25.08997	5.406917	109.8959
infl	1,262,446	1.71e+07	−2.4095	2.31e+08
corr	−0.2257802	0.6771861	−1.44389	1.216737
pgdp	3729.068	3366.077	296.9835	13,598.34
open	96.01191	38.76284	37.42109	225.0231
pol	0.0929862	0.6365353	−1.577046	1.200234
foraid	6.056015	7.056037	−.2602161	50.07259
gvtexp	22.66355	13.48851	2.047122	88.98288
plcdebt	43.87426	32.68917	3.66	204.25
geff	−0.2906111	0.6564018	−1.545878	1.049441
sizshad	35.04848	11.83092	16.58	69.08

Source: Author's calculation

the lack of informality measures in the literature. The mean for tax revenue in the region was 23.50465, with a standard deviation of 9.556973. This is comparable to that of LAC region. However, SADC still remains behind the levels in OECD by over 10%. OECD (2018a) suggests that in 2000, Africa had an average tax ratio of 14% which rose to 19.1% in 2015. LAC was purported to have grown from 18% in 2000 to 23.1% while the average for OECD countries remained at 34% for the period 2000 to 2015.

Figure 1 shows a comparative level of tax ratios in the SADC region. The tax-to-GDP ratio describes the taxes incurred as a percentage of GDP for the same period (in %)

Notably, since 2007 Lesotho has collected tax revenue that surpassed the regional mean for the period 2002–2016.

Model selection

The stochastic tax frontier used in this study follows the standard stochastic production frontier by Aigner, Lovell, and Schmidt (1977). Although there are many functional forms for production functions, this study considered the Cobb-Douglas function and the Translog function as done by several other empirical studies as the models are considered to model reality better than other functional forms. The Log-likelihood test was conducted to choose between the Cobb-Douglas function (restricted model) and the

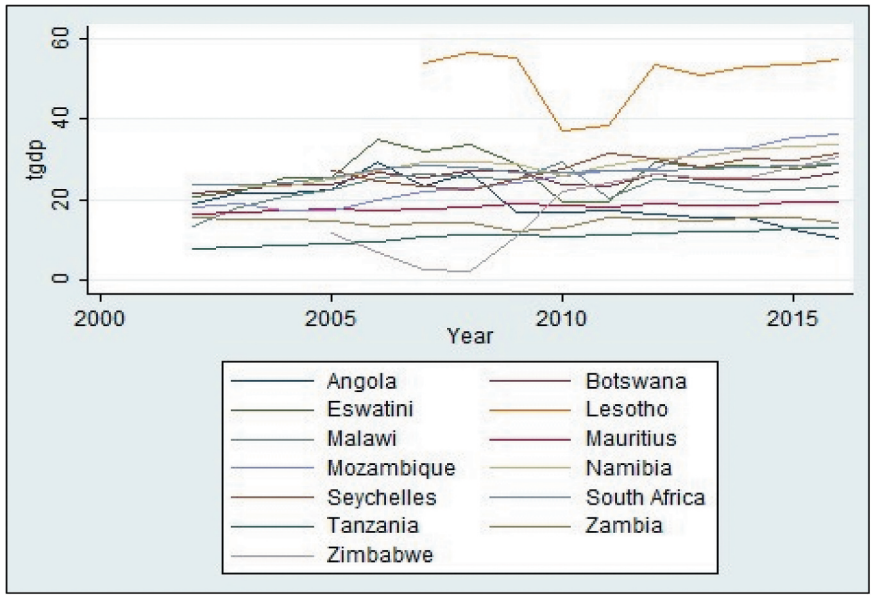


Figure 1. Comparative levels of tax performance in SADC (2002–2016). Source: Authors' calculations

Translog function (unrestricted model) against the null hypothesis that the restricted model is statistically better than the unrestricted model. Table 5 shows the results comparing the two models to ascertain the model that was more appropriate for the estimation.

Therefore, this study rejects the null hypothesis that the Cobb-Douglas function is more appropriate than the Translog function; hence the latter was adopted to estimate tax capacity and tax effort in the SADC over the period 2002–2016.

Estimation of tax capacity and tax effort in the SADC region

After doing all the diagnostic tests, this paper adopted a similar method to that of Heshmati, Kumbhakar, and Kim (2018) which involves a multistep procedure described in Kumbhakar, Lien, and Hardaker (2014). In this regard, this study followed the guide provided by Kumbhakar, Wang, and Horncastle (2015) on how to perform stochastic frontier analysis in STATA, leading to the subsequent stages described in the subsections that follow.

Step 1: Estimation of parameters for tax capacity and random individual effects

Using equation 1:

$$Y_{it} = \beta_0 + \theta_i + \beta x_{it} - r_i + v_{it} - u_{it} \quad (1)$$

Given equation (1), the first step was to estimate the parameters for tax capacity in the SADC using a random effects model to obtain an efficient estimate of β and the time-invariant components β_0 and θ_i.

The estimation of a log-log regression yields coefficients that are interpreted as elasticities in the tax frontier employed in this study. Table 6 depicts the estimates of the Cobb- Douglas tax function. In general, the results in Table 6 confirm the standing of similar findings obtained by the standard approach used to assess tax revenue performance. Notably, urban population, financial deepening, per capita GDP and openness are statistically significant in explaining tax capacity in the SADC as indicated by p-values of less than 0.05 level of significance.

Another alternative way to evaluate the statistical significance of estimated parameters is to follow the rule of thumb, which stipulates that the modulus of the Z-statistic should be greater than 1.96. In this regard, irrespective of the use of different econometric estimation methods, it appears that this does not lead to different interpretations of the role played by the determinants of tax performance (Cyan, Martinez-Vazquez, and Vulovic 2013).

Mu represents the mean of the truncated-normal distribution in terms of a linear function of covariates defined by inflation, corruption, government effectiveness and political stability.

Usigma specifies tax effort as heteroskedastic while vsigma specifies the idiosyncratic error as heteroskedastic. This was done to control for heteroskedasticity observed when diagnostic tests were carried out.

Table 5. Log-likelihood test results.

Likelihood ratio test	LR chi(20) 189.54 Prob > chi2
Assumption: $model_1$ is nested in $model_2$	0.0000

Source: Authors' calculation

Tax frontier estimates

From the five possible determinants of tax capacity selected in this study, only three were significant and positive while the other two variables were insignificant. The decision over the statistical significance of the explanatory variables was made by making use of p-values and the z-scores using the 0.05 level of significance. Nonetheless, the study also considered the 0.01 level of significance as well as the 0.1 level of significance. Financial deepening, economic development and trade openness were found to be significant while urban population and foreign aid were found to be insignificant.

Financial deepening

If financial deepening is increased by 1%, it is expected that tax revenue will increase by 0.2695%. Ndiaye and Korsu (2014) obtained a similar result and conclude that financial deepening is a key driver of tax revenue. When a country's financial sector is developed, it allows the flow of credit to productive activities thereby increasing the incomes of businesses and individuals. This tends to widen the tax net and tax base. In this

Table 6. Results for the estimation of tax capacity.

Lntgdp	Coefficient	Standard. Error.	Z	P > Z	[95% Confidence Interval]	
Tax						
Frontier						
Lnpop	0.0172615	0.0480296	0.36	0.719	−0.0768749	0.1113979
Lnfid	0.2695782	0.0347335	7.76***	0.000	0.2015018	0.3376546
Lnpgdp	0.1657211	0.0259864	6.38**	0.000	0.1147887	0.2166534
Lnopen	0.2933887	0.0309024	9.49***	0.000	0.232821	0.3539564
Lnforaid	−0.0028998	0.0121816	−0.24	0.812	−0.0267754	0.0209758
_cons	−0.1833979	0.190604	−0.96	0.336	−0.5569749	0.1901791
			Determinants of Tax effort			
Mu						
Pol	0.5354948	0.5927825	0.90	0.366	−0.6263376	1.697327
Corr	−2.83914	1.674065	−1.70*	0.090	−6.120248	0.4419666
Infl	9.24e-09	3.50e-09	2.64***	0.008	2.37e-09	1.61e-08
Geff	−0.5274294	1.07867	−0.49	0.625	−2.641585	1.586726
_cons	−3.854953	2.605358	−1.48	0.139	−8.961361	1.251455
			Variance of tax effort component			
Usigma						
_cons	−0.9636224	0.6177428	−1.56	0.119	−2.174376	0.2471312
			Variance of the idiosyncratic error component			
Vsigma						
_cons	−6.09982	0.4082406	−14.94	0.000	−6.899956	−5.299683
			Variance of the random effect component			
Theta						
_cons	0.2865696	0.0103834	27.60	0.000	0.2662185	0.3069208
sigma_u	0.6176637	0.1907786	3.24	0.001	0.3371633	1.131524
sigma_v	0.0473632	0.0096678	4.90	0.000	0.0317463	0.0706624
Lambda	13.04101	0.1891037	68.96	0.000	12.67037	13.41164

Significant at 1% (***), 5% (**), 10% (*)
Source: Authors' calculation

regard, Ndiaye and Korsu (2014) suggest that increasing the degree of monetization makes it easier to collect taxes and increase tax revenue.

Economic development

A 1% change in per capita is expected to increase tax revenue by 0.1657%. Steenekamp (2007) asserts that the level of development is a critical factor for governments to raise adequate revenue to finance public spending as rising per capita incomes tend to drive urbanization and non-agricultural activities (Besley and Persson 2013). This in turn means that more economic activities will fall in the formal sector facing increased exposure to observation by the government (Besley and Persson 2013). The findings are consistent with the greater part of empirical evidence on the determinants of tax revenue performance.

Trade openness

Increasing openness by 1% is expected to yield an increase in tax revenue 0.2934%. In the wake of globalization, many economies have increasingly liberalized trade. The literature considers the international trade sector in developing countries to be the most monetized sector of the economy. Several studies suggest that openness has a positive impact on the tax revenue to GDP ratio (Stotsky and WoldeMariam 1997; Ghura 1998; Tanzi and Zee 2001; Agbeyegbe, Stotsky, and WoldeMariam 2004; Addison and Levin 2012). Conversely, Imam and Jacobs (2007) and Bird, Martinez-Vazquez, and Torgler (2008) suggest a negative relationship while Karagöz (2013) argues that this result could be because only few taxes are directly affected by openness.

Although some studies have found the size of the population and foreign aid to be important in explaining tax revenue performance, the findings of this study show otherwise.

Random-effects component

The random effect component measures the difference between the average tax revenue in each SADC member state and the regional average score of tax revenue. Table 4 shows the summary of the random-effects component in the SADC after estimating equation (12). The random-

effects component controls for unobserved heterogeneity often unaccounted for in the standard approach. From Table 7, the constant of the variance of the random effects component was statistically significant.

The mean for the random-effects component in the SADC is 3.420387. However, there is huge dispersion in the region as indicated by the difference between the minimum and maximum values and the average deviation of 0.3991832.

Step 2: Estimation of transient tax effort/efficiency

The second step involves estimating transient tax effort u^*_{it} through the predicted values of e^*. The study employed the standard stochastic frontier approach using the Battese and Coelli (1988) approach to obtain estimator to obtain the predicted value of time-varying residual technical efficiency [exp $(u_{it}|e^*_{it})$]. The assumption made was that $v_{it} \sim (0, \sigma_v^2)$ and $u_{it} \sim N_+(0, \sigma_u^2)$.

The method used to estimate the determinants of tax effort results in estimates whose magnitude is of limited relevance because E $[u_i|z_i]$ is nonlinear in z. Hence, the slopes of the estimates of z_i are not the same as the marginal effects of (Kumbhakar, Parmeter, and Zelenyuk (2017). Regarding the different parametric distributions, Kumbhakar, Parmeter, and Zelenyuk (2017) suggest that when the truncated normal distribution is assumed, the sign of the coefficient of any determinant of tax effort does not always imply that it will be the direct impact of z_i on tax effort. Kumbhakar, Parmeter, and Zelenyuk (2017) therefore suggest that caution must be exercised not to directly interpret the impact of the determinants of tax effort purely based on the signs of the coefficients. Kumbhakar, Parmeter, and Zelenyuk (2017) maintain that concise statistics like the average partial effect (APE) or the partial effect of the average (PEA) can be used, although caution is essential. Nevertheless, this study elected not to give estimates of the marginal effects.

In this regard, this study considers the notions raised by Kumbhakar, Parmeter, and Zelenyuk (2017) and therefore reports on both the signs of the coefficients and marginal effects of the determinates of tax effort in the SADC. Table 8 shows the regression results for transient tax effort, while

Table 7. Summary for estimated random-effects component in the SADC (2002–2016).

Variable	Mean	Standard deviation	Min	Max
Random Effect	3.420387	0.3991832	2.557146	4.156366

Source: Authors' calculation

Figure 2 shows graphs by country of transient tax effort in the SADC. In this case, the transient estimated efficiency scores are not affected by unobserved heterogeneity.

The mean score of tax efficiency in the SADC is 0.7060952 based on the Battese and Coelli (1988) approach. This suggests that there was about 70.61% tax effort towards the attainment of maximum or potential tax revenue. Hence SADC operates at an average of about 70.61%. In this regard, an additional 29.39% of tax effort is required to get to maximum tax revenue in the region. The results show a minimum transient tax effort score of 0.1368 and a maximum score of 0.9969 while the average deviation from the mean transient tax effort is about 21.73%. The range of 0.86003 suggests the existence of wide variation in the level of tax effort in the SADC.

Given the need for tax cooperation and tax coordination in the SADC, the range of transient tax effort is indicative of great dispersion among member states. Although tax policy is a key instrument that can be used to tune tax effort towards the attainment of potential revenues, the effort in member states is pitched at various levels. Tax policy coordination will likely be stalled as other countries have very low levels of tax effort.

The paper estimated the determinants of mean tax effort where tax effort was modelled against four independent variables, which include political stability, corruption, inflation and government effectiveness. The p-values of corruption and inflation show that the variables are statistically significant in explaining changes in tax effort at the 0.1 level of significance and 0.05 level of significance respectively.

Table 8. Summary of transient tax effort in tax systems of the SADC.

Variable	Mean	Standard deviation	Min	Max
TE	0.7060952	0.2173386	0.1368432	0.9968731

Note: TE (bc) refers to transient tax effort that was obtained Battese and Coelli (1988).
Source: Author's calculation

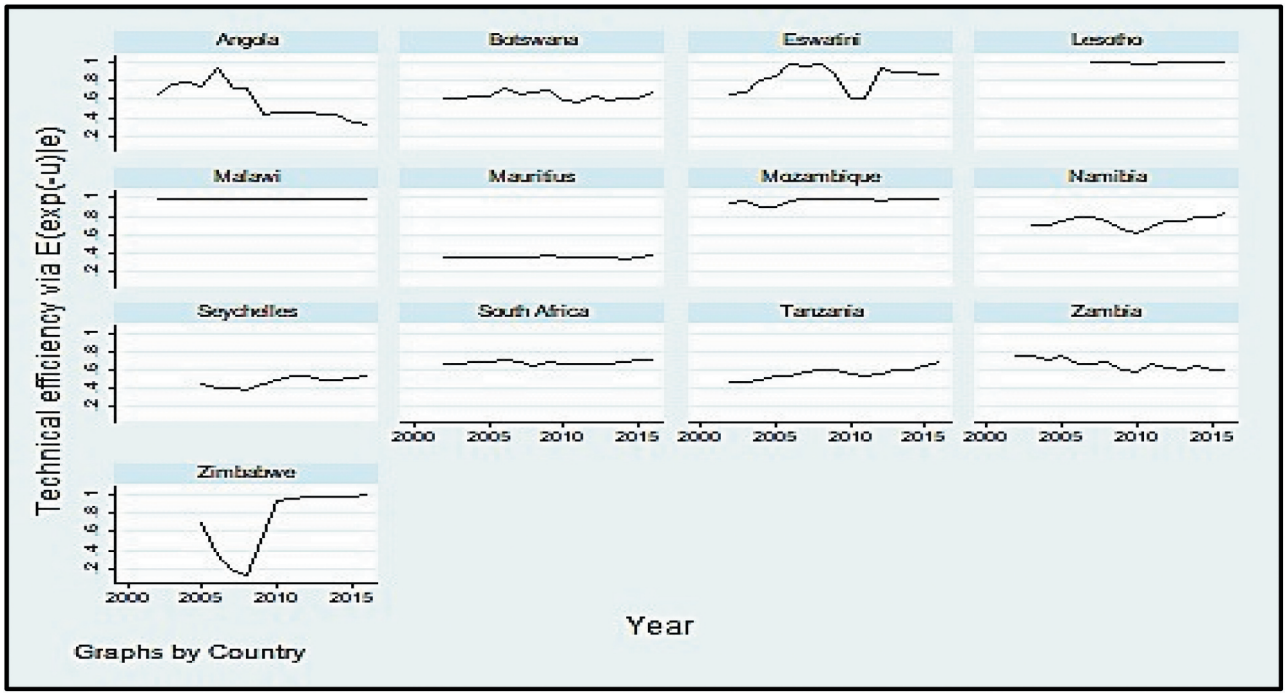


Figure 2. Transient tax effort of tax systems in the SADC (2002–2016). Note: Tax effort in Figure 2 is based on the Battese and Coelli (1988) approachSource: Authors' calculation

Corruption

A unit increase in corruption is expected to reduce tax effort by 2.8391 and this is consistent with the findings of Fenochietto and Pessino (2013), Cyan, Martinez-Vazquez, and Vulovic (2013) and Langford and Ohlenburg (2015).

The adverse effects of corruption may reduce the efficiency of tax systems through policy decisions and the administration of taxes (Langford and Ohlenburg, 2015). In the former, corruption may be infested in the political system where political interest overrides economic reasoning and hence if the desire to tax is not aligned with the need for political survival, political dominance and political legitimacy, then less effort would be exerted in raising potential tax revenues. On the other hand, designing taxes appropriately is critical in view of the environment in which taxation occurs. Rampant corruption may increase inequalities as corrupt political figures may recuse themselves from paying taxes, as such tax morale is likely to decline leading to tax avoidance and tax evasion. Ajaz and Ahmad (2010) describe corruption in tax administration as one of the institutional problems affecting the process of tax revenue generation. Notably, corruption as a social issue seems to be relatively easier to deal with than the complications of restructuring tax handles. According to Besley and Persson (2013), if political turnover is considerable then corruption may hinder the process of building effective tax systems. Bird, Martinez-Vazquez, and Torgler (2008) suggest that it is possible that developing countries do not meet their tax revenue needs because those who dominate political institutions may not be willing to increase taxes. In this regard, Bird, Martinez-Vazquez, and Torgler (2008), Ajaz and Ahmad (2010) hypothesize that if taxpayers feel that their country is rampant with corruption, and then there is an increased likelihood of not complying with tax obligations. This in turn will result in declining tax revenues. Several empirical studies suggest that corruption negatively affects tax revenue generation in developing countries (Gupta 2007; Imam and Jacobs 2007; Ajaz and Ahmad 2010).

Corruption affects the quality of governance and is likely to influence tax effort negatively as expected. Notably, Slemrod (2016) contends that assessing the effect of corruption on tax systems in developing countries is important as bureaucratic

organizations can reduce the effectiveness of the public policy. In this regard, Cyan, Martinez-Vazquez, and Vulovic (2013) suggest that corruption may limit tax effort by increasing the effective tax on taxpayers owing to unobserved payments being charged on tax and yet they do not find their way into public finance accounts. However, this is likely to motivate a further reduction in taxes if the payment for corruption falls short of the amount required as tax. Additionally, Cyan, Martinez-Vazquez, and Vulovic (2013) posit that tax policy decisions like an increase in the tax rate can result in increased bargaining power being handed over to tax collectors, hence increased corruption allows the loss of potential tax revenue.

Inflation

The results show a positive relationship between inflation and tax effort as a unit increase in inflation is expected to yield a 9.24e-09 increase in tax effort. Fenochietto and Pessino (2013) assert that inflation decreases tax effort, meaning that increased levels of inflation move tax effort downward or increase tax effort in tax collection. Similarly, Ciro, Camilo and de Mendonça (2016) argue that inflation targeting can improve the reputation of central banks in improving tax capacity use. This is contradictory to the findings of this study probably because the average inflation for the region was raised by high inflation in some individual countries like Zimbabwe. However, the SADC region has not performed as expected in meeting the target of 3–7% of inflation. In this regard, member states may be exerting more effort towards taxation, compensating for the loss of real value of their tax collections, through raising more revenue. However, political stability and government effectiveness were found to be statistically insignificant in explaining tax effort in the SADC.

Since transient tax effort relates to tax effort in the short run, it means that tax effort can be adjusted over time without making major tax policy changes (Baduneko and Kumbhakar, 2016). In this regard, it would imply that if tax effort is limited in one particular year, it is most likely that a particular event of corruption or inflation would have stimulated the change but it would not mean it would happen again in the same year in the period that follows.

While most of the countries have tax efforts which are above 50% over the period 20,022,016, Zimbabwe was below average for the greater part of the period before 2010. Notably, Figure 2, suggests Malawi and Lesotho have somewhat achieved consistent and high levels of tax effort during the period of analysis.

Step 3: Estimation of persistent tax effort

The third step involves estimating persistent tax effort r^*_i through the predicted values of α^*. The study used the standard stochastic frontier approach and the Jondrow et al. (1982) while assuming that $\theta_i \sim (0, \sigma_\theta^2)$ and $r_i \sim (0, \sigma_r^2)$. Table 9 shows the summary of persistent tax effort.

The mean score of persistent tax effort is about 13.35%. On average, SADC countries fall short of attaining full tax capacity or their tax frontiers by 86.65% in the long run. The maximum value of persistent tax effort is one while the minimum value is 0.1034. In addition, the average deviation is relatively low at about 9.14% indicating that the variation in the persistent efficiency in the SADC is relatively low. High persistent tax effort would mean that a country is expected to operate such a tax system over time with those inefficiencies unless some major changes are undertaken. In this regard, high levels of persistent tax effort should be of concern to tax policymakers (Baduneko and Kumbhakar et al., 2016).

Figure 3 shows persistent tax effort in member states of the SADC over the period 20,022,016. This paper, therefore, finds it unnecessary to advocate reorientation and restructuring of tax systems in the region as the experiences low persistent tax effort. Since it does not change over time, if a country wants to improve efficiency then some fundamental changes are needed in tax policy or tax administration. Before the period 2010, Zimbabwe had a sharp increase in persistent tax effort, which would have called for tax policymakers to review the

Table 9. Summary of persistent tax effort.

Variable	Mean	Standard deviation	Min	Max
PTE	0.133524	0.0914642	0.1033575	1

Source: Authors' calculation

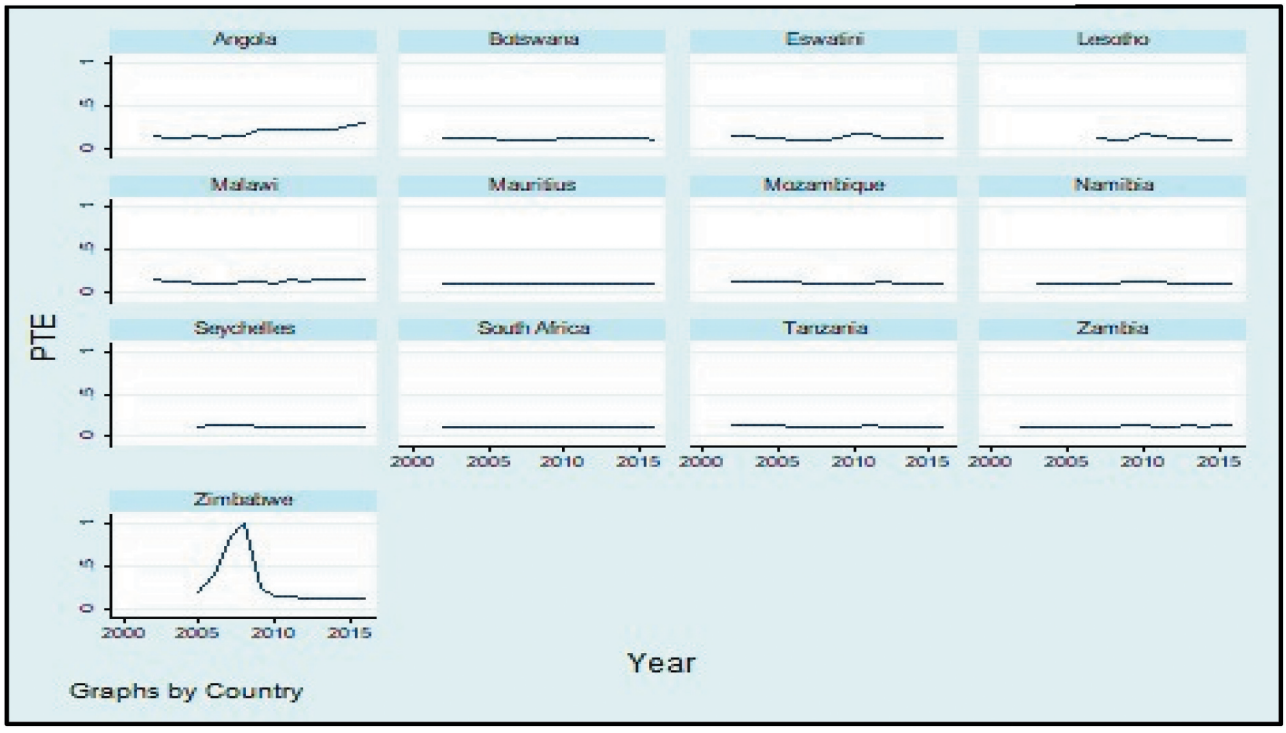


Figure 3. Persistent tax effort of tax systems in the SADC (2002–2016). Source: Author's calculation

tax system and consider options to reorient or restructure. However, in the aftermath of 2010, persistent tax effort began to decline and relatively lower, consistent and comparable with other SADC member states.

Heshmati, Kumbhakar, and Kim (2018) suggest that lower persistent tax effort is expected if heterogeneity is separated from persistent tax effort. This assertion is consistent with the findings of this study as it separated heterogeneity from persistent tax effort. In addition, Baduneko and Kumbhakar (2016) argue that if the level of persistent tax effort is similar among panels then the overall value will be low.

Summary of tax effort in the SADC (2002-2016)

The tax effort index is the ratio of the actual tax-GDP ratio over that estimated tax-GDP ratio. Table 10 shows the overall tax effort of SADC tax systems. Persistent tax effort is low and has lower dispersion while transient tax effort is high with considerable dispersion of about 21.73%. Overall, the mean tax effort is 0.08.

Figure 4 shows the overall state of tax effort in the SADC over the period 2002–2016.

According to Heshmati, Kumbhakar, and Kim (2018), there is a trade-off between high levels of tax effort and the dispersion of tax effort. The higher the levels of tax effort are, the closer it is to the tax frontier, hence lower dispersion.

Had the study not disentangled heterogeneity, persistent tax effort and transient tax effort in the SADC, Table 11 shows the results that would have been obtained for tax effort estimates in the SADC and the rankings of member states.

This study, therefore, concurs with Brun and Diakite (2016) that some methodologies tend to overestimate or underestimate tax effort. Table 12 shows the estimated persistent, transient and overall tax effort in the SADC over the period 2002–2016.

Table 10. Overall tax effort in tax systems of the SADC (2002–2016).

Variable	Obs	Mean	Standard. Deviation	Min	Max
Transient	182	0.7060952	0.2173386	0.1368432	0.9968731
PTE	182	0.133524	0.0914642	0.1033575	1
OTE	182	0.0875422	0.0283364	0.0371725	0.1599946

Source: Author's calculation

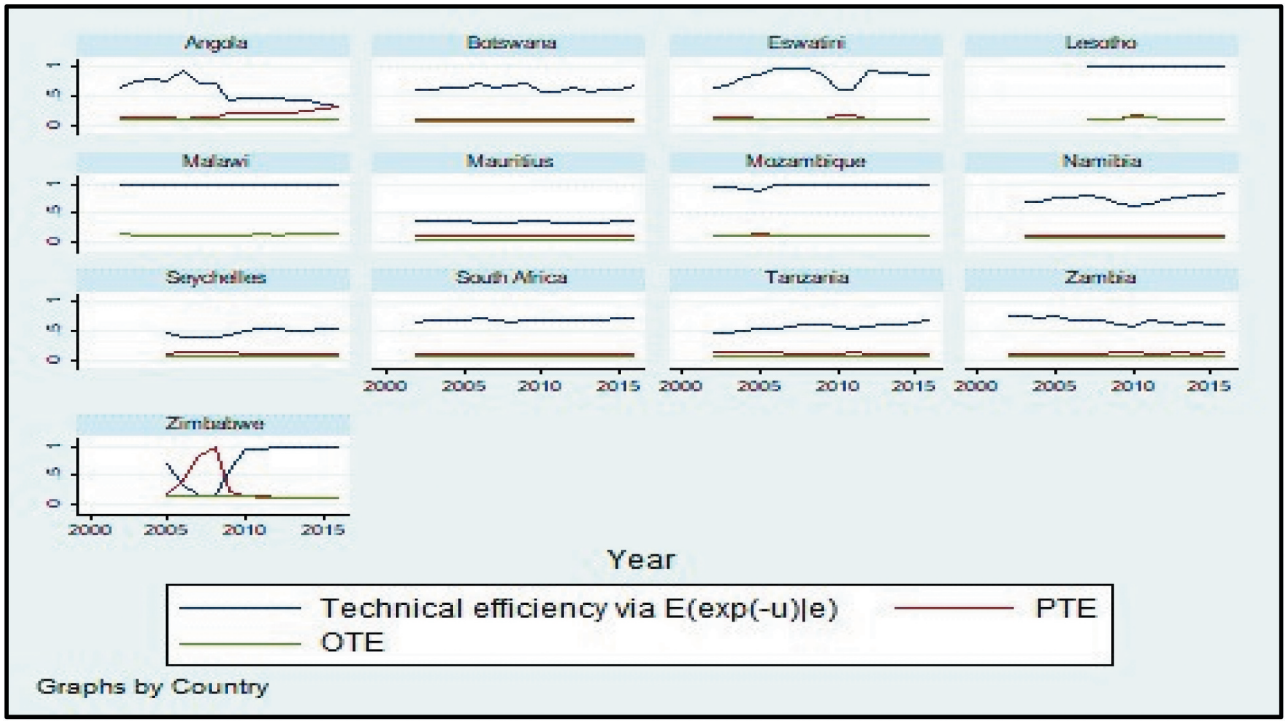


Figure 4. Tax effort in the SADC (2002–2016). Source: Authors' calculation

Table 11. Average tax-to-GDP ratio, estimated tax capacity and estimated tax effort.

Country	Average tax-to GDP ratio	Estimated tax capacity	Estimated tax effort	Rank in the SADC region
Angola	19.06%	23.60%	0.81	9
Botswana	25.20%	26.15%	0.96	7
Eswatini	27.01%	21.15%	1.28	3
Lesotho	50.63%	21.94%	2.31	1
Malawi	22.95%	16.07%	1.43	2
Mauritius	18.15%	29.11%	0.62	12
Mozambique	25.23%	20.00%	1.26	4
Namibia	28.71%	25.63%	1.12	5
Seychelles	27.67%	31.43%	0.88	10
South Africa	26.85%	26.53%	1.01	6
Tanzania	10.77%	17.64%	0.61	13
Zambia	14.64%	19.48%	0.75	11
Zimbabwe	18.05%	19.01%	0.95	8
SADC	24.22%	22.90%	1.06	

Source: Author's calculation

Conclusion

The substantive aim of this paper was to assess the determinants of tax capacity and tax effort in Southern Africa, represented by SADC. The methodology of the study reported on this paper was to estimate determinants of tax capacity and tax effort using stochastic tax function and unbalanced panel data for Southern Africa represented by the 13 SADC countries. The paper disentangled the error term to estimate the random effects separately from tax effort to capture the time-invariant country-specific effects. Further, tax effort was classified as persistent (long-run) and transient (short-run). The findings indicate that financial deepening, economic development and trade openness influence tax capacity while corruption and inflation influence tax effort. The findings indicate low persistent tax effort relative to transient tax effort among SADC countries. Since persistent tax effort is more concerned about tax policy while transient tax effort relates to tax administration issues, this study notes that there is a dire need to address long-term tax effort in the SADC through reorientation or restructuring of tax systems as a way of moving closer to attaining maximum tax capacity. Overall, tax effort was found to be relatively low in the region owing to the low levels of persistent tax effort.

There is a common trend of delays in the process of tax policy making especially among low tax effort countries. Nonetheless, there are success stories of countries like Botswana that transformed from having one of the least efficient tax systems in Africa to one of the most efficient. Notably, there it seems that greater emphasis was placed on improving tax administration, hence, several countries

Table 12. Estimated persistent tax effort, estimated transient tax effort and overall tax effort in the SADC (2002–2016).

Rank in the SADC region	Country	Transient Tax effort	Persistent Tax effort	Tax effort
1	Zimbabwe	0.73	0.3090	0.13
2	Malawi	0.991	0.1300	0.13
3	Lesotho	0.995	0.1165	0.12
4	Mozambique	0.97	0.1171	0.11
5	Eswatini	0.83	0.1262	0.102
6	Angola	0.58	0.188	0.1
6	Zambia	0.66	0.1151	0.08
8	Namibia	0.74	0.1102	0.08
9	South Africa	0.68	0.1070	0.073
10	Botswana	0.63	0.1079	0.07
11	Tanzania	0.57	0.1191	0.067
12	Seychelles	0.47	0.1154	0.05
13	Mauritius	0.36	0.1063	0.04
	SADC	0.71	0.13	0.08

Source: Authors' calculation from estimated stochastic tax frontier estimates

made legislative changes to establish autonomous tax revenue agencies or to alter rules and procedures of administering taxes. This coincides with the fact that the quantitative analysis shows higher tax effort relating to tax administration than tax policy.

[2]This study focused on tax capacity and tax effort in the SADC, in view of the need to inform tax policymakers towards a practical guide to tax policy in the region. However, it came with its own limitations. Since there are numerous ways to assess tax capacity and tax effort, this study could not employ all the four rungs suggested by Slemrod (2016). In this regard, further studies can consider how enforcement rules and remittance rules influence tax capacity and tax effort since this study focused on tax rates, tax bases, tax structure and elements of the bureaucratic organization which include corruption and government effectiveness. In other studies, scholars pay attention to particular sectoral tax bases, however, this study tended to be general by focusing on the wider definitions of tax base. However, this study concurs with Mawejje and Francis Munyambonera (2016) that there is need for further studies to also consider sector–specific elasticities on tax revenue. Nevertheless, this may be ideal on the condition that current tax policies in the SADC first change so that it is possible to evaluate the effect of such changes. Although the political variable considered in this study was insignificant, this study believes that since the type of government is presumed to influence economic prosperity, it may be prudent for further studies to determine whether the same applies for tax capacity and tax effort in developing countries. This comes against the backdrop that there tend to be high economic prosperity indices in countries led by monarchies, hence it is plausible that there may be a phenomenon to link good governance with tax capacity and tax effort.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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[2]Since transient tax effort is concerned with tax administration while persistent tax effort is concerned with tax policy, the ranking in this study is based on the latter. In relation to tax collections Tanzania, Zambia, Zimbabwe, Mauritius, Angola and Malawi have low tax collections, while, Botswana, Mozambique, South Africa, Eswatini, Seychelles, Namibia and Lesotho have high tax collections in the respective order.

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