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# ICT, E-Formalization and Tax Mobilization Efforts in Sub-Saharan Africa

**by**

**Cyril Chimilila and Vincent Leyaro**

**Abstract**

This paper investigates the effect of ICT and e-formalization on tax mobilization efforts in sub-Saharan Africa. Using a panel of 42 countries from 1991 to 2018 and applying appropriate model specifications; the empirical findings show that there is strong support that ICT (mobile subscription and internet usage) and e-formalization (e-government) enhanced tax mobilization efforts. There is scope to increase tax compliance and expand the tax base in SSA (tax mobilization efforts) through the increase in the usage of ICT that can be applied to simplify tax administration, reduce compliance costs, and provide convenience to taxpayers and enhance enforcement. It is equally important that other policies are skewed toward supporting the development of ICT in SSA countries, supporting the application to improve e-payments, formalization, and tax administration. Furthermore, tax administrations in SSA should take advantage of ICT in discouraging the use of cash in paying taxes to help reduce informality, integrate systems that use third-party information collected from e-payment platforms, and combine advanced data analysis to expand the tax base, enhance enforcement and increase taxpayer compliance.

**JEL Classification: H21, H26, H30**

**Keywords: ICT, e-formalization, tax effort, sub-Saharan Africa**

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Outline



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## 1. Introduction

Most governments in developing countries, especially those in sub-Saharan Africa (SSA), have failed to provide many of the basic public goods and social services that are critical for enhancing human capital or implementing growth and economic development policies due to weak state capacity.[1] As the result, it is widely acknowledged that building capacity for domestic resources mobilization is key to achieving sustainable development, and this issue had gained prominence in key development agendas and debates. This includes the 2002 Monterrey Consensus on Financing for Development that identified resource mobilization as the first of the six financial pillars that would help achieve Millennium Development Goals (United Nations, 2003); Agenda 2063: The Africa We Want (African Union, 2015); and the 3rd Financing for Development meeting in Addis Abba in July, 2015 (see Amoako-Tuffour, 2015; Runde and Savoy, 2015; Runde *et al*., 2014). Despite of the appreciation of the need for adequate domestic revenue mobilization, performance has always been suboptimal, especially for most developing countries. In particular, most sub-Saharan African countries are performing poorly in tax collection relative to most other countries as measured by tax shares to GDP. The average tax to GDP ratio for sub-Saharan Africa countries is less than 18 percent, which is far below the average of 35 to 40 percent in developed countries.

Furthermore, it is argued that differences in tax mobilization capacities between developed and developing countries are the main cause of the differences in development between the rich developed countries and the poor developing countries (Brautigam *et al*., 2008; Besley and Persson, 2013). Due to weak tax mobilization, the provision of public goods and social services in sub-Saharan Africa is far below requirements, leaving most of the populations in most countries living below the poverty line, with rising income inequality. Hence, the central question in taxation and development is 'how does a government in developing countries like most of those in SSA go from raising around 10 percent of GDP in taxes to raising around 40 percent as developed countries do?"

Low tax mobilization, in terms of low tax compliance and a small tax base, in sub-Saharan Africa is a result of a combination of factors, some of which are internal, and others external,

1 The situation is worse for countries with abundant natural resources that generates a natural resource curse, exacerbating further the weak state capability.

to the tax administration. External factors include the structure of the economies which are dominated by a large enclave sector, a large informal sector, low levels of incomes (Tanzi and Zee, 2000; Joshi *et al*., 2014), low ethic of paying taxes (Torgler, 2007; Gordon and Li, 2009) and governance and effectiveness of the government. Internal factors include the tax administration capability as a result of resources allocation, level of technologies utilisation and human resources quality. For example, in many developing countries, incentives for civil servants are poor: pay is relatively low and not linked to performance; career advancement opportunities are limited/uncertain; and non-pecuniary job benefits in terms of social status/influence, rent seeking and corruption can be substantial.

The challenge of low tax mobilization in sub-Saharan Africa is aggravated by a rampant informality and inadequate resources to enforce tax collection. In dealing with the low tax mobilization problem, tax administrations are increasingly designing policies and taking various initiatives that take advantage of technologies such as Information and Communication Technology (ICT) to enhance formalization, the efforts that the ILO report termed it "*e-formality*" (Chacaltana *et a*l., 2018). ICT simplifies tax administration, payment of taxes, improved efficiency, reduce costs and corruption, promote tax compliance and can be taped to expand tax base. These possibilities brought by ICT have seen many governments developing self-service and ease to use e-government platforms and enable easy person's payments to government. Despite the potential benefits of technology, especially under high informality and low tax collection, most countries are underutilising these potentials. Furthermore, there is limited empirical evidence as to the effect of these technologies on enhancing tax compliance and expand tax base (tax mobilization efforts) in sub-Saharan Africa. This study therefore sets out to provide more empirical evidence on how ICT can be harnessed to increase tax effort in sub-Saharan Africa. Specifically, the study dwells to examine the effects of mobile subscription, internet usage and e-government on tax efforts.

Following this introduction, the remainder of the article is organised as follows. Section 2 provides a review of literature on tax mobilization efforts, compliance behaviour and the potential of ICT and e-government to enhance tax compliance and expand tax base (tax mobilization efforts). Section 3 presents the empirical strategy for this study, which covers the analytical framework, estimation approach and data. Section 4 presents empirical analysis of the results, while section 5 summarises the key findings and provide implications of the findings.

## 2. Tax Mobilization: A Review of Empirical Literature

### 2.1 Tax Mobilization Efforts in sub-Saharan Africa

Tax efforts, measured as a ratio of tax to GDP is a primary indicator of how well a country is faring in terms of tax mobilization. Other measures of tax mobilization include the income tax to GDP ratio, the non-resource tax to GDP ratio and the share of income taxes to total tax revenue. These other measures are perceived to be more rigorous measures of efforts and capacity. This follows a recognition that some sources of tax revenue such as resources taxes and trade taxes are relatively ease to collect (Bird and Zolt, 2005).

Most sub-Saharan African countries are performing poorly in almost all of these indicators. Despite this underperformance, the capacity to collect taxes especially in low-income countries has improved over time, and much improvement in tax revenue mobilization capacity was observed in the 2000s due to a number of reasons including increases in exports and improved institutional quality (Tagem and Morrisey, 2022). Revenue collections are suboptimal due to capacity of tax administration as well as economic, social and political constraints. The average tax to GDP ratio for sub-Saharan Africa countries is less than 18 percent, which is far below the average of 35 to 40 percent in developed countries. As a result of these constraints, most poor countries, especially those in sub-Saharan Africa, tend to rely on less efficient and easy to collect taxes areas such as trade taxes but have not significantly improved on collection of income taxes. This means there is greater scope to improve the collection of income taxes. The contribution of personal income taxes to overall revenue collection is very minimal, which reflects the low capacity of the tax administrations (Rogers and Weller, 2014). Table 1 depicts the contribution of various taxes as a share of GDP. It can be seen from the table that the contribution of individual income tax is low as compared to consumption taxes. It can be seen also that value added tax (VAT) is the workhorse of taxes on goods and services. It relatively easy to achieve higher VAT compliance in the formal sector where businesses transactions and payments of goods and services are done through formal channels. This provides information trails for VAT audit and deter the scope for over reporting of input tax and deter trader's motives of evading final VAT obligations.

**Table 1: Contribution of Various Taxes in SSA (% of GDP)**

| Year | Overall | Taxes on income | | | Taxes on goods and services | |
|---|---|---|---|---|---|---|
| | | Total | O/w Individuals | O/w Corporations | Total | O/w VAT |
| 2016 | 14.70 | 5.41 | 2.76 | 2.37 | 6.99 | 4.31 |
| 2017 | 14.44 | 5.15 | 2.76 | 2.39 | 6.66 | 4.20 |
| 2018 | 14.73 | 5.47 | 3.01 | 2.32 | 6.81 | 5.42 |

*Source:* Computed from UNU-WIDER, GRD dataset

Necessary policy reforms to improve personal income taxation requires commitments to tax the extreme ends of the taxpayer spectrum – the rich in society and the poor in the informal sector. Raising taxes from personal incomes is necessary for broadening the tax base for more tax mobilization efforts and to enhance the equity of the tax structure (Bird and Zolt 2005; Junquera-Varela *et al.*, 2017).

## 2.2 Determinants of Tax Mobilization Efforts

### *Economic factors*

The first and foremost determinant of tax effort is the tax base, as represented by the size of GDP (Tanzi, 1992). Apart from the size of the economy, the structure also matters. In developing countries, especially in sub-Saharan Africa there is high dominance of the informal sector in almost all economic activities. The informality of economic activities complicates tax mobilization efforts (Tanzi and Zee, 2000; Joshi *et al.*, 2014). In similar vein, a large mainly subsistence agricultural sector also raises challenges (Tanzi and Zee, 2000; Joshi *et al.*, 2014), with very low value addition and short value chains that reduces the scope to raise taxes from modern taxes such as personal income taxand Value Added Tax (VAT). Furthermore, the level of incomes, per capita GDP, in developing countries is another limiting factor for raising income taxes. A large proportion of the population earn incomes that are very close to the poverty line (just enough for subsistence). As a result, most low-income countries impose very low marginal income tax rates (Sicat and Virmani, 1988). Conversely, raising taxes from incomes of the poor has both political and social challenges (Ricciuti *et al.*, 2016). Considerations of equity and cost-effectiveness are other limitations of taxing incomes from the poor (Bird and Zolt 2005; Junquera-Varela *et al.*, 2017).

Developing countries that are rich in natural resources tend to rely on this source for government revenue and put little efforts to develop structure for non-resource tax collection.

Empirical findings have shown that higher natural resource revenue correlates negatively with total non-resource domestic tax revenues. However, Thomas and Treviño (2013) provide further insights as to what causes this tendency. According to them, the difference in non-resource domestic revenues between resource-rich and non-resources rich countries is not as a result of differences in statutory tax rates, as these are more or less the same, but governance problems, internal conflicts, large tax exemptions, and/or weaker enforcement.

Those countries that depend on trade taxes tend to put low efforts in collection of efficient but hard to tax personal incomes. Trade taxes are, however, prone to volatility due to price shocks, trade shocks and political stability (Haldenwang and Ivanyna, 2018). These shocks also do affect resource-rich countries. Likewise, foreign aid dependence affects tax mobilization efforts in developing countries. The literature on the effect of aid on tax effort, although, provides mixed conclusions because the effect of aid on domestic tax effort is not consistent across countries (see Clist and Morrissey, 2011). Furthermore, empirical findings conclude that the effect depends on the level of aid. At lower level, aid may be a significant input by providing resources to the government initiatives that strengthen revenue collections while higher aid levels relax domestic taxes collection efforts (Morrisey *et al*., 2016).

***Social factors***

Social factors are to do with compliance norms and attitude. According to Besley and Persson (2014), the observed high tax/GDP ratio in modern high-income countries is largely as a result of social and cultural norms which have evolved in a way that supports a reasonable degree of tax compliance. Conversely, most developing countries have lower levels of taxation due to, among other reasons, weak ethics of paying tax. Because of a weaker compliance norm, any given statutory level of taxation will raise less revenue than would otherwise be expected.

However, norms can be shaped (Bénabou and Tirole, 2011). Generally, perception of unfair treatment by government institutions or that tax evasion is rampant and the state is weaker in capacity to detect and punish non-compliance may lower tax morale. Unless a broad-base-low-rate tax structure that tries to pull every eligible taxpayer into the tax net, the tax system becomes unfair as only a few taxpayers bear a higher burden and hence diminishes compliance and tax efforts. Compliance norms are also influenced by social contracts and demand by citizens for accountable and transparent government (Torgler, 2007; Brautigam *et al.*, 2008), public goods provision (Timmons, 2005), high quality services for their taxes (Hanousek and Palda, 2004) and quality of governance (Moore, 2007).

***Political factors***

The level of development of the political system is an important panacea towards establishment of strong institutions for taxation and development of norms towards compliance (Balamatsias, 2016). Political systems influence the development of the tax system and hence tax mobilization efforts. Weak and unaccountable states are unlikely to have strong motives to build capacity and structures for tax mobilization, and their citizens are unlikely to evolve strong norms of compliance (Bird *et al.,* 2008; Ardanaz and Scartascini, 2013). Weak political systems often fail to develop institutions for checks and balances, and weak voice for accountability has resulted into weak governance and rampant fiscal corruption in most of developing countries. Corruption lowers tax compliance and is negatively associated with overall tax revenue, and most of its components (Baum *et al*., 2017). Thus, commitment of political leadership is critical in improving governance structures for enhanced tax mobilization efforts (Purohit, 2007; Martini, 2014).

***Institutional capacity***

According to North, (1989), the development of rules and enforcement characteristics depend on the quality of institutions. Thus, taxation as a rule enforcement demands on the capacity of institutions to shape citizens´ attitudes towards paying tax (Nikiema and Zahonogo, 2017). Under high non-compliance situation, the tax administration will have to play the role of policeman (Savić *et al.,* 2015). However, the lack of resources has been the main challenges that have hindered tax administrations to behave like policeman, and instead they have to play a role of supporting voluntary compliance through provision of quality taxpayer services and taxpayer education about voluntary compliance of tax laws. Likewise, tax administrations have to have adequate resources to perform enforcement of taxes to detect and penalize non-compliance. Capacity of the tax administration is influenced also by its position in the government, either is semi autonomy, its quality of human resources, motivation and technology utilisation (Mavungu and Krsic, 2017).

### 2.3 E–formalization and taxation

The above discussion on determinants of tax efforts point to the effects of high informality. In developing countries, especially in the SSA countries, the level of informality is very high. To deal with it, an increasing number of governments are designing and implementing policies to support digital technologies to facilitate the transition from the informal to the formal economy through various e-government initiatives. The ILO report has coined a phrase "*e-formality*" to

refer to these policies and initiatives (Chacaltana *et al*., 2018). To the core of e-formalization is the support for digital economy and development of e-government services. Thus, in a modern world ICT developments and formalization are interlinked (Kring and Leung, 2021) and these are likely to influence changes in formalization processes, increase formalization, increase productivity, improve norms and regulations, provide incentives and improve enforcement systems (Chacaltana *et al.*, 2018).

According to the ILO´s estimates, almost 85 percent of the labour force in Africa is in the informal economy. Considering the sheer size, the resulting loss in tax income is huge. Among the setbacks to achieving high levels of businesses registration and formalization is the cost and time of complying to registration formalities. The application of ICT in government service provision (e-government) is among the options to reduce these hurdles and enhance formalization. Formalization is likely to bring in new taxpayers to the tax net, however, this is not automatic and immediate. Tax administrations, while taking advantages of e-formalization, have to develop culture of nurturing compliance of those who transform from the inform economy to the formal economy. Citing recent studies on tax compliance in Eswatini, Rwanda and Uganda, Gallien and van den Boogaard (2021) highlight the problem that taxpayers who are registered with the tax authority and file declarations still report a zero tax declaration on all taxes including income tax.

### 2.4 ICT and tax administration

Technology developments have found their way into the tax administration to provide cutting edge solutions to almost all tax administration processes, from registration of taxpayers to filing tax returns, auditing, payment of taxes and compliance enforcement. The adoption of these technologies has improved efficiency of tax administrations, reduce tax administration costs, reduce compliance costs and ease payment of taxes. Online self-service applications, for example, have simplified registration process, point of sale (POS) have improved revenue collection process and seal revenue loss, e-filing systems have simplified submission of tax declarations, electronic fiscal devices (EFD) have improved issuance of receipts and VAT compliance and mobile payment has simplified payment process (digital person to government – P2G), just to mention a few. A study by Ali *et al*. (2017) found that both reported sales and VAT have increased significantly following electronic sales register machines (ESRM) adoption in Ethiopia.

Apart from improving internal efficiency and easing compliance, ICT application in tax administration improves integrity and reduces revenue loss. ICT provides possibilities for reducing the direct interaction between taxpayers and tax officers, improves risk-based auditing and enforcement, all of which benefits revenue mobilization. Empirical studies support that ICT improves administration, reduce evasion and improve compliance (and by extension expanding tax base). For example, Ünal (2019) found that a negative relationship between ICT (mobile cellular phones and number of internet users) and the size of tax evasion.

A recent study by Hamudi (2022), argues for enhanced adoption of new telecommunication technologies to ease payment of tax through e-payment systems and link these payment mechanisms to the taxpayer's information for enhanced compliance and monitoring. Further, the study sees opportunities for sending various tax related information to taxpayers through telecommunication and electronic platforms with the intention of providing taxpayer education and promoting compliance.

## 3. Empirical Strategy and Data

### 3.1 Analytical Framework

The analytical framework employed in this study involves five main stages. In the first stage, unit root test is performed to test the stationarity of the variables. The panel unit root test is implemented using the Im, Pesaran and Shin (IPS, 2003) test, which accounts for countries' heterogeneity. The test is performed in level, with trend and first difference. The second stage involves cointegration test to confirm if the variables specified in the model have a long run relationship; if variables are not cointergrated it may lead to spurious regressions. Panel cointegration test was implemented using two different tests: Kao and Pedroni tests.

Since cointegration is confirmed, we proceed to estimate the analytical model using a panel data framework. However, in order to handle problems of heteroskedasticity and autocorrelation, a generalized method of moments (GMM) estimator for panel data analysis is used. This is achieved by estimating long-run covariates of Fully Modified Ordinary Least Squares (FMOLS), which generates heteroskedasticity – and autocorrelation – consistent standard errors (Kao and Chiang, 2000; Wang and Wu, 2012). Using different specifications, FMOLS model have been estimated to analyse the effects of ICT (mobile phones and internet) and e-formalization (proxied by e-government) on domestic revenue mobilization efforts (tax to GDP). In the fourth stage, panel error correction model (panel ECM) is estimated to examine

the short and long run effects of the ICT and e-formalization variables on tax effort, with panel Granger causality tests in the fifth stage to confirm the direction of causality.

### 3.2 Estimation Specification

We present empirical estimation specifications for the five stages in this section. We are starting with the basic panel data model specification as follows;

$$y_{i,t} = \alpha_i + \beta_i x_{t,i} + \mu_{it} \quad (1)$$

where *y* is the tax mobilization effort measured as tax to GDP ratio, *x* are the variables that influence tax mobilization efforts, which, in addition to control variables, include per capita GDP, shadow economy, trade openness, Official Development Assistance (ODA), private credit, control of corruption and executive constraint. The variables of interests are mobile subscription, internet usage and e-government index.

#### *Panel unit root test*

Unit root test is implemented using a panel data framework proposed by Im, Pesaran and Shin (IPS, 2003). A panel unit root test offers advantages of a large number of data point, reduce multicollinearity between the regressors and more powerful test statistics asymptotically follow a normal distribution. The IPS panel unit root test is based on the following model;

$$\Delta X_{it} = \alpha_i + \beta_i X_{i,t-1} + \sum_{k=1}^{n_i} \rho_{ij} \Delta X_{i,t-j} + \varepsilon_{i,t} \; i = 1, \ldots, N, \quad t = 1, \ldots \ldots, T \quad (2)$$

where Δ is the first difference, $x_{it}$ is a series for variable *x* in the panel of countries *i* in the period *t*, $n_i$ is the number of lags and $\varepsilon_{i,t}$ is the distributed random variable.

#### *Panel cointegration test*

Panel cointegration test is performed in order to test the long-run cross-sectional dependency and causality between variables. Panel cointegration is implemented using Kao test and confirmed using Pedroni test. Pedroni test can also be applied to data that are nonstationary and exhibit a cointegration relationship between the variables (Neal, 2014). Pedroni test is performed using a panel time-series model specified as follows;

$$y_{i,t} = \alpha_i + \beta_i x_{i,t} + \sum_{j=-p}^{P} \gamma_{i,j} \Delta x_{i,t-j} + \mu_{it} \quad (3)$$

Using group mean method, the $\beta$ coefficients and associated *t* statistics are then averaged over the entire panel, such that

$$\hat{\beta}_{GM} = \left[ \frac{1}{N} \sum_{i=1}^{N} \left( \sum_{t=1}^{T} z_{i,t} z'_{i,t} \right)^{-1} \left\{ \sum_{t=1}^{T} z_{i,t} \left( y_{i,t} - \bar{y}_i \right) \right\} \right] \quad (4)$$

$$t_{\hat{\beta}_i} = \left( \hat{\beta}_i - \beta_0 \right) \left\{ \hat{\sigma}_i^{-2} \sum_{t=1}^{T} \left( x_{i,t} - \bar{x} \right)^2 \right\}^{\frac{1}{2}} \quad (5)$$

$$t_{\hat{\beta}_{GM}} = \frac{1}{\sqrt{N}} \sum_{i-1}^{N} t_{\hat{\beta}_i} \quad (6)$$

The coefficient $\beta_i$ is the slope, $y_{i,t}$ is the dependent variable, $x_{i,t}$ is the explanatory variable, $z_{i,t}$ is the vector of regressors (this includes the lags and leads of the differenced explanatory variables), and $\sigma^2_i$ is the long-run variance of the residuals $\mu_{it}$.

***Fully modified ordinary least square (FMOLS)***

The strong evidence of presence of cointegration allows for estimation of the FMOLS to confirm the long-run relationship. The estimator for FMOLS models is specified as follows;

$$\beta_{GFM} = \frac{1}{N} \sum_{t-1}^{N} \left[ \sum_{t=1}^{T} (X_{it} - X_i^{'})^2 \right]^{-1} \left[ \sum_{t=1}^{T} (X_{it} - X_i^{'}) Y_{it}^{'} - T r_i^{'} \right] \quad (7)$$

where $\beta_{GFM}$ is the FMOLS estimator for individual variables.

***Panel Error Correction Model (Panel ECM)***

We implement a panel ECM to examine the short-run relationship among the variables, where the panel ECM is specified as follows;

$$\Delta y_{it} = \alpha_i + \sum_{k=1}^{h} \delta_j D_{j,it} + \sum_{k=1}^{h} \varphi_j \Delta X_{it-j} + \lambda \varepsilon_{it-1} \quad (8)$$

***Panel causality***

Lastly, we investigate the direction of causality in the panel model. The causality analysis is performed using the two-step procedure as suggested by Engle and Granger (1987). The estimated panel Granger Causality model test is based on the following regressions:

$$y_{i,t} = \alpha_i + \sum_{k=1}^{h} \phi_{ik} \Delta x_{i,t-k} + \lambda_i ECT_{i,t-1} + e_{it} \quad (9a)$$

$$x_{i,t} = \alpha_i + \sum_{k=1}^{h} \phi_{ik} \Delta x_{i,t-k} + \lambda_i ECT_{i,t-1} + e_{it} \quad (9b)$$

Causality is shown by testing the statistical significance of the coefficients $\phi$ and $\lambda$ in each error correction model. When $\phi_{ik}$ is significant it provides evidence of short-run causality, and when $\lambda_i$ is significant and the value is negative, it supports the evidence of long-run causality.

**Table 2: Descriptive Statistics**

| Variable | Source | Obs | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|---|---|
| Tax to GDP | GRD | 1,218 | 13.4 | 7.7 | 0.6 | 53.9 |
| Log. GDP per capita | WDI | 1,218 | 6.7 | 1.1 | 4.2 | 10.0 |
| ODA (% of GDP) | WDI | 1,216 | 9.9 | 10.2 | -0.3 | 94.9 |
| Openness (% of GDP) | WDI | 1,179 | 70.3 | 44.0 | 20.4 | 531.7 |
| Shadow economy (% of GDP) | IMF | 1,214 | 39.4 | 9.16 | 19.2 | 69.1 |
| Private credit (% of GDP) | WDI | 1,211 | 17.9 | 22.4 | 0 | 160.1 |
| Mobile subscription (per 100 people) | GSMA | 1,218 | 31.8 | 40.4 | 0 | 165.6 |
| Internet users (% of population) | WDI | 1,218 | 7.6 | 15.1 | 0 | 94.8 |
| E-government index | GSMA | 1,160 | 0.18 | 0.16 | 0 | 0.7 |
| Control of corruption | WGI | 1,138 | -0.6 | 0.6 | -1.8 | 1.2 |
| Executive constraint | Polity IV | 1,215 | 4.1 | 1.9 | 1 | 7 |

*Source:* Computed from GRD dataset (UNU-WIDER, 2020)

### 3.3 Data and Descriptive Statistics

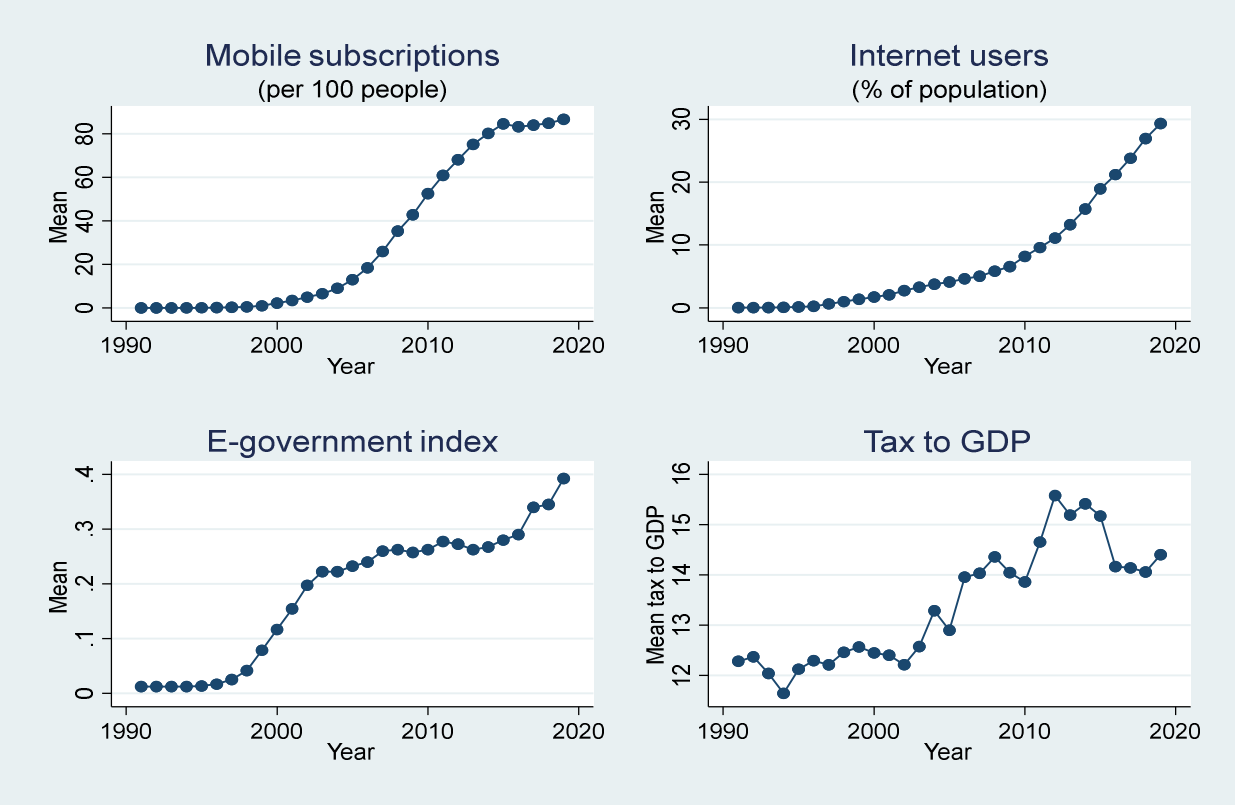
The data for this study covers a sample of 42 sub-Saharan Africa countries for the period from 1991 to 2018. The study mainly uses secondary data, collected from various sources. Tax revenues data were compiled from the Government Revenue Dataset (UNU-WIDER, GRD 2020), which is one of the most comprehensive and up to date compilation of government revenue data. Data on the size of informal sector are extracted from IMF informal sector estimation reports (Medina and Schneider, 2018). Data on per capita GDP, ODA, private sector credit and internet usage are compiled from the World Development Indicators (WDI) dataset. Data on regulatory quality are compiled from World Governance Indicators (WGI) datasets and data on executive constraint were compiled from Polity IV reports and dataset[2]. Data on

2 The Polity IV compiles data on annual information on the level of democracy for most independent states. The data measures state's level of democracy based on an evaluation of elections competitiveness and openness, the nature of political participation in general, and the extent of checks on executive authority.

mobile phone subscription and e-government are compiled from GSMA dataset. Table 2 presents data sources and descriptive statistics.

Figure 1presents the trend of key variables. As depicted, ICT usage in sub-Saharan Africa started to pick up in the mid-1990s (that coincides with major economic reforms the region was going through under the auspices of World Bank and IMF). The introduction of mobile phones has increased individuals´ access and improved internet usage. The development in the e-government follows a similar pattern. The usage of internet, as depicted in the lower right panel of the Figure, is very low in sub-Saharan Africa where in 2020 the percent of individuals using internet is just 30 percent of the total population, although the variable is increasing at an increasing rate. Increased internet usage and mobile subscriptions are likely to benefit e-government in many areas, including in taxation for improving tax compliance and expanding tax base; these are then explored empirically in the subsequent section.

**Figure 1: Trend of Key Variables**




*Source:* Authors own compilation

## 4. Empirical results

### Panel unit root test

Unit root tests results that are implemented using IPS test performed in level, level with trend and first difference are as presented in Table 3. Results indicate that the unit root tests are only stationery at level for tax to GDP and ODA variables. However, all the variables were statistically significant at $p<0.01$ after first difference, indicating that all variables are stationary at first difference.

**Table 3: Results of panel unit root test**

| Variable | Im-Pesaran-Shin test | | |
|---|---|---|---|
| | Level without trend | Level with trend | First difference |
| Tax to GDP | -2.2003** | -8.6144*** | -19.0227*** |
| Log. GDP per capita | 5.7113 | -4.3398*** | -16.7450*** |
| ODA | -6.9564*** | -10.4242*** | -21.3760*** |
| Shadow economy | 0.8313 | -7.7093*** | -19.8692*** |
| Private credit | 1.7580 | -5.5095*** | -17.4097*** |
| Mobile subscription | 19.1202 | -0.6584 | -9.7571*** |
| Internet users | 34.3290 | 15.3045 | -4.1157*** |
| E-government | 7.8274 | -2.2294** | -14.9617*** |
| Control of corruption | -0.7068 | -2.6593*** | -16.1258*** |

*** p<0.01, ** p<0.05, * p<0.1

### Panel cointegration test

Panel cointegration test results that are implemented using two different tests, Kao and Pedroni tests, with a null hypothesis of no cointegration are presented in Table 4. The results of Kao and Pedroni tests indicate that both tests are statistically significant at $p<0.01$, and therefore, the null hypothesis is rejected in favour of an alternative hypothesis that all panels are cointegrated, implying that the variables proposed for the model have a long-run relationship. The presence of cointegration warrants estimation of the model in the subsequent stage.

**Table 4: Results of panel cointegration tests**

| Kao test | | Pedroni test | |
|---|---|---|---|
| Modified Dickey-Fuller | -10.0738*** | Modified Phillips-Perron | 4.4522*** |
| Dickey-Fuller | -6.8574*** | Phillips-Perron | -8.5609*** |
| Augmented Dickey-Fuller | -7.9454*** | Augmented Dickey-Fuller | -8.3762*** |
| Unadjusted modified Dickey-Fuller | -11.2346*** | | |
| Unadjusted Dickey-Fuller | -7.1712*** | | |

*** p<0.01, ** p<0.05, * p<0.1

**FMOLS estimation**

Table 5 presents results based on FMOLS estimation. Different model specifications are used to account for the effects of ICT and e-formalization variables as well as control variables on the tax mobilization efforts, as measured by tax to GDP ratio. Results indicate that level of income, as measured by per capita GDP, level of openness, and private credits have positive effect on tax mobilization efforts. ODA and shadow economy have negative effects. Control for corruption and executive constraint have positive effects. GDP per capita and openness represent the tax bases for taxation, thus countries with higher levels of these variables are likely to collect more taxes. Private sector credit represents the support for economic activities and businesses growth, which in turn stimulate the expansion of the tax base.

ODA has a negative effect indicating countries which receive higher ODA tends to have low efforts in domestic resources mobilization. These results corroborate the findings of previous studies. The size of the shadow economy has a negative though statistically insignificant in all model specifications. Nevertheless, a large informal sector is very difficult to tax, as in most cases it represents activities undertaken out of reach of the tax authority or very small individual businesses without incentive to formalise and falls out of tax brackets. Thus, any efforts to identify and register informal businesses, and support growth of small informal businesses to grow boosts tax mobilization efforts by increasing tax compliance and expand tax base. Controlling for corruption and executive constraint has positive and significant effects on tax mobilization efforts. These variables are related to governance, which are important aspect in tax administration, especially in countries like sub-Saharan Africa where institutions and norms are weak.

**Table 5: Results of FMOLS models estimation**

| Tax to GDP | Model 1 (Basic model) | Model 2 (Control) | Model 3 (Mobile) | Model 4 (Internet) | Model 5 (E-gov) |
|---|---|---|---|---|---|
| Log. GDP per capita | 1.458*** | 0.963*** | 0.856** | 0.608* | 0.363 |
| | (0.306) | (0.313) | (0.364) | (0.335) | (0.344) |
| ODA | -0.0614*** | -0.122*** | -0.123*** | -0.124*** | -0.128*** |
| | (0.0182) | (0.0248) | (0.0248) | (0.0246) | (0.0245) |
| Openness | 0.0313*** | 0.0358*** | 0.0362*** | 0.0361*** | 0.0367*** |
| | (0.0094) | (0.0092) | (0.0093) | (0.0091) | (0.0093) |
| Shadow economy | -0.0117 | 0.0184 | 0.0212 | 0.0179 | 0.00961 |
| | (0.0237) | (0.0219) | (0.0219) | (0.0219) | (0.0219) |
| Private credit | 0.103*** | 0.0648*** | 0.0642*** | 0.0604*** | 0.0575*** |
| | (0.0092) | (0.0096) | (0.0096) | (0.0096) | (0.0105) |
| Control of corruption | | 2.604*** | 2.652*** | 2.498*** | 2.393*** |
| | | (0.366) | (0.389) | (0.360) | (0.364) |
| Executive constraint | | 0.390*** | 0.369*** | 0.424*** | 0.442*** |
| | | (0.127) | (0.124) | (0.123) | (0.110) |
| D. Tax to GDP | 0.355* | 0.346* | 0.347* | 0.349* | 0.313 |
| | (0.189) | (0.189) | (0.189) | (0.188) | (0.202) |
| L. Tax to GDP | 0.427** | 0.423** | 0.424** | 0.430** | 0.408** |
| | (0.187) | (0.191) | (0.191) | (0.190) | (0.204) |
| Mobile subscription | | | 0.00493 | | |
| | | | (0.0054) | | |
| Internet users | | | | 0.0516*** | |
| | | | | (0.0142) | |
| E-government | | | | | 5.220*** |
| | | | | | (1.609) |
| Constant | 0.332 | 3.439* | 3.977* | 5.285** | 6.422*** |
| | (1.957) | (1.980) | (2.235) | (2.122) | (2.112) |
| Observations | 1,092 | 1,043 | 1,043 | 1,043 | 1,010 |
| R-squared | 0.360 | 0.400 | 0.401 | 0.409 | 0.400 |

*** p<0.01, ** p<0.05, * p<0.1

Mobile subscription has a positive, though not statistically significant, effect on tax mobilization efforts. Internet usage and e-government both have positive and statistically significant effects on tax mobilization efforts. The positive effects indicate that increasing mobile subscription, internet usage and e-government increases tax mobilization efforts, both in terms of increasing tax compliance and expanding tax base. This is because ICT improves the business environment, simplifies tax administration and reduces compliance costs. For instance, countries like Tanzania and Kenya are at the forefront of using the mobile payment of taxes.

**Table 6: Results of Panel ECM model estimation**

| Tax to GDP | **(6)** **All ICT** | **(7)** **Mobile** | **(8)** **Internet** | **(9)** **E-gov** |
|---|---|---|---|---|
| **Long Run (Lags - L.)** | | | | |
| Log. GDP per capita | 1.328*** | 1.446*** | 1.442*** | 1.384*** |
| | (0.0868) | (0.106) | (0.106) | (0.108) |
| ODA | -0.0175 | -0.0432** | 0.126*** | -0.0292 |
| | (0.0169) | (0.0214) | (0.0230) | (0.0210) |
| Openness | 0.127*** | 0.115*** | 0.0477*** | 0.108*** |
| | (0.0083) | (0.0094) | (0.0097) | (0.0079) |
| Shadow economy | -0.149*** | -0.130*** | -0.0534*** | -0.114*** |
| | (0.0172) | (0.0191) | (0.0134) | (0.0191) |
| Private credit | 0.0730*** | 0.0407* | -0.0033 | 0.0164 |
| | (0.0145) | (0.0222) | (0.0158) | (0.0184) |
| Mobile subscription | -0.0147*** | 0.0009 | | |
| | (0.0048) | (0.0042) | | |
| Internet users | 0.0688*** | | 0.0278*** | |
| | (0.0147) | | (0.0097) | |
| E-government | 1.103 | | | 1.418 |
| | (0.849) | | | (1.156) |
| ECM (-1) | -0.181*** | -0.152*** | -0.146*** | -0.149*** |
| | (0.0359) | (0.0290) | (0.0245) | (0.0309) |
| **Short Run (First Difference - Δ)** | | | | |
| Log. GDP per capita | -0.424 | -0.415 | -0.192 | 0.203 |
| | (0.897) | (0.817) | (0.823) | (0.711) |
| ODA | -0.0128 | -0.0587 | -0.0419 | -0.0254 |
| | (0.0929) | (0.0878) | (0.0960) | (0.0809) |
| Openness | 0.0378*** | 0.0250** | 0.0271** | 0.0343*** |
| | (0.0100) | (0.0102) | (0.0111) | (0.0098) |
| Shadow economy | -0.0419 | -0.0746 | -0.0742 | -0.0454 |
| | (0.0533) | (0.0541) | (0.0576) | (0.0505) |
| Private credit | 0.143 | 0.130 | 0.166* | 0.149 |
| | (0.101) | (0.0923) | (0.0889) | (0.0934) |
| Mobile subscription | 0.0281 | 0.0316 | | |
| | (0.0245) | (0.0227) | | |
| Internet users | -0.0464 | | 0.00037 | |
| | (0.0704) | | (0.0542) | |
| E-government | 3.007* | | | 3.167** |
| | (1.636) | | | (1.487) |
| Observations | 1,089 | 1,125 | 1,125 | 1,089 |

*** p<0.01, ** p<0.05, * p<0.1

Many countries are introducing self-service e-government platforms for administration of taxes. All these have improved businesses registration and formalization, provide taxpayers' convenience and ease of paying taxes, reduce tax compliance costs and reduce tax administration costs. Apart from simplifying payment and administration, generally, developments in the use of ICT for tax administration have reduced the loss government revenue in various areas.

**Panel ECM estimation**

Results of the short-run effects are presented in Table 6. As shown, there is a convergence in the long-run equilibrium as indicated by a negative and statistically significant error correction term (ECM). If there is a one percent disequilibrium, then tax to GDP ratio will respond by about 0.15 to 0.18 percent each time to restore to equilibrium (see ECM term in models 1 to 4). Furthermore, results indicate that mobile subscriptions, internet usage and e-government have positive effects in the short run. However, only e-government is statistically significant.

**Table 7: Results of Granger causality test**

| Null hypothesis | Statistic | Lags | Decision |
|---|---|---|---|
| Mobile subscription does not Granger-cause Tax to GDP | 9.1259*** | 1 | Reject the null hypothesis |
| Internet usage does not Granger-cause Tax to GDP | 6.6645*** | 1 | Reject the null hypothesis |
| E-government does not Granger-cause Tax to GDP | 6.5533*** | 1 | Reject the null hypothesis |
| Tax to GDP does not Granger-cause Mobile subscriptions | 12.7080*** | 1 | Reject the null hypothesis |
| Tax to GDP does not Granger-cause Internet usage | 4.6043*** | 1 | Reject the null hypothesis |
| Tax to GDP does not Granger-cause E-government | 0.2556 | 1 | Accept the null hypothesis |

*** p<0.01, ** p<0.05, * p<0.1

**Panel causality test**

Granger causality test results are implemented to confirm the direction of causality of the variables of interest, that is, mobile subscriptions, internet usage, and e-government. Results are as presented in Table 7. Results confirm a reverse causality between mobile subscription and tax to GDP ratio as well as internet usage and tax to GDP ratio. However, for e-government

the study found a one-way causality running from e-government to tax to GDP ratio. The reverse causality is likely; the increase in ICT improves revenue collection and increase in revenue demands interventions to simplify administration.

## 5. Summary and Implications

The study is among few studies which investigated the effect of ICT and e-formalization on tax mobilization efforts in sub-Saharan Africa. It came in a quest to provide empirical evidence following recent trends and developments in the use of ICT and e-government platforms to support tax administration in sub-Saharan Africa where tax compliance and efforts to expand tax base (i.e., tax mobilization efforts) are very low as compared to developed countries.

The analytical framework and model specification for the study is informed by previous studies (such as Tanzi, 1992; Tanzi and Zee, 2000; Bird and Zvolt, 2005; Besley and Person, 2008; Langford and Ohlenburg, 2018). Modifications have been undertaken in this study to introduce additional variables: mobile subscription, internet usage, and e-government. The study used panel data for 42 countries for a period from 1991 to 2018. The empirical strategy involves a number of econometric tests and estimations. Hence, the study implemented panel cointegration, FMOLs, panel ECM and panel granger-causality test to test the hypotheses that ICT and e-formalization influence tax mobilization efforts.

Using different model specifications, the study found strong evidence that these variables influence tax mobilization efforts in sub-Saharan Africa. Therefore, this suggests that there is scope to increase tax compliance and expand the tax base (i.e., tax mobilization efforts) through enhancing the usage of ICT systems and e-government platforms to simplify tax administration, reduce compliance costs, provide convenience to taxpayers and enhance enforcement. It is equally important that other policies are made to be supportive towards development of ICT (Ndulu *et al*., 2021) and its usage to improve tax administration. Many countries have introduced taxes on mobile transactions, but these taxes and mobile operators service charges should be limited at very low rates so as not to discourage e-payment from person to government (P2G).

Moreover, tax administrations should take advantages of ICT in counteracting the use of cash in paying taxes so as to reduce informality, integrate systems that uses third-party information collected from e-payment platforms and combine advanced data analysis to improve enforcement and taxpayer compliance.

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