Journal of Infrastructure, Policy and Development 2024, 8(10), 5742.
https://doi.org/10.24294/jipd.v8i10.5742

Article

Public finance and sustainable development in Sub-Saharan Africa: An economic analysis

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CITATION

Olaoye OO, Zerihun MF. (2024). Public finance and sustainable development in Sub-Saharan Africa: An economic analysis. Journal of Infrastructure, Policy and Development. 8(10): 5742. https://doi.org/10.24294/jipd.v8i10.5742

ARTICLE INFO

Received: 9 April 2024
Accepted: 28 May 2024
Available online: 27 September 2024

Abstract: The objective of the research is twofold. The study examines the role of public finance in promoting sustainable development in SSA. Secondly, the study investigates the optimal level of public finance beyond which public finance crowds out investment and hinders sustainable development in SSA. The study adopts a battery of econometric techniques such as the traditional ordinary least square (OLS) estimation technique, Driscoll-Kraay covariance matrix estimator, and the dynamic panel threshold model. The study found that an increase in public debts lead to a decline in sustainable development. In contrast, the results show that increase in spending on health and education, and tax can engender sustainable development in SSA. Further, we uncover the optimal levels of public spending on health and education, and public debts that engenders sustainable development in SSA. One main implication of the findings is that governments across SSA needs to reduce public debts levels and increase public spending on health and education to within the threshold levels established in this study to aid sustainable development in SSA.

Keywords: fiscal policy; sustainable development; dynamic panel threshold; Driscoll-Kraay covariance matrix estimator; Non-linearity; SSA

1. Introduction

In 2015, world leaders adopted a global shared plan with 17 Sustainable Development Goals (SDGs). The SDGs were adopted to address and tackle unnecessary risks and fragilities—such as poverty, inequality, violent conflicts, and climate change—across the economic, social, and environmental domains (International Monetary Fund (IMF), 2014b). Reducing inequality and ending poverty in all its manifestations worldwide by 2030 are central to the 17 SDGs, which aim to provide everyone with the opportunity to thrive and lead a prosperous and fruitful life. Specifically, the early idea of economic development emphasizes that, through the trickle-down effect, economic expansion inevitably helps the less fortunate or the indigent (Mulok et al., 2012). Unfortunately, though, the gains of progress did not instantly trickle down to the poor, and as a result, socioeconomic circumstances in sub-Saharan Africa (SSA) continue to deteriorate. For instance, SSA is currently the world's capital of poverty and has the second-highest rate of economic inequality after Latin America (Klasen, 2016). This pattern implies that, in the absence of sufficient action, the 2030 sustainable development agenda for sub-Saharan Africa might not come to pass.

As a result, academics and decision-makers have argued that government action is necessary to ensure that the poor benefit from economic expansion (Mulok et al., 2012; Simson, 2012). The authors assert that government programmers (captured by

government spending, public debts, and tax) are crucial to reduce private monopolies, externalities, and asymmetric information; provide public goods and macroeconomic stabilization; and redistribute income to reduce income inequality. More specifically, the authors noted that to reduce the income gap, government needs to put in place policies that seek to redistribute income and assets equitably. They argue that alongside growth, government (through fiscal policy instruments) needs to put in place policies that engender sustainable development. According to the report of United Nations World Commission on Environment and Development (1987), sustainable development is defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs). To this end, fiscal policy is being considered by policymakers as a weapon (IMF, 2019). According to a UNCTAD assessment from 2014, achieving the SDGs will cost over USD 7 trillion annually. Therefore, it is necessary to deploy all the resources—public, private, national, and international—that are accessible. The three primary goals of fiscal policy are to redistribute income, provide public goods and address market imperfections, and maintain macroeconomic stability. Furthermore, by producing domestic public resources, promoting efficient public expenditure, and enabling budgetary room for priority investments and wider fiscal reform, fiscal policy offers a range of tools for promoting equitable and sustainable development. To mitigate the COVID-19 pandemic's consequences, prevent a recession, and advance sustainable development, governments throughout the world turned to a few crucial fiscal policy tools. To mitigate the consequences of the pandemic and promote sustainable development, for instance, governments all over the world went on a borrowing and spending binge (Olaoye et al., 2022).

While there have been a few research looking at how fiscal policy affects sustainable development, the studies that have been done thus have had some significant flaws. Initially, most of the prior research on the examination of fiscal policy has focused on how fiscal policy affects economic growth (Boug et al., 2023; Lin and Zhu, 2019; Sosvilla-Rivero and Rubio-Guerrero, 2022). This strategy implicitly assumes that the poor would eventually benefit from economic progress (Olaoye, 2023). Two, the use of a single metric approach by the studies that are currently in existence is a significant limitation of those studies. That is, each of the 17 SDGs has only adopted each of the 17 SDGs per time. For example, for literature on fiscal policy and poverty (Borrisov and Hashimzade, 2022; Ehinmilorin et al., 2021; Jouini et al., 2018; Kunawotor et al., 2022; Siburian, 2022). Unfortunately, the complexity in the SDGs is not entirely captured by the single metric method. Three, prior research on fiscal policy has operated under the premise that there is a linear relationship between fiscal policy and sustainable development. This may be too restrictive in empirical research (Olaoye and Olomola, 2022).

Against this background, some fundamental questions arise. One, does fiscal policy promote sustainable development in SSA? Two, what is the optimal level of fiscal that engenders sustainable development?

The main objective of this research is twofold. First, the study provides empirical-based evidence on the effect of fiscal policy (namely, tax, total government spending, spending on health, and spending on education) on sustainable development using a robust measure of sustainable development which considers a wide range of

sustainable development goals such as life expectancy, expected and mean years of schooling, GNI per capita, CO_2 emissions, and material footprint. We adopted this robust single metric to measure sustainable development since it has been argued that multiple indicators such as the sustainable development indicators may be imperfect and highly correlated with each other (Slesman et al., 2015), and therefore suggested that the variables should be employed in a single regression framework. However, employing all the variables in a single regression framework may lead to a problem of multicollinearity when used in a single regression equation (Buchanan et al., 2012; Globerman and Shapiro, 2002). Further, employing all the variables could lead to an over-parametrized specification in the model (Kim et al., 2018). To address these problems, some authors such as Meon and Sekkat (2004) and Acemoglu et al. (2001) have used different indicators separately in different equations. However, this could lead to the omission of an important indicator which will most likely lead to invalid inferences owing to omitted variable biases. Thus, to avoid these problems, our study follows Globerman and Shapiro (2002), Buchanan et al. (2012) and Slesman et al. (2015) to adopt an overall composite index of the major indicators of sustainable development as developed by Hickel (2020).

Second, the study also assessed the optimal level of fiscal policy that engenders sustainable development in SSA.

In sum, by addressing the gaps in the literature, the study aims to provide an evidence-based strategy that will inform robust policy formulation for sustainable development in SSA.

The study found that an increase in public debts lead to a decline in sustainable development. This is an indication that the level of public debts across SSA may hinder the sustainable development agenda in SSA. In contrast, the results show that spending on health and tax exert a positive, albeit statistically insignificant effect on sustainable development. The results suggest there may be an optimal threshold of fiscal policy that fosters sustainable development in SSA. However, public spending on education exerts a positive and statistically significant impact on sustainable development, indicating that spending on education may help to foster sustainable development in SSA. We do not find any statistically significant effect of domestic investment and quality of governance on sustainable development in SSA. Similarly, we found an optimal level of 4 and 3 percent of GDP for public spending on health and education, respectively, below which spending on education and health will not stimulate sustainable development in SSA. In addition, the study uncovers a debt/GDP ratio of 30 percent beyond which public debts hinder sustainable development in SSA.

The rest of the paper is organized as follows: Section 2 presents the literature review. Section 3 contains the Data, theoretical framework, model specification and methodology. Section 4 presents the empirical findings, and Section 5 concludes the paper.

2. Literature review

2.1. Theoretical literature

There are different theoretical postulations on the role of fiscal policy in sustainable development (Bénabou, 2000; Muinelo-Gallo and Roca-Sagalés, 2013;

Philip and Miguel, 2015). First, the Keynesian view emphasizes the role of government intervention for sustainable development (Keynes, 1936). Keynes noted that government intervention can spur economic growth, create employment opportunities, redistribute income, end social conflicts, and ultimately engender sustainable development (Keynes, 1936). In line with Keynes, Bénabou (2000) submits that distributive and progressive fiscal policies remove credit constraints and allows greater investment in human capital by poor individuals, thereby reducing the levels of poverty and inequality, which ultimately fosters sustainable development. Another theoretical literature—The classical view advocates a limited role for government. There is also the Marxian/radical view. The Marxists, like the Keynesian advocate for the intervention of the state and the regulation of markets for sustainable development.

2.1.1. Empirical review

Fiscal policy and economic growth

A vast volume of literature has examined the effect of fiscal policy on economic growth in both developed and developing countries. The study highlights a few.

Afonso (2023) used the horizontal-R&D growth model to study how monetary and fiscal policy affected the economy. Given that there is a significant preference for a clean environment, the author reported that fiscal policy in the form of taxing pollution slows growth while increasing labor welfare. Boug et al. (2023) used an inflation targeting monetary rule to analyze how fiscal policy affected the Norwegian economy. The Norwegian industry structure is impacted by expansionary fiscal policy, according to the authors' findings. When analyzing the effect of fiscal spending on growth in China, Lin and Zhu (2019) selected the green growth as a metric of economic activity. The results show that China's green economic growth is supported by fiscal expenditures on R&D and education. Fiscal consolidation in sub-Saharan Africa short-term suppresses GDP and private demand, according to Woldu and Kanó (2023). According to Sosvilla-Rivero and Rubio-Guerrero (2022), Spain's economic development was facilitated by lower taxes and higher public spending.

Fiscal policy and income inequality

Fiscal policy has played a significant role in reducing income inequality, particularly in advanced economies. For example, research by Immervoll et al. (2005) and Paulus et al. (2009) revealed that around two-thirds of the decline in income inequality may be attributed to social payments. Furthermore, most of the redistribution within transfers is accounted for by non-means-tested transfers (such as family benefits and state pensions), and personal income taxes greatly lower inequality. Mengistu (2013) examined the effects of Ethiopia's fiscal policy measures on poverty using a computable general equilibrium microsimulation model. The authors discovered that fiscal policy helps urban households become less impoverished. Muinelo-Gallo and Roca-Sagalés (2013) use fiscal policy to analyze the connection between economic growth and income inequality. In particular, the authors conducted an empirical study from 1972 to 2006 on the growth and distributive consequences of fiscal policies in a panel of 21 high-income OECD nations. The authors discovered that implementing fiscal consolidation as a strategy might boost GDP growth and lower income disparity.

In the International Monetary Fund (IMF) (2014a)'s report, it makes the case that, in the short and medium terms, expenditure and tax policies can change how income is distributed. For instance, they contend that through influencing future wages, in-kind benefits like education spending can have an impact on the disparity of market incomes (i.e., incomes before taxes and transfers). They also point out that the disparity in disposable income can be lessened by other fiscal tools like cash transfers and income taxes. Bhatti et al. (2015) used a Computable General Equilibrium (CGE) model to investigate how fiscal policy might lessen income disparity in Pakistan. The authors demonstrate how fiscal tools may be used to adjust the distribution of income. They discovered that the distribution of income can be impacted using transfers or sales taxes. The writers concluded that a variety of fiscal tools can improve the distribution of income. The distributional effect of fiscal policy in South Africa was studied by Inchauste et al. (2015). The outcome demonstrates that fiscal policy, as measured by an increase in social spending, lowers poverty and economic inequality in South Africa. Similarly, fiscal policy lowers inequality but not poverty, according to Lustig (2017). In a similar vein, government investment on preschool and elementary education benefits the poor in practically every nation, but expenditure on secondary education does not.

Alejandro et al. (2017) conducted a study on behalf of the World Bank that looked at how fiscal policy affected poverty and income disparity in Zambia. They discovered that spending on education, which is a component of fiscal policy, lowers inequality in Zambia. However, if direct-transfer spending is not appropriately targeted, fiscal policy may potentially make poverty worse. Two, if energy subsidies—which account for a sizable portion of government spending—do not benefit the targeted impoverished households. In their 2018 study, Jouini et al. examined how fiscal policy affected redistribution in Tunisia. The authors discovered that as Tunisia's transfer payment increased, poverty and inequality decreased. Salotti and Trecroci (2018) looked at how fiscal policy affected redistribution in OECD nations and discovered that while public spending on consumption, social spending, and education promoted distributive effects in the disaggregated model, rising public debt and government spending encouraged unequal income distribution. Sanogo (2019) investigated how poverty in towns in Côte d'Ivoire was affected by fiscal decentralization. The authors discovered that while revenue decentralization had a larger effect on public service than on poverty, increases in municipally derived revenues lower poverty in Côte d'Ivoire municipalities. The effect of fiscal policy on income disparity in Latin American nations was examined by Clifton et al. (2020). The findings indicate that fiscal intervention in Latin America only slightly lowers income inequality. Income inequality is specifically decreased by spending on social security, income taxation, and education. According to Apergis (2021), social transfers have a higher chance of reducing income disparity than taxes. According to Ehinmilorin et al. (2021), fiscal policy can also aid in the reduction of poverty in Nigeria.

Borrisov and Hashimzade (2022) looked at how fiscal policy affected wealth disparity in a model that included endogenous positional considerations. The results show that the economy progresses from any initial state towards an egalitarian equilibrium with higher aggregate wealth when fiscal policy is implemented with government consumption financed by taxes on labor income and wealth. In the same

vein, Biyase et al. (2022) looked at how South Africa's economic disparity was affected by military spending. The authors discovered that South Africa's wealth disparity rises in tandem with increases in military spending. Fiscal redistribution in income taxes and transfers lowers the income gap between the rich and the poor, as demonstrated by Kunawotor et al. (2022). Malla and Pathranarakul (2022) discovered through comparative analysis that income taxes only lessen income inequality in emerging nations—Not in wealthy nations. Furthermore, the findings indicate that, solely in industrialized nations, government size, health care spending, and education spending are adversely correlated with income inequality. Fiscal decentralization encourages poverty reduction in Indonesia, according to Siburian (2022).

Fiscal policy and sustainable development

Fiscal policy provides a set of instruments for fostering inclusive and sustainable development by generating domestic public resources, fostering effective public spending, create fiscal space for priority investments and support broader fiscal reform. However, the literature on fiscal policy and sustainable development is sparse, and largely anecdotal. The study highlights a few.

Figure 1. Overview of how fiscal policies can support delivery of multiple SDGs.
Source: Te Velde et al. (2015).

Halim and Rahman (2022) investigated the effect of taxation on sustainable development in emerging countries. The study found that corporate tax engenders sustainable development in emerging economies. Chishti et al. (2021) examined the role of fiscal and monetary policies in fostering sustainable development in BRICS economies. The authors found that expansionary fiscal policy fosters sustainable development in BRICS economies. Ramón and Eugenio (2016) analyzed the fiscal policy—Sustainable development nexus in Chile and reported that tax policies induce high levels of inequality, which may ultimately render the economy unsustainable. In a recent literature, Meng (2024) analyzed the role of fiscal policy in promoting sustainable development in renewable energy (RE) consumption-based economies. The author finds that countries that implement eco-friendly budgetary policies achieve sustainable development.

All things considered, fiscal policies can help reach a few SDGs and related targets (T) in a variety of sectors both nationally and internationally (see **Figure 1**).

3. Data, theoretical framework, methodology and model specification

3.1. Data

Secondary data for 44 sub-Saharan African nations, mainly spanning the years 1997–2020, were used in the study. The dependent variable is sustainable development. Public debt, taxes, overall government spending, and government spending on health and education are the independent variables. The GDP, interest rate, unemployment rate, inflation rate, and rate of population growth are the primary control factors. The World Development Indicators (WDI), Global Database, ICRG Quality of Governance Standard Dataset, UNU-WIDER Government Revenue Dataset, and Hickel (2020) Sustainable Development Database are the sources of the data. See Appendix for the list of sub-Saharan African nations that were included in the research.

3.1.1. Theoretical framework

The study is premised on the Keynesian theory of government spending and the UNEP Finance Initiative (2020) on fiscal policies and the sustainable development goals (SDGs) (see **Figure 1**). Keynes (1936) pioneered the importance of government intervention for economic growth. Specifically, Keynes emphasizes the role of government in bringing the economy back to equilibrium after an initial displacement. The UNEP finance initiative asserts that finance is a critical element for delivering the Sustainable Development Goals (SDGs) and is recognized as a key means of actualizing the 2030 development agenda. UNEP notes further that fiscal policies provide a critical set of instruments for building an inclusive, green economy and supporting delivery of the SDGs. They conclude that fiscal policies help to generate domestic public resources and encourage more effective public spending, create fiscal space for priority investments that will aid sustainable development.

model specification

$$sd_t = \tau + \theta fis_t + \vartheta K_t + \lambda X_t + \varepsilon_t \quad (1)$$

where subscript t is the time index, *sd* denotes sustainable development, *fis* denotes

fiscal policy (captured by total government spending, tax revenue, public debt, spending on health, and spending on education). Importantly, public spending on health and education is a form of human capital, which is vital to sustainable development (Maitra and Mukhopadhyay, 2013). K is the stock of available capital; X is a vector of other control variables hypothesized to affect growth and development, and ε_t is the usual error term. The main control variables are inflation rate, population growth rate, domestic investment, GDP growth rate, and institutional quality (proxied by the ICRG's quality of governance indicator, which is measured by the mean value of the ICRG variables on 'Corruption', 'Law and Order' and 'Bureaucracy Quality'). The quality of governance variables ranges between 0 and 1—the closer to 1, the higher the quality of governance (Krueger and Maleckova (2003) and Choi (2010) argue that sound institutions (captured by corruption, bureaucratic quality, and law and order) promote sustainable development, while a deficient rule of law, high level of corruption, and low bureaucratic quality hinder sustainable development). Equation (1) forms the basis for the estimation. **Table 1** presents the description of variables and measurement of data.

Table 1. Measurement and sources of variables.

Variables	Definition/Measurement	Source
1. Sustainable development	This is measured by a single index which considers the following five indicators: life expectancy, education, income, material footprint, and CO_2 emissions	Hickel (2020) Sustainable development dataset
2. Government expenditure	This includes all government current expenditure for the purchase of goods and services.	WDI
3. Public debt	This consists of all government debts. That is Central government, State government, and Local government debts. It is captured by central government debts (CGD).	Global Database
4. GDP (growth rate)	This is gross domestic product. It measures the productive capacity of a state.	WDI
5. Domestic investment (% GDP)	It is measured by gross capital formation.	WDI
6. Quality of governance	This is measured by the mean value of the ICRG variables on 'Corruption', 'Law and Order' and 'Bureaucracy Quality'. The quality of governance variables ranges between 0 and 1—the closer to 1, the higher the quality of governance.	ICRG Quality of Governance Standard Dataset
7. Education	This is measured by school enrollment, secondary (% gross)	WDI
8. Tax	It is a measure of government size. It consists of all the revenues collected from taxes. It is measured by the ratio of tax revenue to GDP	WDI
9. Population (growth rate)	It measures the growth rate of the population in a geographical location	WDI
10. Spending on health and education (% of GDP)	Public spending on health and education are a form of human capital, which are vital to sustainable development.	WDI

Source: Authors' computation. Note: WDI denotes World Bank Development Indicators. ICRG is the International Country Risk Guide.

3.2. Estimation techniques

3.2.1. Baseline

The baseline regression estimation is the Ordinary Least Square (OLS). However, the traditional OLS is limited, in that, it does not adjust for the potential cross-sectional and temporal dependence in panel data (Driscoll and Kraay, 1998). In view of this, the study adopts Driscoll and Kraay's covariance matrix estimator was also implemented to deal with the issue of cross-sectional and temporal dependence inherent in panel

data.

The study also adopts the dynamic panel threshold model to estimate the optimal threshold level of fiscal policy that fosters sustainable development. The dynamic panel threshold model allows for nonlinear or asymmetric dynamics and cross-sectional heterogeneity, simultaneously. The lagged dependent variable and endogenous covariates are likewise supported in this paradigm, which also permits the threshold variable and regressors to be endogenous. The dynamic panel threshold model is significant because it permits statistical inference for the threshold parameter to consider both the "fixed threshold effect" and the "diminishing or small threshold effect." Moreover, the model also permits us to take into consideration the possibility of a kink, or false leap, in the model.

Driscoll and Kraay covariance matrix estimation with cross-sectionally and spatially dependent panel data

To correct for cross-sectional and spatial dependence, previous studies have adopted standard nonparametric covariance matrix estimators. For example, extant studies have adopted the feasible generalized least squares (FGLS) by Parks (1967), and/or the panel corrected standard error (PSCE) popularized by Kmenta (1986). However, in a panel data model with large *N* and small *T*, the FGLS and PCSE has been found to be inappropriate (Hoechle, 2007). However, these estimators require that the time dimension *T* of the panel is sufficiently large for a fixed size of the cross-sectional dimension *N* (Driscoll and Kraay, 1998; Newey and West, 1987). However, these methods suffer two major setbacks (Driscoll and Kraay, 1998) for details. Driscoll and Kraay (1998) modified the standard nonparametric covariance matrix estimator to take care of the deficiencies associated with previous techniques which rely on large *T* asymptotic. Driscoll and Kraay robust covariance matrix estimator remains consistent for any value of *N*, (i.e., $N \rightarrow \infty$relative to T). Additionally, the technique also eliminates the deficiencies associated with Parks-Kmenta (FGLS) or the PCSE approach, and it is robust to any form of cross-sectional, temporal, and spatial dependency. Interestingly, the method can be used with both balanced and unbalanced panels (Driscoll and Kraay, 1998; Hoechle, 2007).

Robust Hausman test

There are 3 possible models in Driscoll-Kraay estimation technique. These are the random effects, fixed effects, and the pooled OLS. Therefore, it is important to perform the Hausman test. Existing studies have used the standard Hausman test. The test is set under the null hypothesis that the random effects model is valid, i.e., $E(\alpha_{it} + e_{it}/x_{it}) = 0$. The standard Hausman test is performed with either the fixed effects or the random effects estimate of σ_e^2 (Wooldridge, 2002)—where the coefficient estimates obtained from FGLS is compared with those of the FE estimator. However, in the presence of cross-sectional dependence, the standard Hausman test may fail.

Therefore, to get valid statistical inference for the Hausman test when α_i and e_{it} are non-*iid*, we adopt Driscoll and Kraay's robust Hausman test to control for every form of spatial, cross-sectional, and temporal dependence.

The model is seen in Equation (2):

$$y_{it} - \hat{\lambda}\overline{y_{it}} = (1 - \hat{\lambda})\mu + (X_{1i,t} - \hat{\lambda}\overline{X_{1i}})'\beta_1 + (X_{1i,t} - \hat{\lambda}\overline{X_{1i}})'\gamma + v_{it} \quad (2)$$

Using Equation (2), the study performs a Wald test of $\gamma = 0$ in the auxiliary OLS regression. The null hypothesis of this alternative test (i.e., $\gamma = 0$).

After accounting for cross-sectional dependence, the robust Hausmann test indicates that the Driscoll-Kraay fixed effect model should be consistent (result not reported).

The dynamic panel threshold model

Following, Seo and Shin (2016) we adopt the dynamic panel threshold regression model in Equation (3):

$$y_{it} = (1, x_{it}')\phi_1 1(q_{it} \le \gamma) + (1, x_{it}')\phi_2 1(q_{it} > \gamma) + \varepsilon_{it,}\ i = 1, \ldots, n;\ t = 1, \ldots, T, \quad (3)$$

where y_{it} is a scalar stochastic variable of interest, x_{it} is the k_1x1 vector of time-varying regressors, that may include the lagged dependent variable, Equation (3) is an indicator function, q is institutional quality and the transition variable, γ is the threshold parameter, ϕ_1 and ϕ_2 are the slope parameters associated with different regimes. The regression error, ε_{it} consists of the error components:

$$\varepsilon_{it} = \alpha_i + \upsilon_{it}, \quad (4)$$

where α_i is a time-invariant unobserved country-specific effect term and υ_{it} is a zero mean idiosyncratic random disturbance. υ_{it} is assumed to be a martingale difference sequence.

$$E(\upsilon_{it}/F_{t-1}) = 0 \quad (5)$$

where F_t is a natural filtration at time t. x_{it} or q_{it} are not assumed to be measurable with respect to F_{t-1}. This allows endogeneity in both the regressor, x_{it}, and the threshold variable, q_{it}. However, efficient estimation depends on whether q_{it} is exogenous or not. Seo and Shin (2016) took into consideration the asymptotic experiment under large n with a fixed T with sample generated from random sampling across i.

4. Discussion of results

4.1. Descriptive statistics

The descriptive statistics are presented in **Tables 2**. The study reports the mean, standard deviation, minimum and maximum values. The results also show that the mean and the median values are close, indicating low variability, and a high level of consistency. Importantly, the results also mean that the model is not affected by outliers.

Table 2. Descriptive statistics of variables.

Panel A	**sus. dev.**	**govt expend.**	**public debt**	**gdp**	**sp. health**	**quality o G**	**educ.**	**sp. educ.**	**tax**
summary statistics									
mean	0.49	15.41	70.26	4.47	1.66	0.47	46.07	3.83	16.63
median	0.49	14.13	54.57	4.50	1.39	0.38	38.11	3.51	14.69
max	0.72	24.64	547.77	149.97	5.8	13.76	147.39	13.21	39.98

Table 2. (*Continued*).

Panel A	sus. dev.	govt expend.	public debt	gdp	sp. health	quality o G	educ.	sp. educ.	tax
summary statistics									
min	0.26	–10.23	0.48	–46.08	0.06	0.25	5.29	0.62	4.09
std. dev.	0.09	4.90	58.40	7.27	1.08	1.03	31.72	1.88	7.38
skewness	0.08	–1.22	2.80	8.07	1.15	10.36	1.18	1.50	0.84
kurtosis	2.59	8.22	16.53	173.6	4.02	115.52	3.92	6.88	2.96
observations	869	888	998	985	765	746	589	547	434
Panel B									
sus. dev.									
govt. expend.	1.0000								
public. debt	–0.3984	1.0000							
gdp	–0.1387	–0.0832	1.0000						
sp. health	0.3940	–0.0987	–0.2467	1.0000					
quality o G	0.2016	–0.2067	0.0288	0.1605	1.0000				
educ.	0.1136	–0.1041	–0.1420	0.4569	0.2289	1.0000			
sp. educ.	0.3824	–0.2002	0.0744	0.2371	0.6011	0.1043	0.3299	1.0000	
tax	0.6521	–0.2163	–0.2164	0.6786	0.4258	0.3381	0.5795	0.7026	1.0000

Source: Authors' computation. Note: **Table 2** presents the descriptive statistics for the variables used in the study. sus.dev. govt.expend. gdp, sp.health, educ. sp.educ. Denote sustainable development, government expenditure, gross domestic product, spending on health, education, and spending on education, respectively.

The result of the unit root test is presented in **Table 3**. The results show that the variables are stationary at levels, i.e., I(0) or at first difference, i.e., I(1).

Table 3. Result of the panel unit root tests (individual effects).

Variables	LLC	Breitung	IPS	PP-Fisher	ADF-Fisher	Order
public debts	–7.32***		–1.44*	125.57***	141.95***	I (0)
inf	–17.84***		–15.55***	413.26***	486.84***	I (0)
sus.dev	–13.68***	-	–12.51***	297.26***	299.91***	I (1)
gdp	–18.25***		–17.02***	441.88***	459.80***	I (0)
govt.expend	–5.43***		–4.62***	172.26***	194.23**	I (0)
tax	–6.38***		–2.67***	–77.87**	81.44**	I (0)

Source: Authors' computations. Notes: **Table 3** shows the results of unit root tests under individual and linear trends.

4.2. Cross-sectional dependence

However, given that many panel data models exhibit some form of cross-sectional or temporal dependence, the study tests for cross-sectional or temporal dependence in the model. The test is set under the null hypothesis (H0) the errors are cross-sectional independent. The result is presented in **Table 4**. The results reject the null hypothesis of cross-sectional independence. This indicates that the units are cross-sectionally dependent (see **Tables 4**). Thus, the OLS estimation may not be adequate. Therefore, in the presence of cross-sectional dependence, the unit root test is re-

estimated. The results are shown in **Table 5**.

Table 4. Panel cross-section dependence tests (in the variable).

Variable	Breusch-Pagan LM	Pesaran scaled LM	Bias-corr. scaled LM	Pesaran CD
sus.dev	12938.96*** (0.0000)	315.84*** (0.0000)	314.95*** (0.000)	79.27*** (0.0000)
gdp	1326.92*** (0.0000)	7.74*** (0.0000)	6.78** (0.0000)	4.53** (0.0000)
population	6536.61*** (0.0000)	127.49*** (0.0000)	126.53*** (0.0000)	2.40*** (0.0162)
public debts	7153.20*** (0.0000)	141.69*** (0.0000)	140.75**** (0.0000)	53.07*** (0.0000)

Source: Authors' computation. Notes: The cross-section dependence test is set under the null hypothesis of cross-section independence, CD–N (0.1) *P*-values close to zero indicate data are correlated across panel groups. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$. Abbreviations: CSD, Cross-sectional dependence; LM, Lagrange multiplier.

Table 5. Results of panel unit root tests in presence of cross-section dependence.

	CIPS[a] CADF[b]	
	Level	**1st Difference**
sus. dev.	3.10** 3.10***	
govt. expend	2.60*** 2.64***	
domestic investment	2.164***	

Authors' computation. Notes: [a]H_0 (homogeneous non-stationary): $bi = 0$ for all I whereas [b] the null hypothesis assumes all series are non-stationary in a heterogeneous panel with cross-sectional dependence. ***$p < 0.01$, **$p < 0.05$, *$p < 0.10$.

Having confirmed the presence of cross-sectional dependence in the model, the study re-examines the order of stationarity in the presence of cross-sectional dependency. The results are presented in **Table 5**. The results show that the variables are stationary at levels, i.e., I (0).

4.3. Baseline model

Table 6 presents the baseline model. The method of estimation is the ordinary least square (OLS). The result indicates that government spending exerts a negative and statistically significant effect on sustainable development, indicating that aggregate government expenditure does not engender sustainable development in SSA (see model 1, **Table 6**). Similarly, the results show that public debts, government spending on health, and tax do not foster sustainable development. This suggests that government policies have not promoted sustainable development in SSA. While, spending on education promotes sustainable development. However, the OLS is limited, given that it cannot correct for cross-sectional or temporal dependence in panel data models. To correct for this limitation, the study adopts Driscoll and Kraay's cross-sectional and spatial dependence—Consistent model in **Table 7**.

Table 6. Baseline model: Ordinary Least Square (OLS) estimates.

Variable sustainable development	Model 1	Model 2	Model 3	Model 4	Model 5
govt.expend	–0.002*** (0.0007)	-	-	-	-
public debts	-	–0.00005 (0.0001)	-	-	-
sp.health	-	-	0.00008 (0.0002)	-	-
sp.education	-	-	-	0.006** (0.002)	-
tax	-	-	-	-	–0.001 (0.001)
gdp	–0.0008(0.0009)	–0.0006 (0.0009)	–0.0003 (.0009)	–0.001 (0.001)	–0.0002 (0.001)
gcf	0.001(0.002)	0.002 (0.002)	0.003 (0.002)	0.007*** (0.003)	0.004 (0.002)
domestic inves.	–0.0005(0.002)	–0.001 (0.002)	–0.002 (0.002)	–0.006* (0.003)	–0.002 (0.002)
quality of gov.	0.114*** (0.048)	0.034 (0.044)	0.022 (0.044)	0.099** (0.051)	0.076 (0.066)
education	0.002*** (0.0001)	0.002*** (0.0001)	0.001*** (0.0001)	0.001***(0.0001)	0.002***(0.0002)
population	–0.032*** (0.008)	–0.033*** (0.008)	–0.034*** (0.008)	–0.051***(0.009)	–0.015 (0.015)
inflation	0.001*** (0.0002)	0.0003** (0.0001)	0.0003*** (0.038)	0.0001 (0.0001)	0.0003* (0.0001)
constant	0.476*** (0.038)	0.446*** (0.039)	0.459*** (0.038)	0.462*** (0.040)	0.385*** (0.069)
observation	283	294	264	192	161
adjusted R^2	0.5800	0.5664	0.5751	0.6855	0.5904
root MSE	0.0596	0.0613	0.0575	0.0513	0.0588

Source: Authors' computation. Note: govtexpend, sp.helath, sp.education, gdp, gcf, quality of gov. denote government expenditure, spending health, spending on education, gross domestic product, gross capital formation, and quality of governance, respectively.*, **, *** denote 10%, 5%, and 1% level of significance. Note: The standard errors are in parenthesis.

Table 7. Drisoll-Kraay Covariance matrix estimator (adjusted for fixed effects).

Variable sustainable development	Model 1	Model 2	Model 3	Model 4	Model 5
public debts	–0.0005*** (0.00008)	-	-	-	-
govtexpend	-	–0.0004 (0.0009)	-	-	-
sp.health	-	-	0.00005 (0.0009)	-	-
sp.education	-	-	-	0.003** (0.001)	-
tax	-	-	-	-	0.001 (0.001)
gdp	–0.0005 (0.0003)	–0.0003 (0.0004)	0.00006 (0.0001)	0.001*** (0.003)	0.0004 (0.0005)
gcf	–0.001 (0.0008)	0.001 (0.0009)	0.001** (0.0008)	–0.001 (0.0007)	0.0009 (0.0013)
domestic inves.	0.0016* (0.0008)	–0.0001 (0.001)	–0.0009 (0.0008)	0.002*** (0.0006)	–0.00009 (0.001)
quality of gov.	0.044 (0.049)	0.030 (0.037)	0.004 (0.045)	0.023 (0.048)	0.040 (0.067)
education	0.002*** (0.0001)	0.002*** (0.0001)	0.0013*** (0.0001)	0.003*** (0.0001)	0.002*** (0.0002)
population	0.026 (0.023)	0.037 (0.026)	0.037**(0.016)	0.034*** (0.011)	–0.007 (0.028)
inflation	–0.00003 (0.00003)	–0.0004*** (0.0001)	–0.0002*** (0.00004)	–0.0001*** (0.00002)	–0.0003* (0.0001)
constant	0.304*** (0.072)	0.446*** (0.021)	0.231*** (0.049)	0.197*** (0.037)	0.328*** (0.064)
observation	294	283	264	192	161

Table 7. (*Continued*).

Variable sustainable development	Model 1	Model 2	Model 3	Model 4	Model 5
within R^2	0.5919	0.6015	0.6836	0.8343	0.6742
F statistics	602.02	261.96	555.25	531.23	86.28
Prob. F(statistics)	0.0000	0.0000	0.0000	0.0000	0.0000

Source: Authors' computation. Note: govtexpend, sp.helath, sp.education, gdp, gcf, quality of gov. denote government expenditure, spending health, spending on education, gross domestic product, gross capital formation, and quality of governance, respectively.*, **, *** denote 10%, 5%, and 1% level of significance. Driscoll-Kraay robust standard errors are in parenthesis.

Table 7 presents the Driscoll-Kraay covariance estimation. The result is robust to different estimation technique. The result shows that an increase in public debts leads to a decline in sustainable development. This is an indication that the level of public debts across SSA may hinder the sustainable development agenda in SSA. This is tenable since a high debt-to-GDP ratio increases debt servicing cost, which reduces fiscal space for sustainable development programmers. In contrast, the results show that spending on health, tax, and public spending on education exert a positive impact on sustainable development. While public spending on health and tax revenue shows a positive and statistically insignificant effect. The results suggest there may be an optimal threshold of fiscal policy that fosters sustainable development in SSA. However, public spending on education exerts a positive and statistically significant impact on sustainable development, indicating that spending on education engenders sustainable development in SSA. The result is consistent with the findings of Lin and Zhu (2019) who found that that fiscal spending on R&D and education foster green economic growth in China. However, the results negate the findings of Chishti et al. (2021) and Halim and Rahman (2022).

The results also reveal that education (captured by gross secondary school enrolment) engenders sustainable development. In contrast inflation exerts a negative and statistically significant impact on sustainable development. This implies that a high level of domestic inflation hinders sustainable development in SSA. We do not find any statistically significant effect of domestic investment and quality of governance on sustainable development in SSA. This might be that the quality of governance and the level of domestic investment in SSA cannot engender sustainable development.

Before estimating the dynamic panel threshold model, we test for non-linearity in the model. The test of linearity was evaluated by *p*-values using a bootstrap algorithm method with trim rate set by default at 0.4. The model is set under H0 is linear, i.e., $\delta = 0$. The linearity test result shows that the null hypothesis of linearity is rejected at 5% level of significance.

The result of the dynamic panel threshold model is presented in **Table 8**. The results support the non-linearity hypothesis. The result indicates that the effect of fiscal policy on sustainable development is non-linear. Specifically, we found an optimal level of 4 and 3 percent of GDP for public spending on health and education, respectively, below which spending on education and health will not stimulate sustainable development in SSA. This is consistent with the benchmark of at least 4% to 6% endorsed by the Education 2030 Framework for Action for public spending on

education, and the World Health Organization's 5% of GDP benchmark for health spending. Likewise, governments across SSA must increase tax revenue/GDP to a minimum 8 percent to propel sustainable development in SSA. In contrast, public debt has a maximum threshold of 30 percent/GDP ratio, beyond which public debt will negatively impact sustainable development in SSA.

Table 8. The dynamic panel threshold with a kink.

Dependent variable	**1**	**2**	**3**	**4**
Sustainable Development	**(Pub.debt)**	**(Sp.edu)**	**(Sp.health)**	**(Tax)**
Bootstrap *p*-value	0.0000	0.0000	0.0000	0.0000
Threshold estimate	30.45	4.03	3.02	8.47
	upper regime ($\delta 1$) >			
Pub.debt	–0.009*** (0.0035)			
Sp.edu		0.057*** (0.006)		
Sp.health			0.057*** (0.006)	
Tax				0.043*** (0.003)
	lower regime (δ) <			
Pub.debt	0.015*** (0.0004)			
Sp.edu		–0.012** (0.063)		
Sp.health			–0.008*** (0.0022)	
Tax				–0.040** (0.021)

Source: Authors' computation. Note: The bootstrap algorithm to test for the presence of the threshold effect is set under the null hypothesis$H_0: \delta_0 = 0$. *, **, *** denote 10, 5 and 1 percent levels of significance, respectively. Number of moment conditions: 528.
Bootstrap *p*-value for linearity test = 0

5. Conclusion, and policy recommendations

The study investigates the role of public finance in fostering sustainable development in SSA. The study also investigates the optimal threshold of public financing for sustainable development. The study found that an increase in public debts lead to a decline in sustainable development. This is an indication that the level of public debts across SSA may hinder the sustainable development agenda in SSA. In contrast, the results show that spending on health and tax exert a positive, albeit statistically insignificant effect on sustainable development. The results suggest there may be an optimal threshold of fiscal policy that fosters sustainable development in SSA. However, public spending on education exerts a positive and statistically significant impact on sustainable development, indicating that spending on education may help to foster sustainable development in SSA. We do not find any statistically significant effect of domestic investment and quality of governance on sustainable development in SSA. Similarly, we found an optimal level of 4 and 3 percent of GDP for public spending on health and education, respectively, below which spending on education and health will not stimulate sustainable development in SSA. This is consistent with the benchmark of at least 4% to 6% endorsed by the Education 2030 Framework for Action for public spending on education, and the World Health Organization's 5% of GDP benchmark for health spending. In addition, the study

uncovers a debt/GDP ratio of 30 percent beyond which public debts hinder sustainable development in SSA.

Against this background, the study makes the following recommendations.

One, governments across SSA should increase public spending on health and education and formulate policies to increase tax revenue to within the threshold established in this study. This will limit out-of-pocket spending and help to promote sustainable development in SSA.

In addition, governments should reduce the escalating stock of public debts to within the benchmark established in this study since a high debt-to-GDP ratio increases debt servicing cost, which reduces fiscal space for sustainable development programmers.

Two, governments across SSA should increase domestic investments, and investment in education (i.e., human capital) to foster sustainable development in the region.

Three, governments and policymakers in SSA should improve the quality of governance by fighting corruption, upholding law, and order, and improving on bureaucracy quality to promote sustainable development. Similarly, improvements in the quality of governance will aid the development of state and institutional capacity to drive and support innovation and create an enabling business environment that will engender sustainable development in SSA.

5.1. Suggestion for further studies

The study investigates the role of public finance in fostering sustainable development in SSA and uncovers the optimal threshold of public financing for sustainable development. However. The study adopted public debts and spending on health and education as measures of public finance due to data un(availability). Future studies may consider other aspects of public financing.

Author contributions: Conceptualization, OOO; methodology, OOO; software, OOO; validation, MFZ; formal analysis, OOO and MFZ; investigation, OOO; resources, MFZ; data curation, OOO; writing—original draft preparation, OOO and MFZ; writing—review and editing, MFZ; visualization, MFZ; supervision, MFZ; project administration, MFZ. All authors have read and agreed to the published version of the manuscript.

Acknowledgments: The research was funded by Tshwane University of Technology, Pretoria, South Africa.

Conflict of interests: The authors declare no conflict of interests.

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Appendix

Country
Angola, Madagascar, Malawi, Sierra Leone, South Africa, Botswana, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Republic, Congo Democratic Republic, Benin, Equatorial Guinea, Ethiopia, Eritrea, Gabon, Gambia The, Ghana, Guinea, Cote d' Ivoire, Kenya, Lesotho, Liberia, Togo, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Guinea-Bissau, Rwanda, Senegal, Seychelles, Zimbabwe, Sudan, Uganda, Tanzania, Burkina Faso, Zambia.