Economic Transformation and Tax Revenue Performance in SSA Countries

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Working Paper 025-2025

Bringing Rigour and Evidence to Economic Policy Making in Africa

AFRICAN ECONOMIC RESEARCH CONSORTIUM
CONSORTIUM POUR LA RECHERCHE ÉCONOMIQUE EN AFRIQUE

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AERC Working Paper 025-2025
African Economic Research Consortium, Nairobi
November 2025

Published by: The African Economic Research Consortium
P.O. Box 62882 - City Square
Nairobi 00200, Kenya

Acknowledgements

This paper was made possible by a research grant of the African Economic Research Consortium (AERC). We are very grateful to AERC, who enabled the publication of the present paper. We acknowledge the full support of the AERC fraternity in making this research a better piece as we contribute to research in economics and policy analysis in Africa. Our thanks go to AERC who contributed towards the technical and financial assistance during the process of conducting this research and gave the enlightened comments and suggestions that contributed to the transformation of this study. Special recognition is given to the technical assistance of Dr. Ngugi Rose and Dr. Odongo Kodongo and other resource persons who gave comments and suggestions that helped improve the overall quality of the paper. Our gratitude to all the members of AERC (directly and indirectly involved in this project), especially, Prof. Scholastica Odhiambo, Nathalie Chaponda and to the LoRDA Research Center for providing us with working space to carry out this research. The work is solely that of the authors in regard to content, findings and opinions in this paper.

Abstract

Many studies have addressed the determinants of tax revenue performance, but knowledge on the causal impacts of economic transformation is nearly non-existent. This study used panel data from the World Bank Development Indicators and UNDP database over the period 1990–2021 to provide evidence on the effect of economic transformation on tax revenue performance. Our panel data estimation disentangled the causal effects of economic transformation in resource-rich and non-resource-rich countries. We employed the GMM to correct the problem of dynamic endogeneity and unobserved panel heterogeneity. We further utilized the fixed and random effects to assess the robustness of the GMM estimations. GMM results indicated that economic transformation has a significant positive effect on tax revenue performance in SSA. The fixed and random effects results reported a positive and significant effect of economic transformation on tax revenue performance in SSA, similar to the GMM results. We used two ICT-related transmission mechanisms: ICT adoption and ICT export/import. We found that ICT stock does mediate the effect of economic transformation on tax revenue performance. Like in resource-rich countries, economic transformation had a positive impact on tax revenue performance in non-resource-rich countries. Thus, this study recommends that SSA countries, in an effort to increase tax revenue performance, should promote economic transformation through the DEPTH (diversification, export competitiveness, productivity, technological upgrading, and human well-being). Measures to enhance ICT adoption the for e-tax system are vital in strengthening the relationship between economic transformation and tax revenue performance in SSA.

Keywords: Economic transformation, Tax Revenue Performance, Transmission channels, Resource and non-resource rich countries and Sub-Saharan Africa.

1. Introduction and Statement of the Problem

Economic transformation plays a critical role in shaping tax revenue performance because it directly influences the composition and size of the tax base. Significant structural changes, such as shifts from agrarian to industrial or from manufacturing to services-oriented, alter the nature of economic activities, thereby affecting the sources and levels of taxable income. According to Acemoglu et al. (2001), economic transformations can lead to changes in the distribution of wealth and income, impacting tax revenue generation. For instance, rapid industrialization may widen the tax base by incorporating previously untaxed sectors into the formal economy. Bird and Zolt (2005) demonstrate that as economies undergo transformation, such as transitioning from agrarian to industrial or service-based sectors, significant shifts occur in production patterns, consumption behaviours, and income distribution, subsequently influencing tax revenue streams. Moreover, studies examining the tax revenue performance of countries undergoing rapid industrialization, such as South Korea and China, have revealed a positive correlation between economic transformation and tax revenue growth (Gemmell & Morrissey, 2005; Tanzi & Zee, 2001).

Tax revenue collection in many Sub-Saharan Africa (SSA) countries (collecting on average 14% in taxes as a share of GDP) is still well below the world's average of 20% of GDP and far below the levels in Europe and Central Asia (UNU-WIDER Government Revenue Dataset, 2021). These countries fail to collect and account for a significant portion of the taxes they should. Many Latin America and Caribbean countries are in the low tax performers group, except Brazil and Guyana, who are the only high tax performers; in South and Southeast Asia, high tax performers are virtually absent, and in Africa, only Ghana, Morocco, Burundi, Algeria, and Liberia are in the high tax performers group (Von Haldenwang and Ivanyna 2015). Literature has highlighted factors like ineffective tax policies, tax evasion and avoidance, tax exemptions, and widespread corruption (Fuest and Riedel 2009) as reasons for these countries' low tax performance. Global players such as the United Nations, World Bank, and G20 are calling for more action to fight corruption, tax evasion, and avoidance.

Many SSA countries, as a response, have implemented practical and robust means (such as taxpayer education and taxpayer service, reducing tax compliance costs and administrative costs, creating semi-autonomous revenue authorities, setting up large taxpayer units such as one-stop services, etc.) to boost tax revenue collection. Again, the 2008 Doha Declaration on Financing for Development pledged to "enhance tax revenues by modernizing tax systems, enhancing the efficiency of tax collection, broadening the tax base, and effectively fighting tax evasion."

In 2018, Sub-Saharan African countries collected 14% of GDP taxes (UNU-WIDER Government Revenue Dataset, 2021). However, this continent-wide average does not level out across SSA countries. Notably, high- and upper-middle-income countries like the Seychelles, Namibia, and South Africa recorded rates as high as 28–33%, whereas low-income countries like Chad, the Democratic Republic of the Congo, and Ethiopia registered rates as low as 7%. The continent-wide average has more or less remained stagnant over the past three decades, with African countries collecting an average of 12–15% of GDP as taxes from 1990 to 2020. Like SSA, both the South Asia region and the Middle East and North Africa region have similarly low rates of about 14% in taxes as a share of GDP. However, a recent report by the World Bank points out that tax revenue collection in Africa and SSA remains relatively low. The World Bank (2022) report highlights that Africa's average tax-to-GDP rate of 16.5% stands to be the lowest compared to other regions: Asia and the Pacific with a rate of 19.1%, Latin America and the Caribbean with a rate of 21.9%, and OECD countries with a rate of 33.5%. Conversely, Europe and the Central Asia region have the highest rate of 32% in taxes as a share of GDP (UNU-WIDER Government Revenue Dataset, 2021). Importantly, on average, higher-income countries tend to enjoy a higher share of tax to GDP. These countries have succeeded in putting in place more effective tax policies and tax systems that minimize fund leakage (Oyebola and Santorob, 2023). This suggests that as we transform our economies, we could achieve better tax outcomes through effective tax administration, policy, and tax systems.

Existing studies on the determinants of tax revenue performance in developing countries (Imran and Farzana 2010; Addison 2012; Micah 2015; Onakoya et al. 2017; Ade et al. 2018) have not addressed the causal impacts of economic transformation variables. Research on economic transformation has focused attention on its effects on productivity growth and human capital accumulation. Regrettably, the impact of economic transformation on tax mobilization over time and across countries remains largely unexplored (IMF, 2019). With economic transformation here, we simply mean the transition from low productivity sectors and labor-intensive economic activities to high productivity and skill-intensive activities in the manufacturing and service sectors as countries develop. In this regard, economic transformation results in a gradual decline in the relative size of the agriculture sector and a corresponding rise in manufacturing and services (Kuznets, 1973).

Importantly, this research (see ACET, 2014) uses a definition and measurement of economic transformation that excludes shifts to manufacturing and service sectors motivated by less competitiveness, such as the need to distribute manufactured or service products produced abroad to replace less efficient and thus uncompetitive domestic production. It is probable, though not verified empirically, that economic transformation, has potential to shift labour from lower to higher productive activities, harbours potential to shift countries from low tax revenue performers to high tax revenue performers.

The Solow-Swan growth model and subsequent extensions incorporate the role of productivity growth, technological progress, and capital accumulation in driving economic transformation. These theories suggest that as countries transition from lower to higher productive activities, they can experience sustained economic growth, leading to increased incomes and potentially higher tax revenues (Solow, 1956; Swan, 1956). Furthermore, comparative advantage and productivity growth theories suggest that as countries transition from lower to higher productive activities, they can generate more income, potentially leading to higher tax revenues. This theoretical underpinning provides a framework for analysing the relationship between economic transformation and tax revenue performance. Economic transformation often prompts governments to undertake tax reforms aimed at modernizing tax systems, broadening the tax base, improving compliance, and enhancing revenue collection efficiency (Besley and Persson, 2014; Lisinge and Ndikumana, 2018). Such evidence motivated us to investigate whether economic transformation with its huge potential to prompt tax reforms can help, either directly or indirectly, promote revenue mobilization in SSA.

It is worth noting that transformational countries in Eastern Europe and Central Asia (such as Slovenia, Kazakhstan, and Russia) have been able to significantly improve their tax performance (Svejnar, 2002). This evidence further supports the idea that economic transformation may have a significant impact on SSA tax revenue performance. A low-performing country today can change to a high-performing country tomorrow, and vice versa. Bird and Torgler (2008) emphasize that a transition from low tax performers to high tax performers is attributable to improvements in governing institutions. According to Cevik et al. (2019), economic transformation is associated with a higher level of GDP per capita and greater institutional development, which are important drivers of tax revenue collection. While institutions play a significant role in tax performance, the effect of economic transformation on tax performance has received less empirical research. Thus, the question is: Can economic transformation promote and sustain tax revenue performance? Or can tax revenue performance become more sustained with economic transformation? Our study will divide the study period into different time-based and resource-based sub-samples and perform the tax performance assessment to identify the countries that changed categories over time (that is, from low tax performers to average or to high tax performers, and vice versa).

African countries should aim to achieve high tax performance for several reasons, as it brings numerous benefits, such as effective tax collection serving as a primary source of revenue for governments. This revenue is crucial for funding public services such as education, healthcare, infrastructure development, and social welfare programs, all of which are vital for economic and social development. According to the International Monetary Fund (IMF, 2020), taxation is the most sustainable way for governments to finance their activities. It allows African countries to reduce their reliance on external sources of financing, such as foreign aid and loans, thereby enhancing fiscal sovereignty and autonomy. For instance, research by Gupta et al. (2001) indicated that a well-structured tax system contributes to economic stability by reducing budget deficits, financing public investments, and ensuring macroeconomic stability. A diverse revenue base, including taxes, provides governments with the flexibility to respond to economic shocks and crises effectively (IMF, 2019). According to the World Bank (2020), domestic resources, including taxes, are the largest and most stable source of financing for development in low-income countries. For Besley & Persson (2011), high levels of tax performance encourage governments to be more responsive and accountable to their citizens' needs and preferences, thereby promoting beneficial governance.

It is important to highlight that boosting the tax revenue performance of developing countries improves their ability to render public tasks and services that are more affordable and accessible compared to private services. With the help of tax resources and other government finance, the available and affordable public services can go a long way toward achieving many Sustainable Development Goals: Goal One (aimed at ending extreme poverty by 2030), Goal Ten (aimed at reducing inequalities), Goal Six (aimed at providing clean sanitation), and Goal Seven (aimed at providing affordable and clean energy).

2. Stylised Facts on Economic Transformation

In many developing countries, including Africa, the increasing share of services in aggregate value added has outpaced manufacturing. Manufacturing expanded sharply during the early period of economic development, roughly from 1960 to 1975. The relative share of employment in manufacturing increased in many African countries, averaging 4.7% in 1960 to 7.8% in 1975. The manufacturing value added share also improved markedly during that period, from 9.2 to 14.7%. According to the classic Lewis-type dual economy model, this development pattern reflects the economic transformation in Africa as workers transition from subsistence agriculture to modern manufacturing (Lewis, 1954). As explained by Lewis (1954), the differences in earnings between traditional and modern sectors are key in explaining these reallocation dynamics. However, since the 1970s, manufacturing's value-added share has remained fundamentally flat, as the paragraphs below explain. Unlike manufacturing, services have been growing rapidly, rising by 10.2 percentage points between 1970 and 2014. We can all witness that Africa's economic structure has changed rapidly with a growing share of service activities, specifically distribution services. In 2010, the average workforce in many African countries engaged in these services, up from 11% in 1990 (Vries et al., 2015).

Concerning productivity level in Africa, the relative productivity level in agriculture stood at about 0.5 in 1960, indicating that the average productivity level in agriculture was half that of the total economy. Productivity in manufacturing was about 2.5 times that of the total economy level, showing that the average productivity level in manufacturing was more than twice that of the total economy. This also implies that the average output of workers in manufacturing did not fall relative to other sectors of the economy, despite the rapid employment expansion in this sector. These variations in productivity levels may approximate differences in relative earnings across sectors. These employment-share, value-added, and productivity-based evidence point to the reality of economic transformation in Africa.

Both at the national and global levels, political and economic unrest engulfed Africa in the 1970s. For instance, the oil crises in the 1970s, currency instability, and related events led to a long period of stagnation. According to international standards, the share of employment in industry was still considered low, and this share barely increased. The share of agriculture continued to decline slowly, releasing more workers into the service sector instead. Notably, in the period 1975-1990, growth was low or negative across the African continent, triggering a major process of restructuring and liberalization through the structural adjustment programs (Lensink, 1996; Collier & Gunning, 1999).

When growth resumed in the 1990s, structural change continued, and we witnessed a rapid reallocation of workers across sectors. The agricultural employment share dropped from 61.6% in 1990 to 49.8% in 2010. Like agriculture, manufacturing did not expand during this period; its employment share fell from 8.9% in 1990 to 8.3% in 2010. According to Page (2012), after 1990, deindustrialization led to a decline in the diversity and sophistication of manufacturing activities, further eroding the region's manufacturing capabilities. As a result, market services sectors, particularly distribution services, absorbed workers transitioning from agriculture (Rodrik, 2013). The share of distribution services increased and almost doubled to 20.1% in 2010, with one-fifth of Africa's labor force employed in the distribution sector, which is analogous to levels observed in OECD countries (Jorgenson & Timmer, 2011). Several factors have contributed to the shift towards services. First, market-oriented policy reforms in the 1990s likely increased demand for wholesaling and retail services. Trade liberalization, for example, eased the imports of numerous consumer and investment goods and stimulated the expansion of foreign retail chains through FDI. Second, with rising incomes in the distribution sector, a relatively larger share of domestic demand is shifting towards service consumption. According to Jedwab (2013), the expansion of natural resource exports in African countries has led to a surge in demand for urban services such as trading, transport, and personal services in 'consumption cities'. Thirdly, there has been a decrease in the demand and prices of agricultural products. For example, Johnston and Meller (1961) and Martin and Warr (1990) say that the following things are making the agriculture sector less important compared to manufacturing and services: (1) the falling income elasticity of demand for food; (2) the changes in relative commodity prices that come from these changes in demand; and (3) the chance of a big increase in agricultural production with a farm labour force that stays the same or goes down.

The reallocation of workers to services did not necessarily lead to an increase in aggregate productivity, unlike the shift towards industry in the 1960s and 1970s discussed above. The marginal productivity of additional workers in market services was below that of existing activities. The relative productivity level fell from three times the overall economy average in 1990 to 1.8 in 2010. Notably, the reallocation of workers to market services (such as wholesale and retail trade, hotels and restaurants services, transport, storage, and communication services, finance, insurance, real estate, and business services) with below-average productivity growth is an indication that the dynamic implications of structural change were negative after 1990. This is likely to occur if workers were reallocated to market services dominated by wholesale and retail of imported services, which are fundamentally labour-based and do not generate any real structural transformation.

Since 2010, the share of employment in agriculture in Africa has been steadily declining. As of 2020, 43.8 percent of total employment in Africa was in agriculture, compared to 49.8% in 2010. Equally, the share of employment in agriculture in SSA has been on a steady decline in the period 1995–2021. On the other hand, in the same period, employment shares in the service and manufacturing sectors have increased steadily in SSA.

The pace of structural change in the 21st century is analogous to that of Africa's golden age (see Graziano, 2011 for Africa's golden age), marking the period between 1100 and 1600 where West African gold was in high demand and led to an increase in the need and use of services such as trade routes and market services. From 1300 onwards, traders, travelers, and scholars utilized the Trans-Saharan trade routes for trade, travel, and scholarship. The reallocation patterns discussed so far hold for most of the Sub-Saharan African countries, but we acknowledge that there might be some remarkable diversity in specific country experiences.

Tax performance assessment analyses

Table 1: Tax performance assessment period policy reform period

COUNTRY	**1990-1999 (Period of SAP)**		**2000-2015 (Period of UN MDGs)**		**2016-2021 (Period of UN SDGs)**		**All sample**	
	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)	N	Mean (SD)
Angola	1	16.294 (NA)	16	18.812 (5.398)	4	9.673 (0.356)	21	16.951 (5.938)
Botswana	7	22.316 (5.178)	10	26.586 (1.494)	6	22.404 (1.147)	23	24.195 (3.622)
Burkina Faso	0		14	11.736 (1.618)	6	14.896 (0.987)	20	12.684 (2.063)
Burundi	9	14.477 (1.517)	0	NA	0		9	14.477 (1.517)
Cabo Verde	0		11	19.469 (1.799)	2	19.345 (1.049)	13	19.450 (1.671)
Cameroon	8	8.433 (1.625)	4	11.816 (0.453)	5	11.755 (0.555)	17	10.206 (2.059)
Central African Republic	0	NA	8	7.009 (1.584)	6	7.96 (.814)	14	7.417 (1.358)
Congo Republic	0	NA	15	7.871 (1.883)	5	9.779 (2.623)	20	8.348 (2.186)
Cote d'Ivoire	2	18.415 (0.571)	15	10.114 (0.83)	6	12.053 (0.449)	23	11.34 (2.493)
Equatorial Guinea	0		10	8.938 (1.853)	6	6.843 (1.458)	16	8.152 (1.967)
Ethiopia	10	8.533 (1.958)	15	8.564 (.831)	5	7.214 (0.766)	30	8.329 (1.364)

Gabon	0		4	14.514 (1.388)	4	11.061 (0.593)	8	12.788 (2.093)
Ghana	4	12.129 (1.216)	15	15.111 (3.463)	5	11.643 (0.481)	24	13.892 (3.185)
Guinea	3	11.231 (0.759)	0	NA	0	NA	3	11.231 (0.759)
Kenya	0		2	15.013 (0.246)	6	14.494 (0.730)	8	14.624 (0.669)
Lesotho	9	27.814 (1.888)	16	32.103 (5.578)	6	31.629 (1.441)	31	30.766 (4.536)
Liberia	0		8	10.339 (2.070)	0	NA	8	10.339 (2.070)
Madagascar	6	6.688 (.5969038)	13	9.018 (0.835)	6	9.984 (0.500)	25	8.690 (1.398)
Malawi	0	NA	7	14.879 (0.846)	6	12.488 (1.503)	13	13.776 (1.685)
Mali	0	NA	16	12.605 (1.007)	5	14.323 (1.634)	21	13.014 (1.362)
Mauritius	10	17.514 (1.836)	16	16.405 (2.366)	6	18.711 (1.158)	32	17.184 (2.169)
Mozambique	0	NA	6	19.551 (3.407)	6	22.663 (2.294)	12	21.107 (3.211)
Namibia	10	25.458 (1.513)	16	28.777 (3.483)	6	30.128 (1.259)	32	27.993 (3.172)
Rwanda	3	9.031 (0.239)	2	13.127 (0.245)	5	14.355 (0.589)	10	12.512 (2.487)
Senegal	0	NA	1	15.774 (NA)	3	16.219 (.2703)	4	16.108 (0.313)

Seychelles	7	28.931 (3.397)	12	27.055 (2.798)	3	30.976 (0.593)	22	28.187 (3.076)
South Africa	10	20.679 (0.988)	16	22.883 (1.499)	5	24.556 (0.705)	31	22.442 (1.835)
Sudan	2	6.292 (0.134)	7	6.706 (1.512)	1	7.390 (NA)	10	6.692 (1.272)
Tanzania	0	NA	7	10.607 (0.662)	3	11.637 (0.224)	10	10.916 (0.742)
Togo	0	NA	12	15.379 (1.932)	4	13.216 (0.530)	16	14.838 (1.931)
Uganda	0	NA	1	10.802 (NA)	6	11.749 (0.508)	7	11.614 (0.586)
Zambia	10	16.895 (1.383)	15	14.443 (1.217)	6	15.831 (1.345)	31	15.502 (1.672)
Zimbabwe	0	NA	5	16.014 (3.815)	3	12.849 (4.884)	8	14.827 (4.221)

Note: NA stands for Not Applicable

Source: Computed by authors

According to Table 1, SSA countries such as Lesotho, the Seychelles, Namibia, and South Africa recorded significant steady progress and the highest tax revenue performance during the policy periods. Burkina Faso, Congo Republic, CAR, Madagascar, Mali, Mozambique, Rwanda, Senegal, and Sudan also recorded some steady progress in tax revenue performance during the policy reform periods. The other countries (Angola, Botswana, Cape Verde, Cameroon, Cote d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Ghana, Kenya, Malawi, Togo, and Zimbabwe) registered unsteady and decreasing tax revenue performance during the policy periods.

Leaning on the work of Martínez-Vázquez and Violeta (2011), we consider relatively high tax performers to be countries with a tax-to-GDP ratio of 20% and above (in this category, we have: Botswana, Lesotho, Mozambique, Namibia, the Seychelles, and South Africa). Except for Botswana, these countries have maintained steady progress in this category during policy reform periods. This could be due to common characteristics such as natural resource exports, improved tax administration efficiency and tax revenue services, a broadening of the taxpayer base, strong economic performance, and high investment in the manufacturing and service sectors in these countries.

We consider the middle/average tax performers to be countries with a tax-to-GDP ratio between 10% and less than 20% (which include Angola, Burkina Faso, Burundi, Cabo Verde, Cameroon, Cote d'Ivoire, Gabon, Ghana, Guinea, Kenya, Liberia, Malawi, Mali, Mauritius, Rwanda, Senegal, Tanzania, Togo, Uganda, Zambia, and Zimbabwe). Among the countries that witnessed a decreasing tax performance during the policy reform periods, Angola is the only country that drifted from an average performer to a low performer in the periods 2000-2015 to 2016-2021. Countries with a tax-to-GDP ratio of less than 10% are considered low-tax performers (here we have; Central African Republic, Congo Republic, Equatorial Guinea, Ethiopia, Madagascar, Sudan).

Overall, it is undeniable that SSA has a real tax performance problem; only six (6) of the thirty-three (33) countries considered in this study are high tax performers (6 of the 33 countries); a large majority are classified as average tax performers (21 of the 33 countries); and six of the 33 countries are in the low tax performers category.

3. Research Questions

The main question is: What are the causal impacts of economic transformation on tax revenue performance in Sub-Saharan African countries (SSA).

This is guided by the following specific research questions:

- What is the impact of economic transformation on SSA tax revenue performance?
- What are the channels through which economic transformation influences tax revenue performance?

Research has highlighted the role of information and communication technology (ICT) as a driver of economic transformation, particularly in developing regions like Sub-Saharan Africa (SSA). ICT facilitates efficiency gains, innovation, and productivity enhancements across various sectors, leading to economic growth (Qiang et al., 2009; World Bank, 2016). Furthermore, studies have shown that ICT adoption can significantly improve SSA tax administration and revenue collection. ICT solutions such as electronic tax filing systems, online payment platforms, and digital tax registers enhance transparency, reduce tax evasion, and streamline tax processes (Fjeldstad et al., 2012; Ali & Fjeldstad, 2014). This leads to increased tax compliance and revenue generation for governments.

We expect economic transformation, characterized by shifts from agriculture to industry and services, to broaden the tax base and increase the efficiency of tax collection. As economies diversify and modernize, new economic activities emerge, creating opportunities for tax revenue generation (World Bank, 2020). Empirical evidence suggests that countries undergoing economic transformation experience increases in tax revenue as a percentage of GDP (World Bank, 2019). In addition, Martinez-Vazquez and McNab (2006) found that fiscal decentralization, often associated with economic transformation, can lead to higher tax revenue and economic growth. Economic transformation often involves increased investment in infrastructure, human capital, and technology, which can improve productivity and generate more income, as underlined by the human capital theory (Becker (1962)), and thus expand the tax base. In line with this, we acknowledge that economic transformation can provoke tax reform policies, which in turn can affect tax revenue mobilization.

Effective use of ICT can improve fiscal governance and transparency, which are critical for boosting tax revenue performance. ICT solutions enable real-time monitoring of tax transactions, data analysis, and performance evaluation, empowering tax authorities to identify tax evasion and enforce compliance more efficiently (Fjeldstad et al., 2012; Ali & Fjeldstad, 2014). This strengthens fiscal institutions and contributes to overall revenue mobilization efforts.

We acknowledge that innovations in ICTs have great potential to spur productivity, thus enhancing competitiveness and sustaining economic growth (ILO, OECD, and UNCTD 2005). Therefore, the adoption of ICTs or innovations increases productivity, leading to taxable income increases based on the human capital theory. We assert that the economic transformation (or labor shift from primary to secondary sectors) resulting from ICT adoptions and innovations could potentially compound the impact on tax revenue performance. This claim is still yet unsettled in the literature, but this study attempts to verify such a mediating role that ICT innovation/adoption can have on the power of economic transformation in explaining tax revenue performance.

Hypotheses

H_1: Economic transformation enhances tax revenue performance in SSA.

H2: In SSA, ICT is an important channel that translates economic transformation into tax revenue performance.

The goal of this study is to make five key contributions. First, one of the marked contributions of our study is the construction of the index of economic transformation for SSA countries, given that the ACET economic transformation index has not yet gone into region-specific (SSA and North Africa, for example) indices. Second, the study will expand the small but growing literature on the causal impacts of economic transformation in developing countries. It will add to existing knowledge on the topic by providing empirical evidence on the impact of economic transformation on tax revenue performance for SSA countries in general and for resource-versus non-resource-rich economies. Third, it will provide policy-relevant knowledge on the transmission channels between economic transformation and tax revenue performance in SSA. Such knowledge is vital to governments in SSA countries that are focused on the economic transformation of their economies (such as Cameroon's National Development Strategy for 2020-2035, with a special focus on economic transformation and emphasis on revenue mobilization). Essentially, according to Sparks (2021), Sub-Saharan Africa is undergoing economic transformation, based on closer regional economic cooperation, a growing middle class, increased demand for locally produced goods and services, and a young population. Fourth, existing empirical knowledge on tax revenue performance in SSA has brought to light the effects of tax reforms on tax revenue performance (Addison, 2012) and the relationship between trade liberalization, tax revenue performance, and macroeconomic variables (Onakoya et al., 2017). Regrettably, there are currently no studies that examine the impact of economic transformation on tax revenue performance in SSA, nor the mechanisms by which this transformation influences tax revenue performance. This research fills the gap. In addition, the study will be of great value to African policymakers as they draw up action plans to transform their economies (ACET, 2014). and ensure sustained economic growth.

Fifth, Africa has been very dependent on external debt, which has had a great influence on its economic landscape. This reliance can be traced back to the post-colonial era, when many African countries sought to fund development projects and address socio-economic problems (Iyoha, 1999; Todaro & Stephen, 2020). Initially, people believed that foreign debt sparked rapid economic growth and enhanced infrastructure. However, the situation changed over the years, with more borrowings leading to unsustainable debts in most African nations. The 1980s and 1990s witnessed an increase in external debt accumulation as a result of global economic changes, poor governance, and commodity price volatility, among other things. Africa's exogenous indebtedness has soared to alarming levels, creating substantial challenges to the region's economic stability and growth. External debt in Africa was about $800 billion in 2022, according to data from the World Bank and the International Monetary Fund (IMF), reflecting an increase from $300 billion in 2010. This amounts to almost 45% of the area's GDP, with a number of countries registering a rate over 100%, such as those seen in Zambia and Mozambique. This way, improved domestic resource mobilization is crucial in addressing the region's persistent budgetary challenges and improving socio-economic conditions. However, the inadequacy of alternative domestic revenue sources, such as domestic debt and the reduction of illicit financial flows, leaves SSA countries with no choice but to rely on taxes as their primary source of domestic revenue.

4. Literature Review

This section hosts the review of theoretical literature, and a critical empirical literature review on the effects of Economic Transformation and Tax Revenue Performance. This section will permit us to identify knowledge gaps that our study will fill.

Theoretical foundations

Our work draws upon existing theoretical literature to construct its analyses. The theory holds that economic transformation is connected with a higher level of per capita income and greater institutional development, which are expected to result in improvements in tax revenue collection (IMF, 2019). For instance, Lewis's dual sector model is a theory of development that holds that as surplus labour and other resources move from traditional agriculture into modern economic activities, overall productivity increases and incomes expand (Lewis, 1954; Kuznets, 1966). Additionally, Arthur Lewis and Simon Kuznets' classical theory of structural transformation says that the rate of structural transformation drives economic growth. This includes the shift from farming to non-farming activities, from industry to services, which means that the size of productive units changes, and from personal business to the impersonal organization of economic firms, which means that workers' job status changes. It is undeniable that economic growth leads to increases in productivity and taxable activities. Conversely, Lewis (1955) structural transformation theory also assumes that if the economy instead shifts into lower-productivity sectors, this could lower aggregate growth and negatively affect taxation.

Clark (1945) propounded a theory known as the critical-limit hypothesis, which is concerned with the tolerance level of taxation. This theory posits that inflation inevitably occurs when government taxes and other receipts surpass

25 percent of aggregate economic activities, regardless of budget balance. The theory relies more on the ratio of taxes to national income than expenditure, and it suggests that the tax rate's political and economic limit is 25 percent of national income. This theory holds significance in our study as it demonstrates that institutional factors determine a country's performance in tax revenue collection. The classical theory of taxation adheres to the basic or traditional supply-side tax policy, recommending tax reforms to close loopholes in the tax system and reduce nominal progressivity (Gandhi, 1987). Generally, supply-side economists argue that apart from fiscal policies, other structural and institutional changes must be considered in explaining any growth performance in developing countries, for example, tax performance. The classical theory gives weight to the control variables used in this work (government effectiveness, regulatory quality of private sector activities, and corruption control).

In addition, the literature on tax revenue performance has put across two major schools of thought that explain the determinants of tax effort or tax revenue performance: 1) structural factors, which include the composition of economic activity; 2) institutional factors, which influence government policies and political economy constraints. Structural factors that influence a country's tax effort include agriculture share in GDP, per capita income, and trade openness (Gupta 2007); the extent of dependence on windfall revenues such as aid (Thornton 2014; Hisali & Ddumba-Ssentamu 2013; Clist & Morrissey 2011); and natural resource endowments such as gas and oil (Treviño & Thomas 2013; Botlhole et al. 2012; Bornhorst et al. 2009); and the shares of direct and indirect taxes (Gupta 2007). The institutional factors that impact the ability and efficiency of tax collection include government quality, policies, and corruption (Bird & Martinez-Vazquez 2008; Ghura 1998).

Empirical Literature

Minh Ha et al. (2022) investigated the determinants of tax revenue performance using dynamic panel data, pooled ordinary least squares, fixed and random effects models, and Driscoll-Kraay standard error to estimate the variables. The results showed that factors such as economic openness, foreign direct investment (FDI), the ratio of foreign debt toag the gross domestic product (GDP), and the share of value added in industry to GDP had positive effects on tax revenue, while official development assistance had a negative impact. Therefore, the study suggests that we should design better international trade policies to attract FDI and accelerate the process of economic restructuring. The study by Minh Ha et al. (2022) is a pointer to the importance of economic transformation in spurring tax revenue performance, though it is still empirically untested.

Micah (2015) used secondary data from 1994–2012 as well as fixed and random effects estimation techniques. He emphasized that exchange rates, trade openness, and the share of industry in GDP all have a positive influence on tax revenue performance, whereas agriculture's share in GDP and foreign aid have a negative influence. The study of Imran and Farzana (2010) made use of secondary data from 1973–2009 and an autoregressive model to estimate the variables. According to the study, Pakistan's low tax revenue is due to a narrow tax base, increased dependence on the agricultural sector, foreign aid, and low literacy rates. Their study also indicated that Pakistan's economy can generate a high tax-to-GDP ratio by increasing openness, literacy level, political stability, broadening the tax base, and controlling income inequality, tax evasion, and tax exemptions. Addison (2012) used an unbalanced panel dataset over the period 1980–2005 and a two-step GMM regression model in Sub-Saharan Africa. He stated that the tax-to-GDP ratio is higher in more open and less agriculturally dependent economies, as well as in less populous and peaceful countries. He also pointed out that the size of the agricultural sector and foreign aid affect the direct-tax GDP ratio negatively. Furthermore, the study provided evidence on the relationships between openness and per-capita GDP in relation to the trade-tax GDP ratio.

Other endeavors have addressed the relationship between trade liberalization, tax revenue performance, and macroeconomic variables in Sub-Saharan Africa. For instance, Onakoya et al. (2017) investigated the relationship between trade liberalization, tax revenue performance, and macroeconomic variables in Sub-Saharan Africa. The study employed time series data from 2005 to 2014, a vector error correction model, and a Granger causality test to estimate the variables. The results highlighted that inflation, interest rate, and trade openness have a short-run relationship with tax revenue. The study recommended enforcing efficient and transparent tax collection.

Cevik et al. (2019) examined the effects of structural transformation and tax efficiency in 134 countries, both advanced and developing, from 1970 to 2014. The results were based on two alternative measures of VAT efficiency. The study investigated the impact of this shift into services on countries' efficiency in collecting the value-added tax. The results showed that a higher percentage of services in total value-added makes VAT less effective. This is primarily because a higher percentage of non-tradable services reduces VAT's effectiveness. The study recommends that structural transformation is necessary for development, but tax systems need to take into account the evolution of economic dynamics away from traditional sectors. Bah (2008) used information from the World Bank Tables (1983) for the years 1955–1997 and the World Development Indicators for the years 1971–2000. He also used a polynomial function to find the best fit between the variables and the relationship between each country's sectoral output shares and per capita income. We compared the structural transformation processes between developed and developing countries and found that all developed countries followed the same process. Results further revealed that developing countries follow distinct structural transformation paths that deviate from those followed by developed countries. The presence of substantial sectoral changes during times of economic stagnation or decline is a puzzling finding.

Dabla-Norris et al. (2013) investigated the benchmarking of structural transformation across the world for a panel of 168 countries over the period 1970–2010 using data on real value added by sectors of economic activity. The results revealed large differences in sector shares, both across and within regions, as well as for countries at similar levels of economic development, using both linear and quantile regression methods. It further revealed that a large proportion of the cross-country variation in sector shares can be accounted for by country characteristics, such as real GDP per capita, demographic structure, and population size. The results also showed that policy and institutional variables, like openness to trade, human and physical capital, and finance, make it easier for the baseline model to explain how sectoral shares vary from country to country. Nickell, Redding, and Swaffield (2008) examined 168 countries between 1970 and 2010, concluding that variations in total factor productivity (TFP) and shifts in the prices of manufactured and non-goods manufactured account for the decline in manufacturing as a share of total value-added.

Kim et al. (2020) examined the structural transformation and inclusive growth in Indonesia. The study investigates the 'developer's dilemma' and the relationship between manufacturing value added, or employment shares, and income inequality trends. The decades before the 1997–1998 Asian financial crisis found structural transformation to be growth-enhancing and inclusive of economic growth. Their study further underlined that after the crisis, structural transformation became less growth-enhancing and registered mixed effects on inclusive growth outcomes. They suggested that the pattern of structural transformation had changed from 'upgrading industrialization' before the crisis to 'stalled industrialization' after the crisis.

Knowledge gaps

Unlike the previous studies, little is known about the impacts of economic transformation on tax revenue performance. To our knowledge, there is no full-fledged study addressing these impacts at the country level in Africa or

SSA as a whole. Our study builds an index of economic transformation for SSA countries and adds to what is known by looking at how economic transformation affects tax revenue performance while taking into account dynamic endogeneity and unobserved heterogeneity biases. The present study fills the gap in the literature and addresses this issue in depth, considering the sensitivity of the impacts by resource-rich and non-resource-rich countries and considering relevant transmission channels (adoption of ICT for tax systems, etc.) in the analyses to check the evidence of indirect effects.

5. Empirical Strategy or Approach

Model specification and estimation techniques

The Economic Transformation Index (ETI)

Kuznets' stylized facts identify two measures of economic transformation: consumption and production. While the production measure analyses changes in employment and value-added shares in the gross domestic product as economies develop, the consumption measure uses final consumption expenditure shares as a measure of economic activity at the sectoral level. The consumption measure includes investment, import, and export (Getachew, 2014). This paper makes use of a more holistic and multidimensional approach to construct the index of economic transformation. The paper leans on the approach defined by the African Center for Economic Transformation (ACET, 2014, 2019). The ACET model assumes that economic transformation is a process that would manifest itself in the DEPTH. As per ACET (2014), the economic transformation is a composite of five sub-indices representing the DEPTH: D represents Diversification, E represents Export Competiveness, P represents Productivity, T represents Technological upgrading, and H represents Human well-being.

D: captures diversification of production. It is measured in this paper by taking the ratio of Value added in manufacturing as a percentage of GDP ($\frac{VAM}{GDP}$). The reasoning here is that as this ratio increases over time, reflects the diversification of SSA economies. Importantly, evidence underlines that value-added in manufacturing, mining, and services has been used as an alternative measure of structural transformation (IMF, 2019). The reason is that African economies are fundamentally agrarian (dependent on agriculture), so an increasing manufacturing sector is a clear indication of diversification.

E: Export competitiveness captures the potential of African countries to exploit their comparative advantage and be more competitive in global markets. It is proxied in this study by the ratio of exports to GDP (ACET, 2014).

P: Productivity measures the increase in the productivity of farms, firms, and government offices. In this paper, it is measured by taking the GDP over the total number of employed persons ($\frac{GDP}{Labour\ force}$). This measure is in line with Vries et al. (2015), who measured productivity as the total value added in a sector divided by the number of persons engaged.

T: Technological upgrading measures the technology that sustains increasing productivity; it reflects the level of the technology countries use throughout the economy. It is surrogated in this paper by taking the ratio of GFCF to GDP. According to the National Bureau of Economic Research (n.d), technological upgrading represents new capital goods and investments. GFCF is a good proxy for technological upgrading because it reflects investments in new and advanced capital assets, which embody the latest technologies. GFCF includes expenditures on new machinery, equipment, and infrastructure. These investments typically involve the acquisition of more advanced technologies compared to what is currently in use, reflecting a process of technological upgrading. According to Baldwin and Gu (2004), investments in machinery and equipment are closely linked to productivity growth, as they embody technological innovations that improve production processes. Capital Deepening and Technological Advancement Capital deepening, which involves increasing the capital available per worker, is a key aspect of GFCF. When this capital is technologically advanced, it enhances labour productivity and signals technological upgrading (Krugman 1997).

H: The human well-being indicator leans on the premise that growth in every country should improve livelihoods by providing more productive jobs and higher incomes. We used the HDI which has health (life expectancy at birth), education (expected years of schooling and mean years of schooling), and decent standard of living (GNI per capita). The HDI is a good indicator of human well-being as it is about expanding the richness of human life rather than simply the richness of the economy, focusing on people and their opportunities and choices (UNDP, 2022).

Normalisation of the indicators

We normalize all indicators before the PCA to ensure they are on the same scale. Our indicators of economic transformation do not have the same unit of measurement; diversification, export competitiveness, and technological upgrading are measured as a proportion of GDP, while productivity and human well-being are not. The z-score is used as a normalization strategy (OECD, 2018). The z-score normalization has the advantage of avoiding outliers and expressing raw data on a z-score scale with a mean of 0 and a standard deviation of 1.

In z-score normalization, the data is normalized concerning its mean ($\bar{u}$) and standard deviation (σ) (Shlens, 2005) to obtain the new indicator (u_n):

$$u_n = \frac{u_i - \bar{u}}{\sigma}$$

Aggregation method: PCA

The use of Principal Component Analysis (PCA) as a weighting scheme is supported by the literature that covers the construction of social indices and economic integration indices (König, 2015; Huh & Park, 2017). PCA is one of the famous approaches to reduce the dimensionality (Pang-Ning, 2015). It is done by eigenvalue decomposition of a correlation matrix such that the eigenvector of the highest eigenvalue captures the largest possible information or variance about the dataset. Before employing the Principal Component Analysis (PCA) to form the index of ET, the following eligibility tests are conducted:

Eligibility Tests:

Cronbach's alpha test: to test for internal consistency of indicators. It measures the extent to which indicators are interrelated and consistent in measuring a single unidimensional phenomenon, Economic Transformation in our case.

Bartlett's test of sphericity: Given that PCA is only useful when there is some degree of correlation between the variables. Bartlett's test of sphericity is used to check whether the observed correlation matrix diverges significantly from the identity matrix. Based on the fact that the identity matrix reflects a perfect and strong correlation, we expect the observed correlation matrix not to diverge significantly from it.

Model specification and data used

Drawing inspiration from the works of Gupta (2007) and IMF (2019), as well as the classical theory of structural transformation by Arthur Lewis and Simon Kuznets, which emphasizes the correlation between the pace of structural transformation and economic performance, we can formulate the empirical model using tax revenue performance as the dependent variable.

$$lnTAXR_{it} = \beta_0 + \beta_1 ETI_{it} + \beta_2 CC_{it} + \beta_3 RQ_{it} + \beta_4 CU_{it} + \varepsilon_{it} \quad (1)$$

$$lnTAXR_{it} = \beta_0 + \beta_1 ETI_{it} + \beta_5 TO_{it} + \beta_6 Foreign\ debt_{it} + \varepsilon_{it} \quad (2)$$

Where: i is a country (33 SSA countries) and t is time (from 1990 to 2021) and, β_0 is the intercept, ln represents the log transformation, ETI is the Economic Transformation Index, $TAXR_{it}$ is the dependent variable - tax revenue (without grants and social contributions) as a % of GDP, CC is Control of Corruption, RQ is Regulatory Quality of private sector activities, CU is civil unrest which will be surrogated by the political stability index, TO is trade openness, β represents the parameters to be estimated and ϵ is the error term.

In Model 1, we control for the quality of institutions, and in Model 2, we control for economic variables. Theory and empirical knowledge guide the control variables used here. Evidence (IMF, 2019) indicates that enhancing the quality of institutions is likely to enhance revenue mobilization. However, if the tax administration fails to adjust by eliminating exemptions and enhancing service compliance, changes in consumption and investment patterns could negatively impact tax revenue performance. Importantly, theoretical frameworks such as Good Governance Theory and New Institutional Economics suggest a strong, positive relationship between corruption control, private sector regulatory quality, and tax performance. Controlling corruption improves the efficiency, fairness, and effectiveness of tax administration, leading to higher tax compliance, reduced evasion, and ultimately, greater tax revenues. It is in this line of thought that we control for regulatory quality and control of corruption in our regression estimation (equation 1). To include civil unrest, we used the idea that conflict and civil unrest could damage public infrastructure and make it harder for the government to do its work, like collecting taxes (Chen et al., 2008; Amodio and Di Maio, 2018). This was based on the Tillian belief that civil unrest would increase revenue collection before and during conflict (Tilly, 1985). Conversely, other evidence underlines that conflicts can motivate governments to raise tax revenues to meet the costs of war (Tilly, 1990; Ertman, 1997).

Trade openness shifts the composition of tax revenues (Anzi, 1992) and can broaden the tax base by stimulating economic growth and increasing the volume of taxable transactions. As countries open up to international trade, they often experience increases in imports and exports, which can expand the base for trade-related taxes such as customs duties, value-added taxes (VAT), and excise taxes. Additionally, trade openness can lead to greater economic activity and higher income levels, which further broaden the tax base (Krueger, 1974). However, the overall impact of trade openness on tax performance depends on a country's ability to adapt its tax policies and administration to the changing economic environment brought about by increased integration into the global economy. Concerning foreign debt, its relationship with tax performance suggests a complex interaction between fiscal pressures, economic growth, and tax policy. While foreign debt can potentially stimulate growth and improve tax performance if used productively, high levels of debt can also strain government finances, leading to increased tax burdens, reduced investment in tax administration, and potential fiscal crises. The overall impact of foreign debt on tax performance varies depending on the debt's sustainability, the effectiveness of tax policy reforms, and the broader economic context in which these dynamics occur (Krugman, 1988). Minh Ha et al. (2022) also support the use of trade openness and foreign debt as control variables.

Estimation Techniques

Descriptive techniques: Tax performance assessment analyses

Before the estimation of the model specification, we conducted the tax performance assessment for the following periods of economic reforms in Africa; periods 1990-99 (representing the period of Structural Adjustment programmes in SSA), and repeat the same exercise for the periods 2000-2015 (representing the period of the UN Millennium Development Goals) and 2016-2021 (representing the period of the UN Sustainable Development Goals). These periods represent major turning points in economic reform policies in Africa. This assessment permitted us to classify the SSA countries into three categories: low tax performers, average performers and high tax performers. It will also allow us to understand the situation of tax performance during some specific periods of economic reform. The classification of tax performers was done by leaning on the world averages as defined in the works of Martínez-Vázquez and Violeta (2011) and Von-Haldenwang and Ivanyna (2010); high tax performers – countries at or above world average (20 per cent of GDP); moderate – countries between world average and half of world average; low – countries below half of world average[1].

Regression analyses: Generalized Method of Moments (GMM)

We first used a number of baseline estimation techniques (Fixed and Random Effects Estimators and the Driscroll and Kraay) to understand the relationships under consideration when econometric issues such as endogeneity, unobserved panel heterogeneity are not accounted for. Thereafter, we conducted preliminary investigations on the panel; notably unit root tests, descriptive statistics and cross-correlation analysis to test the relationships between the dependent variable (tax revenue as a percentage of GDP) and explanatory variables. We ran a multicollinearity test on the independent variables to track the possibility of high correlation given the possibility that

[1] *For* n*on-tax revenue*: high – countries above world average (10.1 per cent GDP); moderate – countries between world average and half of world average; low – countries below half of world average.

these variables could be generated from the same process[2]. We intend to understand the nature of the relationship between economic transformation and tax performance among the four (4) resource-rich (RR[3]) compared to twenty-nine (29) non-resource-rich countries (NRR). This way, we grouped the countries under consideration into resource rich and non-resource rich in order to appraise how the effect of economic transformation on tax revenue performance in RR compares to that in NRR countries. Also, this permitted us to check whether or not the effect of economic transformation on tax revenue suffers too the resource curse theory effect.

The GMM estimation is applied in this paper to ascertain the effects of economic transformation on tax revenue collection. The GMM is good because it produces unbiased and more consistent estimates of the effects of economic transformation on tax revenue collection compared to the OLS, FE, RE, 2SLS or Group mean estimators. It also helped us to internalise the presence of heteroscedasticity of unknown form (Cragg, 1983), to solve the problems of serial correlation and endogeneity (Hansen, 1982), as well as cross-section dependence (Wooldridge, 2001). We preferred the two-step GMM to the one-step procedure, as the results in the case of two-step GMM are asymptotically more efficient (Roodman 2015 and Windmeijer 2005). The method has been broadly used in literature because of Windmeijer's (2005) bias correction procedure and its advantage in dealing with the problem of heteroscedasticity.

Worthy of note, GMM can suffer from finite-sample limitations, particularly when too many moment conditions are included without adding informative content, which inflates instrument count and leads to overfitting (see Bound, et al., 1995; Altonji and Segal 1996; Roodman, 2021; Hayakawa & Ito, 2020). Additionally, when instruments are weak or poorly correlated with endogenous variables, the efficiency gains of GMM become questionable, and bias may persist (Wooldridge, 2001 and Kripfganz, 2019). These issues are especially relevant in small-sample studies common in Sub-Saharan Africa (Baltagi & Kao, 2020). To mitigate these problems, recent approaches recommend limiting instrument proliferation and applying robust diagnostics to validate the model's specifications.

[2] Such as changes in labour productivity in the country as a result of improvements in the countries' human capital endowments, or a response to import threats by way of greater efficiency in production practices, or adoption of new technologies.

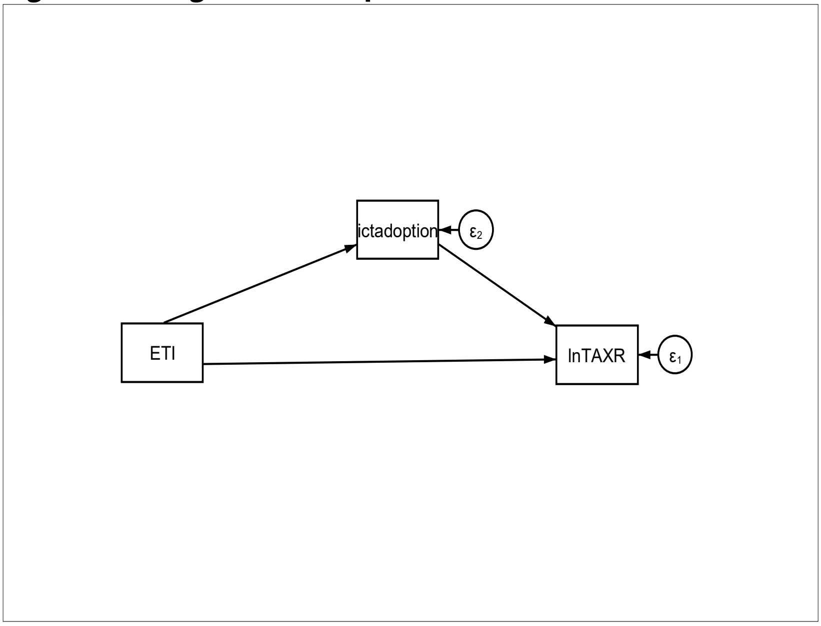
[3] Rep Congo, Guinea, Liberia, Zambia

Accounting for transmission channel: ICT adoption/innovation for tax revenue

To respond to the second specific research question, we will model the direct and indirect effects of economic transformation on tax revenue performance (see Figure 1). We will conduct the indirect effect modeling using the 'medsem' package, a superior approach compared to the Barron and Kenny (1986) regression-based method. The 'medsem' package will allow us to test possible channels (such as ICT adoption/innovation for tax revenue) through which economic transformation can affect tax revenue performance. This will be done using the 'medsem' package as described by Zhao et al. (2010) and Mehmetoglu (2018). The strategy articulated by Zhao et al. (2010) leans on the use of a Monte Carlo resampling-based approach to generate test results for the indirect effects.

Concerning ICT adoption/innovation and ICT import and export as transmission channels, we also acknowledge that innovations in ICTs have great potential to spur productivity, thus enhancing competitiveness and sustaining economic growth (ILO, OECD, and UNCTD 2005). This suggests that the economic transformation resulting from the adoption and innovation of ICTs for tax administration may have a compounding effect on tax revenue performance. This proposal aims to confirm the mediating role of such ICT innovation and adoption in the power of economic transformation to explain tax revenue performance. Also, we lean on the fact that technological and institutional innovations can lead to a fast transition to an industrial model of production and distribution (Arendonk, 2015). In 2019, the African Union adopted its digital transformation strategy for Africa (2020-2030), geared towards creating an integrated and inclusive digital society, improving the quality of life of Africans, providing access to larger markets, and reducing costs. But even before 2019, individual countries in SSA have taken key steps to adopt the e-taxing or invoicing systems; we will capture this adoption for each country in our database as a dummy (taking the value 1 from the year of adoption and the value 0 before).

Figure 5.1: Diagrammatic representation of statistical mediation analysis



Source: Computed by the authors using Stata 14

In summary, statistical mediation analysis involves measuring the indirect impact of an independent variable (TAXR) on the dependent variable (ETI) using a third variable known as the mediator (ICT adoption). Scholars in the social sciences have increasingly adopted the approach of examining indirect effects in addition to direct ones. Lacobucci et al. (2007), on the other hand, used Monte Carlo simulations to show that the regression (REG) method is not as good as the structural equation modeling (SEM) method, even in the simplest mediation model with ETI, ICT adoption, and TAXR. Their simulations show that the regression technique consistently produces larger standard errors for the path coefficients than the SEM technique because the latter estimates all the model parameters simultaneously. A further advantage of the SEM technique is that it inherently can facilitate mediation analysis, including multi-item scales (also referred to as latent variables). The SEM technique is then concluded to be a standard framework for conducting mediation analysis.

Data used

Our panel data will come from the following sources: World Development Indicators (WDI) and the UNDP database. Apart from the HDI which was sourced from UNDP, all the other variables were sourced from the WDI database. Our data will span from 1990 to 2021 and involve thirty-three (33) SSA countries. Tax revenue performance will be measured as general tax revenue (without grants and social contributions) as a % of GDP. Economic transformation is an indicator, since it is a multi-dimensional phenomenon (IMF, 2019), built by referring to ACET (2014).

Table 2: Description of variables used

Variable	**Measure /Description**	**Source**
	Dependent variable	
Tax revenue (TAXR)	Tax revenue refers to compulsory transfers to the central government for public purposes. Compulsory transfers such as fines, penalties, and most social security contributions are excluded. Refunds and corrections of erroneously collected tax revenue are treated as negative revenue.	WDI
	Independent variables	
Economic transformation	It is an index constructed by authors, leaning on ACET (2014)	Constructed by authors
	Economic transformation index variables	
Manufacturing, value added (current LCU) (% of GDP)	Manufacturing refers to industries belonging to ISIC divisions 15-37. Value added is the net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. The origin of value added is determined by the International Standard Industrial Classification (ISIC), revision 3. Data are in current local currency.	WDI

Exports of goods and services (% of GDP)	Exports of goods and services represent the value of all goods and other market services provided to the rest of the world. They include the value of merchandise, freight, insurance, transport, travel, royalties, license fees, and other services, such as communication, construction, financial, information, business, personal, and government services. They exclude compensation of employees and investment income (formerly called factor services) and transfer payments.	WDI
GDP	GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. Data are in the current local currency.	WDI
Employment to population ratio, 15+, total (%) (modeled ILO estimate)	Employment to population ratio is the proportion of a country's population that is employed. Employment is defined as persons of working age who, during a short reference period, were engaged in any activity to produce goods or provide services for pay or profit, whether at work during the reference period (i.e. who worked in a job for at least one hour) or not at work due to temporary absence from a job, or to working-time arrangements. Ages 15	WDI

	and older are generally considered the working-age population.	
Labor force, total	Labor force comprises people ages 15 and older who supply labour for the production of goods and services during a specified period. It includes people who are currently employed and people who are unemployed but seeking work as well as first-time job-seekers. Not everyone who works is included, however. Unpaid workers, family workers, and students are often omitted, and some countries do not count members of the armed forces. Labor force size tends to vary during the year as seasonal workers enter and leave.	
Productivity	GDP/Labour force	
GFCF (% of GDP) Proxy for technological upgrading	Gross fixed capital formation (formerly gross domestic fixed investment) includes land improvements (fences, ditches, drains, and so on); plant, machinery, and equipment purchases; and the construction of roads, railways, and the like, including schools, offices, hospitals, private residential dwellings, and commercial and industrial buildings. According to the 1993 SNA, net acquisitions of valuables are also considered capital formation.	
HDI	The human well-being indicator leans on the premise that growth in every country should improve livelihoods by providing more productive jobs and higher incomes.	UN Database

	We used the HDI which has health (life expectancy at birth), education (expected years of schooling and mean years of schooling), and a decent standard of living (GNI per capita). The HDI is a good indicator of human well-being as it is about expanding the richness of human life rather than simply the richness of the economy, focusing on people and their opportunities and choices (UNDP, 2022).	
	CONTROL VARIABLES	
	Institutional variables	
Control of Corruption (CC): Estimate	Control of Corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests. The estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.	
Regulatory quality (RQ)	Refers to the regulatory quality of private sector activities	
Civil Unrest (CU) which will be surrogated by the political stability index	Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism. The estimate gives the country's score on the aggregate indicator, in units of a standard normal distribution, i.e. ranging from approximately -2.5 to 2.5.	

	Economic variables	
Foreign debt	External debt stocks (% of GNI).	
Trade openness	Import plus export as a percentage of GDP	
	Transmission channel variables	
ICT service exports (% of service exports, BoP)	Information and communication technology service exports include computer and communications services (telecommunications and postal and courier services) and information services (computer data and news-related service transactions).	
ICT goods imports (% total goods imports)	Information and communication technology goods imports include computers and peripheral equipment, communication equipment, consumer electronic equipment, electronic components, and other information and technology goods (miscellaneous).	
ICT adoption	It is a dummy variable taking the value 1 from the years each country adopted the e-tax system	Constructed by authors

6. Results and Discussion

We first conducted a test of internal consistency on the standardised indicators to ensure good convergence and consistency (see Appendix 1a). Thereafter, we performed the PCA as presented in Table 3:

Table 3: Principal components/correlation

Component	Eigenvalue	Difference	Proportion	Cumulative
Comp1	2.017	0.845	0.403	0.403
Comp2	1.171	0.325	0.234	0.638
Comp3	0.847	0.252	0.169	0.807
Comp4	0.595	0.224	0.119	0.926
Comp4	0.371		0.074	1.000

Source: computed by authors using STATA 14

The detailed results of the PCA are in Appendix 1a. Based on Kaiser's criteria, the ETI was generated using the principal components one and two as below:

ETI = (0.4033/0.6376)*pc1 + (0.2342/0.6376)*pc2

It was normalised to have its values fall between 0 and 1 with the help of:

$$\mathrm{ETI\_n} = \frac{\mathrm{ETI} - \mathrm{Min}}{Max - Min}$$

This normalisation strategy is good because it does not reverse the meaning of the indicator values; values towards one (1) indicate good economic transformation and values towards zero (0) indicates low economic transformation.

Presentation of the Unit Root Test

In order to examine the integrating level of variables, standard tests like Dickey and Fuller (1979) tests have been used extensively in order to find out the order of integration, but due to the poor size and power properties, the tests are not reliable for small sample data set (Dejong et al., 1992). Thus, in our case, with small sample size, we employed the Im-Pesaran-Shin unit-root test.

Table 4: Im-Pesaran-Shin unit-root test

Variable	Test statistic (Z)	P- value	No of panel	Avg. No of periods	order of integration
ETI_n	-12.964	0.000	29	24.69	I(1)
TAXR[4]	92.426	0.012	33	17.33	I(0)
CC_n	-10.030	0.000	33	19	I(1)
CU_n	-2.138	0.016	33	23	I(0)
RQ_n	-11.811	0.000	33	19	I(1)
TO	-17.834	0.000	31	28	I(1)
Foreign debt	-13.665	0.000	30	30.50	I(1)

Source: Computed by the authors using Stata 14

Note*:* ET3_n stands for the economic transformation index, TAXR is tax revenue performance, CC_n is control of corruption, CU_n is civil unrest, RQ_n is regulatory quality of private sector activities, ,TO is trade openness and foreign_debtgdpis is foreign debt as a percentage of GNI.

The null hypothesis for the stationary test states that the variable of interest is not stationary and the alternative hypothesis holds that the variable is stationary. These hypotheses can be verified using the p-value approach. For instance, taking ETI_n, we can observe that the p-value (0.0000), which is significant at 1% levels of significant. Thus, we reject the null hypothesis. The last column of Table 3 hosts the level of integration of each variable, indicating the level of stationary as well. The variable CC_n has the level of integration I(1) indicating that it is stationary at first difference. TAXR has the level of integration I(0) indicating it is stationary at levels. Note, for the economic transformation variable (ETI_n), the number of countries dropped to 29 because some countries (Cabo Verde, Liberia, Malawi, Seychelles) did not have data on the indicators used in forming the index, but we maintained them in the analysis because they have data values in the other variables.

[4] The Im-Pesaran-Shin unit-root test could not run due to insufficient observations for TAXR, so we resorted to the Fisher-type unit-root test for TAXR, reason why we may have a high coefficient of Z.

Presentation of Descriptive Statistics

Table 5: Descriptive Statistics of variables used in the GMM

Variable	**Obs**	**Mean**	**Std. Dev.**	**Min**	**Max**
Dependent					
lnTAXR	572	2.676	0.461	1.350	3.689
Independent					
ETI_n	745	0.318	0.164	0	1
Institutional					
CC_n	759	0.336	0.207	0	1
RQ_n	759	0.479	0.183	0	1
CU_n	759	0.563	0.225	0	1
Economic					
TO	922	68.421	35.589	4.128	235.820
Foreign debt	945	74.185	71.979	3.895	610.452
Resource rich dummy					
RR_dummy	1,056	0.121	0.327	0	1

Source: Computed by the authors using Stata 14

From Table 5, except for domestic investment, the mean values of the log of TAXR, FDI and Urban are closer to their maximum values indicating that they have improved, though weakly, over the time period under consideration. Concerning the normalised ET index, values towards one (1) indicate good economic transformation and values towards zero (0) indicate low economic transformation.

Presentation of GMM Regression Results

Before to the GMM results, we used the Variance Inflation Factor (VIF) test to ensure that our structural equation of tax revenue performance is free from the problem of collinearity (see Appendix 1c). Table 6 presents the regression results and the validity tests of the model (beneath the table). Five information criteria were used to test the validity of the model and the results obtained from our analyses: the Fisher test, the Sargan test, the Hansen test, the AR(1) test of first-order autocorrelation and the AR(2) test of second-order autocorrelation.

Table 6: GMM Regression Results

VARIABLES	(1) lnTAXR	(2) lnTAXR	(3) lnTAXR
L.lnTAXR	0.726***	0.786***	0.614***
	(0.033)	(0.030)	(0.057)
ETI_n	0.251***	0.161**	0.357*
	(0.061)	(0.063)	(0.194)
CC_n		0.033	
		(0.073)	
RQ_n		0.141	
		(0.106)	
CU_n		0.203***	
		(0.054)	
RR_dummy		-0.079	-0.330***
		(0.061)	(0.113)
TO			0.005***
			(0.001)
Foreign debt			0.001***
			(0.000)
Constant	0.631***	0.316***	0.541***
	(0.089)	(0.112)	(0.138)
AR(1)	0.006	0.008	0.009
AR(2)	0.826	0.685	0.381
Sargan OIR	0.000	0.001	0.000
Hansen OIR	0.335	0.455	0.294
Fisher	263.65***	358.97***	143.30***

Instruments	14	27	23
Observations	396	348	347
Number of panel_id	29	27	27

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

Note: ET3_n stands for the economic transformation index, TAXR is tax revenue performance, CC_n is control of corruption, CU_n is civil unrest, RQ_n is regulatory quality of private sector activities, lnUrban is the log of urbanisation, lnFDI is log of foreign direct investment and DI is domestic investment.

From Table 6, the Wald test statistics indicate that our model is globally significant and reliable for policy implications. The Hansen test is usually preferred to the Sargan test because it is considered more robust (Nguegang and Ndamsa, 2023). Unlike the Sargan test, the Hansen test of Overidentification (OI) can be weakened by many instruments. The Hansen test is preferred which shows that our instruments are robust and valid, but we then control for the proliferation of instruments in ensuring that the number of countries is higher than the corresponding number of instruments. The information criteria used indicate that the estimated model is valid and fit. Time (year) dummies were employed as instrumental variables of the endogenous variable economic transformation leaning on the work of Nguegang and Ndamsa (2023).

Model 1 (column 1) is the estimation model of the impact of economic transformation (ET) on tax revenue performance without control variables and models 2 and 3 have institutional and economic variables, respectively, as control variables. From Model 1, it is observable that ET has a significant positive effect on tax revenue performance (TAXR) in SSA. This positive effect remains stable as control variables are included (Table 5, Columns 2 and 3). These results clearly show that ET significantly increases tax revenue performance. To check for the robustness of the results, the Fixed and Random effects results were run; these results also showed a positive effect of economic transformation on tax revenue performance in SSA (see Appendix 2).

These results are in line with the works of Kim et al (2020) and Cevik et al (2019). Kim et al (2020) examined the link between structural transformation and inclusive growth in Indonesia and found that structural transformation is growth-enhancing. Cevik et al (2019) assessed the effects of structural transformation, in both advanced and developing countries from 1970 to 2014, and found out that structural transformation is necessary for development.

Further, the RR_dummy (resource rice countries dummy) has a negative effect on tax revenue performance in both models 1 & 2. This implies that being a resource-rich country relates negatively to tax revenue performance in Sub-Saharan Africa.

With respect to the control variables, the coefficient of the lag value of tax revenue (L.TAXR) has a positive and significant effect on tax revenue performance in SSA (Columns 1, 2, and 3). This is feasible because it is most probable that the tax revenue collected in the previous year could be used to enhance the tax administration, improve infrastructure and create a favourable atmosphere for new businesses, thus further boosting tax revenue.

Unlike civil unrest (CU), the results show that the institutional variables (regulatory quality and control of corruption) all affect tax revenue positively and insignificantly (Column 2). The results with respect to the institutional variables are supported by existing knowledge. It is in line with the work of Saptono and Mahmud (2022) who examined the effect of institutional variables on tax performance, using unbalanced panel data on 79 developing countries for the period 2002-2019 and found that countries with low corruption levels and good governance quality could produce more tax revenues. This result is in line with the work of Arif and Rawat (2018), who used data from 10 Emerging and Growth-Leading Economies (EAGLE) in the period between 2001 and 2015, and confirmed the vital role of the institutional environment in determining the level of tax revenue. Hassan et al. (2021) who used data from Pakistan covering the period 1976-2019, and concluded that good governance is an essential resource to increase tax revenue both in the short and in the long run. However, the result runs contrary to Syadullah (2015) who assessed the impact of governance quality and corruption level on tax revenue in 7 Southeast Asian countries during 2003-2012 and found that control of corruption has significant adverse effects on the tax ratio.

Concerning the effect of the economic variables (Column 3), trade openness and foreign debt all affect tax revenue performance in SSA positively and significantly. These results are in tandem with the works of Micah (2015), Minh Ha et al. (2022), and Merrifield (2000).

Presentation of Structural Equation Model and Medsem results:

We employed two possible ICT-related transmission mechanisms; ICT export & import and ICT adoption. This permitted us to test whether or not these variables mediate the relationship between economic transformation and tax revenue performance in SSA.

Table 7: Baron and Kenny test of the mediation hypothesis

Relationships	Direct effect	Indirect effect	Confidence Interval Low	High	p-value	Conclusion
ETI →ICT stock→ lnTAXR	0.094 (0.63)	0.067	0.013	0.146	0.103	Partial mediation, RIT= 41 %
ETI →ICT adoption → lnTAXR	0.180 (1.25)	-0.003	-0.017	0.011	0.648	No mediation

Note: ICT stock represents ICT import and export and ICT adoption represents the adoption of e-tax system; RIT = (Indirect effect / Total effect)*100; Unstandardised coefficients reported; and values in parentheses are z-values; ETI is the economic transformation index.

The results in Table 7 conclude partial mediation for ICT stock (import and export) and no mediation for ICT adoption for e-tax system in the relationship between ET and tax revenue performance in SSA. This shows that ICT stock in a country is important in strengthening the relationship between ET and tax revenue performance. In essence, about 41 % of the effect of ET on tax revenue performance is mediated by ICT. However, SSA countries that have made progress with e-invoicing/tax implementation are still facing some stiff challenges, relating to good and available ICT (such as internet connectivity) and mastery of the e-tax system platform. We believe that the removal of these constraints will only go further to strengthen its mediating role.

Regression results for the non-resource rich and resource rich countries

Regression results for the non-resource rich - NRR and resource rich are obtained using the fixed and random effects estimations.

Regression results for the non-resource rich and resource rich

Models (1) present the results with institutional variables as control variables while models (2) host the results with economic variables as control variables for NNR. While model (3) present the results with institutional variables as control variables while models (4) host the results with economic variables as control variables for RR.

Table 8: FE and RE estimations for NRR and RR countries

	1		2		3		4	
VARIABLES	lnTAXR	lnTAXR	lnTAXR	lnTAXR	lnTAXR	lnTAXR	lnTAXR	lnTAXR
	Control variable: Institutional variables		Control variable: Economic variables		Control variable: Institutional variables		Control variable: Economic variables	
	FE	RE	FE	RE	FE	RE	FE	RE
L.lnTAXR	0.466***	0.903***	0.474***	0.864***	0.650***	0.684***	0.600***	0.777***
	(-0.052)	(-0.026)	(-0.048)	(-0.026)	(-0.106)	(-0.093)	(-0.11)	(-0.12)
ETI_n	0.662***	-0.013	0.222	-0.099	1.111***	1.025***	1.329***	0.770***
	(-0.15)	(-0.075)	(-0.211)	(-0.077)	(-0.313)	(-0.283)	(-0.298)	(-0.294)
CC_n	0.0539	0.122			-0.78	-0.892		
	(-0.183)	(-0.093)			(-0.791)	(-0.765)		
Qin	-0.319*	0.016			1.749	2.366***		
	(-0.17)	(-0.087)			(-1.206)	(-0.792)		
CU_n	-0.121	-0.011			0.28	0.429*		
	(-0.088)	(-0.07)			(-0.324)	(-0.237)		
TO			0.005***	0.002***			-0.0006	-0.005**
			(-0.001)	(0.000)			(-0.002)	(-0.002)
Foreign debt			0.0001	0.00002			0.0003	0.0004
			(-0.0003)	(-0.0002)			(-0.0005)	(-0.0006)
sigma_u	0.252	0	0.137	0	0.128	0	0.36	0
sigma_e	0.133	0.133	0.119	0.119	0.114	0.115	0.115	0.115
rho	0.781	0	0.57	0	0.556	0	0.907	0
Hauseman	98.74***		108.93***	0.47		26.44***		
Constant	1.399***	0.222***	0.990***	0.297***	-0.478	-0.797***	0.214	0.588
	(-0.171)	(-0.064)	(-0.123)	(-0.061)	(-0.544)	(-0.279)	(-0.355)	(-0.379)
Observations	303	303	300	300	30	30	32	32
R-squared	0.346		0.522		0.755		0.733	
Number of panel_id	24	24	23	23	2	2	3	3

Standard errors in parentheses

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

Note: ETI_n stands for the economic transformation index, TAXR is tax revenue performance, CC_n is control of corruption, CU_n is civil unrest, RQ_n is regulatory quality of private sector activities, and TO is trade openness.

Based on the Hausman tests, the fixed effect (FE) models are preferred to the random effect (RE) models. This is further clarified by its relatively high value of rho in both models, 78.1% and 56.97% in models (1) and (2) respectively, showing the total variance in tax revenue performance attributable to differences between countries over time rather than differences within countries. Again, the sigma_u is greater than sigma_e in the two models, indicating that there is less variability within countries over time than there is between countries. The results of the FE estimations show a positive and significant effect of economic transformation on tax revenue performance in the non-resource rich countries in the presence of good governance variables, and the positive effect is maintained but becomes insignificant when only economic variables are controlled for.

In RR countries, for model (1), the random effect (RE) models is preferred to the fixed effect (FE) models. However, for model (2), the fixed effect (FE) model is preferred to the random effect (RE) model, as elucidated by its relatively high value of rho of 0.9079, which shows that about 90.8% of the total variance in tax revenue performance is attributable to differences between countries over time rather than differences within countries. In addition, its sigma_u is greater than sigma_e, indicating that there is less variability within countries over time than there is between countries.

7. Conclusions and Policy Recommendations

This study used panel data from the World Bank Development Indicators and UNDP database over the period 1990–2021 to provide evidence on the effect of economic transformation on tax revenue performance. The research divided the study period into different policy reform-based sub-samples and performed the tax performance assessment to identify the countries that changed categories over time (that is, from low tax performers to average or high tax performers and vice versa). Our panel data estimation disentangled the causal effects of economic transformation in resource-rich and non-resource-rich countries. We employed the GMM to correct the problem of dynamic endogeneity and unobserved panel heterogeneity. We further checked the robustness of our results by employing fixed and random effects estimation.

In terms of the tax revenue assessment, six SSA countries under study were in the high tax performers category (Botswana, Lesotho, Mozambique, Namibia, the Seychelles, and South Africa). We observed that these countries, except for Botswana, had maintained steady progress in this category over the policy reform periods. The majority of SSA countries (21 out of the 33) were in the middle/average tax performers category. We noticed that among the countries that witnessed a decreasing tax performance during the policy reform periods, Angola is the only country that drifted from an average performer to a low performer in the periods 2000-2015 to 2016-2021. Six of the thirty-three SSA countries were in the low tax performers category (Central African Republic, Congo Republic, Equatorial Guinea, Ethiopia, Madagascar, Sudan).

Our GMM results indicated that economic transformation has a significant positive effect on tax revenue performance in SSA. We employed two ICT-related transmission mechanisms (ICT adoption and ICT export & import) and found that ICT import/export does mediate the effect of economic transformation on tax revenue performance while ICT adoption does not.

In non-resource-rich countries, the model incorporating institutional variables showed that economic transformation has a positive and significant impact on tax revenue performance. However, when only economic variables were considered, this positive effect became statistically insignificant, implying that strong institutions are a critical channel through which economic transformation translates into improved tax revenue. In contrast, for resource-rich countries, economic transformation consistently exhibits a positive and significant impact on tax revenue performance, regardless of whether institutional or purely economic variables are included. This suggests that in resource-rich settings, the link between economic transformation and tax revenue is more direct and possibly driven by extractive sector dynamics or stable revenue streams from natural resources.

Based on these findings, the study made the following recommendations:

SSA countries should promote economic transformation through the DEPTH (diversification, export competitiveness, productivity, technological upgrading, and human well-being) as a means to boost domestic revenue mobilization and reduce reliance on aid. We call upon SSA countries to increase and encourage investments in manufacturing and processing, as this will enable them to enhance export competitiveness and increase the value of exports.

The government and the private sector should invest in technological upgrading and new technology that sustains increasing productivity, such as ICT—good internet connectivity and stable electricity supply.

We encourage SSA countries that have implemented the e-tax system to continue sustaining and improving it, as it significantly impacts the potential for economic transformation and enhances tax revenue performance. In summary, SSA countries that have not yet implemented or are in the process of implementing the e-tax system should accelerate the process to fully reap its numerous benefits on tax revenue performance.

Resource-rich and non-resource-rich countries should promote good governance, especially the regulatory quality of private sector activities and corruption control of corruption, as an accompanying policy measure to boost tax revenue performance.

Many SSA countries are still facing some stiff challenges relating to good and available ICT (such as internet connectivity) and mastery of the e-tax system platform. Measures to remove these constraints are vital in strengthening the mediating role of ICT adoption for the e-tax system in the relationship between economic transformation and tax revenue performance.

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Appendices

Appendix 1a:

Test for Internal Consistency

Test scale = mean(unstandardized items)

Item	Obs	Sign	item-test correlation	item-rest correlation	average interitem covariance	alpha
z_D	902	+	0.3863	0.0299	.3760229	0.7068
z_E	922	+	0.7817	0.5820	.1638161	0.4393
z_P	1013	+	0.6399	0.3519	.2455824	0.5656
z_T	872	+	0.6416	0.3857	.2343442	0.5504
z_H	975	+	0.7482	0.5238	.1751902	0.4593
Test scale					.2397167	0.6119

Principal components (eigenvectors)

Principal components (eigenvectors)

Variable	Comp1	Comp2	Comp3	Comp4	Comp5	Unexplained
z_D	0.1070	0.8345	-0.1414	0.4401	0.2801	0
z_E	0.5898	-0.1070	-0.1400	-0.4128	0.6713	0
z_P	0.3872	0.3079	0.7845	-0.2478	-0.2799	0
z_T	0.4489	-0.4345	0.2017	0.7532	0.0416	0
z_H	0.5378	0.0923	-0.5515	-0.0851	-0.6251	0

Scoring coefficients

sum of squares(column-loading) =

Variable	Comp1	Comp2	Comp3	Comp4	Comp5
z_D	0.1070	0.8345	-0.1414	0.4401	0.2801
z_E	0.5898	-0.1070	-0.1400	-0.4128	0.6713
z_P	0.3872	0.3079	0.7845	-0.2478	-0.2799
z_T	0.4489	-0.4345	0.2017	0.7532	0.0416
z_H	0.5378	0.0923	-0.5515	-0.0851	-0.6251

Appendix 1b: Multicollinearity test (gotten after simple OLS)

Variable	VIF	1/VIF
CC_n	4.80	0.208279
RQ_n	4.43	0.225755
CU_n	2.57	0.389534
ETI_n	1.47	0.679687
Mean VIF	3.32	

Variable	VIF	1/VIF
TO	1.56	0.639868
ETI_n	1.55	0.644734
foreign_debt	1.13	0.887577
Mean VIF	1.41	

Appendix 2: Fixed and Random Effects

FE and RE results for the total sample

VARIABLES	(FE) lnTAXR	(RE) lnTAXR	(FE) lnTAXR	(RE) lnTAXR
	Control variables: Institutional variables		Control variables: Economic variables	
L.lnTAXR	0.572***	0.873***	0.533***	0.837***
	(0.0482)	(0.0276)	(0.0483)	(0.0291)
ETI_n	0.289**	-0.0172	0.171	-0.128**
	(0.135)	(0.0546)	(0.123)	(0.0605)
CC_n	-0.190	0.0897		
	(0.182)	(0.0772)		
RQ_n	-0.479**	0.0265		
	(0.185)	(0.0860)		
CU_n	0.0323	0.0607		
	(0.0878)	(0.0551)		
TO			0.00460***	0.00113***
			(0.000705)	(0.000346)
foreign_debt			-6.09e-06	9.98e-05
			(0.000293)	(0.000252)
Constant	1.278***	0.256***	0.791***	0.379***
	(0.185)	(0.0664)	(0.124)	(0.0776)
Observations	325	325	285	285
R-squared	0.367		0.500	
Number of panel_id	26	26	22	22
sigma_u	.27580239	0	.16102363	0
sigma_e	.1388774	.1388774	.13351185	.12383244
rho	.79773314	0	.59259944	0
F-Stats	2.87		3.83	
[p-value]	[0.0000]		[0.0000]	
F test that all u_i=0				

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

Hausman tests:

```
             ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
      lnTAXR |
         L1. |    .5723573     .8728316       -.3004743        .0395727
       ETI_n |      .28906    -.0171636        .3062235        .1239362
        CC_n |   -.1896057      .089684       -.2792897        .1648274
        RQ_n |   -.4786679     .0265383       -.5052062        .1639613
        CU_n |    .0323458     .0606776       -.0283318        .0683231
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(5) = (b-B)'[(V_b-V_B)^(-1)](b-B)
                          =       69.94
                Prob>chi2 =      0.0000



             ---- Coefficients ----
             |      (b)          (B)            (b-B)     sqrt(diag(V_b-V_B))
             |     fixed        random       Difference          S.E.
-------------+----------------------------------------------------------------
      lnTAXR |
         L1. |    .5325837     .8374508       -.3048671        .0385603
       ETI_n |    .1706577    -.1277517        .2984094        .1074779
          TO |    .0046033     .0011267        .0034766        .0006143
foreign_debt |   -6.09e-06     .0000998       -.0001059        .0001495
------------------------------------------------------------------------------
                           b = consistent under Ho and Ha; obtained from xtreg
            B = inconsistent under Ha, efficient under Ho; obtained from xtreg

    Test:  Ho:  difference in coefficients not systematic

                  chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)
```

= 79.47
Prob>chi2 = 0.0000

Appendix 3: ICT year of Adoption (adoption of e-tax system)

Country	Year	Country	Year
Angola	2019	Madagascar	2016
Botswana	2023	Malawi	2023
Burkina Faso	2022	Mali	2023
Burundi	2022	Mauritius	2023
Cabo Verde	2022	Mozambique	2023
Cameroon	2016	Namibia	2019
Central African Republic	2022	Rwanda	2021
Congo, Rep.	2022	Senegal	2021
Cote d'Ivoire	2019	Seychelles	2010
Equatorial Guinea		South Africa	2012
Ethiopia	2005	Sudan	
Gabon	2014	Tanzania	2020
Ghana	2022	Togo	2018
Guinea	2023	Uganda	2022
Kenya	2005	Zambia	2020
Lesotho	2023	Zimbabwe	2022
Liberia	2023		

Appendix 4: Structural Stability Test

D99 is the dummy variable taking values 0 for time period 1990-1999 and values 1 for time period 2000-2021. This is based on the hypothesis that earlier periods (just after 1990 per the analysis) may have reflected negative transformation, thus the impact of ETI on TAXR could be different in these earlier periods (1990-1999) compared to the subsequent period, 2000-2021.

Structural stability – Dummy variable test of structural stability

	(1)	(2)
VARIABLES	lnTAXR	lnTAXR
L.lnTAXR	0.794***	0.684***
	(0.132)	(0.0927)
o.ETI_n		-
CC_n		-0.892
		(0.765)
RQ_n		2.366***
		(0.792)
CU_n		0.429*
		(0.237)
o.D99		-
D99_ETI	4.854	1.025***
	(15.46)	(0.283)
ETI_n	4.037	
	(15.48)	
TO	-0.00511**	
	(0.00229)	
foreign_debt	0.000438	
	(0.000589)	
D99	-0.911	
	(2.763)	
Constant	1.412	-0.797***
	(2.724)	(0.279)
Observations	32	30
R-squared	0.866	0.925

Standard errors in parentheses

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

The intercept is not statistically significant, implying that it is not different in the period from 2000-2021 (ie post 1999 period). Also the coefficient of interaction between the dummy (D99) and ETI is not statistically significant, it means the slope coefficient is not different in the period from 2000 and above. We only relied on the first model (that with economic variables, model 1) to run the test; this is because in the model with institutional variables (model 2), the dummy and ETI are omitted due to collinearity issues.

Appendix 4: Structural equation and mediation results: Baron and Kenny

Structural Equation Model: ICT export and import (ICT stock)

structural equation model					
Estimation method = mlmv Log likelihood = -1804.4392	Number of obs = 919				
	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval] LL UL
Structural ICT <-					
ETI	-8.668007	3.173691	-2.73	0.006	-14.88833 -2.447686
_cons	13.46762	1.091243	12.34	0.000	11.32883 15.60642
lnTAXR <- ICT	.0076747	0037726	2.03	0.042	-.0002805 .0150689
ETI_n	.0943972	.1500194	0.63	0.529	-.1996353 .3884297
_cons	2.723274	.0766889	35.51	0.000	2.572967 2.873582
mean(ETI)	.3192	.0059992	53.21	0.000	.3074419 .3309582
var(e.ict)	55.68278	3.555681			49.13224 63.10667
var(e.lnTAXR)	.2086364	.0125408			.1854496 .2347224

var(ETI)	.0268139	.0013885			.0242259 0296782

LR test of model vs. saturated: chi2(0) = 0.00, Prob > chi2 =

After the structural equation model (SEM), we proceeded with the medsem command to test the mediation hypothesis .

Significance testing of indirect effect (unstandardised): ICT export and import

Estimates	Delta	Sobel	Monte Carlo*
Indirect effect	0.067	0.067	0.067
Std. Err.	0.036	0.041	0.042
z-value	1.826	1.631	1.576
p-value	0.068	0.103	0.115
Conf. Interval	-0.005, 0.138	0.013, 0.146	0.005, 0.166
*You typed in mcreps < #of obs, your mcreps is however set to #of obs!			
Baron and Kenny approach to testing mediation Baron and Kenny approach to testing mediation STEP 1 - ICT:ETI_n (X -> M) with B=-8.668 and p=0.006 STEP 2 - lnTAXR:ICT (M -> Y) with B=-0.008 and p=0.042 STEP 3 - lnTAXR:ETI_n (X -> Y) with B=0.094 and p=0.529 As STEP 1 and STEP 2 are significant and neither STEP 3 nor the Sobel's test above is significant the mediation is partial!			
RIT = (Indirect effect / Total effect) (0.067 / 0.161) = 0.413 Meaning that about 41 % of the effect of ETI_n on lnTAXR is mediated by ICT!			
RID = (Indirect effect / Direct effect) (0.067 / 0.094) = 0.705 That is, the mediated effect is about 0.7 times as large as the direct effect of ETI_n on lnTAXR!			

Source: Computed by the authors using Stata 14

Structural Equation Model: ICT adoption (that is, adoption of e-tax system)

structural equation model	
Estimation method = mlmv Log likelihood = -252.42759	Number of obs = 1,056

	Coef.	Std. Err.	Z	P>|z|	[95% Conf. Interval] LL UL
Structural ictadoption <-					
ETI	.1178382	.0603492	1.95	0.051	-.0004441 .2361205
_cons	.0525257	.0210676	2.49	0.013	.011234 .0938175
lnTAXR <- ICTadoption	.027585	.0587359	-0.47	0.639	.0027054 .0675353
ETI_n	.1800652	.1439363	1.25	0.211	-.1020448 .4621752
_cons	2.616946	.0539139	48.54	0.000	2.511277 2.722615
mean(ETI)	.3176931	.0059999	52.95	0.000	.3059335 .3294528
var(e.ictadoption)	.0814964	.003551			.0748255 .088762
var(e.lnTAXR)	.2116512	.0125393			.1884479 .2377114
var(ETI)	.0268285	.0013901			.0242378 .0296961

LR test of model vs. saturated: chi2(0) = 0.00, Prob > chi2 =

After the structural equation model (SEM), we proceeded with the medsem command to test the mediation hypothesis.

Significance testing of indirect effect (unstandardised): ICT adoption (that is, adoption of e-tax system)

Estimates	Delta	Sobel	Monte Carlo*
Indirect effect	-0.003	-0.003	-0.003
Std. Err.	0.007	0.007	0.008
z-value	-0.455	-0.457	-0.422
p-value	0.649	0.648	0.620
Conf. Interval	-0.017, 0.011	-0.017, 0.011	-0.022, 0.010
*You typed in mcreps < #of obs, your mcreps is however set to #of obs!			
Baron and Kenny approach to testing mediation STEP 1 - ictadoption:ETI_n (X -> M) with B=0.118 and p=0.051 STEP 2 - lnTAXR:ictadoption (M -> Y) with B=-0.028 and p=0.639			

As either STEP 1 or STEP 2 (or both) are not significant, there is no mediation!
RIT = (Indirect effect / Total effect) (0.003 / 0.177) = 0.018 Meaning that about 2 % of the effect of ETI_n on lnTAXR is mediated by ictadoption!
RID = (Indirect effect / Direct effect) (0.003 / 0.180) = 0.018 That is, the mediated effect is about 0.0 times as large as the direct effect of ETI_n on lnTAXR!

Source: Computed by the authors using Stata 14

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