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Tax revenue mobilization effort in Southern African Development Community (SADC) bloc: Does ICT matter?

Cogent Economics & Finance

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Suggested Citation: Jemiluyi, Olufunmilayo Olayemi; Jeke, Leward (2023) : Tax revenue mobilization effort in Southern African Development Community (SADC) bloc: Does ICT matter?, Cogent Economics & Finance, ISSN 2332-2039, Taylor & Francis, Abingdon, Vol. 11, Iss. 1, pp. 1-14, https://doi.org/10.1080/23322039.2023.2172810

This Version is available at: https://hdl.handle.net/10419/303963

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Cogent Economics & Finance

ISSN: (Print) (Online) Journal homepage: www.tandfonline.com/journals/oaef20

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To cite this article: Olufunmilayo Olayemi Jemiluyi & Leward Jeke (2023) Tax revenue mobilization effort in Southern African Development Community (SADC) bloc: Does ICT matter?, Cogent Economics & Finance, 11:1, 2172810, DOI: <u>10.1080/23322039.2023.2172810</u>

To link to this article: <u>https://doi.org/10.1080/23322039.2023.2172810</u>

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Published online: 13 Feb 2023.

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Received: 30 September 2022 Accepted: 21 January 2023

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Reviewing editor: Goodness Aye, Agricultural Economics, University Of Agriculture, Makurdi Benue State, Nigeria

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DEVELOPMENT ECONOMICS | RESEARCH ARTICLE

Tax revenue mobilization effort in Southern African Development Community (SADC) bloc: Does ICT matter?

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economics & finance

Olufunmilayo Olayemi Jemiluyi^{1*} and Leward Jeke²

Abstract: In addition to performing their basic fiscal functions, governments in developing economies are constantly challenged by new and re-emerging socioeconomic issues such as insecurity, hunger, natural disaster, collapsing infrastructure and disease outbreaks. These piles of challenges have made the competition for limited resources fierce and hence the need to mobilize more funds. Bearing this in mind, this study explored the role of ICT in mobilizing tax revenue in a trade bloc made up of developing countries—Southern African Development Community (SADC). Using panel data of 12 member countries of the bloc between 2001 and 2020 within the Fully Modified OLS (FMOLS) framework, the estimated parameters of the employed measures of ICT (internet usage and mobile cellular) indicated that ICT has a statistically significant positive effect on tax revenue. The results are consistent for all categories of taxes examined including total tax revenue, taxes on goods and services, and taxes on income, profit and capital gains. Following the outcomes of this study, it is recommended that in addition to sound public finance policies, policies aimed at fostering digital automation of tax processes should be focal in revenue mobilization plans of member countries.

Subjects: Economics and Development; Economics; Finance

Keywords: tax revenue; ICT; public finance; digital technology; Southern Africa; SADC

1. Introduction

The outbreak of the COVID-19 pandemic has again exemplified the significance of public revenue especially in the developing economies. In fact, fiscal buoyancy was a significant factor in how countries responded to the pandemic. Aside from the needed resources in the health sector to contain the spread of the virus and treat the infected population, the aftermath socioeconomic challenges of the scourge also have huge financial implications. While the poor developing countries were waiting on development partners for assistance due to fiscal constraints imposed by lean public resources, many rich developed countries were able to actively rise to the occasion owing to buoyant fiscal capacity. Thus, the latter were able to forestall various socioeconomic challenges fueled by the pandemic especially in the wake of the aftermath lockdowns. On the contrary, developing economies are still grappling with diverse socioeconomic woes exacerbated by the pandemic (OECD, 2020; World Bank (2021b)).

Public revenue is in fact an integral aspect of any economy, representing a key ingredient in the achievement of developmental plans and agendas (IMF, 2017; World Bank (2021b)). In particular, mobilization of resources has been argued as a significant predictor of the achievement of the





Millennium Development Goals and the post-2015 Sustainable Development Goals (SDGs). As a matter of fact, the poor success of MDGs in most developing countries was hinged on low domestic resources amongst other factors (UNDP, 2010); and in the same vein, it has been identified as a principal element in the failing of SDGs in those countries (United Nations, 2022a, 2022b; World Bank (2020, 2018). Saddled with diverse socioeconomic aspirations, competition for limited resources has become fierce in many developing countries (OECD, 2020). In addition to performing their basic fiscal functions, governments in developing economies are constantly challenged by new and re-emerging socioeconomic issues such as insecurity, hunger, natural disaster, collapsing infrastructure and disease outbreaks with huge implication for public resources (OECD, 2020).

Although sources of public finance are diverse and vary in characteristics, due to features such as sustainability and stability, tax revenue has been pinpointed as a more reliable and efficient source of financing public expenditure than other sources such as foreign official development assistance (ODA), foreign investment inflows and debt which are often rippled with unsustainability and volatility. However, developing countries are particularly challenged in mobilizing tax revenue due to prevailing high level of tax evasion. Low tax revenue has been identified as both a cause and a product of underdevelopment in the developing regions (World Bank (2014, 2021a)). While tax revenue as a proportion of GDP is as high as 40 percent in rich developed countries, the largest share of lower- and middle-income countries are unable to mobilize tax revenue to the tune of 15 percent share of GDP (World Bank (2021a)). Evidence has shown that the ability of a government to raise tax is either enhanced or hampered by changes in certain factors such as the level of economic development (Gnangnon & Brun, 2019; Gupta, 2007), nature of the economy (Arodoye & Izevbigie, 2019; Manamba & Kaaya, 2020), openness to trade (Gnangnon & Brun, 2019), institutional quality (Gupta, 2007; Johnson & Omodero, 2021; Arvin et al., 2021) and foreign direct investment (Camara, 2022).

Much recently, the wave of research on the role of ICT in economic performance has likewise permeated the public finance literature and its role in revenue mobilization has surged in recent time (Ofori et al., 2021; Otieno et al., 2013; Uyar et al., 2021; Wandaogo et al., 2022). The intuition that ICT will have a fueling effect on tax revenue generation is linked to its ability to mitigate the challenges of delay, high administrative cost, evasion and corruption associated with paper-based tax procedures (Ajala & Adegbite, 2020; OECD, 2021; IMF, 2021). In addition, ICT could spur tax revenue by increasing tax base through its employment generation capabilities, and also by spurring productivity through innovation, ICT could raise taxable income and profit in the economy (Cirera et al., 2016; Dedrick et al., 2013; UN-DESA, 2021). It is, however, argued, on the other hand, that ICT development could hamper tax revenue. Tax-generating capacity of ICT is contended on the ground that ICT erodes tax base by providing platforms for unrestricted cross-border transactions, thereby aiding taxpayers, particularly multinationals, to repatriate profits (Hanrahan, 2021; OECD, 2018).

Owing to the dual challenge of low technological progress and paucity of public fund, the growing research thread has its focus more on the developing and emerging economies of Africa, Asia and Latin America. Although the strand of the literature for Africa and sub-Saharan Africa (SSA) in particular is growing (Adegboye et al., 2022; Adhikari, 2022; Ali et al., 2017; Mpofu, 2020; Ofori et al., 2021), we are making contribution to the literature by investigating the nexus in the southern region of SSA. Specifically, we evaluated the relationship in a sample of Southern Africa Development Community (SADC). While we are aware that the member countries of the SADC bloc were pooled in analyses on the continent of Africa and SSA, findings of such studies cannot be validated for specific sub-regions of the continent due to variation in political and socioeconomic structure among the pooled countries (Adegboye et al., 2022; Chimilila & Leyaro, 2018).

Although our interest in the SADC region is premised on the need to investigate the relationship within panel of countries with similar structure thereby controlling the problem of unobserved heterogeneity characterizing pooled analyses of countries with different structural context, the analysis is also worthy of consideration in the SADC region due to certain peculiarities of the region which may have implications for the relationship between ICT and revenue mobilization. In particular, the expected dividends of ICT are not automatic as certain enabling conditions such institutional quality, literacy and ICT access and usage are imperative to reaping the intuitive dividends; and these factors vary across countries, hence the need to reassess the relationship among countries with similar socioeconomic structure. For example, in addition to relatively better technology-support infrastructure such as power, there has also been higher investment in digital infrastructure in Southern Africa region than other sub-regions of SSA (Kraemer-Mbula & Muchie, 2009; Kraemer-Mbula et al., 2021). According to the Africa Infrastructure Development Index (AIDI) 2018 sub-region ranking, Southern Africa only came next to the Northern Africa region (Africa Development Bank (AfDB), 2018). On country basis, six of the fourteen Southern Africa countries are in the first twenty countries among the ranked 54 African countries.

Moreover, level of literacy, which is a requisite for ICT skill and usage (Donou-Adonsou, 2018; Ortiz et al., 2015), is relatively higher in Southern Africa, and in the same vein, the sub-region is characterized by strong institutional quality (Kraemer-Mbula et al., 2021). For instance, Southern Africa ranks second in secondary education enrolment and completion rates among the five sub-regions of Africa (UNESCO,). Furthermore, the sub-region is a focus for development partners on the matter of digital development (Kraemer-Mbula et al., 2021; OECD, 2021). Therefore, given the above narratives, ICT could have unique implications for revenue generation in the sub-region. Thus, an empirical analysis of the role of ICT in revenue mobilization in the SADC region is worth considering as this will provide a more vivid understanding of the relationship in the sub-region and offer further insights on the subject matter.

The rest of the article is structured as follows; next to this introductory section is a brief review of extant literatures on the subject matter. Sections 3 and 4 focus on methodology and results and discussion of findings, respectively, while the final section centers on conclusion and policy recommendations.

2. Literature review

The wave of research on the role of ICT in economic performance has likewise permeated the public finance literature, and its role in revenue mobilization has particularly surged in recent times. In order to emphasize the contemporaneity of the ICT-revenue mobilization nexus, our review of literature focused on empirical evidence in recent time. Amongst the most recent studies, Wandaogo et al. (2022) assessed the revenue mobilization capacity of ICT-enabled Persons to Government (P2G) mobile payment system in developing countries. The propensity scores matching regression estimates showed that the investigated ICT product serves as a pulley for mobilizing different types of taxes in developing countries. Also, in another recent study, Martinez et al. (2022) examined factors that boost revenue collection in the OECD countries. Amongst other factors, the author and his colleagues documented digitalization as a foremost tax booster. Gnangnon and Brun (2018) tested the effect of government effort at bridging the gap between national internet usage and global average internet usage on revenue mobilization in a sample of developed and developing economies. The findings showed that reducing internet gap causes significant increase in tax revenue. Further analysis of the sub-samples showed that the effect is most significant in lower-income countries. In an earlier study, Koyuncu et al. (2016) tested the hypothesis whether ICT development stimulates tax revenue in developing countries. The fixed effect analysis based on 157 developing countries affirmed that ICT stimulates tax generation in the studied context.

Moreover, in an attempt to find solution to the twin challenge of poor technological development and low public revenue in Africa, the ICT-tax revenue literature is also growing in the continent. The relationship has been investigated at the aggregate level, sub-region as well as country-specific studies. For instance, in a literature review of ICT opportunities and challenges in the Africa continent, Mpofu (2020) argued that while revenue mobilization potentials are well documented, the potential could be compromised by negative externalities such as high cost of ICT products which could hinder the adoption of ICT in tax processes. In a study on SSA, Ofori et al. (2021) investigated the independent as well as the joint effect of ICT and industrialization on public revenue. The empirical analysis explored within the framework of GMM found that ICT is important for the generation of all categories of tax tested in the analysis. Similar findings were reported for SSA by Adegboye et al. (2022).

In a firm-level analysis, Ali et al. (2017) assessed how the use of electronic sales register machines (ESRM) has influenced fiscal capacity of the Ethiopian economy and the resultant effect on VAT. The authors found that the adoption of the machine has led to significant rise in VAT revenue in the country. In a similar analysis on Nepal, Adhikari (2022) asserts that tax revenue has risen upon automation of tax administration process. Based on the estimates of the survey study, the effect was hinged on the cost- and time-saving effects of ICT. Otieno et al. (2013) also reported that effectiveness and efficiency are achieved in Homa Bay county of Kenya tax administration due to adoption of ICT-based tax system.

In a quest to thoroughly explore the ICT-tax revenue nexus, a strand of the growing literature focuses on the indirect effect of ICT on tax revenue. For example, Uyar et al. (2021) examined the role of ICT in curbing the menace of tax evasion in a large sample of developing countries and hence the attendant implications for tax revenue. The panel analysis established that ICT amplifies the reducing effect of digitalization of government services on tax evasion with potential for increase in tax revenue. In a similar analysis of indirect effect of ICT on tax revenue, Gnangnon (2020) also found that internet usage promotes tax reform with resultant positive effect on revenue mobilization in developing countries. Mascagni et al. (2021) also tested if ICT helps in mitigating the challenge of non-tax compliance in Ethiopia. The authors found that ICT enhances tax compliance with a resultant effect of rise in both income taxes and VAT. Similar findings were documented by Li et al. (2020) and Harelimana and Gayawira (2020) for China and Rwanda respectively. In an empirical investigation focused on the Chinese Golden Tax Project (GTP) III Li et al. (2020) used data from quoted firms and the study's findings indicated that the adoption of ICT-powered GTP raised tax compliance by almost 2 percent. In Rwanda, Harelimana and his colleagues found that electronic billing machine (EBM) promotes tax compliance among smalland medium-scale enterprises.

On the contrary, in spite of the growing evidence on the tax fueling effect of ICT, a thread of the literature has likewise documented adverse or no effect of ICT on revenue generation. For example, Mallick (2021) using a composite ICT infrastructure index found that the use of ICT-enabled tax procedure has a statistically significant negative effect on mobilized direct and indirect tax revenue of the combined tiers of government in India. In the same vein, Okunogbe and Pouloguen (2022), in an assessment of how automation of tax administration has impacted tax payment in Tajikistan, found that introduction of e-filling of tax return increases tax evasion among firms which were previously unlikely to evade tax. Moreover, Hanrahan (2021) contend the revenuegenerating capacity of ICT in OECD countries. Exploring the effect of digitalization on taxgenerating capacities of the 36 member countries of the OECD, the static analyses suggest that advancement in digitalization of the economies deter tax generation, although the dynamic analysis suggests otherwise. In particular, the static analyses of pooled OLS and fixed effect estimators found that increasing digitalization of the economy has a statistically negative effect on tax revenue in the OECD countries. Furthermore, in an earlier study, Chimilila and Leyaro (2018) found varying effects of ICT types on tax revenue in SSA. The authors, using FMOLS estimator, found a statistically significant positive effect of internet usage while no significant effect was documented for mobile subscription. Using panel ECM estimator, mobile subscription has

a statistically negative effect on tax revenue while a statistically positive effect was found for internet usage.

Thus, following an extensive review of related research, we uncovered that although the ICTrevenue mobilization literature is growing, it is particularly small for sub-Saharan Africa, and to the best of our knowledge, no study has examined the relationship for the Southern area of the subregion.

3. Methodology

3.1. Data and variables

In order to investigate the possible role of ICT development in revenue mobilization in the SADC region, we collected annual time series on 12 member countries of SADC representing 75 percent membership of the trade bloc. Specifically, annual data spanning the periods of 2001 to 2020 were collected for Angola, Botswana, Lesotho, Madagascar, Malawi, Mauritius, Mozambique, Namibia, South Africa, Tanzania, Zambia and Zimbabwe. 2020. Our choice of countries is, however, largely determined by data availability. In particular, the adopted measures of tax categories employed in this study are missing for Democratic Republic of Congo, Congo Republic, Eswatini and Seychelles. The study period was also chosen based on availability of data and consideration for the intended method of estimation. In addition, the scope also coincides with the period of increased usage and penetration of ICT in the continent of Africa

For robust analysis, we examined the role of ICT in revenue mobilization effort for different forms of taxes, namely total tax revenue (TAXR), taxes on goods and services (TAXGS), and taxes on income, profit and capital gains (TAXC) (see appendix A for the definition of the tax categories). Also, we adopted two measures of ICT development, namely percentage of the population using internet (INTUSER) and mobile cellular subscription (MOBILE), to account for ICT usage and access respectively.

Other macroeconomic variables which have been identified as significant predictors of public revenue size were incorporated to curtail misspecification error due to omitted variable bias. Our choice of control variables was largely informed by consideration of the peculiarities of the context of our study, evidence from extant studies and data availability. Due to the significance of a country's level of economic development and degree of involvement in international trade in revenue mobilization (Gupta, 2007; Ofori et al., 2018, 2022), we collected data on economic development proxy by GDP per capita growth rate (GDPCG) and degree of trade openness (TRADE). Moreover, urbanization and labour force size have been argued as significant predictors of tax performance (Cebula, 2018); hence, urban population as proportion of total population (URBP) and labour force participation rate (LFPR) were included to represent the degree of urbanization and rate of economic participation respectively. Urbanization is regarded an important influencer of tax revenue in developing countries as tax-generating economic activities are mostly in the urban cities and towns. Furthermore, owing to the relevance of the informal sector in sub-Saharan African region, informality measured by the proportion of contributing family workers was also accounted for in our mode. For uniformity, data were obtained only from the World Development Indicator (WDI), an online database of the World Bank which compiles data at national, regional and global levels from internationally recognized sources.

3.2. Estimation technique

Since our study is concerned with pooling of data for many countries, our estimation strategy is therefore one of panel analysis. The meritorious features of panel model include its ability to control for heterogeneity in pooled data and enhancement of efficiency in estimation. Moreover, aside from its capacity in identifying and measuring relationships where time series are limited, panel model also mitigates the effect of multicollinearity in econometric regressions (Baltagi, 2005). While econometric literature is replete with various suggestions on estimation techniques

for panel models, not all is efficient in cointegrating regressions. For example, pooled ordinary least square (POLS), random and fixed effects models have been criticized for producing biased and inconsistent estimates when applied to regressions having cointegrated variables (Phillips & Hansen, 1990; Phillips & Moon, 1999). Thus, new methods with capacity to estimate cointegrating vectors of panel data were developed. These include within and between groups estimators such as ordinary least square estimators—fully modified OLS (FMOLS) and dynamic OLS (DOLS) estimators which have been adjudged efficient in producing unbiased estimates (Phillips & Hansen, 1990; Phillips & Moon, 1999; Kao & Chiang, 2001; Pedroni, 2000).

DOLS is a parametric method including the lagged first difference, while the FMOLS is a nonparametric approach. The relative efficiencies of both estimators have been subjected to empirical debates. While studies such as Harris and Sollis (2005) showed that DOLS is more efficient than FMOLS, Pedroni (2000) argued that the latter is more efficient owing to the former's higher size distortions. Ramirez (2007) also argued for the efficiency of FMOLS in small sample size. Since our study focuses only on Southern Africa represented by SADC trade bloc, our sample size is relatively small to what would have been obtained in the case of SSA, and we are further constrained by the challenge of data unavailability in some SADC member countries. Hence, we chose the FMOLS as the preferred method of estimation to combat the challenge of small size. Aside from its ability to produce asymptotically unbiased estimates in small samples, FMOLS also mitigates the inherent challenge of endogeneity and serial correlation in the regression model in addition to its capacity to correct for heterogeneity in cointegrating vectors (Hamit-Haggar, 2012; Pedroni, 2000).

3.3. Model estimation

Based on the choice variables for the analysis, the functional form of the analytical model is represented as follows;

$$Tax = (ICT, Gdpcg, Urbg, Trade, Cont, Lfpr)$$
(1)

The estimated linear econometric equation is therefore stated as:

$$Tax_{it} = \mu_0 + \mu_1 ICT_{it} + \mu_2 Gdpcg_{it} + \mu_3 Urbg_{it} + \mu_4 Trade_{it} + \mu_5 Cont_{it} + \mu_6 Lfpr_{it} + \varepsilon_{it}$$
(2)

where: Tax_{it} is the measure of tax revenue in country *i* at time *t* and *ICT*_{it} is the measure of ICT development in country *i* at time *t*. Other variables are as earlier discussed. $\mu_1, \mu_2, \mu_3, \mu_4, \mu_5, \mu_6$ are the estimated coefficients which measure the effect of the principal regressor (ICT) and other explanatory variables respectively on tax revenue.

As earlier noted, the role of ICT in revenue mobilization effort in the SADC region is tested using three categories of tax revenue and ICT is proxied by two measures of ICT—mobile cellular subscription and number of individuals using internet. Hence, two revenue models were estimated for each category of tax revenue with one measure of ICT included separately in each model; therefore, six tax revenue models were estimated in all.

3.4. FMOL pre-estimation test

There are certain requisites which are critical to the use of FMOLS. First, it is of utmost importance that both the dependent and explanatory variables are stationary. While the method was initially developed for optimum estimation of cointegrating models whose variables are only stationary at first difference I(1; Phillips & Hansen, 1990), it has, however, been modified to allow for the estimation of models with only I(1) variable as well as those with combination of variables stationary at level (I(0) and at first difference I(1) (Phillips, 1993). Moreover, for the purpose of estimating long-run relationship, it is important to ensure that the concerned variables are capable of forming an equilibrium relationship over a long-run period (Engle & Granger, 1987; Pesaran et al., 2001). Thus, in order to ascertain the suitability of the choice method, we tested for the

stationarity properties of the series as well as the existence of long-run relationship among the series using unit root and cointegration tests respectively.

3.4.1. Unit root test

Estimation of non-stationary time-series will produce biased results such that that the regression results will suggest the existence of significant relationships among the variables when in real sense, the variables are uncorrelated. In such situations, the regressions are said to be spurious and inferences based on such results are misleading (Cavaliere et al., 2015). Thus, we tested for the stationarity of the data employed in this study. While application of unit root and cointegration in panel analyses has been considered meritorious on the ground of its ability to increase the statistical power of the model relative to time series analyses, the procedures are, however, complicated (Breitung & Pesaran, 2005). Thus, high power tests have been developed to account for the complexities. Examples of such tests which have been extensively employed in the literature are Fisher-Augmented Dickey- Fuller (Fisher-ADF) and Philip-Perron (PP) tests which assume that the heterogeneous cross-section sequences have different individual unit root process.

The results of the two unit root tests as presented in Table 1 show that the series' order of integration are combinations of stationarity at level I(0) and at first difference I(1). For the Fisher-ADF test, individuals using internet, per capita GDP growth rate and informality are stationary at level while other variables are only stationary at first difference. However, using PP test, all the variables are stationary at level except tax from income profit and capital gain, individuals using internet, mobile cellular subscription and trade openness. Having established stationarity of the series either at level or at first difference, we proceeded to test for long-run equilibrium relationship among the series

3.4.2. Cointegration test

In addition to ascertaining the stationarity of the variables of interest to avoid biased estimates from spurious regressions, it is also important that the selected series share co-movement over a long period of time (Engle & Granger, 1987; Pesaran et al., 2001). In other words, for correct application of FMOLS, it is not only important that two or more variables are able to form equilibrium relationship, it is also crucial that the relationship is sustained in the long-run. This is known as level relationship or cointegration among the variables. There are similarly various econometric tests popularized in the literature for estimating cointegrating relationships among economic series. For this study, we adopted Kao (1999) cointegration test which is based on Engle and Granger's (1987) two-step residual, having null hypothesis of no cointegration. While Kao (1999) specified both Dickey-Fuller (DF) and the Augmented Dickey-Fuller (ADF) tests, EViews 12 statistical package only reports the ADF t-statistics and the corresponding probability value.

Since we proposed to estimate six separate models due to the adoption of three different types of tax revenue and two different measures of ICT development which are interchangeably incorporated in each model, we tested for cointegration among six different combinations of the adopted series. The results are presented in Table 2.

The associated probability values of the reported t-statistic showed strong evidence of long-run relationship among the estimated series as the null hypothesis of no cointegration was rejected for all the combinations of the estimated series at the stipulated 5 percent level of significance. Having ascertained the existence of cointegration among the variables, the study proceeded to estimate the FMOLS model.

3.5. Fully modified OLS (FMOLS) estimation result and discussion

The result of the FMOLS regression is presented in Table 3. The results are presented in three panels A, B and C representing the total tax revenue (TAXR), taxes on goods and services (TAXGS), and taxes on income, profit and capital gains (TAXC) regression models respectively. Each panel

Table 1. Fisher-Augmented Dickey Fuller (ADF) and Philip-Perron (PP) unit root tests								
	Fisher	ADF Test	PP-Fisher Test					
	Chi2	Chi2	Chi2	Chi2				
		1 st Difference I		1 st Difference I				
Variables	Level I(0)	(1)	Level I(0)	(1)				
TAXR	25.0044	75.5313*	37.1520**	125.338*				
TAXGS	28.3759	63/6423*	49.7528*	126.545*				
TAXC	23.3533	65.5930*	25.4500	102.473*				
INTUSER	39.4312**	31.3808	31.7365	63.6282*				
MOBILE	14.0217	85.3819*	2.3793	96.3350*				
GDPCG	37.0704**	63.8641*	81.9039*	229.323*				
URBG	28.8464	55.7255*	45.3845*	166.553*				
TRADE	17.8843	58.9570*	21.0802	156.845*				
CONT	60.1504*	43.3108*	116.467*	146.708*				
LFPR	22.1857	41.7172*	45.6883*	63.5643*				

Note: * and ** represent 1 and 5 percent level of statistical significance

Source: Authors' computation extracted from EViews 12

Table 2. Kao (Engle Cointegration Test)							
Series	ADF						
	t-Statistic	Prob. value					
TAXR, INTUSER, GDPCG, URBG, TRADE, CONT, LFPR	-7.2763	0.0000					
TAXR, LMOBILE, GDPCG, URBG, TRADE, CONT, LFPR	-6.4294	0.0000					
TAXGS, INTUSER, GDPCG, URBG, TRADE, CONT, LFPR	-6.6569	0.0000					
TAXGS, LMOBILE, GDPCG, URBG, TRADE, CONT, LFPR	-6.2935	0.0000					
TAXC, INTUSER, GDPCG, URBG, TRADE, CONT, LFPR	-4.1024	0.0000					
TAXC, LMOBILE, GDPCG, URBG, TRADE, CONT, LFPR	-3.5455	0.0002					

Note: Log transformation of mobile cellular subscription (LMOBILE) was used in all the models Source: Authors' estimation (extracted from EViews12)

comprises two columns, I and II, showing the estimated regression for each measure of ICT. In particular, model I reports the regression output for ICT usage (INTERUSER) model, while model II indicates the findings for ICT access (MOBILE) for each category of tax revenue.

Based on the sign of the estimated parameters and the associated probability values, both ICT usage and access are significant stimulants for revenue mobilization with the magnitude of the effect being higher for internet usage for all categories of tax revenue. While a unit increase in number of cellular subscriptions raises taxes on goods and services (TAXGS) and taxes on income, profit capital gain (TAXC) by 0.002 percent and 0.008 percent, respectively, internet subscription raises the taxes in the two categories by 0.03 percent and 0.18 percent respectively. For total tax revenue (TAXR), a unit increase in mobile phone will cause TAXR to rise by 0.005 percent, while a percentage increase in internet usage will fuel total revenue by 0.04 percent. The higher magnitude of internet usage is not very surprising in that internet will serve as a better stimulant of revenue mobilization than mobile cellular subscription. While voice communication which

Table 3. Fully modified OLS regressions results										
Variables	A: TAXR MODEL		B: TAXGS MODEL		C: TAXC MODEL					
	Model I	Model II	Model I	Model II	Model I	Model II				
Interuser	0.042*** (0.023)		0.050** (0.023)		0.177* (0.061)					
Lmobile		0.050** (0.123)		0.175*** (0099)		0.795*** (0.424)				
Gdpcg	0.313* (0.070)	0.072** (0.011)	0.144* (0.046)	0.188* (0.045)	0.924* (0.187)	1.088* (0.193)				
Urbg	1.432*** (0.855)	0.227*** (0.130)	0.654 (0.582)	0.425 (0.569)	6.834* (2.286)	5.417** (2.392)				
Trade	0.121* (0.024)	0.007** (0.004)	0.012 (0.016)	-0.005 (0.016)	0.120*** (0.064)	0.033 (0.069)				
Cont.	-0.042 (0.102)	0.023 (0016)	0.086 (0.068)	0.031 (0.068)	0.466*** (0.273)	0.287 (0.289)				
Lfpr	0.178* (0.045)	0.020** (0.007)	0.067 (0.029)	0.064** (0.030)	0.247** (0.120)	0.248 (0129)				
No. of observation	169	173	164	168	169	173				
Adj. R ²	0.864	0.568	0.818	0.795	0.793	0.737				
Wald test	104.48 (0.000)	112.45 (0.000)	30.58 (0.000)	37.24 (0.000)	61.32 (0.000)	66.39 (0.000)				

Note: *,** and *** represent 1, 5 and 10 percent level of significance respectively

Log transformation of mobile cellular subscription (LMOBILE) was used in all the models and results are interpreted accordingly.

Standard errors are reported in bracket along with the estimated coefficient of each variable

Probability value of the Wald test Chi² statistic is reported in bracket

accounts for a significant proportion of mobile cellular subscription aids communication and faster exchange of information, internet is more important for the automation of tax procedures. In sum, these findings corroborate the argument that enhancing resource mobilization constitutes a remarkable pathway through which ICT development impacts an economy (Adegboye et al., 2022; Koyuncu et al., 2016; Mpofu, 2020; UN-DESA, 2022; UNDP, 2010).

In most SADC member countries, huge investments have been made towards technological advancement with resultant effects of improved and efficient ICT. Hence, the obtained results might not be unconnected to the dividends of ICT development in those economies. For example, improvement in ICT has offered, in addition to online payment systems, online platforms for seamless tax administration which has not only enhanced government fiscal capacity and tax compliance rate but has also helped in mitigating corruption. While corruption remains a challenging menace in developing countries, it is particularly pervasive in the continent of Africa, SADC region inclusive (Transparency International, 2022). In addition to enhancing the tax base and curbing corruption, ICT might have also boosted tax revenue in the SADC region by enabling the achievement of cost-effectiveness and time-saving goals which are significant challenges associated with the manual-based tax administration (Adhikari, 2022).

Furthermore, the observed positive nexus between ICT and tax revenue might be stemming from increase in income and company profit taxes. ICT could have fueled tax revenue by increasing tax base through its employment generation capabilities and also by spurring productivity through innovation, ICT could raise taxable income and profit in the economy, thereby increasing the volume of generated tax revenue (Gaglio et al., 2022; Kraemer-Mbula et al., 2021; OECD, 2021; Olamide et al., 2022)

As for the other correlates of tax revenue, economic development measured by growth rate of GDP has a statistically significant positive effect on tax revenue for all categories of tax revenue considered.

This finding reinforced the viewpoint that the size of a country's tax revenue is a direct function of its level of economic development (Gnangnon & Brun, 2019; Gupta, 2007). The magnitude of the effect is particularly high for taxes on income, profit and capital gain (TAXC). This might be due to the fact that economic development is often associated with industrialization, thereby causing a rise in taxes on income, profit and capital gain. In the same vein, the degree of urbanization has a fueling effect on revenue mobilization. In all the models, except for the taxes on goods and service (TAXGS) model, the effect is statistically distinguishable from zero. The increasing effect of urbanization on revenue mobilization is not unexpected given that tax-generating economic activities in developing countries are mostly in the urban cities and town (Khujamkulov, 2016). Likewise, increasing rate of urbanization propels governments to mobilize more funds to finance the increasing infrastructure demand due to rapid rate of urbanization (Li, 2017; World Bank, 2020).

Furthermore, informality measured by the size of contributing family worker is positively related to revenue mobilization except in the internet usage model (model I) of total tax revenue (TAXR). However, the effect is not statistically significant in any of the models except in mobile cellular model (model II) of taxes on income profit and capital gain (TAXC). Labour force participation rate, on the other hand, has a statistically positive effect on all categories of taxes except model I of TAXGS and model II of TAXC. The positive effect is in consonance with the intuition that as more people are engaged in productive activities, the tax base will increase following increase in income tax as well as taxes on goods and services due to rise in aggregate demand.

The adjusted coefficient of determination (adj. R^2) for each model shows that the change in tax revenue is well explained by the explanatory variables. In all the estimated models, the adjusted R^2 indicates that the explanatory variables explain more than 50 percent variation in tax revenue. We further tested the goodness of fit for our model specifications and hence the validity of our findings, by performing Wald test coefficient restriction. Specifically, we verified the joint significance of the variables in our models by testing the null hypothesis that the variables are equal to zero. Based on the associated probability value, we rejected the null hypothesis that the joint significance of the explanatory variables is equal to zero in all the models.

4. Conclusion

Much recently the wave of research on the role of ICT in economic performance has permeated the public finance literature, and the investigation of its probable role in revenue mobilization has drawn significant attention. The intuition that ICT will have a fueling effect on tax revenue generation is linked to its ability to mitigate the challenges of delay, high administrative cost, evasion and corruption associated with paper-based tax procedures. So, owing to certain peculia-rities of the SADC region which may have implications for the usage of ICT, this study contributes to the small, but growing, literature by examining the possible role of ICT in revenue mobilization in SADC region within the FMOLS framework using data on 12 member countries of SADC between the period 2001 and 2020.

The results of the FMOLS model show that ICT has a significant positive effect on revenue mobilization effort in the bloc. The result was robust to the two adopted measures of ICT, namely internet usage and mobile cellular subscription. The magnitude of the effect is higher for internet usage. Overall, these findings imply that ICT serves as a revenue booster in SADC bloc.

Based on the outcomes of this study, it is recommended that policies aimed at fostering ICT development and diffusion should be focal in the development plans of member countries. In particular, affordability of ICT products should be prioritized to give wider access to internet usage in order to eradicate the challenge of digital divide mitigating against widespread use of ICT products in developing countries. In addition, there is need to foster ICT skill as access to ICT services only is not sufficient to achieve wider scope of ICT in revenue mobilization effort, but effective usage. While this study has made a further contribution to the ICT revenue in the continent of Africa, the study was only able to examine the nexus in the southern part of SSA

region. Future research in this area of study can investigate the relationship in other parts of the continent, namely Eastern, Western, Central and Northern Africa. It should, however, be noted that while the identified gap will certainly enrich the extant literature, it does not by any means undermine the relevance of this study.

Funding

The authors received financial support from Research Development and the Department of Economics, Nelson Mandela University

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Disclosure statement

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

Citation information

Cite this article as: Tax revenue mobilization effort in Southern African Development Community (SADC) bloc: Does ICT matter?, Olufunmilayo Olayemi Jemiluyi & Leward Jeke, *Cogent Economics & Finance* (2023), 11: 2172810.

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Appendix: Definitions of tax variables

(1) Total tax revenue (TAXR) is the total amount of tax collected from all categories of tax.

- (2) Taxes on goods and services (TAGS) is otherwise known as value-added tax. it is levied on all taxable goods and services sold for domestic consumption. It is calculated as a certain percentage of the price of the commodity, and included in the final price. It is collected on behalf of government by an intermediary, usually the seller. The aggregate TAGS is calculated as share of total revenue.
- (3) Profit, income and capital gain taxes (TAXC) are taxes levied on net income of individuals, profits of corporations and enterprises, and on capital gains. The aggregate TAXC is also calculated as share of total revenue.



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