


**FINANCIAL INCLUSION AND INFORMATION COMMUNICATION TECHNOLOGY ON
TAX PERFORMANCE IN SUB-SAHARAN AFRICA**

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ARTICLE INFO	ABSTRACT
<p>Article history:</p> <p>Received 01 September 2023</p> <p>Accepted 01 December 2023</p>	<p>Purpose: The main objective of this paper is to determine empirically the impact of financial inclusion and Information Communication Technology (ICT) on tax performance in Sub-Saharan African countries; determine the extent to which the elements of financial inclusion have influenced tax performance of countries in Sub-Saharan Africa; and examine the role technology plays in impacting the performance of taxes in Sub-Saharan African countries.</p>
<p>Keywords:</p> <p>ICT; Tax Performance; Financial Inclusion.</p> <div data-bbox="172 958 480 1205" style="text-align: center;">  </div>	<p>Theoretical Framework: The existing theories that serve as a roadmap for the development of this study are Theory of Digital Diffusion and Theory of Margins. Digital transformation has an important impact on the operations and systems of every economy, which often triggers a positive effect on taxes. Diffusion innovation theory was initiated by Rogers in 1962. The Theory of Margin on the other hand, is a theoretical school that gives validity to the impact of financial development on product output. It suggests that more access to financial services and products is vital for high output and economic advancement.</p> <p>Design/Methodology/Approach: The population considered in this study was 48 sub-Saharan African Countries from the period of 1999 to 2019. The methods used for the analysis consists of the descriptive and correlation analysis on the identified variables and a creation of financial inclusion index using the Principal Component Analysis to deal with multicollinearity challenge amongst the financial inclusion proxies, it also adopted the two-staged least square estimation technique for the empirical analysis.</p> <p>Findings: The study reveals inter alia that the variables for financial inclusion and ICT proxies are overwhelmingly positive and significantly impact on the tax performance (i.e., total tax revenue and the non-resource tax revenue as percentages of GDP), in sub-Saharan Africa and that the financial inclusion index has positive effect on tax performance in sub-Saharan Africa. We also observed that there is a positive relationship between technology and tax performance in sub-Saharan Africa.</p> <p>Research Practical & Social implications: Policies should be formulated to engender enhancement of technology and more investment should be allocated to technology as it is discovered to drive financial inclusion and promotes tax revenue mobilization. In general, the findings indicate that policies are needed to engender an enhancement of technology and more investment should be channeled to technology</p>

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as it affects financial inclusion and by logical extension, the promotion of tax revenue mobilization.

Originality/value: The challenge of tax implementation can be directly ascribed to an ineffective tax system. A tax management that is of high in superiority, helps to make the tax mobilization process more transparent and efficient, and also reduce the level of shadow economy, which main feature is non-remittance or payment of tax. This study reveals that a tax administration system can only operate effectively with the use of modern information technologies.

Doi: <https://doi.org/10.26668/businessreview/2023.v8i12.2341>

INCLUSÃO FINANCEIRA E TECNOLOGIA DE INFORMAÇÃO E COMUNICAÇÃO SOBRE DESEMPENHO FISCAL NA ÁFRICA SUBSAARIANA

RESUMO

Objectivo: O principal objectivo deste artigo é determinar empiricamente o impacto da inclusão financeira e das Tecnologias de Informação e Comunicação (TIC) no desempenho fiscal nos países da África Subsariana; determinar até que ponto os elementos de inclusão financeira influenciaram o desempenho fiscal dos países da África Subsariana; e examinar o papel que a tecnologia desempenha no impacto do desempenho dos impostos nos países da África Subsariana.

Referencial Teórico: As teorias existentes que servem de roteiro para o desenvolvimento deste estudo são a Teoria da Difusão Digital e a Teoria das Margens. A transformação digital tem um impacto importante nas operações e nos sistemas de todas as economias, o que muitas vezes desencadeia um efeito positivo nos impostos. A teoria da inovação por difusão foi iniciada por Rogers em 1962. A Teoria da Margem, por outro lado, é uma escola teórica que dá validade ao impacto do desenvolvimento financeiro na produção de produtos. Sugere que um maior acesso a serviços e produtos financeiros é vital para um elevado rendimento e para o avanço económico.

Desenho/Metodologia/Abordagem: A população considerada neste estudo foi de 48 países da África Subsariana do período de 1999 a 2019. Os métodos utilizados para a análise consistem na análise descritiva e de correlação sobre as variáveis identificadas e na criação de inclusão financeira índice usando a Análise de Componentes Principais para lidar com o desafio da multiclonalidade entre as proxies de inclusão financeira, também adotou a técnica de estimação de mínimos quadrados em dois estágios para a análise empírica.

Constatações: O estudo revela, entre outras coisas, que as variáveis para a inclusão financeira e os indicadores de TIC são esmagadoramente positivas e têm um impacto significativo no desempenho fiscal (ou seja, receitas fiscais totais e receitas fiscais não relacionadas com recursos como percentagens do PIB), na África Subsariana e que o índice de inclusão financeira tem um efeito positivo no desempenho fiscal na África Subsariana. Observámos também que existe uma relação positiva entre a tecnologia e o desempenho fiscal na África Subsariana.

Implicações práticas e sociais da investigação: As políticas devem ser formuladas para gerar o aprimoramento da tecnologia e mais investimento deve ser alocado à tecnologia, uma vez que se descobre que esta impulsiona a inclusão financeira e promove a mobilização de receitas fiscais. Em geral, as conclusões indicam que são necessárias políticas para gerar uma melhoria da tecnologia e que mais investimento deve ser canalizado para a tecnologia, uma vez que afecta a inclusão financeira e, por extensão lógica, a promoção da mobilização de receitas fiscais.

Originalidade/valor: O desafio da implementação fiscal pode ser directamente atribuído a um sistema fiscal ineficaz. Uma gestão fiscal de elevada superioridade ajuda a tornar o processo de mobilização fiscal mais transparente e eficiente, e também a reduzir o nível de economia paralela, cuja principal característica é a não remessa ou pagamento de impostos. Este estudo revela que um sistema de administração fiscal só pode funcionar eficazmente com a utilização de modernas tecnologias de informação.

Palavras-chave: TIC, Desempenho Fiscal, Inclusão Financeira.

INCLUSIÓN FINANCIERA Y TECNOLOGÍAS DE LA INFORMACIÓN Y LA COMUNICACIÓN SOBRE EL DESEMPEÑO FISCAL EN EL ÁFRICA SUBSAHARIANA

RESUMEN

Propósito: El objetivo principal de este artículo es determinar empíricamente el impacto de la inclusión financiera y las Tecnologías de la Información y la Comunicación (TIC) en el desempeño tributario en los países del África subsahariana; determinar en qué medida los elementos de la inclusión financiera han influido en el desempeño fiscal de los países del África subsahariana; y examinar el papel que juega la tecnología en el impacto en el desempeño de los impuestos en los países del África subsahariana.

Marco Teórico: Las teorías existentes que sirven de hoja de ruta para el desarrollo de este estudio son Teoría de la Difusión Digital y Teoría de los Márgenes. La transformación digital tiene un impacto importante en las operaciones y sistemas de cada economía, lo que a menudo genera un efecto positivo en los impuestos. La teoría de la innovación por difusión fue iniciada por Rogers en 1962. La teoría del margen, por otro lado, es una escuela teórica que da validez al impacto del desarrollo financiero en la producción de productos. Sugiere que un mayor acceso a servicios y productos financieros es vital para lograr una alta producción y un avance económico.

Diseño/ Metodología/ Enfoque: La población considerada en este estudio fue 48 países de África subsahariana durante el período de 1999 a 2019. Los métodos utilizados para el análisis consisten en el análisis descriptivo y de correlación sobre las variables identificadas y una creación de inclusión financiera. El índice utilizó el análisis de componentes principales para abordar el desafío de la multiclonalidad entre los indicadores de inclusión financiera, y también adoptó la técnica de estimación de mínimos cuadrados en dos etapas para el análisis empírico.

Hallazgos: El estudio revela, entre otras cosas, que las variables para la inclusión financiera y los indicadores de TIC son abrumadoramente positivos y tienen un impacto significativo en el desempeño tributario (es decir, los ingresos tributarios totales y los ingresos tributarios no relacionados con los recursos como porcentajes del PIB) en el África subsahariana. y que el índice de inclusión financiera tiene un efecto positivo en el desempeño fiscal en el África subsahariana. También observamos que existe una relación positiva entre la tecnología y el desempeño fiscal en el África subsahariana.

Implicaciones prácticas y sociales de la investigación: Se deben formular políticas que generen una mejora de la tecnología y se debe asignar más inversión a la tecnología a medida que se descubra que impulsa la inclusión financiera y promueve la movilización de ingresos fiscales. En general, los hallazgos indican que se necesitan políticas para generar una mejora de la tecnología y se debe canalizar más inversión hacia la tecnología, ya que afecta la inclusión financiera y, por extensión lógica, la promoción de la movilización de ingresos fiscales.

Originalidad/valor: El desafío de la implementación tributaria puede atribuirse directamente a un sistema tributario ineficaz. Una gestión tributaria de alta superioridad ayuda a hacer más transparente y eficiente el proceso de movilización de impuestos y también a reducir el nivel de economía sumergida, cuya característica principal es la no remesa o pago de impuestos. Este estudio revela que un sistema de administración tributaria sólo puede funcionar eficazmente con el uso de tecnologías de la información modernas.

Palabra clave: TIC, Desempeño Tributario, Inclusión Financiera.

INTRODUCTION

In most African countries, the levels of debts are huge and increasing, with a middling ratio of public debt to Gross domestic product GDP growing above 56% in 2018 a rise from the 38% that it used to be as at 10 years before (World Bank, 2018). This increase is partly due to reduced growth in the export revenue which sprouts from an unstable macroeconomic and governance environment which encouraged more African countries to tap into the international debt markets for the first time (Zakharov, 2019). African Governments have had a structural shift in the source of their debts, with reduced dependence on concessional borrowings from multilateral institutions and Paris club of lenders, to a wider access from international capital markets, sourcing for finance from Bilateral creditors such as China, and huge domestic borrowing (up to 35% of debt to GDP) shows the increased level of government debts for capital investment in order to close the gap in infrastructure (African Development Bank Group, 2020). The level at which debt profile is rising and the associated cost attached to the servicing of the debt, and the growing necessity for domestic financing are an indicators that the challenge of sustainable development in the region is yet to be addressed (Coulibaly & Gandhi, 2018a).

However, in order to develop a more sustainable source of government finance other than debts, grants and foreign aid which have become the major source of finance for counties in Sub-Saharan Africa, the need to come up with policies and innovations to mobilize domestic revenue through taxes has become crucial.

The International Monetary Fund (2019) alluded that, notwithstanding the general economic growth, Sub-Saharan Africa's nations are at an increasing danger of large debt burdens as a result of high cost of servicing the debt. This highest authority for international monetary agenda proposes that, in the future Sub-Saharan African nations should depend on a long term, more enduring source of financing, considering the increasing dangers attached to borrowing (International Monetary Fund, 2015). This sustainable long-term source of finance would be applicable if the countries make generating and mobilizing domestic incomes their most crucial policy priority.

Previous studies have shown that tax operation is shaped majorly by traditional and non-traditional factors. Majority of the previous work done, have focused mainly on traditional factors (Asongu, Adegboye, & Nnanna, 2021; Bird et al., 2008). Moreso, according to Bird et al. (2008) this traditional factors are not effective enough to produce the kind of tax revenue required by a country for sustainable growth. Essentially, Drummond et al. (2012) states that developing countries are incapable of altering the conventional factors in the short term to achieve the desired tax revenue levels unlike the non-conventional factors (such as transparency, governance, and accountability etc.). Therefore, additional non-traditional factors such as Financial Inclusion and Technology were explored in this work, so as to ascertain whether these factors would improve the current level of tax performance.

The problems of tax performance can be directly attributed to an inefficient tax system, a tax administration that is of high quality helps to make the tax mobilization process more transparent and efficient and also reduce the level of shadow economy, which main feature is non-remittance or payment of tax, a tax administration system can only operate effectively with the use of modern information technologies (Mikhaleva & Vochozka, 2021). Digitalization has assumed a vivacious role in the functioning of economic activities in virtually all nations of the world (Joshi, Manna, Ajotikar, Ramaswamy, & Borah, 2023) and this has made most tax laws in various Sub-Saharan African countries obsolete and inefficient to meet the needs of the current economic situation, the introduction of the digitalization has been the driving force behind many human activities (Ajala & Adegbie, 2020). Information technology has led to digitalized economy, e-commerce and also the computerization of tax systems which

has accelerated the speed of business activities and the outlook of tax systems in countries (OBE, 2019).

Financial inclusion is basically defined as a situation where an individual possesses a personal account with a financial establishment. This account permits the individual to save or lend money in a formal agreement, to take on an insurance contract or use the institution's services to make payments. Thus, an individual that is financially included is exposed to various economic opportunities and benefits. Without the presence of financial services, poverty traps can surface and hinder the economic advancement of any country, the presence of financial services would enable people to invest in education, carry out financial projects and become businessmen (Bruhn & Love, 2014; Demirguc-Kunt & Klapper, 2012; Zins & Weill, 2016). An estimate of 1.7 billion population in the world do not possess a personal financial account and since 2011 an estimate of 1.2 billion people have opened their financial accounts around the world (Gammage et al., 2017). Empirical Studies such as the database of the Global Findex shows that adults who have opened an account have been estimated at 1.2 billion since 2011 and 515 million since 2015. The percentage of adults who now have an account with an institution that offers financial services or through a cashless money, service has increased from 62% to 65% between 2014 and 2017 globally, this growth in financial inclusion would lead to a great increase in income generated globally and this would also create more opportunities and challenges for countries (Capasso & Jappelli, 2013; Park & Mercado, 2018). The more people become financially included, the more productive and capable they are to raise funds for developmental strides, and the more revenue the government is able to generate through taxes.

In sub-Saharan Africa, just like other developing nations, the aim of the fiscal policy is the generation of revenues. Confronted with rising cost of external sources of finance (such as debt), raising sufficient tax incomes in a stable and predictable manner is necessary to enable the government make available the fundamental amenities needed by the populace (Gupta et al., 2017). Although, like in many low-income countries, there are a lot of difficulties in raising incomes in the region. Firstly, as a result of the minimal level of resources or income raised from their economic activities, they are unable to adequately pay up their debts (Lin & Jia, 2019; Martorano, 2016). Secondly, income raised is subject to the fact that tax liability is not equally distributed, the majority of the tax liability is incurred by the disadvantaged group usually based on the actions of the advantaged group (Ivica, 2016; Kennedy et al., 2017; Stantcheva, 2020). Also, the problem of Accountability in policies that make the tax payers feel a sense of unfairness (Gbato, 2017). According to Bird et al., (2008) the study proposed that

tax income generated increases if there is political responsibility and that tax payers are able to hold the administrators responsible, but most regrettably this is not the situation in Sub-Saharan Africa.

The main objective of this study, therefore, is to determine empirically the influence of financial inclusion and technology on tax performance in Sub-Saharan Africa. Other specific objectives are to: determine the extent to which the elements of financial inclusion have influenced tax performance of countries in Sub-Saharan Africa; examine the role technology plays in impacting the performance of taxes in Sub-Saharan African countries; and ascertain the interactive relationship between Financial Inclusion and technology in Sub-Sahara.

LITERATURE REVIEW

The relationship between financial inclusion, technology and tax performance has been a subject of expounded argument amongst practitioners, scholars and policy makers. Financial Inclusion is defined by how effortless an economic agent (individual and enterprise) can access financial services such as deposit, credit, payment, insurance, and other risk-related service (Menyelim et al., 2021). Financial inclusion is determined by the percentage of these economic agents who can easily access financial services. A country's economic stability is influenced by the ratio of people who can access financial services. Digital transformations, on the other hand, have important repercussions for the organization and functioning of every economy (Alsuwaidi, & Sultan, 2023), one of which is the effect on taxes. The incorporation of digital technologies into every aspect of life, Innovation theory was developed by a sociologist Everett Rogers in 1962 in the first edition of his publication.

In 1962, the Diffusion of Innovations was studied. The theory of digital diffusion is based on the concept that the spontaneous or expected dissemination of new ideas is needed for innovation acceptance. It entails the use of a novel concept, practice, or object in a previously unexplored region. (Rogers, 1995). According to the theory, the interpretation of change is crucial; if a concept seems to be strange to a potential adopter, it should be classified as an invention. For instance, controlling scurvy in the British Navy, diffusion of hybrid corn in Iowa, diffusion of new news, bottle feeding babies in the third world, how the refrigerator got its hum, Xerox Parc and Apple computers, digital economy, black music in white America, and the possible information technological revolution were all examples of how the theory approached innovation diffusion (Ajala & Adegbie, 2020). The theory's ideology is linked to the research's independent variables, Financial Inclusion, and technology, making it acceptable and important

to the study. The theory states that a technical invention embodies knowledge, and its implementation reduces complexities, such as tax-related issues in Nigeria (Ajala & Adegbie, 2020).

Analyzing the impact of financial access on welfare Total Factor Productivity (TFP), Asongu (2020) discovered that, whereas the effect is not significant on TFP, real TFP and welfare TFP. Sharma et al. (2019) explore bank accounts, ATM penetration, bank concentration, mobile and connectivity coverage in Asian and the Middle East countries, which establish a negative association with the mobile phone used to receive money. In addition, Lenka et al. (2017) showed that financial inclusion has an important and optimistic impact on India's economic development over the long and short term. In terms of financial and macroeconomic stability.

Technology and Tax Performance

Ajala & Adegbie (2020) analyzed the impact of information on the effective assessment of tax in Nigeria. Their findings indicated that information technology has many benefits, and they includes ease of tax return filing, ease of registration, ease of tax payment, accurate tax assessment of taxpayers in Nigeria and easy access to information technology in tax administration, as they are in many other technologically inclined environments. Tax evasion being one of the challenges to mobilizing optimal tax revenue, Uyar et al. (2021) proposed that the employment of information technology in government that is e-government in the administration of tax would assist in reducing tax evasion and improve tax revenue, the result of the study showed in line with the underlying institutional and modernization theory, countries in long-standing use of ICT have had more success in curbing tax evasion (Nam, 2018). In analyzing the impact of the usage of digital technology on economic growth, Solomon & van Klyton (2020) distinguished among the individual impact, business impact and the impact of government usage on the economy. It emphasized the component pillar for individuals to be social media through the use of mobile technology to stimulate entrepreneurship and firm performance which in turn improves tax generated.

METHODOLOGY

This study explores a sample of 46 Sub-Saharan African nations for the period 2010-2018. The choice of study span and the sample were occasioned by data availability. For the construction of the database, this study combines different sources, notably: the International

Centre for Tax and Development (ICTD)/United Nations University World Institute for Development Economics Research (UNU-WIDER) Government Revenue Dataset for tax performance variables (namely: the total taxes revenue excluding social contributions and non-resource taxes) in accordance with recent taxation literature (Gamze, 2019; Mawejje, 2019; Mawejje & Sebudde, 2019). The choice of the ICTD/UNU-WIDER database for taxation measures is twofold. First, it provides synchronized tax and non-tax revenue data for legitimate comparability across countries. More detailed and reliable insights into tax collection rates and patterns are provided in the updated dataset. Other studies (Baunsgaard & Keen, 2010; Guner et al., 2016; Poterba, 2007) have used different data sources for taxation measures such as the International Monetary Fund, the World Bank, the Organization for Economic Co-operation and Development, and the Economic Commission for Latin America databases. However, these measures have been documented to provide conflicting results and difficulties in results replication and comparison (Mawejje, 2019). Second, the database provided by the ICTD has the originality of responding to immediate needs of scholars and practitioners for significant advancement in data coverage and quality (Asongu, Adegboye & Nnanna, 2021).

Accompanying the prior works on information and communication technology (ICT) utilization (Asongu & Nwachukwu, 2016; Efobi & Osabuohien, 2015; Tchamyu, 2017), the study employs the five popularly known ICT indicators viz.: the internet practical application rate per 100 individuals, the mobile phone dispersal rate per 100 citizenry, the telephone usage rate per 100 citizenry, internet utilizers in percent of total population and ICT import in percent of entire import. The fundamental premise for embracing these three indices tends to have policy logical implication. In addition, bundling the three indicants have elicited fears about the efficiency, consistency and illative validity of Principal Constituent Analysis, which have not been sufficiently worked-out (Asongu & Roux, 2017). The dataset for ICT and variables for financial inclusion were extracted from World Development Indicators of the World Bank. This study settled for three specific variables for financial inclusion in line with the Global Financial Inclusion (Global Findex) database. The variables include the number of commercial bank branches, domestic credit to private sector by banks and domestic credit to private sector.

World Development Indicators (WDI) for control variables. Gross Domestic Product per capita growth, foreign direct investment and personal remittance are the variables of control selected. A favourable association between covariates, and tax performance is expected, following the previous studies (Gnangnon & Brun, 2018; Mansour & Keen, 2009; Mawejje, 2019). Previous studies have shown that the need for private spending to boost tax performance

lies with GDP per capita growth, private domestic credit and foreign direct investment, while remittances primarily for consumption purpose increase tax performance (Alabede, 2017; Asongu, Adegboye, & Nnanna, 2021; Feger & Asafu-Adjaye, 2014).

In addition, Tables 1 contains descriptions and references for the variables taken, while Table 2 provides summary statistics. The related correlation matrix is revealed in Table 3. The summary statistics reveal that variables in the sample had equivalent mean values and that there is a potential of significant approximate relationships given the variations from corresponding standard deviations. The essence of the correlation matrix is also to detect possible multicollinearity issues that could greatly distort the approximate coefficients.

Table 1 Definitions and Sources of Variables

Acronyms	Variables	Description	Sources
Tax Performance Measures			
TTAX	Total tax revenue	Tax revenue, % of GDP	ICTD database
NTR	Non-resource tax revenue	Non-resource tax revenue, % of GDP	ICTD database
Financial Inclusion Measures			
Branches	Bank Branches	Borrowers from commercial banks (per 1,000 adults)	
Bank	Credit by Banks	Domestic credit to private sector by banks (% of GDP)	
Credit	Credit-Private Sector	Domestic credit to private sector (% of GDP)	
Technology Proxy			
Mobile	Mobile phone	Mobile cellular subscriptions (per 100 people)	WDI
Telephone	Telephone	Fixed telephone subscriptions (per 100 people)	WDI
Internet	Internet Usage	Fixed broadband subscriptions (per 100 people)	WDI
Interuser	Internet Users	Individuals using the Internet (% of population)	WDI
ICT	ICT imports	ICT goods imports (% total goods imports)	WDI
Control Variables			
GDP	GDP growth	Gross Domestic Product (GDP) growth (annual %)	WDI
Remittance	Personal remittance	Remittance inflows (% of GDP)	WDI
FDI	Foreign direct investment	Foreign Direct Investment net inflows (% of GDP)	WDI

Note: ICTD - International Centre of Tax and Development; WDI - World Bank, World Development Indicators.

Source: Compiled by the authors (2023)

Table 2 Descriptive Statistics

Variable	Obs	Mean	Std.Dev.	Min	Max
TTAX	361	.154	.076	.055	.491
NRT	356	.142	.076	.009	.491
Mobile	410	75.496	36.333	7.821	184.298
Telephone	408	2.874	5.847	0	34.273
Internet	386	1.053	3.042	0	21.678
Interuser	369	15.3	13.726	.58	58.77
ICT	329	3.53	1.917	.541	10.834
Branches	386	7.209	9.443	.6	54.36
Bank	396	21.018	17.809	.498	106.26
Credit	384	22.946	25.25	.498	150.974
GDP	411	1.667	4.961	-47.591	18.066
Remittance	371	4.025	4.985	0	26.883
FDI	409	5.47	10.612	-6.37	103.337

Source: Prepared by the authors (2023)

Table 3 Correlation Matrix

	1	2	3	4	5	6	7	8	9	10	11	12	13
1.TTAX	1												
2.NRT	0.979***	1											
3.Mobile	0.535***	0.519***	1										
4.Telephone	0.377***	0.387***	0.623***	1									
5.Internet	0.328***	0.342***	0.593***	0.931***	1								
6.Interuser	0.525***	0.530***	0.813***	0.744***	0.716***	1							
7.ICT	0.138*	0.169*	0.165*	0.285***	0.254***	0.388***	1						
8.Branches	0.400***	0.408***	0.542***	0.725***	0.689***	0.709***	0.145*	1					
9.Bank	0.362***	0.373***	0.523***	0.736***	0.642***	0.672***	0.540***	0.451***	1				
10.Credit	0.401***	0.414***	0.523***	0.555***	0.459***	0.646***	0.610***	0.322***	0.890***	1			
11.GDP	0.0973	0.123	0.0483	0.100	0.0909	-0.0467	0.0950	0.0460	0.00404	-0.0667	1		
12.Remittance	0.241***	0.285***	-0.0206	-0.105	-0.135	-0.0323	-0.0799	0.00782	-0.0657	-0.126	0.0340	1	
13.FDI	0.0997	0.116	-0.0447	0.0884	0.105	0.0373	-0.117	0.261***	-0.0171	-0.0634	0.0874	-0.116	1

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Source: Prepared by the authors (2023)

Estimation Technique

This study proceeds with the standard ordinary least squares (OLS) procedure, which pools of all of the observations. Like any other specification techniques, it is necessary to indicate that the standard OLS method has two explicit failings. It does not give interpretation for country-specific circumstances and claims that the countries' intercept values are the same. Two panel calculation techniques that allow for the peculiar existence of the countries are used to test whether they are implausible characteristics. However, extant literature still finds the technique useful for inference as a baseline analysis (Asongu & Odhiambo, 2020; Gordon et al., 2012; Kingu et al., 2018; Macha et al., 2018). The specification model for this study is identified below:

$$TAX_{i,t} = \sigma_0 + \sigma_1 FIN_{i,t} + \sigma_2 ICT_{i,t} + \sigma_3 FIN * ICT_{i,t} + \sum_{h=1}^3 \delta_h W_{h,i,t-\tau} + \varepsilon_{i,t} \quad (1)$$

Where $TAX_{i,t}$ is the tax performance measure (i.e. aggregate tax income and the non-resource tax revenue both in percentage of GDP) of country i in period t , σ_0 is a constant, FIN represents the financial inclusion proxies (i.e. number of commercial bank branches, domestic credit to private sector by banks and domestic credit to private sector); ICT reflects the technology measures (i.e. the internet utilization rate per 100 people, the mobile phone penetration rate per 100 people, the telephone utilization rate per 100 people, internet user in percentage of total population and ICT import in percentage of total import); $FIN*ICT$ denotes the interactions between the financial inclusion indicators and technology variables; W is the vector of control variables (GDP per capita growth, foreign direct investment, and personal remittances); and $\varepsilon_{i,t}$ is the error term.

It is important to note that, since, the estimation technique includes interactive regressions; it is necessary to identify certain pitfalls associated with this type of regression reported by Brambor, Clark and Golder (2006). Consequently, the specifications should include all constituent variables. In addition, the appropriate estimated interactive terms parameters should be interpreted as conditional or marginal effects for the economic significance estimates.

Table 4 Bank Branches, ICT and Tax Performance

	Dependent Variables									
	Total Tax Revenue in percentage of GDP					Non-resource Tax Revenue in percentage of GDP				
Branches	0.00210* (0.00127)	0.00368*** (0.000838)	0.00311*** (0.000672)	0.00441*** (0.00126)	0.00489*** (0.000973)	0.000375 (0.00114)	0.00271*** (0.000781)	0.00258*** (0.000629)	0.00180 (0.00113)	0.00467*** (0.000908)
Mobile	0.000606*** (0.000144)					0.000762*** (0.000132)				
Mobile x Branches	0.000000459 (0.00000975)					0.0000107 (0.00000876)				
Telephone	0.00424*** (0.00131)					0.00450*** (0.00122)			
Telephone x Branches		-0.000123** (0.0000535)					-0.0000808 (0.0000499)			
Internet			0.00295 (0.00274)					0.00413 (0.00257)		
Internet x Branches			-0.0000529 (0.0000845)					-0.0000284 (0.000079)		
Interuser				0.00191*** (0.000434)					0.00270*** (0.000415)	
Interuser x Branches				-0.0000648** (0.0000283)					-0.0000258 (0.0000254)	
ICT					0.00859** (0.00364)					0.0118*** (0.00346)
ICT x Branches					-0.000597** (0.000270)					-0.000637** (0.000253)
GDP	0.000658 (0.00127)	0.000545 (0.00131)	0.000746 (0.00140)	0.00153 (0.00131)	0.000127 (0.00152)	0.00194* (0.00114)	0.00158 (0.00122)	0.00216 (0.00131)	0.00315*** (0.00117)	0.00101 (0.00148)
Remittance	0.00140* (0.000757)	0.00163** (0.000776)	0.00166** (0.000804)	0.00155* (0.000797)	0.00198** (0.000915)	0.00290*** (0.000682)	0.00310*** (0.000726)	0.00313*** (0.000755)	0.00301*** (0.000715)	0.00382*** (0.000863)
FDI	-0.000287 (0.000351)	-0.000369 (0.000357)	-0.000590 (0.000379)	-0.000311 (0.000358)	-0.000260 (0.000665)	0.00000167 (0.000315)	-0.000128 (0.000334)	-0.000344 (0.000356)	0.0000378 (0.000320)	0.00107* (0.000624)
Constant	0.0896*** (0.0126)	0.120*** (0.00795)	0.129*** (0.00769)	0.101*** (0.00961)	0.108*** (0.0141)	0.0643*** (0.0114)	0.105*** (0.00750)	0.112*** (0.00727)	0.0804*** (0.00876)	0.0776*** (0.0133)

Net Effect	N/A	0.033	N/A	0.0034	0.0028	N/A	N/A	N/A	N/A	0.0024
Observations	317	316	305	295	277	298	297	286	278	251
R-squared	0.250	0.221	0.195	0.242	0.192	0.361	0.284	0.256	0.353	0.268
RMSE	0.0680	0.0694	0.0714	0.0689	0.0721	0.0610	0.0647	0.0667	0.0615	0.0670
F-test	17.27	14.65	12	15.31	10.72	27.44	19.16	15.99	24.60	14.92
Prob > F	0	0	0	0	0	0	0	0	0	0

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
 Source: Prepared by the authors (2023)

Table 5 Domestic Credit by Banks, ICT and Tax Performance

	Dependent Variables									
	Total Tax Revenue in percentage of GDP					Non-resource Tax Revenue in percentage of GDP				
Bank	0.00314*** (0.000787)	0.00312*** (0.000312)	0.00283*** (0.000277)	0.00377*** (0.000502)	0.00314*** (0.000552)	0.00270*** (0.000685)	0.00312*** (0.000271)	0.00289*** (0.000239)	0.00350*** (0.000434)	0.00285*** (0.000511)
Mobile	0.00102*** (0.000186)					0.00104*** (0.000157)				
Mobile x Bank	-0.0000171** (0.00000673)					-0.0000129** (0.00000582)				
Telephone		0.0107*** (0.00113)					0.0109*** (0.000979)			
Telephone x Bank		-0.000181*** (0.0000172)					-0.000178*** (0.0000149)			
Internet			0.0188*** (0.00219)					0.0195*** (0.00190)		
Internet x Bank			-0.000320*** (0.0000344)					-0.000321*** (0.0000298)		
Interuser				0.00358*** (0.000478)					0.00378*** (0.000409)	
Interuser x Bank				-0.0000818*** (0.0000131)					-0.0000753*** (0.0000113)	
ICT					0.00311 (0.00391)					0.00406 (0.00371)
ICT x Bank					-0.000243***					-0.000195**

					(0.0000922)					(0.0000854)
GDP	0.000745 (0.00110)	0.000920 (0.000997)	0.00175 (0.00126)	0.00114 (0.00109)	0.00109 (0.00135)	0.00177* (0.000963)	0.00148* (0.000859)	0.00287*** (0.00108)	0.00228** (0.000941)	0.00178 (0.00128)
Remittance	0.00158** (0.000747)	0.00201*** (0.000665)	0.00239*** (0.000709)	0.00186** (0.000753)	0.00220** (0.000904)	0.00322*** (0.000652)	0.00330*** (0.000576)	0.00376*** (0.000612)	0.00338*** (0.000652)	0.00406*** (0.000841)
FDI	0.000063 (0.000337)	-0.000201 (0.000303)	-0.000436 (0.000334)	-0.00000976 (0.000332)	0.000617 (0.000634)	0.000278 (0.000296)	0.0000453 (0.000263)	-0.000212 (0.000289)	0.000203 (0.000287)	0.00179*** (0.000586)
Constant	0.0343** (0.0168)	0.0714*** (0.00789)	0.0803*** (0.00836)	0.0488*** (0.0111)	0.0902*** (0.0162)	0.0154 (0.0145)	0.0541*** (0.00677)	0.0603*** (0.00712)	0.0293*** (0.00961)	0.0669*** (0.0152)
Net Effect	0.0018	0.0026	0.0025	0.0025	N/A	0.0017	0.0026	0.26	0.0023	N/A
Observations	320	319	302	297	277	305	304	287	284	251
R-squared	0.293	0.430	0.389	0.336	0.216	0.414	0.540	0.511	0.459	0.312
RMSE	0.0663	0.0596	0.0627	0.0647	0.0712	0.0583	0.0517	0.0542	0.0561	0.0653
F-test	21.60	39.22	31.29	24.47	12.41	35.12	58.14	48.67	39.14	18.44
Prob > F	0	0	0	0	0	0	0	0	0	0

Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1
 Source: Prepared by the authors (2023)

Table 6 Domestic Credit to Private Sector, ICT and Tax Performance

	Dependent Variables									
	Total Tax Revenue in percentage of GDP					Non-resource Tax Revenue in percentage of GDP				
Credit	0.00216*** (0.000554)	0.00212*** (0.000172)	0.00175*** (0.000151)	0.00226*** (0.000395)	0.00268*** (0.000435)	0.00223*** (0.000550)	0.00214*** (0.000171)	0.00178*** (0.000148)	0.00224*** (0.000389)	0.00248*** (0.000448)
Mobile	0.000939*** (0.000134)					0.000904*** (0.000130)				
Mobile x Credit	-0.000010** (0.00000425)					-0.0000104** (0.00000421)				
Telephone		0.0110*** (0.000951)					0.0107*** (0.000952)			
Telephone x Credit		-0.000154*** (0.0000147)					-0.000151*** (0.0000146)			
Internet			0.0189***					0.0189***		

Internet x Credit			(0.00188)					(0.00186)		
			-0.000257***					-0.000256***		
			(0.0000287)					(0.0000283)		
Interuser				0.00283***					0.00286***	
				(0.000361)					(0.000353)	
Interuser x Credit				-0.0000408***					-0.0000395***	
				(0.0000092)					(0.00000905)	
ICT					-0.00146					-0.000608
					(0.00304)					(0.00320)
ICT x Credit					-0.000177***					-0.000153**
					(0.0000604)					(0.0000621)
GDP	0.000967	0.00104	0.00211*	0.00135	0.00177	0.00185**	0.00156*	0.00309***	0.00229**	0.00242**
	(0.000947)	(0.000859)	(0.00110)	(0.000945)	(0.00116)	(0.000938)	(0.000853)	(0.00107)	(0.000929)	(0.00122)
Remittance	0.00273***	0.00314***	0.00367***	0.00296***	0.00379***	0.00363***	0.00374***	0.00430***	0.00374***	0.00461***
	(0.000640)	(0.000573)	(0.000616)	(0.000658)	(0.000775)	(0.000635)	(0.000572)	(0.000606)	(0.000649)	(0.000804)
FDI	0.000265	-0.0000766	-0.000321	0.000139	0.00148***	0.000230	-0.0000499	-0.000311	0.000116	0.00177***
	(0.000288)	(0.000259)	(0.000287)	(0.000287)	(0.000541)	(0.000287)	(0.000259)	(0.000284)	(0.000284)	(0.000557)
Constant	0.0340***	0.0754***	0.0853***	0.0601***	0.0887***	0.0260**	0.0677***	0.0762***	0.0502***	0.0795***
	(0.0128)	(0.00603)	(0.00648)	(0.00902)	(0.0131)	(0.0126)	(0.00597)	(0.00629)	(0.00893)	(0.0136)
Net Effect	0.0014	0.0017	0.0015	0.0016	N/A	0.0014	0.0017	0.0015	0.0016	N/A
Observations	308	307	290	285	265	293	292	275	272	239
R-squared	0.393	0.508	0.467	0.406	0.340	0.426	0.533	0.508	0.448	0.365
RMSE	0.0564	0.0509	0.0538	0.0557	0.0599	0.0563	0.0508	0.0531	0.0551	0.0611
F-test	32.42	51.58	41.33	31.63	22.14	35.40	54.29	46.13	35.89	22.25
Prob > F	0	0	0	0	0	0	0	0	0	0

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

Source: Prepared by the authors (2023)

RESULTS AND DISCUSSION

Table 4 discloses the linkages between the number of commercial bank branches, technology and tax performance using Ordinary Least Square estimate while Table 5 divulges the connections between domestic credit to private sector by banks, technology, and tax performance. Table 6 relates to the influences between domestic credit to private sector, technology and tax performance using standard Ordinary Least Square estimate. The tables contain two panels, notably, i) Panel A (i.e. the first-four columns) showing the nexus relating to total tax revenue whereas (ii) Panel B (i.e. the last-four columns) indicating the connexion in relative to non-resource tax revenue. Notably, the main information criteria for the validity of the corresponding model is the Fisher's Test. It is interesting that Fisher's Test reports that the models of this study are overwhelmingly valid and significant. From Table 4-6, the results show that the significant variables for financial inclusion and technology proxies are overwhelmingly positive on the tax performance (i.e. total tax revenue and the non-resource tax revenue both in percentage of GDP) accordingly. The results imply that the enhancement of financial inclusion and technological utilization will lead to more domestic revenue mobilization for the sampled countries. However, the interactive effects between financial inclusion measures and ICT proxies are mostly negative and significant on tax performance. It is essential to estimate net effect because of certain pitfalls associated with interactive regression reported by Brambor, Clark and Golder (2006).

Following the extant scholarly outputs on interactive regressions (Asongu, Adegboye, Ejemeyovwi & Umukoro, 2021; Asongu & Odhiambo, 2020b), this study estimates the net effects to assess the incidence of technology in modulating the effect of financial inclusion on tax performance. For instance, from Table 4 (in column 2), the net effect of financial intermediary formalization in modulating the effect of indirect tax revenue (excluding the indirect resource tax revenue) on inclusive human development is $0.0033 [(2.874 \times -0.000123) + (0.00368)]$. In this computation, 2.874 is the mean value of telephone penetration, -0.000123 is the conditional effect from the interaction between bank branches and technology while 0.00368 is the unconditional effect of bank branches. Since the outcome variable is a positive economic signal, a favorable effect on the outcome variable can be interpreted as an improvement in tax performance by interpreting the positive net results. As a result, a rising magnitude in the outcome variable indicates more tax performance.

The following empirical results are documented. First, in Table 4, regarding the net impacts between commercial bank branches and technology measures (i.e., telephone

penetration, internet users and ICT import) are positive on total tax revenue whereas the net effect between commercial bank branches and technology measure (i.e. only ICT import) is positive on non-resource tax revenue. Second, in Table 5, concerning the net influences between domestic credit to private sector by banks and technology measures (i.e., mobile phone, telephone penetration, internet penetration and internet users) are positive on total tax revenue whereas the net effect between domestic credit to private sector by banks and technology measure (i.e. mobile phone, telephone penetration, internet penetration and internet users) is positive on non-resource tax revenue. Third, in Table 5, considering the net influences between domestic credit to private sector and technology measures (i.e., mobile phone, telephone penetration, internet penetration and internet users) are positive on total tax revenue whereas the net effect between domestic credit to private sector and technology measure (i.e. mobile phone, telephone penetration, internet penetration and internet users) is positive on non-resource tax revenue. Finally, the significant control follows the apriori expectations. Accordingly, the gross domestic product growth, remittance, and foreign direct investment affect tax revenue positively.

CONCLUSION

This study investigates the relevance of technology in moderating the incidence of financial inclusion on tax performance in 46 Sub-Saharan Africa for the period 2010-2018. Tax performance was measured by the total taxes' revenue excluding social contributions and non-resource taxes respectively. The study adopts five basic ICT indicators namely: the internet utilization rate per 100 people, the mobile phone penetration rate per 100 people, the telephone utilization rate per 100 people, internet user in percentage of total population and ICT import in percentage of total import. The financial inclusion variables include the numbers of commercial bank branches, domestic credit to private sector by banks and domestic credit to private sector. This study utilized the standard ordinary least squares (OLS) procedure, which pools all of the observations. From the empirical findings, it is established that technology modulates financial inclusion to exert a net positive effect on tax revenue mobilization. In general, the findings indicate that policy is needed to engender enhancement of technology and more investment should be channeled to technology as it affects financial inclusion and consequently promotes tax revenue mobilization.

Sequel to the foregoing analysis, the followings constitute the recommendations of this study:

a. Having identifies the importance of a nation being financially and technologically included, there is a need for the governments in sub-Saharan Africa to improve the level of financial inclusion and technology in their various nations.

b. Policies should be formulated to engender enhancement of technology and more investment should be allocated to technology as its effect financial inclusion and promote tax revenue mobilization.

The study contributed to knowledge by building an index that captures the various financial inclusion variables, which sheds light on the importance of financial inclusion on the tax performance in sub-Saharan Africa. Additionally, we computed the graphical representation of data of mobile cellular usage per 100 inhabitants of sub-Saharan African nations for a five-year period from 2015-2019. We expanded the tax performance indicator by including the non-resource tax to provide a more robust result. This study has contributed to the literature on financial inclusion, technology, and taxation as well as financial inclusion and technological determinants of tax outcomes.

On the side of limitations of study, the generalization of this study is restricted to the period of 1999-2019, this is because more recent data for tax performance in sub-Saharan were not available at the time of the study. This study is limited to only the nations in sub-Saharan Africa in Africa.

Further studies can consider examining the role of education and the informal sector on the level of financial inclusion, as prior studies have shown that illiteracy is a factor that causes financial exclusion, level of technological usage and its resultant effect on the tax performance in sub-Saharan Africa.

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