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RESEARCH PAPER

Assessing the Government Spending Efficiency in Africa: A Regional Analysis of Spending Efficiency with Stochastic Frontier Approach

Olawale Daniel Akinyele[a,*], **Philip Olawale Odewole**[b], and **Ifeoluwa Kosemani**[c]

a. Department of Economics, Obafemi Awolowo University, Ile-Ife, Nigeria.
b. Department of Accounting and Finance, Elizade University, Ondo, Nigeria.
c. Department of Economics, Elizade University, Ondo, Nigeria.

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Abstract

The performance of any government is measured by improvement in its citizens' well-being and the quality of life they live, which tends toward human development. The need to improve human development remains an age-long phenomenon, from millennium development to sustainable development over the last two decades. With the current global economic crisis triggered by the COVID-19 pandemic, supply chain crisis, and macroeconomic imbalance, a rise in government spending profile may not be feasible to inhibit fiscal deficit. More so, increased government spending over time among African countries has not translated to a rise in human development. Therefore, this study assessed government spending efficiency among African countries. The study adopts stochastic frontier analysis among 40 African countries between 2000 and 2020. There is relatively low efficiency in government spending among African countries. Meanwhile, the region of North Africa has the most efficient level of spending. However, to have all-round development in Africa, there is a need for African countries to be more focused. Spending efficiency has been remarkable in 2019/2020 across all regions of Africa. Countries like South Africa, Cameroon, Burkina-Faso, Mozambique, and Morocco were able to perform above the regional average of government spending efficiency. There are relative differences in spending patterns among African regions. The divergence in spending efficiency among African countries could be the reason for the different ranks of human development in Africa.

Keywords: efficiency, frontier analysis, government spending, human development, panel data.
JEL Classifications: C23, C87, H21, H53, I30.

Introduction

The performance of any government is measured by improvement in its citizens' well-being and the quality of life they live, which tends toward human

development. Since the late 1930s, government involvement in economic activities has persisted owing to contributions to public goals (Prasetyo and Zuhdi, 2013). Government spending has remained an important instrument for the provision of public goods and services including health, education, transport, infrastructure, and security (Edeme et al., 2017; Olaoye et al., 2023; Kofi et al., 2018; Rafiy et al., 2018; Adegboye and Akinyele, 2022). The quality provision of these public goods and services situates the development episodes in many economies. Also, several analytical and empirical studies have focused on expenditure as the traditional avenue through which the government can achieve its aim (Barro and Sala-i-Martin, 1992; Sala-i-Martin and Barro, 1995; Barro, 1990). Meanwhile, human development has remained the biggest challenge of the time and a threat to most countries of the world, particularly among African countries (more than half of African countries listed in the United Nations Development Programme Report 2021 are ranked low in human development). This challenge allows most countries to either improve their spending profile or increase the spending efficiency level.

The need to improve human development remains an age-long phenomenon, from the Millennium Development Goals to the Sustainable Development Goals. Insights from theories and various viewpoints maintain that increasing government spending profiles remains the potential fuel for achieving human development. However, with the current global economic crisis triggered by the COVID-19 pandemic, supply chain crisis, and macroeconomic imbalance, a rise in government spending profile may not be feasible to inhibit fiscal deficit. Moreover, increased government spending over time among African countries has not translated into a rise in human development (Figures 1 and 2). Following UNDP reports, most African countries recorded a low human development index. Studies have documented that countries with high-quality spending experienced exponential development episodes (Akinyele et al., 2023; Adegboye and Akinyele, 2022; Akinyele and Dada, 2022; Alexiou et al., 2014; Perera and Lee, 2013; Kilishi et al., 2013; Dandume, 2013; Valeriani and Peluso, 2011). Following the Adam Smith and the Neo-realist perspective, the government's fundamental primary responsibility lies in quality-of-life provisions.

Within the foregoing, it becomes inadequate and insufficient to limit development episodes to a rise in government spending profile. In recent times, the issue of government spending has continued to draw the attention of both policymakers and researchers globally, especially toward achieving the SDGs. A host of resources are needed to meet such goals. However, the extent of the

increase in government spending is limited due to macroeconomic constraints (Jayasuriya and Wodon, 2003; Mohanty and Bhanumurthy, 2018), making efficiency inevitable. Meanwhile, existing spending has not met the development episodes in Africa compared to spending in other regions. However, existing studies have provided evidence of the spending-development nexus with mixed and controversial results. The disparity between these studies could be due to a variety of factors, including the use of various human development indices, econometric methodologies, and/or explanatory variables. In addition, the reason could be that existing literature fails to account for potential cross-country dependence when assessing the spending-development nexus in most previous investigations.

Government spending is a tool to strengthen the capacities of people. Meanwhile, more than half of African countries listed in the UNDP Report 2021 are ranked low in human development. The need to improve human development and achieve sustainable goals within the available government resources necessitates government spending efficiency in African countries. Amidst this, the importance of the efficient use of public resources and high-quality fiscal policies for economic development and individual well-being has been brought to the forefront by several developments over the past decades. Herrera and Pang (2005) submit that developing country governments usually spend resources similar to 15–30% of GDP with evidence showing that nations with greater spending records reduced efficiency ratings. To accentuate African countries' development, government spending efficiency becomes inevitable. A small change in government spending efficiency could have a major effect on human development and the achievement of the objectives of the government in the quality of citizens' lives. This study assessed the government spending efficiency among African countries using stochastic frontier analysis.

Following the introduction, the study discusses the related existing studies on the efficiency of government spending in Section Two. In Section Three, we present the methodological approaches adopted in the study. In Section Four, the results and discussion of the study are presented and Section Five discusses the conclusion and policy implications.

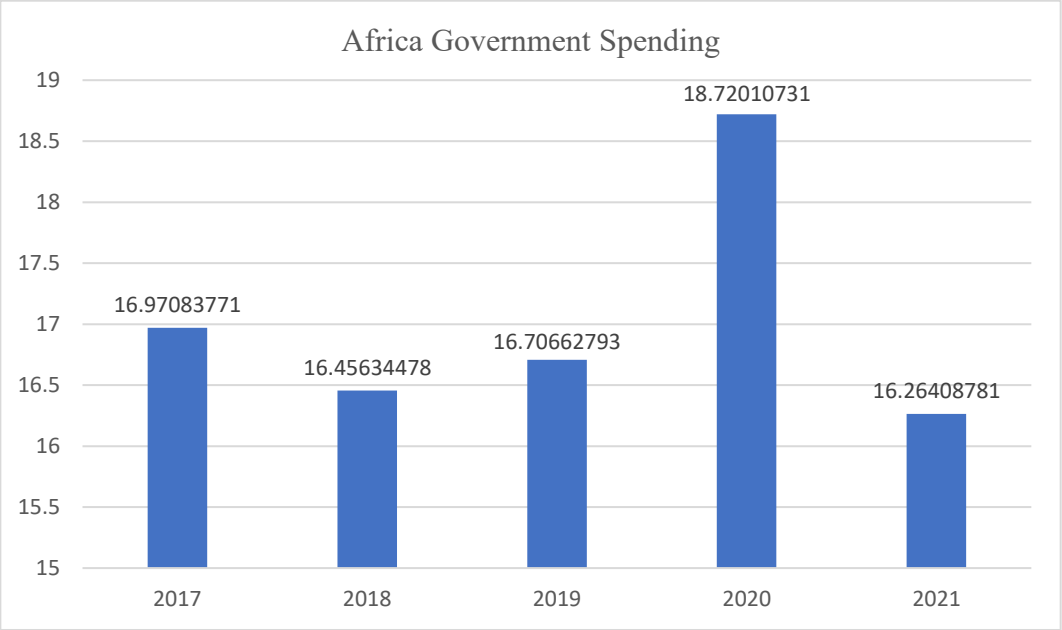

Figure 1. African Government Spending
Source: Research finding.

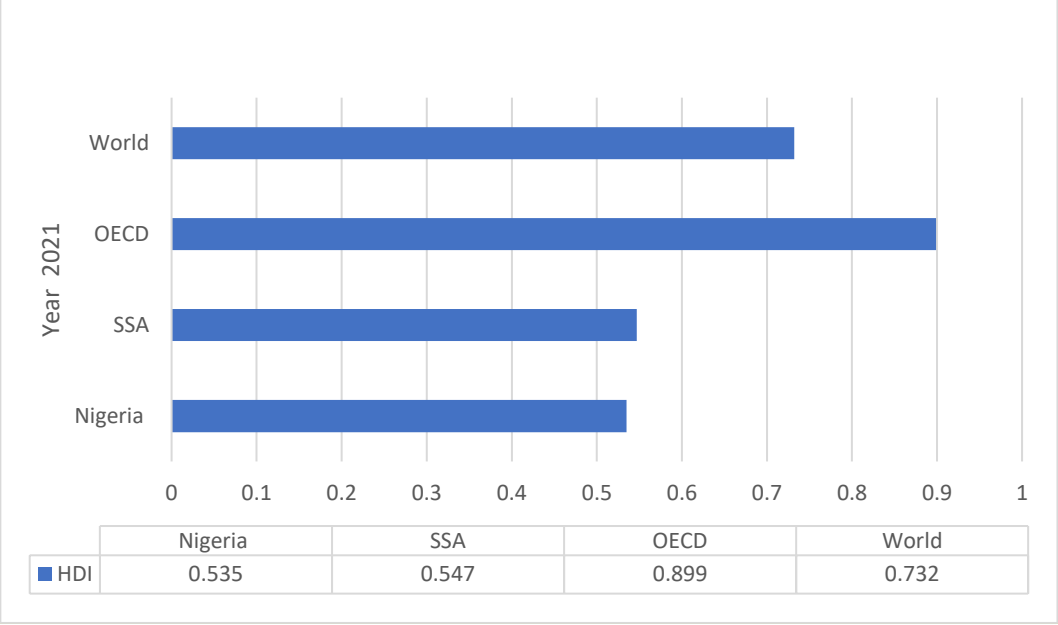

Figure 2. Human Development Index 2021
Source: Research finding.

Literature Review

Theoretical Foundations

The paradigm of government spending efficiency can be anchored on Keynesian propositions in African economies. Government spending has been argued to have a positive relationship with well-being, following insights from Wagner (1911), Peacock and Wiseman (1961), Musgrave (1969), and the argument from various empirical standpoints (Razmi et al., 2012; Prasetyo and Zuhdi, 2013; Iheoma, 2014; Akinyele et al., 2023; Adegboye and Akinyele, 2022; Akinyele and Dada, 2022). However, a cursory look at human development in Africa shows that the reverse is the case between growing government spending and development episodes. Countries that are ranked first in development episodes among African countries were among the least in the world (United Nations Development Programme (UNDP) Report, 2021). Low development indicators as against huge African government spending indicate low efficiency in spending. To answer how efficient the use of government spending to improve social welfare, the study assessed government spending efficiency among African countries. The frontier approach was adopted to establish the government spending efficiency level, the government becomes a producer of social welfare through the single output-multiple inputs framework. This explains the efficiency of government spending through single output (human development index) and multiple inputs (government spending, labour force participation, and gross fixed capital formation).

Following insights from the Wagner law of state activity, which emphasizes an endogenous relationship between spending and development, the need for efficiency becomes palpable owing to conflicting results on spending and development among African countries. A cursory look at n development in Africa shows that the growing government spending there is not commensurate with development episodes.

Existing Studies

Sustainable goals have become the interest of many countries of the world, particularly among African countries where high levels of poverty are pronounced. Though an instrument to reduce poverty and inequality levels as well as to promote human performance and capabilities has become well pronounced in development economics (Sen, 1982), a large number of studies have attributed government spending as an instrument in achieving sustainable goals and welfare. Theoretically, improving education, health, sanitation,

security, and other social services has been attributed to government responsibilities (Suescun, 2007; Adegboye and Akinyele, 2022). In an attempt to achieve sustainable development among many economies, there has been a rise in research on the factors that influence government spending since the late 1970s, which coincides with social policy reforms that industrialized nations have implemented to enhance their welfare states (Kittel and Obinger, 2003).

Development has been a long-age phenomenon from the millennium to sustainability (UN SDGs 2030 agenda). Several theoretical underpinnings have been carried out with an emphasis on government involvement as the underlying driver for human development (Wagner, 1911; Peacock and Wiseman, 1961; Musgrave, 1969). Similarly, various empirical studies have identified government involvement as a means of enhancing human development in many parts of the world (Razmi et al., 2012; Prasetyo and Zuhdi, 2013; Iheoma, 2014; Akinyele et al., 2023; Adegboye and Akinyele, 2022; Akinyele and Dada, 2022).

Globalization has been established to influence government spending in many economies (Kaufman and Segura-Ubiergo, 2001; Avelino et al., 2005; Dreher et al., 2008; Leibrecht et al., 2011). Also, trade and capital openness have been assessed to influence public spending (Hicks and Swank, 1992; Huber et al., 1993; Quinn, 1997; Bernauer and Achini, 2000; Balle and Vaidya, 2002; Bretschger and Hettich, 2002). However, the primary goals of government social spending are lowering income inequality, improving citizens' wellbeing and quality of life, and battling social exclusion (Antonelli and De Bonis, 2018; Adegboye and Akinyele, 2022). It has been made clear that the quantity of government spending falls short of producing the desired outcomes in terms of closing the inequality gap, reducing poverty, and promoting human performance and capabilities. The results of this research demonstrate that better policies, as opposed to larger spending levels, could provide the same benefits in the social situation (Anderson et al., 2018; Anderson et al., 2017; Haile and Niño-Zarazúa, 2018; Sánchez and Pérez-Corral, 2018; Adegboye and Akinyele, 2022).

Over the years, the size of government spending maintains a high profile without being commensurate with human capital development. This trend negates the Wagner law of state activity that emphasizes an endogenous relationship between government spending and human capital development. In addition, a cursory look at the socio-economic outcomes in Africa shows that the reverse is the case between growing government spending and socioeconomic outcomes. Countries that are ranked first in development episodes among African countries were among the least in the world (United Nations Development

Programme (UNDP) Report, 2021; Adegboye and Akinyele, 2022). Low development indicators as against huge African government spending indicate low-quality spending among African countries.

The need for efficiency in government spending has remained a key interest of policymakers and researchers in the discussion of fiscal instruments among many economies, especially among African countries where development issues of rising poverty, wide inequality, and high unemployment are more pronounced, despite a consistent rise in government expenditure. One of the ways of addressing the problems, as used in the literature, is via fiscal spending instruments. The performance of the government drives many development indicators from human capital development to a sustainable diversified economy (Akinyele et al., 2022; Akinyele and Dada, 2022; Adegboye and Akinyele, 2022). Government spending has remained an important instrument for the provision of public goods and services including health, education, transport infrastructure and security (Kim and Lane, 2013; Iheoma, 2014; Jaba et al., 2014; Edeme et al., 2017; Kofi et al., 2018; Adegboye and Akinyele, 2022).

Adegboye and Akinyele (2022) identified government spending efficiency in Africa as the framework to explain Africa's development owing to the divergence relationship between naturally endowed resources and low human development. The need for efficiency of government intervention becomes palpable. Studies have examined the importance and efficiency of government spending across the world. The range of studies includes the differences in the efficiency of education spending (Afonso and Aubyn, 2006), public sector efficiency (Afonso and Aubyn, 2006), the efficiency of public expenditure in improving health, education, and governance performance (Rayp and Van De Sijpe, 2007), assessment of the effectiveness of health care delivery (World Health Report, 2000), efficiency and variation in cultural and economic characteristic (Greene, 2003). Also, there was a re-estimation of efficiency with parametric and non-parametric methods (Hollingsworth and Wildman, 2003). The effectiveness and efficiency of government in establishing the relationship between government approaches and employment level (Akinyele et al., 2022). Government efficiency and effectiveness in addressing burgeoning export diversification (Akinyele and Dada, 2022). There is little or no attention to government spending efficiency in African countries. Hence, this study assessed the efficiency of government spending among African countries.

In terms of approaches employed to establish efficiency in recent times, both parametric and nonparametric strategies have been dominant in the

literature. However, a parametric approach such as stochastic frontier analysis (SFA) separates deviations from the production function between random error and inefficiency component (Battese and Coelli, 1995; Bolarinwa et al., 2021; Akinyele and Dada, 2022; Akinyele et al., 2022; Adegboye and Akinyele, 2022). The SFA was independently proposed by Aigner et al. (1977) as well as Meeusen and Van den Broek (1977) to estimate technical efficiency in applied economic research. As for the non-parametric approach such as Free Disposal Hull (FDH) and Data Envelopment Analysis (DEA), what is involved is a mathematical programming technique and it allocates all the deviations from the production frontier to technical inefficiencies (Linuma et al., 1999) though provide access to rank performance among the decision-making units. Meanwhile, there is no specific functional relationship in the production frontier between inputs and output or in the efficiencies term, unlike the SFA.

The specific functional relationship between inputs and output in the SFA methodology to efficiency can be Cobb-Douglas, translog, or any other that may have been developed along the lines of specific distributions, estimation methods, production, or cost approach. For instance, Battese and Coelli (1995) proposed truncated normal distribution and maximum likelihood for the estimation of inefficiency terms in a panel analysis. Greene (2005) provided an extension through the measure of efficiency as time-invariant. He incorporated a term used to capture the inefficiency of the random effects and fixed effects estimators containing time-invariant cross-unit heterogeneity. Efficiency can take a production function approach (Akinyele and Dada, 2022; Akinyele et al., 2022; Adegboye and Akinyele, 2022) or a cost function approach (Bolarinwa et al., 2021). Following various theoretical and empirical reviews, the study tested the spending-development nexus among regions of Africa and provided the best-performing region in general and specific spending patterns.

Methodology

The stochastic frontier model of government spending adopts a single output-multiple inputs approach that employs panel data, this demonstrates the efficiency of government spending. Aigner et al. (1977) and Meeusen and van den Broeck (1977) presented the studies that introduced SFA in econometrics. Pitt and Lee (1981), Jondrow et al. (1982), Schmidt and Sickles (1984), Battese and Coelli, (1988; 1992; 1995), Kumbhakar (1990), Greene (2005; 2008), and others have extended the original formulation to the models to suit various empirical analyses. The SFA modelling strategy permits inference-making on the

functional relationship between inputs and output framework. Thereafter, explains the performance of producing government over time. However, the possible sources of government performance may be exogenously determined by factors that may not necessarily be within the control of the frontier. The stochastic frontier model that employs panel data is given as:

$$Y_{it} = f(X_{it};\beta) \quad (1)$$

where Y is the maximum output obtainable (human development index), X is the vector of nonstochastic inputs (government spending, labour force participation, and gross fixed capital formation) and β is an unknown parameter. The SFA allows the producer (government) to incorporate the possibility of measurement error into inefficiency terms and noise effect as follows;

$$\begin{aligned} Y_{it} &= X_{it};\beta + \varepsilon_{it} \; for \; i = 1, \dots, N \; and \; t = 1, \dots, T \\ Y_{it} &= X_{it};\beta + V_{it} - U_{it} \end{aligned} \quad (2)$$

where $\varepsilon_{it} = V_{it} - U_{it}$. Here, $V_{it} \sim i.\,i.\,d.\ \mathrm{N}(0, \sigma_{v2})$ and $Uit \sim i.\,i.\,d.\ \mathrm{N}(\mu, \sigma_{\mu 2})$ are identically and independently distributed of each other and other explanatory variables. N and T represent the number of countries in the sample and time respectively. Following Greene (2005) as well as Battese and Coelli (1995) models which assume truncated normal distribution, this study estimated the technical efficiency of government spending in selected forty (40) African countries through the Cobb-Douglas stochastic frontier function. The linear form of the equation, which is made up of the deterministic component and the composite error, is derived for estimation. The choice of frontier variables is guided by economic theory, particularly the Keynesian propositions. The study utilizes panel data from 40 African countries (Algeria, Egypt, Morocco, Sudan, Tunisia, Botswana, Namibia, South Africa, Eswatini, Angola, Cameroon, Central Africa Republic, Chad, Congo Brazzaville, Congo DR, Gabon, Benin, Burkina Faso, Gambia, Ghana, Guinea, Guinea Bissau, Mali, Niger, Nigeria, Senegal, Sierra Leone, Togo, Mauritania, Burundi, Comoros, Kenya, Madagascar, Mauritius, Mozambique, Rwanda, Tanzania, Uganda, Zambia, and Zimbabwe) according to the International Monetary Fund (IMF, 2018) and Venables (2016) African countries classifications and covering the period between 2000 and 2020, following the era of strong growth output and increased economic activities among most African countries. Also, a second-generation panel unit root was implemented to address the cross-sectional dependence phenomenon among 40 African countries. Data were sourced from 2021 Editions of the World Bank's Development Indicators to establish the government spending efficiency using

African, sub-Saharan, general, and health spending models. These models were considered to establish the robustness of government performance among African countries. The variables and measures in the model are presented in Table 2.

Descriptive Statistics

Descriptive statistics assist in providing a clear summary and behaviour of variables adopted in the study. The study explored the use of both measures of central tendency and dispersion. A key assumption was that the data were drawn from a normally distributed population. Therefore, before conducting the regression analysis, tests for normality, skewness, and kurtosis were conducted to establish the appropriateness of the data for making inferences (Field, 2009).

Correlation Analysis

When two or more predictors in the model are highly correlated, redundant information about the response becomes inevitable. To avoid this, it requires that none of the explanatory variables in the model should be correlated with any other explanatory variable or with any linear combination of those explanatory variables. The presence of explanatory variables means that it is difficult to separate the impact of x1 on y from that of x2, which makes regression results misleading. This was tested in the study using a correlation matrix whereby the cut-off point for severe correlation was 0.8 (Cooper and Schindler, 2011; Gujarati, 2006). Failure to account for high correlation between variables results in indeterminate regression coefficients and infinite standard errors. Meanwhile, the existence of imperfect multicollinearity results in large standard errors. Large standard errors affect the precision and accuracy of rejection or failure to reject the null hypothesis. During estimation, the problem is not the presence of multicollinearity but rather its severity. A correlation coefficient greater than 0.8 thus indicates the presence of multicollinearity.

Cross-Sectional Dependence Result

To analyze the presence of cross-section dependence and the order of integration of our variables, the Pesaran cross-sectional dependence (CD) test (Pesaran, 2004) and the cross-sectionally augmented IPS (CIPS) test (Pesaran, 2007) were performed. Given the results of the Pesaran CD test (Pesaran, 2004), ignoring cross-sectional dependence may lead to misleading inferences. Cross-sectional dependence means that a correlation exists between our series across countries. This phenomenon happens due to the common shocks that our cross-sections

share, and if we ignore it, it can produce inconsistent and incorrect conclusions in the econometric approach (Eberhardt and Teal, 2011). Since the presence of cross-sectional dependence was verified in all the variables, we executed only the second-generation unit root test, the CIPS test by Pesaran (2007), because first-generation unit root tests are not trustworthy when this phenomenon is present.

Table 2. Data and Sources

Variables	Symbols	Measurement	Source
Human Development Index	HDI	This is a statistic composite of human development measured by life expectancy, school rate, and per capita income which represent the single output of the frontier	WDI
Government Spending	GOV	This is the ratio of government expenditure to GDP	WDI
Size of an Economy	GDP	This is measured by GDP (current US$)	WDI
Resource Rent	RENT	This is measured by total natural resources rents as a % of GDP	WDI
Gross Fixed Capital Formation	CAP	This is measured as Gross fixed capital formation (% of GDP) which represent part of the multiple input of the frontier	WDI
Labour Productivity	LAB	Labour force participation rate (% of total population ages 15+) which represents part of the multiple inputs of the frontier	WDI
Health Spending	HEA	This is the ratio of health expenditure to GDP	WDI
Life Expectancy	LIFE	This is the life expectancy at birth, total (years)	WDI

Source: Research finding (2023).

Result and Discussion

This section provides results and discussion on the efficiency of government spending among African countries. This section is divided into three subsections. Subsection one presents the preliminary tests, including descriptive statistics, correlation analysis, cross-sectional dependence, and unit root tests, while subsection two presents the frontier results on government spending efficiency, and subsection three discusses the efficiency scores across African countries.

Preliminary Result

The descriptive statistics show that, on average, human development among African countries is 0.502, indicating low human development. Meanwhile, some

countries experienced high human development (at most 0.804), while others recorded levels as low as 0.252. This divergence in human development among African countries could be attributed to differences in the management of government spending in the region. Furthermore, government spending in Africa ranged between 1% and 35%. On average, African countries spend about 14% of their resources to provide a quality life for their citizens (Table 3). Yet there is a low level of human development.

Specifically, to provide a long and healthy life, most African countries spend 5% of their resources on the health sector, while some countries spend up to 20%. Yet the life expectancy for African countries stood at 59 years, which is below the world average life expectancy at birth. Though most African countries are naturally endowed (Adegboye and Akinyele, 2022), the low level of development has crowded out the possible enabling and sustainable environment for development. This suggests the need for African countries to improve the performance of government spending. Further, the degree of association between human development and government spending is positive, suggesting that government spending is a viable instrument to address low development indicators in Africa (Table 4). This result is not unexpected since it conforms to the theoretical foundation of Keynesian proponents and some empirical standpoints (Akinyele and Dada, 2022; Akinyele, Oloba and Mah, 2022; Adegboye and Akinyele, 2022). It is essential to conduct pretests to prevent erroneous results due to the use of macro panel data in the study.

To analyze the presence of cross-section dependence and the order of integration of our variables, the Pesaran cross-sectional dependence (CD) test (Pesaran, 2004) and the cross-sectionally augmented IPS (CIPS) test (Pesaran, 2007) were performed. Table 5 and Table 6 give the results of both tests. Given the results of the Pesaran CD test (Pesaran, 2004) in Table 5, there is a presence of cross-sectional dependence in all the variables among selected African countries. By implication, African countries are correlated in terms of the series adopted for the study. The reason could be that the practices of public sector activities are the ones handed down by colonial masters across African countries (Adegboye and Akinyele, 2022). Within the foregoing, since there is the presence of cross-sectional dependence in the series, the second-generation unit root test (CIPS test by Pesaran, 2007) becomes appropriate because first-generation unit root tests are not trustworthy when this phenomenon is present. Table 6 reveals that some of the variables lie on the borderline between I(0) and I(1) integration

orders, but that in the first differences, all variables are stationary with and without trend.

Table 3. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
HDI	840	0.502	0.116	0.252	0.804
GOV	840	14.028	5.125	0.952	35.351
LAB	840	64.863	13.025	40.3	89.05
CAP	840	21.778	8.745	1.097	81.021
RENT	840	11.005	10.499	0.001	58.65
GDP	840	4.030e+10	8.239e+10	3.511e+08	5.467e+11
LIFE	840	59.007	7.735	39.441	77.063
HEA	840	5.224	2.126	1.505	20.413

Source: Research finding (2023).

Table 4. Matrix of Correlations

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
(1) HDI	1.000							
(2) GOV	0.276	1.000						
(3) LAB	-0.470	-0.047	1.000					
(4) CAP	0.264	0.145	-0.144	1.000				
(5)RENT	-0.098	-0.144	0.081	0.199	1.000			
(6) GDP	0.385	-0.056	-0.285	0.004	-0.004	1.000		
(7) LIFE	0.739	0.208	-0.446	0.322	-0.168	0.191	1.000	
(8) HEA	0.000	0.301	-0.021	-0.244	-0.281	0.017	-0.114	1.000

Source: Research finding (2023).

Table 5. Cross-Sectional Dependence

Variable	CD-test	p-value	Corr	abs(Corr)
HDI	122.950	0.000	0.961	0.961
GOV	6.880	0.000	0.054	0.422
LAB	24.810	0.000	0.194	0.547
CAP	10.560	0.000	0.082	0.368
RENT	33.62	0.000	0.263	0.377
GDP	110.53	0.000	0.864	0.864
LIFE	125.38	0.000	0.980	0.980
HEA	1.69	0.091	0.013	0.380

Source: Research finding (2023).

Note: Under the null hypothesis of cross-section independence CD ~ N(0,1).

Table 6. First- and Second-Generation Panel Unit Root Tests
Maddala and Wu (1999) and Panel Unit Root test (MW)

	Specification	**without**	**Trend**
Variable	**Lags**	**chi_sq**	**p-value**
hdi	0	126.684	0.001
hdi	1	90.110	0.206
hdi	2	108.215	0.020
hdi	3	111.963	0.011
gov	0	86.715	0.285
gov	1	78.748	0.519
gov	2	69.982	0.781
gov	3	70.516	0.767
lab	0	68.874	0.808
lab	1	47.768	0.998
lab	2	49.978	0.997
lab	3	50.584	0.996
cap	0	91.758	0.174
cap	1	109.918	0.015
cap	2	79.741	0.487
cap	3	76.255	0.598
rent	0	94.817	0.123
rent	1	105.556	0.029
rent	2	70.818	0.759
rent	3	53.223	0.991
gdp	0	34.452	1.000
gdp	1	51.178	0.995
gdp	2	68.526	0.816
gdp	3	63.281	0.915
hea	0	115.848	0.005
hea	1	95.529	0.114
hea	2	139.188	0.000
hea	3	81.573	0.430
life	0	713.737	0.000
life	1	1800.327	0.000
life	2	294.419	0.000
life	3	428.026	0.000
	Specification	**with**	**Trend**
Variable	**Lags**	**chi_sq**	**p-value**
hdi	0	114.646	0.007
hdi	1	79.174	0.505
hdi	2	46.772	0.999
hdi	3	33.800	1.000

gov	0	89.110	0.228
gov	1	102.225	0.048
gov	2	70.974	0.755
gov	3	83.393	0.376
lab	0	23.927	1.000
lab	1	64.468	0.897
lab	2	59.313	0.960
lab	3	65.488	0.879
cap	0	72.383	0.715
cap	1	91.646	0.176
cap	2	60.955	0.944
cap	3	77.588	0.556
rent	0	61.635	0.937
rent	1	93.721	0.140
rent	2	91.379	0.181
rent	3	79.269	0.502
gdp	0	73.624	0.679
gdp	1	55.412	0.984
gdp	2	38.940	1.000
gdp	3	40.188	1.000
hea	0	134.662	0.000
hea	1	112.355	0.010
hea	2	200.155	0.000
hea	3	79.606	0.491
life	0	126.279	0.001
life	1	1048.944	0.000
life	2	222.660	0.000
life	3	247.723	0.000

Pesaran (2007) and Panel Unit Root test (CIPS)

	Specification	**without**		**Trend**
Variable	**Lags**	**Zt-bar**	**p-value**	**t-bar**
hdi	0	0.915	0.820	.
hdi	1	0.963	0.832	.
hdi	2	0.730	0.767	.
hdi	3	1.168	0.879	.
gov	0	0.854	0.803	.
gov	1	1.423	0.923	.
gov	2	3.376	1.000	.
gov	3	2.499	0.994	.
lab	0	6.634	1.000	.
lab	1	1.475	0.930	.
lab	2	1.910	0.972	.

lab	3	0.627	0.735	.
cap	0	-0.200	0.421	.
cap	1	0.178	0.571	.
cap	2	2.886	0.998	.
cap	3	-0.205	0.419	.
rent	0	-2.732	0.003	.
rent	1	-2.868	0.002	.
rent	2	-1.943	0.026	.
rent	3	1.383	0.917	.
gdp	0	1.204	0.886	.
gdp	1	0.916	0.820	.
gdp	2	3.765	1.000	.
gdp	3	6.600	1.000	.
hea	0	-1.468	0.071	.
hea	1	-0.384	0.350	.
hea	2	-0.614	0.270	.
hea	3	0.515	0.697	.
life	0	2.955	0.998	.
life	1	-17.480	0.000	.
life	2	-1.887	0.030	.
life	3	-4.550	0.000	.
	Specification	**with**	**Trend**	
Variable	**Lags**	**Zt-bar**	**p-value**	**t-bar**
hdi	0	3.569	1.000	.
hdi	1	3.474	1.000	.
hdi	2	4.770	1.000	.
hdi	3	6.218	1.000	.
gov	0	-0.406	0.343	.
gov	1	-0.291	0.385	.
gov	2	2.121	0.983	.
gov	3	2.164	0.985	.
lab	0	11.871	1.000	.
lab	1	6.026	1.000	.
lab	2	6.824	1.000	.
lab	3	5.222	1.000	.
cap	0	0.292	0.615	.
cap	1	0.267	0.605	.
cap	2	2.782	0.997	.
cap	3	2.459	0.993	.
rent	0	1.011	0.844	.
rent	1	-0.070	0.472	.
rent	2	1.649	0.950	.

rent	3	6.097	1.000	.
gdp	0	-3.421	0.000	.
gdp	1	-4.396	0.000	.
gdp	2	0.994	0.840	.
gdp	3	3.356	1.000	.
hea	0	-1.905	0.028	.
hea	1	0.431	0.667	.
hea	2	1.649	0.950	.
hea	3	3.454	1.000	.
life	0	2.982	0.999	.
life	1	-23.065	0.000	.
life	2	-8.353	0.000	.
life	3	-8.532	0.000	.

Source: Research finding (2023).

Note: Null for MW and CIPS tests: series is I(1).

MW test assumes cross-section independence.

CIPS test assumes cross-section dependence is in form of a single unobserved common factor. -multipurt- uses Scott Merryman's -xtfisher- and Piotr Lewandowski's -pescadf-.

Frontier Estimate

The government production function was adopted to generate the quality of life through a single output-multiple inputs framework of stochastic frontier within the functional relationship assumptions. To establish the quality of life produced by government function, general (government spending) and specific spending (health spending) were estimated across the African and sub-Saharan African regions. Following the conventional production frontier, the general production process involves combinations of government spending, labour force participation, and capital formation inputs to produce human development.

Results in Table 7 show that government spending and capital formation are positively and significantly related to human development across Africa and the SSA region. Meanwhile, within the same scope, labour force participation is negatively and significantly related to human development. This result is not unexpected as it conforms with existing empirical standpoints (Akinyele and Dada, 2022; Akinyele et al., 2022; Adegboye and Akinyele, 2022). By implication, an increase in government spending and capital formation accentuates a rise in the human development of Africa and SSA.

Also, government spending on health, capital formation, and the size of the economy accentuate the quality of life for the citizens, as evidenced in the

relationship between inputs and output of health spending in the study. This result shows that the variables of input factors in producing output are highly significant in assessing the efficiency level of government spending in Africa. Moreover, the signs of the variables are within the a priori expectations. The gamma shows that total variation in human development and/or life expectancy is explained by technical efficiency. Hence, this highlights the need to establish the extent to which technical efficiency varies across the regions. More so, over fifty-eight per cent of the variations in the frontier models are accounted for by the technical efficiency. This implies that the variables in the models largely explain government spending efficiency among African countries. Other information is within the acceptable region of the estimates.

Table 7. Frontier Estimates

Africa Estimates				Sub-Sahara Estimates			
Frontier: General Spending		**Frontier: Specific Spending (Health Sector)**		**Frontier: General Spending**		**Frontier: Specific Spending (Health Sector)**	
Dep= HDI	**Coefficient**	**Dep= LIFE**	**Coefficient**	**Dep= HDI**	**Coefficient**	**Dep= LIFE**	**Coefficient**
GOV	0.0008*** (5.07E-08)	HEA	0.2889 (0.6518)	GOV	0.0006*** (8.74E-06)	HEA	0.2645** (0.1294)
LAB	-0.0103*** (1.76E-08)	GDP	3.03E-11* (1.79E-11)	LAB	-0.0125*** (4.46E-06)	GDP	4.44E-11*** (4.21E-12)
CAP	0.0006*** (1.29E-08)	CAP	01274* (0.0710)	CAP	0.0006*** (1.44E-06)	CAP	0.2116*** (0.0229)
Diagnostic		Diagnostic		Diagnostic		Diagnostic	
Mu	0.00007 (0.0068)	Mu	1.4206*** (0.4201)	Mu	-0.0097 (0.0227)	Mu	1.1370*** (0.2587)
Log Likelihood	1650.4832	Log Likelihood	-2145.4199	Log Likelihood	1408.7637	Log Likelihood	-1990.4569
Prob. Value	0.0000	Prob. Value	0.0000	Prob. Value	0.0000	Prob. Value	0.0000
Sigma_U^2	0.1039	Sigma_U^2	698.594	Sigma_U^2	0.3364	Sigma_U^2	18.5496
Sigma_V^2	7.84E-18	Sigma_V^2	2.3104E-10	Sigma_V^2	4.90E-17	Sigma_V^2	1.31E+01
Gamma	0.9979	Gamma	0.9998	Gamma	0.9979	Gamma	0.5870
Obs	840	Obs	840	Observation	735	Observation	735
Group (Obs per Group)	40 (21)	Group (Obs per Group)	40 (21)	Group (Obs per Group)	35 (21)	Group (Obs per Group)	35 (21)

Source: Research finding (2023).

Note: ***, ** and * are 1%, 5% and 10% significant level, respectively.

Regional Analysis of Government Spending Efficiency

In assessing government spending efficiency, we follow closely the parametric frontier approach owing to the separation between technical efficiency and noise effect as stated above. In summary, there is relatively low efficiency in government spending among African countries. This is the reason for the low development indicators in Africa. However, there are divergences in efficiency levels among regions of Africa. Our result suggests differences in regional spending efficiency in Africa. Although they are cross-sectionally related, there are relative differences in spending patterns among those regions.

In terms of government spending efficiency, the region of North Africa has the most efficient level of spending (Figure 3). By implication, government spending in North Africa accentuates higher human development than in other regions. This could be the reason why countries like Algeria, Egypt, and Tunisia rank with high human development in 2021 following the UNDP reports. Statistically, Algeria has a 0.745 human development index with about 18% of government spending, while Egypt has a 0.731 human development index with about 8% of government spending. The government spending in the northern region of Africa is commensurate with a high human development index, as evident in Algeria and Egypt. Meanwhile, it has the lowest spending efficiency score in the health sector compared to other regions. This establishes the need to focus on health spending efficiency to achieve all-round development. In providing quality of life through life expectancy at birth, the Southern region has the most efficient spending in Africa. By implication, the rise in health spending in the Southern region of Africa situates the region with more life expectancy at birth. This could be the reason why most of the countries in Southern Africa are ranked between high and medium human development (Figure 3). Statistically, Mauritius, the highest-ranked country in terms of human development index in Africa, has a 0.802 human development index with about 17% of government spending, while South Africa has a 0.713 human development index with about 20% of government spending. The government spending in southern Africa has various levels of human development episodes, as evident in Mauritius and South Africa.

Moreover, we compile the trend of government spending efficiency between 2000 and 2020. The result shows that the West Africa region had the most government spending efficiency between 2000 and 2006. The reason could be a change of government from a military regime to a democratic system in the region, which influenced the spending pattern. Meanwhile, between 2007 and

2016, the North Africa region had the most government spending efficiency, and the Central Africa region experienced the most efficient government spending between 2017 and 2020 (Figure 4). This result provides diversity in the citadel of government institutions in Africa. On the other hand, health spending efficiency has been oscillatory in the North and Central Africa regions. The result shows a slight worsening of health spending efficiency in North and Central Africa. However, since 2014, quality health spending has been experienced in the two regions (Figure 5).

Finally, within the period considered, spending efficiency has been remarkable in 2019/2020 across all regions of Africa. This performance of government spending, particularly in the health sector, is commendable within the period considered (Table 8). The reason could be the COVID-19 pandemic that led to the global lockdown. Government instruments served as effective and efficient ways of dealing with the pandemic. In terms of government spending efficiency, countries like South Africa, Cameroon, Burkina-Faso, Mozambique, and Morocco were able to perform above the regional average of government spending efficiency (Table 9). Likewise, on health spending efficiency, Namibia, Cameroon, Benin, Mauritius, and Algeria were able to perform above the regional average of health spending efficiency. This result is in tandem with Herrera and Pang (2005). The divergence in spending efficiency among African countries could be the reason for the different ranks of human development in Africa.

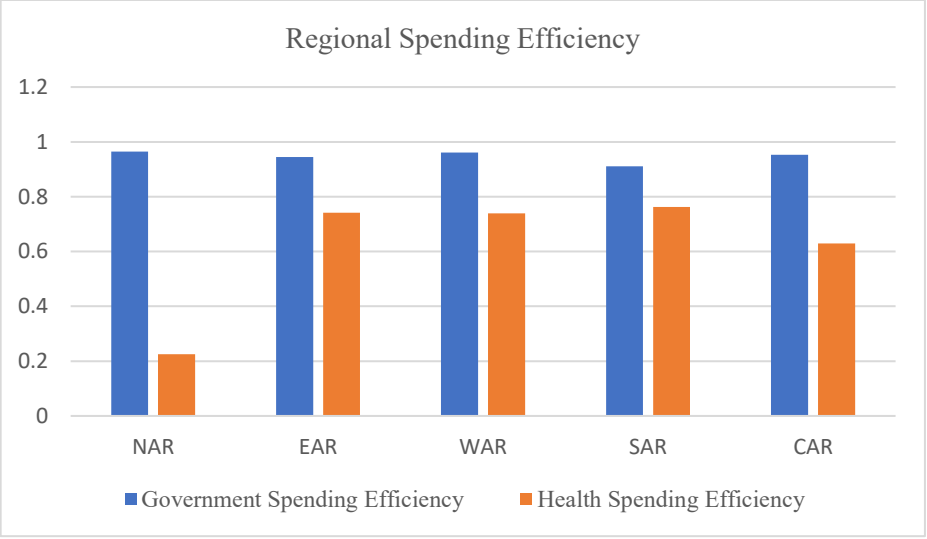

Figure 3. Regional Spending Efficiency
Source: Research finding (2023).

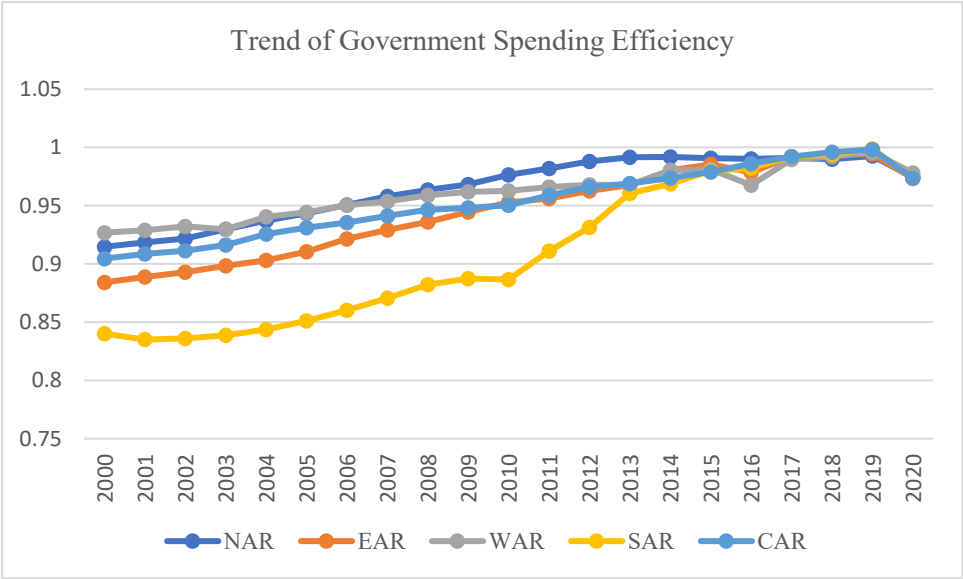

Figure 4. The Trend of Government Spending Efficiency
Source: Research finding (2023).

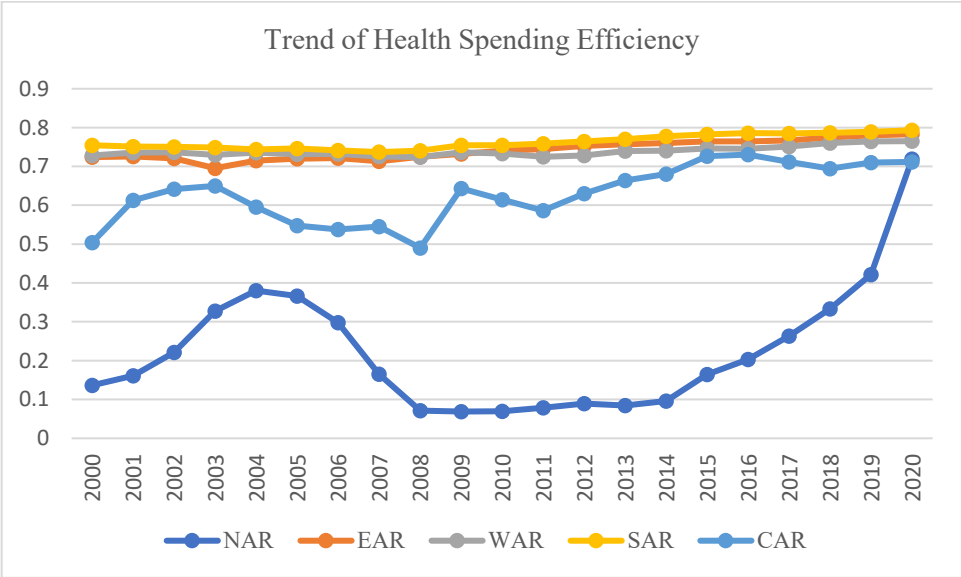

Figure 5. The Trend of Health Spending Efficiency
Source: Research finding (2023).

Table 8. The Period with the most Regional Spending Efficiency

Regions	Government Spending Efficiency	Health Spending Efficiency
SAR	2019	2020
CER	2019	2016
WAR	2019	2020
EAR	2019	2020
NAR	2019	2020

Source: Research finding (2023).

Note: NAR, SAR, CER, WAR and EAR represent the North African region, Southern African Region, Central African Region, West African Region and East African Region, respectively.

Table 9. Countries with most Regional Spending Efficiency

Regions	Government Spending Efficiency	Health Spending Efficiency
SAR	South Africa	Namibia
CER	Cameroon	Cameroon
WAR	Burkina Faso	Benin
EAR	Mozambique	Mauritius
NAR	Morocco	Algeria

Source: Research finding (2023).

Note: NAR, SAR, CER, WAR and EAR represent the North African region, Southern African Region, Central African Region, West African Region and East African Region, respectively.

Conclusion

In assessing government spending efficiency, we follow closely the parametric frontier approach owing to the separation between technical efficiency and noise effect. The government production function was adopted to generate the quality of life through a single output-multiple inputs framework of stochastic frontier within the functional relationship assumptions. To establish the quality of life produced by government function, both general and specific spending models were estimated across the African and sub-Saharan African regions.

Human development has remained the biggest challenge of our time and a threat to most countries of the world, particularly among African countries. This study estimated the technical efficiency of government spending in selected forty African countries through the Cobb-Douglas stochastic frontier function. The linear form of the equation, which is made up of the deterministic component and the composite error, is derived for estimation. The study provides evidence that there is relatively low efficiency in government spending among African countries. This could be a reason for the low development indicators in Africa.

However, there are divergences in efficiency levels among regions of Africa. Our result suggests differences in regional spending efficiency in Africa. Although they are cross-sectionally related, there are relative differences in spending patterns among those regions.

In government spending efficiency, the region of North Africa has the most efficient level of spending. Government spending in North Africa accentuates higher human development than in other regions. Meanwhile, it has the lowest spending efficiency score in the health sector compared to other regions. To achieve all-round development, there is a need for African countries to be more focused. Spending efficiency has been remarkable in 2019/2020 across all regions of Africa. This performance of government spending, particularly in the health sector, is commendable within the period considered. Government instruments served as effective and efficient ways of dealing with the pandemic. In terms of government spending efficiency, countries like South Africa, Cameroon, Burkina-Faso, Mozambique, and Morocco were able to perform above the regional average of government spending efficiency. Likewise, on health spending efficiency, Namibia, Cameroon, Benin, Mauritius, and Algeria were able to perform above the regional average of health spending efficiency. The divergence in spending efficiency among African countries could be the reason for the different ranks of human development in Africa.

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Appendix

Table I. Southern Africa Estimates on General

YEAR	SSA_G	SSA_G	SSA_G	SSA_G	OVERALL
2000	0.730211	0.862348	0.91823	0.849496	0.840071
2001	0.734864	0.862587	0.898906	0.844085	0.835111
2002	0.737009	0.863733	0.904182	0.838925	0.835962
2003	0.746582	0.867822	0.901525	0.838853	0.838695
2004	0.756901	0.872261	0.899245	0.846862	0.843817
2005	0.770203	0.874196	0.900839	0.85985	0.851272
2006	0.784937	0.879378	0.902558	0.874309	0.860295
2007	0.804597	0.887176	0.907501	0.88384	0.870779
2008	0.822789	0.896105	0.91877	0.89153	0.882298
2009	0.836942	0.903865	0.909403	0.899975	0.887546
2010	0.818482	0.917882	0.900224	0.910336	0.886731
2011	0.875119	0.937142	0.907872	0.924643	0.911194
2012	0.920898	0.947835	0.919499	0.937242	0.931368
2013	0.967927	0.988438	0.937159	0.948396	0.96048
2014	0.983724	0.987129	0.958003	0.945697	0.968638
2015	0.987605	0.992104	0.98223	0.957798	0.979934
2016	0.985617	1	0.979163	0.964335	0.982279
2017	0.998664	0.994747	0.996859	0.978346	0.992154
2018	0.99967	0.988638	0.996736	0.990802	0.993961
2019	1	0.994504	1	1	0.998626
2020	0.9838	0.986937	0.944691	0.980157	0.973896
	0.868883	0.928801	0.932552	0.912642	0.910719

Source: Research finding (2023).

Table II. Southern Africa Estimates on Specific

YEAR	SSA_H	SSA_H	SSA_H	SSA_H	OVERALL
2000	0.727908	0.759156	0.785033	0.74693	0.754757
2001	0.73001	0.751557	0.780415	0.744565	0.751637
2002	0.728679	0.749842	0.780443	0.743035	0.7505
2003	0.724972	0.747672	0.770678	0.750882	0.748551
2004	0.723116	0.748076	0.751269	0.752907	0.743842
2005	0.735984	0.747977	0.745489	0.756499	0.746487
2006	0.72528	0.742244	0.74005	0.758446	0.741505
2007	0.726485	0.733024	0.730004	0.75833	0.736961
2008	0.74574	0.751161	0.709398	0.755741	0.74051
2009	0.75512	0.757081	0.744216	0.762357	0.754693
2010	0.764284	0.762918	0.725356	0.76682	0.754845
2011	0.773098	0.771594	0.718764	0.769974	0.758357
2012	0.774676	0.775482	0.736964	0.769079	0.76405
2013	0.784361	0.777483	0.749896	0.769968	0.770427
2014	0.796148	0.77686	0.762825	0.774494	0.777582
2015	0.798751	0.780596	0.776107	0.775566	0.782755
2016	0.802811	0.787794	0.779903	0.77302	0.785882
2017	0.804093	0.789997	0.77224	0.775033	0.785341
2018	0.804105	0.795852	0.769856	0.778473	0.787071
2019	0.8037	0.799422	0.772946	0.779956	0.789006
2020	0.805177	0.801464	0.783701	0.781574	0.792979
	0.763547	0.767012	0.756455	0.763983	0.762749

Source: Research finding (2023).

Table III. Central Africa Estimate on General

Year	SSA_G	SSA_G	SSA_G	SSA_G	SSA_G	SSA_G	SSA_G	ALL
2000	0.812299	0.948844	0.920351	0.915377	0.907309	0.960811	0.867268	0.904608
2001	0.820888	0.961944	0.924212	0.91292	0.908547	0.965209	0.865938	0.908522
2002	0.837233	0.963441	0.925485	0.904313	0.910932	0.970397	0.868412	0.911459
2003	0.844524	0.969301	0.929163	0.907741	0.912866	0.978351	0.872821	0.916395
2004	0.858425	0.973495	0.932142	0.934175	0.920833	0.983198	0.876325	0.925513
2005	0.869058	0.97486	0.935343	0.940467	0.922096	0.990595	0.88557	0.931141
2006	0.886773	0.981678	0.94312	0.941617	0.925	0.983813	0.886875	0.935554
2007	0.903691	0.992861	0.949915	0.950045	0.922022	0.977889	0.892857	0.941326
2008	0.909933	0.977206	0.954822	0.95492	0.952876	0.976582	0.898888	0.946461
2009	0.919827	0.96131	0.960008	0.962467	0.959189	0.968717	0.906515	0.948291
2010	0.928609	0.943948	0.964793	0.965975	0.977273	0.956731	0.915287	0.950374
2011	0.944354	0.952894	0.975219	0.979667	0.983855	0.952715	0.92346	0.958881
2012	0.952738	0.964698	0.981503	0.984955	0.994726	0.950167	0.933883	0.966096
2013	0.961702	0.974147	0.963206	0.990223	0.998529	0.95091	0.945359	0.969154
2014	0.974214	0.97915	0.977681	0.990568	0.969105	0.982143	0.943053	0.973702
2015	0.981895	0.988371	0.983078	0.989979	0.970675	0.982928	0.956435	0.979052
2016	0.990118	0.991905	0.967666	1	1	0.975957	0.976224	0.985981
2017	0.99729	0.996033	0.99098	0.991988	0.990733	0.996303	0.982155	0.992212
2018	1	0.99796	0.9908	0.991785	0.998284	1	0.992823	0.99595
2019	0.998788	1	1	0.990602	0.99826	0.999926	1	0.998225
2020	0.97604	0.982803	0.981677	0.959265	0.956912	0.97045	0.98909	0.973748
	0.922305	0.975088	0.959579	0.959955	0.956192	0.974942	0.922821	0.952983

Source: Research finding (2023).

Table IV.

Year	SSA_H	SSA_H	SSA_H	SSA_H	SSA_H	SSA_H	SSA_H	ALL
2000	0.114579	0.728962	0.718172	0.72808	0.113486	0.723392	0.403532	0.504315
2001	0.438058	0.740424	0.720453	0.720121	0.377032	0.684949	0.610319	0.613051
2002	0.583808	0.74265	0.71828	0.684059	0.456979	0.686068	0.620453	0.641757
2003	0.623887	0.74457	0.721184	0.66294	0.535297	0.612242	0.651189	0.650187
2004	0.443183	0.745273	0.737455	0.532309	0.447023	0.65391	0.607197	0.595193
2005	0.372392	0.735431	0.734081	0.529562	0.310537	0.664755	0.486393	0.547593
2006	0.445788	0.732503	0.729557	0.542281	0.18335	0.660609	0.469572	0.537666
2007	0.393235	0.733102	0.731511	0.586409	0.213322	0.654301	0.504597	0.545211
2008	0.17269	0.727752	0.724911	0.572359	0.182529	0.643868	0.4073	0.490201
2009	0.570892	0.75072	0.739248	0.683855	0.492425	0.643339	0.622095	0.643225
2010	0.518465	0.748993	0.743627	0.652409	0.426412	0.638789	0.573257	0.614565
2011	0.507867	0.744976	0.747294	0.63305	0.295578	0.631123	0.542886	0.586111
2012	0.567734	0.747115	0.750354	0.653567	0.472073	0.666074	0.554622	0.63022
2013	0.622686	0.753452	0.742931	0.685697	0.567011	0.664162	0.609669	0.663658
2014	0.674427	0.75386	0.737459	0.686855	0.592338	0.668974	0.64919	0.680443
2015	0.74739	0.763915	0.736219	0.737173	0.662913	0.699884	0.739861	0.726765
2016	0.754527	0.766339	0.737456	0.742399	0.662702	0.701879	0.747712	0.73043
2017	0.733357	0.764736	0.732049	0.712038	0.6404	0.673324	0.726445	0.711764
2018	0.691736	0.765371	0.740542	0.69751	0.536513	0.716458	0.710338	0.694067
2019	0.705635	0.771085	0.76577	0.715814	0.541867	0.747917	0.719644	0.709676
2020	0.719959	0.773207	0.764107	0.717263	0.538112	0.746247	0.723741	0.711805
	0.542966	0.749259	0.736793	0.66075	0.440376	0.675346	0.60381	0.6299

Source: Research finding (2023).

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