# Fiscal Space for Health in Sub-Saharan African Countries: An Efficiency Approach

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## Abstract

The study argues that potential savings from efficiency could be effective alternative to increasing health system financing in SSA. Health system efficiency estimates were derived from the Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) and used to compute potential gains from efficiency. Data was sourced from the World Bank's world development indicators for 45 SSA countries in 2011. The results reveal that average potential saving in health expenditure from improved efficiency was 8.09% and 2.24% of GDP per capita in the DEA and SFA models, respectively. Countries with relatively higher potential gains from efficiency include Sierra Leone, Liberia, Lesotho and Swaziland. On the other hand, Cape Verde, Eritrea, Madagascar and Mauritius recorded low potential gains from efficiency. The results imply that in the face of significant economic challenges and burden on government budget, improving health expenditure efficiency to create some fiscal space will be an important step.

Keywords: Fiscal Space for Health, Health Expenditure, DEA, SFA.

## Introduction

Health financing remains a major constraint to effective health service delivery worldwide, notably in developing countries which experience significant gaps between population health demands and financing. In sub-Saharan Africa (SSA) in particular, the lack of sufficient resources committed to the health sector has limited improvements in population health conditions, instigating several efforts by global and local non-governmental actors to improve investments in the health sector. Such efforts include the Abuja Declaration of 2001, which required governments to allocate a minimum of 15% of annual national budgets to the health sector. Fourteen years after the declaration, few countries (Rwanda, Malawi, Madagascar, Liberia, Togo and Zambia)[1] have achieved the target. Many other countries are still far from achieving the target.

An emerging concept directed towards increased and sustainable resource commitment to the health sector is Fiscal Space for Health (FSH). The concept seeks to identify opportunities for governments to raise additional funds for the health sector without jeopardizing the financial position of the government [1-2]. The idea is to find ways of increasing health resources while not compromising sustainability. This concept is particularly important for resource-constrained regions such as SSA. For countries in such regions, placing extra burden on government budgetary allocations may result in major macroeconomic challenges.

A widely recognized approach to achieving FSH is by improving efficiency and reducing wastages in the use of resources in the health sector. Health systems with low efficiency tend to waste significant amount of resources that could hitherto have been saved and re-invested into the sector. In that case, resources committed to the health sector would have 'increased' without any extra strain on the national budget.

While this approach has been documented in the theoretical literature on FSH, empirical applications have generally been limited. Available studies have either discussed the opportunities for efficiency gains in the health sector [3] or provided some

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[1] These countries had health spending as percent of total government expenditure above 15%, using 2011 data from the world development indicators.

quantitative evidence of efficiency gains for individual countries at various levels of the health system [1, 4]. Belay and Tandon [5] provided evidence from Napal to show that improvement in health system efficiency is by far the best option for realizing additional fiscal space for health. They suggested interventions in provider payments, drug procurement mechanisms and hospital and district grant allocations as effective ways to improve efficiency, hence increase fiscal space for the health sector.

Empirical evidence from Ghana also suggests that while there are prospects for fiscal space in the health sector, this may only be achieved through significant improvement in revenue collection and major efficiency gains [6]. Powell-Jackson [2] noted that attempts to use improved conceptual understanding to conduct rigorous empirical work is still at its infancy.

In spite of the credence given to efficiency gains as a critical source of FSH there has been little empirical studies in this regard. While macro level studies on efficiency gains are generally scarce, the existing once have mostly considered gains in health output due to improved efficiency [7]. Analysing the potential savings in health expenditure and hence available FSH will be an important addition to the health economics literature. The purpose of the current study was, therefore, to estimate available FSH through potential efficiency gains (savings on health expenditure from improved efficiency) at the national level and compare this across SSA countries.

To achieve this objective, we estimate health expenditure efficiency for 45 SSA countries using the Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) models. The individual country efficiency scores were used to compute potential savings in health expenditure from improved efficiency. The relationship between efficiency, health expenditure and health outcomes was also estimated. We found evidence of potential saving in health expenditure across SSA countries. This indicates potential fiscal space for health that could be explored if health system management was improved.

**Methods**

Empirical Analysis

The empirical analysis was performed in two stages. The efficiency of health expenditure was estimated in the first stage using both the Data Envelopment Analysis (DEA) and Stochastic Frontier Analysis (SFA) models. In the second stage, these efficiency scores were used to compute potential gains from efficiency for each country included in the analysis. The potential efficiency gain showed how much could be saved in terms of per-capita health expenditure at maximum efficiency. This was used to represent available FSH from increased efficiency.

The DEA Model

The methodology adopted in the study follows Fare et al. [21] and Alexander et al. [17] using non-parametric linear programming techniques. The analysis starts with an optimization problem which determines the available population health outcome of other health systems. A 'best practice' frontier based on a piece-wise linear envelopment of the health expenditure – health outcome data for the sample countries, was used to solve the optimization problem.

Efficiency in the production of population health is measured relative to such a frontier for each country. The health systems of countries that operate on (and determine) the frontier are termed efficient (with efficiency score of 1.00), while countries operating off the frontier are considered inefficient (with efficiency scores less than 1.00). Inefficiency in this case should be understood to mean that lower health expenditure could have been used to attain the observed health outcome, were performance similar to that of 'best practice' countries.

To better understand the procedures described above, let $S^t$ be the technology that transforms health sector expenditure into population health outcomes. This technology can be modelled by the output possibility set

$$P^t(x^t) = \{y^t : (x^t, y^t) \in S^t\}\ t = 1, \dots, T \qquad (1)$$

where $P^t(x^t)$ denotes the collection of population health output vectors that consume no more that the bundle of resources indicated by the resource vector $x^t$, during period $t$[2].

The best practice frontier can be empirically estimated as the upper bound of the output possibility set, $P^t(x^t)$. The output possibility set,

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[2] For this study, we let t=1. This enables cross section analysis.

$P^t(x^t)$, can be estimated empirically by assuming that the sample set is made up of observations on $j = 1, ..., J$ countries' health systems, each using $n = 1, ..., N$ resources, $x_{jn}^t$, during period $t$, to generate $m = 1, ..., M$ population health outcomes, $y_{jn}^t$, in period $t$. Accordingly, $P^t(x^t)$ is estimated from the observed set of health expenditures, and population health outcomes for all the countries of the sample.

The empirical construction of the piece-wise linear envelopment of the input possibility set is given by

$$P^t(x^t) = \{y^t: x_n^t \leq \sum_{j=1}^{J} Z_j x_{jn}^t, n = 1, ..., N$$

$$\sum_{j=1}^{J} Z_j x_{jm}^t \geq y_m^t, m = 1, ..., M$$

$$\sum_{j=1}^{J} Z_j = 1$$

$$Z_j \geq 0, j = 1, ..., J\} \tag{2}$$

where $Z_j$ is a variable indicating the weighting of each of the health systems.

The efficiency score for each country's health system for period $t$ can be derived as

$$F_o^t(x_j^t, y_i^t) = max\{\theta \ such \ that \ \theta y^t = P^t(x^t)\} \tag{3}$$

Where

$$F_o^t(x_j^t, y_i^t) \geq 1.$$

This suggests that a county's health outcomes vector, $y^t$, will be located on the efficiency frontier when equation (3) has a value of one. However, if equation (3) produces a value less than one, the health system must be classified as inefficient relative to best-observed practice. This measure can be computed for country $j$ as the solution to the linear programming problem

$$F_o^t(x_j^t, y_i^t) = max \ \theta \tag{4}$$

With $\theta, z$ such that

$$\sum_{j=1}^{J} Z_j y_{jm}^t \geq \theta y_m^t, m = 1, ..., M,$$

$$\sum_{j=1}^{J} Z_j x_{jn}^t \leq x_m^t, n = 1, ..., N$$

$$\sum_{j=1}^{J} Z_j = 1,$$

$$Z_j \geq 0, j = 1, ..., J \tag{5}$$

where the restrictions on the weighting variables, $Z_j$, imply a variable returns to scale assumption in regard to the underlying technology of health production.

The estimates of technical efficiency depend on the scale assumptions imposed on the model. The variable returns to scale (VRS) and constant returns to scale (CRS) are generally imposed. The VRS assumption was originally proposed by Afriat [22] but popularized in the literature by Banker et al. [23]. Banker et al. [23] showed that the addition of a convexity constraint to the CRS specification results in a DEA model that allows for increasing, constant and decreasing returns to scale. The efficiency estimates in this paper were, therefore, based on the VRS assumption to allow for flexibility in returns to scale.

Choice of Orientation for DEA Efficiency measurement

The choice between input or output orientation depends on the objective of the Decision Making Units (DMU). The primary objective of a DMU may be to minimize inputs or maximize outputs as much as possible. The output orientation helps to understand the potential for improvement in health outcomes while the input orientation helps to understand the potential for saving in health expenditure or reducing health related resources in general. In line with the objective of the current study (which is to explore the potential for health expenditure savings), the input orientation was employed.

The SFA Model

A simple cross sectional SFA model was used in the analysis [24]. The model basically generates stochastic error and inefficiency term based on the residuals obtained from an estimated production function expressed as follows:

$$y_i = \alpha + x_i \beta + \varepsilon_i$$
$$\varepsilon_i = v_i - u_i \qquad\qquad i = 1, ..., N \tag{6}$$
$$v_i \sim N(0, \delta_v^2)$$
$$u_i \sim f$$

where $y_i$ represents the logarithm of output of the ith DMU, $x_i$ is a vector of inputs and $\beta$ is the vector of technology parameters. The error term $\varepsilon_i$ is composed of a sum of normally distributed disturbance $(v_i)$ which accounts for measurement and specification error and a one-sided disturbance $(u_i)$ which measures inefficiency. Both $v_i$ and $u_i$ are assumed to be independent of each other and $i.i.d$ across observations. An exponential assumption proposed by Meensen and VanBroeck [25], was made about the distribution of the inefficiency term.[3]

An important component of SFA models is the specification of the functional forms of the production function. The Cobb-Douglas specification is the commonly used type in the literature due to its simplicity. Alternative specifications of the functional form have been suggested in the literature. The most notable include the translog specification (Greene, 1980b) and the Zellner-Revanker generalised production function (Forsund and Hjalmarsson, 1979, Kumbhakar et al., 1991). The Cobb-Douglas functional type has, however, been confirmed to be a sufficient functional form specification of stochastic frontier production functions [26]. The Cobb-Douglas functional form is, therefore, employed in this study.

While the DEA is the most used in the estimation of health system efficiency among the two models, it is weak in the sense that it is extremely sensitive to the presence of outliers, which define the frontier. Its nonparametric nature also implies that it is unable to address random variations in the data which are then captured as inefficiency. While the SFA addresses these weaknesses, it is also limited in the imposition of some functional form on the production function which, in some cases, become difficult to estimate. However, a critical advantage of the SFA over nonparametric methods lies in its ability to control for large number of variables that can influence health outcomes. In this study, we used both approaches to allow for robustness and comparison.

Choice of Inputs and Outputs

The choice of inputs in estimating the health production function is not straight forward as there exist several factors that influence population health status both directly and indirectly. As noted by

Afonso and Aubyn [16], efficiency results may be sensitive to the type of input used. The current study used monetary inputs measured as health expenditure per capita expressed in purchasing power parity (PPP) terms for the mono input specifications. Education (measured by average years of schooling) was introduced in the multiple input specification to serve as an additional input variable which, even though, not directly controlled by the health system, is highly likely to influence health status [27]. This was necessary because health outcomes are not only influenced by direct inputs (such as health expenditure) but also indirect inputs that are not directly controlled by the health system [28]. This is intuitively appealing since two countries that spend the same amounts on health may not necessarily have the same health outcomes if they operate in different settings.

In terms of health system outputs used in the efficiency analysis, we employed infant and under five mortality rates. However, as noted by Afonso and Aubyn [16], efficiency measurement techniques suggest that outputs are measured in such a way that "more is better". In this regard, various transformations were performed on the mortality variables so that they are measured in survival rates. For instance, infant mortality rate (IMR) is measured as:

$$\frac{Number\ of\ children\ who\ died\ before\ 12\ months}{Number\ of\ children\ born} \times 1000$$

This implies that an infant survival rate (ISR) can be computed as follows:

$$ISR = \frac{1000 - IMR}{IMR} \qquad (7)$$

This shows the ratio of children that survived the first year to the number of children that died and this increases with better health status. Similar transformations were performed for under five mortality rate.

In the SFA model, each of the transformed health outcome variables were used in separate specifications. Each specification employed per capita health expenditure as the main input variable as well as other control variables such as education, urbanization, sanitation etc. (these variables are further described in Table 1)

Computing Efficiency Gain

The potential gains from efficiency was computed by finding the proportion of health expenditure that could be saved if efficiency was improved. The starting point was to compute the proportion of per

[3] for further details on SFA models, see 24. Belotti F, Daidone S, Ilardi G, Atella V: Stochastic frontier analysis using Stata. Center for Economic and International Studies Tor Vergata Research Paper Series 2012, 10:1-48.

capita health expenditure that is lost to inefficiency as follows:

$$exp_i = (eff_{max} - eff_i) \times HE_{pc_i}$$

where $exp_i$ represents per capita health expenditure of the $ith$ country that could be gained if inefficiency levels are corrected, $eff_{max}$ is maximum efficiency level (1.00 in this case), $eff_i$ is actual efficiency score of the ith country and $HE_{pc_i}$ is health expenditure per capita of the $ith$ country.

The per capita expenditure gain can be expressed as percentage of per capita gross domestic product ($GDP_{pci}$) as follows:

$$gain_i = \left[\frac{exp_i}{GDP_{pci}}\right] \times 100 \qquad (8)$$

The potential savings in per capita health expenditure ($gain_i$) shows the fiscal space for health available for the $ith$ country if efficiency were improved.

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**Table 1: Variables definition and data source**

| Variables | Description |
| --- | --- |
| Infant mortality rate (IMR) | Health outcome variable measured as infant deaths per 1000 live births |
| Under-five mortality rate (UMR) | Health outcome variable measured as under-five deaths per 1000 live births |
| Per capita health expenditure (HEpc) | Health expenditure per capita measured in constant 2005 international dollars |
| Real GDP per capita (RGDPpc) | Real GDP per capita measured in constant 2005 international dollars |
| DPT Immunization (Imm) | Percentage of children ages 12-23 months who received DPT immunization before 12 months |
| Sanitation | Percentage of population using an improved sanitation facility |
| HIV prevalence rate (HIV) | Estimated number of adults aged 15-49 years with HIV infection expressed as percent of total population in that age group |
| Urbanization | Annual urban population growth rate. |
| Population aged 14 years and below (Pop1) | Population age group below or equal to 14 years expressed as percentage of total population |
| Population 15-64 years (Pop2) | Population age group between 15 and 64 years expressed as percentage of total population |
| Population 65 years and above (Pop3) | Population age group above 65 years expressed as percentage of total population |
| Education | Average years of schooling |

*Source: Author's compilation. Note: All data were sourced from The World Bank's World Development Indicators.*

Data and Variable Definition

Data for the study was obtained from the World Bank's World Development Indicators (WDI) The data were collected across 45 countries in SSA[4] for the year 2011 [29]. Table 1 gives a detailed description of the variables used in the analysis

**Results**

Table 2 presents descriptive statistics of the variables included in the model. The mean values, standard deviations, minimum and maximum values are presented. On average, annual urban population growth rate was about 3.6%. Mean per capita GDP was about US$3630.5 with minimum and maximum values of US$349.0 and US$26142.0 respectively. On average, the countries included in the analysis spent US$225.4 per capita on health with minimum and maximum values of about US$17.0 and US$1642.7, respectively. Average infant mortality rate was about 63.2 per 1000 live births.

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[4] The following countries were included in the study: Angola, Benin, Burkina Faso, Botswana, Burundi, Cameroon, Cape Verde, Central African Republic, Chad, Comoros, Congo Demographic Republic, Congo, Cote d'Ivoire, Equatorial Guinea, Eritrea, Ethiopia, Gabon, Ghana, Guinea, Guinea Bissau, Kenya, Lesotho, Liberia, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, South Africa, Sao Tome, Senegal, Seychelles, Sierra Leone, Somalia, Sudan, Swaziland, Tanzania, The Gambia, Togo, Uganda and Zambia.

**Table 2: Descriptive statistics**

| Variable* | Observation | Mean | Standard deviation | Minimum | Maximum |
|---|---|---|---|---|---|
| Urbanization (%) | 45 | 3.61 | 1.44 | -1.90 | 6.11 |
| GDP per capita (US$) | 45 | 3630.51 | 5676.14 | 349.01 | 26142.02 |
| Immunization (%) | 45 | 78.24 | 18.61 | 22.00 | 99.00 |
| Sanitation (%) | 45 | 35.45 | 22.40 | 9.60 | 97.10 |
| Per-capita Health expenditure (US$) | 45 | 225.39 | 322.26 | 16.99 | 1642.71 |
| Infant Mortality Rate | 45 | 63.17 | 25.51 | 11.90 | 119.20 |
| Population under 14 yrs (%) | 45 | 41.45 | 6.04 | 20.64 | 49.92 |
| Population 15-64 yrs (%) | 45 | 55.20 | 4.95 | 47.49 | 71.32 |
| Population above 65 yrs (%) | 45 | 3.35 | 1.23 | 2.16 | 8.04 |
| HIV prevalence (%) | 43 | 5.10 | 6.58 | 0.10 | 26.00 |
| Education (years) | 45 | 4.50 | 2.12 | 1.20 | 9.40 |

*Source: Authors' computation *Detailed variable definitions and units of measurement are presented in Table 1 above.*

*Potential Expenditure Savings (Efficiency Gains)*

Table 3 presents potential savings on health expenditure per capita given improvement in health expenditure efficiency. The potential expenditure savings are expressed as percentage of each country's GDP per capita. The potential expenditure savings differed across countries with some countries potentially benefiting significantly from efficiency improvements. The results from the DEA analysis show that on average, SSA countries could save per capita health expenditure of up to 12.8% and 8.1% of GDP per capita for single and multiple input specifications, respectively. A relatively lower average was found in the SFA model with a potential health expenditure saving of about 2.24% of per capita GDP.

The individual country analysis reveal that, per definition, countries located on the production frontier (efficiency score of 1.00) had no potential savings in health expenditure in the DEA model. These countries were relatively efficient, and by definition, they were using their resources optimally. Examples of such countries include Cape Verde, Eritrea, and Seychelles. In both the DEA and SFA models, Sierra Leone recorded the highest potential saving in health expenditure with about 38.71% (DEA with single input), 27.10% (DEA with multiple inputs) and 6.49% (SFA) of GDP per capita, respectively (Table 3). Other countries with relatively high potential saving on health expenditure using the single input DEA model include Burundi (23.43), Liberia (37.20%), Lesotho (22.27%), Rwanda (25.68%), Malawi (22.96%) and Uganda (26.88%).

In the SFA model, other countries with high potential health expenditure savings include Lesotho (5.97%), Equatorial Guinea (5.74%), Swaziland (6.37%), and South Africa (4.70%). Countries with the lowest potential saving on health expenditure include Cape Verde (0.50%), Madagascar (0.55%), Eritrea (0.59) and Mauritius (0.60%).

**Table 3: Potential savings in health expenditure (Infant mortality as outcome variable)**

| Country name | DEA Mono Input* | | DEA Multiple Input** | | SFA model | |
|---|---|---|---|---|---|---|
| | Efficiency score | Potential gain | Efficiency score | Potential gain | Efficiency score | Potential gain |
| Angola | 0.08 | 7.61 | 0.27 | 6.04 | 0.35 | 2.95 |
| Benin | 0.23 | 10.39 | 0.5 | 6.74 | 0.74 | 1.65 |
| Botswana | 0.20 | 8.86 | 0.36 | 7.09 | 0.81 | 1.11 |
| Burkina Faso | 0.21 | 13.10 | 0.92 | 1.33 | 0.56 | 3.62 |
| Burundi | 0.32 | 23.43 | 0.67 | 11.37 | 0.78 | 2.87 |
| Cameroon | 0.13 | 11.81 | 0.28 | 9.77 | 0.75 | 1.83 |
| Cape Verde | 1.00 | 0.00 | 1.00 | 0.00 | 0.91 | 0.50 |

**Table 3: Contd. Potential savings in health expenditure (Infant mortality as outcome variable)**

| Country name | DEA Mono Input* | | DEA Multiple Input** | | SFA model | |
|---|---|---|---|---|---|---|
| | Efficiency score | Potential gain | Efficiency score | Potential gain | Efficiency score | Potential gain |
| Central African Republic | 0.55 | 3.81 | 0.79 | 1.78 | 0.56 | 1.82 |
| Chad | 0.26 | 6.94 | 0.85 | 1.41 | 0.68 | 2.02 |
| Comoros | 0.29 | 6.92 | 0.64 | 3.51 | 0.80 | 1.05 |
| Congo, Dem. Rep. | 0.53 | 5.76 | 0.77 | 2.82 | 0.69 | 2.77 |
| Congo, Rep. | 0.16 | 4.75 | 0.32 | 3.84 | 0.67 | 1.02 |
| Cote d'Ivoire | 0.14 | 10.97 | 0.33 | 8.54 | 0.78 | 1.55 |
| Equatorial Guinea | 0.01 | 12.30 | 0.22 | 9.69 | 0.11 | 5.74 |
| Eritrea | 1.00 | 0.00 | 1.00 | 0.00 | 0.86 | 0.59 |
| Ethiopia | 0.33 | 13.47 | 0.88 | 2.41 | 0.84 | 1.05 |
| Gabon | 0.03 | 7.49 | 0.21 | 6.10 | 0.49 | 1.83 |
| Gambia, The | 0.18 | 17.77 | 0.54 | 9.97 | 0.77 | 1.86 |
| Ghana | 0.19 | 10.78 | 0.35 | 8.65 | 0.85 | 0.96 |
| Guinea | 0.25 | 16.57 | 0.8 | 4.42 | 0.80 | 1.76 |
| Guinea-Bissau | 0.23 | 12.29 | 0.59 | 6.55 | 0.71 | 2.29 |
| Kenya | 0.22 | 9.95 | 0.39 | 7.78 | 0.91 | 0.61 |
| Lesotho | 0.08 | 22.27 | 0.24 | 18.40 | 0.54 | 5.97 |
| Liberia | 0.15 | 37.20 | 0.4 | 26.26 | 0.88 | 2.86 |
| Madagascar | 0.64 | 5.25 | 0.65 | 5.10 | 0.90 | 0.55 |
| Malawi | 0.22 | 22.96 | 0.5 | 14.72 | 0.80 | 2.45 |
| Mali | 0.23 | 11.35 | 0.66 | 5.01 | 0.55 | 3.67 |
| Mauritania | 0.13 | 14.22 | 0.36 | 10.46 | 0.55 | 2.73 |
| Mauritius | 0.98 | 0.26 | 1.00 | 0.00 | 0.92 | 0.60 |
| Mozambique | 0.26 | 12.15 | 1.00 | 0.00 | 0.70 | 2.32 |
| Namibia | 0.2 | 6.81 | 0.37 | 5.36 | 0.83 | 1.15 |
| Niger | 0.43 | 8.25 | 1.00 | 0.00 | 0.75 | 2.80 |
| Nigeria | 0.12 | 12.08 | 0.28 | 9.88 | 0.69 | 2.13 |
| Rwanda | 0.29 | 25.68 | 0.60 | 14.47 | 0.88 | 1.84 |
| Sao Tome and Principe | 0.10 | 15.35 | 0.32 | 11.60 | 0.83 | 2.12 |
| Senegal | 0.14 | 12.84 | 0.45 | 8.21 | 0.84 | 1.25 |
| Seychelles | 1.00 | 0.00 | 1.00 | 0.00 | 0.84 | 0.77 |
| Sierra Leone | 0.10 | 38.71 | 0.37 | 27.10 | 0.61 | 6.49 |
| South Africa | 0.05 | 14.90 | 0.24 | 11.92 | 0.53 | 4.70 |
| Sudan | 0.10 | 18.30 | 0.45 | 11.18 | 0.84 | 1.88 |
| Swaziland | 0.04 | 17.10 | 0.17 | 14.78 | 0.35 | 6.37 |
| Tanzania | 0.18 | 16.16 | 0.45 | 10.84 | 0.90 | 1.03 |
| Togo | 0.21 | 15.76 | 0.4 | 11.97 | 0.74 | 2.56 |
| Uganda | 0.13 | 26.88 | 0.34 | 20.39 | 0.88 | 1.62 |
| Zambia | 0.17 | 8.36 | 0.34 | 6.65 | 0.83 | 1.53 |
| Mean | 0.28 | 12.84 | 0.54 | 8.09 | 0.72 | 2.24 |

*Source: Authors' computation. Note: Potential savings on health expenditure are expressed as percent of each country's GDPpc. *mono input DEA model with infant survival rate as output and health expenditure as input. ** multi input DEA model with infant survival rate as output and health expenditure and education as inputs.*

In Table 4, similar analysis was conducted with under-five mortality as health outcome variable. Again there was evidence of variation in potential expenditure savings across countries with some countries potentially benefiting significantly from efficiency improvements. The results from the DEA analysis show that on average, SSA countries could save per capita health expenditure of up to 12.89% and 7.99% of GDP per capita for single and multiple input specifications, respectively. Like in Table 3, the SFA model showed lower potential expenditure savings of about 2.02% of per capita GDP.

The individual country analysis from the DEA models reveals that Cape Verde, Eritrea, Seychelles, had no potential savings since they recorded efficiency scores of 1.00. These countries were consistent across both single and multiple input specifications. In both the DEA and SFA models, Sierra Leone recorded the highest potential saving in health expenditure with about 38.71%

(DEA with single input), 27.10% (DEA with multiple inputs) and 6.28% (SFA) of GDP per capita, respectively (Table 4). Other countries with relatively high potential saving on health expenditure using the single input DEA model include Liberia (37.20%), Lesotho (22.27%) and Uganda (26.88%). In the SFA model, Lesotho (6.14%), Swaziland (6.05%) and Equatorial Guinea (5.59%) were among the highest potential savers.

**Table 4: Potential savings in health expenditure (Under-5 mortality as outcome variable)**

| Country name | DEA Mono input | | DEA Multi input | | SFA model | |
|---|---|---|---|---|---|---|
| | Efficiency score | Potential gain | Efficiency score | Potential gain | Efficiency score | Potential gain |
| Angola | 0.08 | 7.61 | 0.27 | 6.04 | 0.30 | 5.78 |
| Benin | 0.23 | 10.39 | 0.52 | 6.47 | 0.71 | 1.47 |
| Botswana | 0.18 | 9.09 | 0.34 | 7.31 | 0.79 | 1.01 |
| Burkina Faso | 0.21 | 13.10 | 0.92 | 1.33 | 0.46 | 2.91 |
| Burundi | 0.32 | 23.43 | 0.67 | 11.37 | 0.74 | 2.43 |
| Cameroon | 0.13 | 11.81 | 0.28 | 9.77 | 0.72 | 1.61 |
| Cape Verde | 1.00 | 0.00 | 1.00 | 0.00 | 0.89 | 0.43 |
| Central African Republic | 0.55 | 3.81 | 0.79 | 1.78 | 0.57 | 1.90 |
| Chad | 0.26 | 6.94 | 0.85 | 1.41 | 0.61 | 1.64 |
| Comoros | 0.29 | 6.92 | 0.74 | 2.53 | 0.81 | 1.10 |
| Congo, Dem. Rep. | 0.53 | 5.76 | 0.77 | 2.82 | 0.70 | 2.81 |
| Congo, Rep. | 0.16 | 4.75 | 0.33 | 3.79 | 0.65 | 0.96 |
| Cote d'Ivoire | 0.14 | 10.97 | 0.35 | 8.29 | 0.79 | 1.64 |
| Equatorial Guinea | 0.01 | 12.30 | 0.22 | 9.69 | 0.09 | 5.59 |
| Eritrea | 1.00 | 0.00 | 1.00 | 0.00 | 0.84 | 0.50 |
| Ethiopia | 0.33 | 13.47 | 0.91 | 1.81 | 0.81 | 0.90 |
| Gabon | 0.04 | 7.41 | 0.21 | 6.10 | 0.53 | 1.95 |
| Gambia, The | 0.18 | 17.77 | 0.52 | 10.40 | 0.68 | 1.34 |
| Ghana | 0.19 | 10.78 | 0.36 | 8.52 | 0.82 | 0.82 |
| Guinea | 0.25 | 16.57 | 0.8 | 4.42 | 0.76 | 1.49 |
| Guinea-Bissau | 0.23 | 12.29 | 0.59 | 6.55 | 0.67 | 2.01 |
| Kenya | 0.22 | 9.95 | 0.39 | 7.78 | 0.88 | 0.49 |
| Lesotho | 0.08 | 22.27 | 0.26 | 17.92 | 0.55 | 6.14 |
| Liberia | 0.15 | 37.20 | 0.46 | 23.63 | 0.87 | 2.64 |
| Madagascar | 0.61 | 5.69 | 0.65 | 5.10 | 0.88 | 0.46 |
| Malawi | 0.22 | 22.96 | 0.51 | 14.42 | 0.75 | 1.98 |
| Mali | 0.23 | 11.35 | 0.66 | 5.01 | 0.45 | 3.05 |
| Mauritania | 0.13 | 14.22 | 0.37 | 10.30 | 0.55 | 2.71 |
| Mauritius | 0.94 | 0.78 | 1.00 | 0.00 | 0.91 | 0.49 |
| Mozambique | 0.26 | 12.15 | 1.00 | 0.00 | 0.70 | 2.32 |
| Namibia | 0.17 | 7.06 | 0.34 | 5.61 | 0.80 | 0.98 |
| Niger | 0.43 | 8.25 | 1.00 | 0.00 | 0.62 | 1.83 |
| Nigeria | 0.12 | 12.08 | 0.28 | 9.88 | 0.66 | 1.93 |
| Rwanda | 0.26 | 26.76 | 0.58 | 15.19 | 0.85 | 1.50 |
| Sao Tome and Principe | 0.1 | 15.35 | 0.33 | 11.43 | 0.80 | 1.78 |
| Senegal | 0.17 | 12.39 | 0.47 | 7.91 | 0.82 | 1.16 |
| Seychelles | 1.00 | 0.00 | 1.00 | 0.00 | 0.82 | 0.70 |
| Sierra Leone | 0.1 | 38.71 | 0.37 | 27.10 | 0.59 | 6.28 |
| South Africa | 0.05 | 14.90 | 0.23 | 12.07 | 0.52 | 4.58 |
| Sudan | 0.1 | 18.30 | 0.43 | 11.59 | 0.80 | 1.58 |
| Swaziland | 0.04 | 17.10 | 0.17 | 14.78 | 0.32 | 6.05 |
| Tanzania | 0.16 | 16.55 | 0.45 | 10.84 | 0.87 | 0.82 |
| Togo | 0.21 | 15.76 | 0.4 | 11.97 | 0.72 | 2.40 |
| Uganda | 0.13 | 26.88 | 0.36 | 19.77 | 0.85 | 1.27 |
| Zambia | 0.17 | 8.36 | 0.34 | 6.65 | 0.78 | 1.22 |
| Mean | 0.28 | 12.89 | 0.54 | 7.99 | 0.70 | 2.02 |

*Source: Authors' computation. Note: Potential savings on health expenditure are expressed as percent of each country's*

*Mono input DEA model with under-five survival rate as output and health expenditure as input. ** Multi input DEA model with under-five survival rate as output and health expenditure and education as inputs.

To compare the DEA and SFA models used in the above analysis, we present a Spearman correlation matrix in Table 5. In general, the correlation matrix suggests that there exists a weak resemblance between the various SFA and DEA specifications. For instance, the correlation between the SFA models with under-five survival rate as output variable and that with infant survival rate as outcome variable was about 98%. On the contrary, the correlation between the SFA and multiple inputs DEA both with under-five survival rate as outcome was about 48%. The similarity was strong among the DEA and SFA models separately.

**Table 5: Spearman rank correlation matrix for DEA and SFA efficiency estimates**

|          | DEA_ISR1 | DEA_ISR2 | DEA_USR1 | DEA_USR2 | SFA_USR | SFA_ISR |
|----------|----------|----------|----------|----------|---------|---------|
| DEA_ISR1 | 1        |          |          |          |         |         |
| DEA_ISR2 | 0.8588   | 1        |          |          |         |         |
| DEA_USR1 | 0.9901   | 0.8266   | 1        |          |         |         |
| DEA_USR2 | 0.8647   | 0.9902   | 0.8459   | 1        |         |         |
| SFA_USR  | 0.6406   | 0.4936   | 0.6097   | 0.479    | 1       |         |
| SFA_ISR  | 0.644    | 0.5388   | 0.5939   | 0.5083   | 0.9839  | 1       |

*Source: Authors' computation. Note: SFA_USR: Efficiency scores from SFA model with under five survival as outcome variable. SFA_ISR: Efficiency scores from SFA model with infant survival as outcome variable. DEA_USR1: Efficiency scores from single input DEA model with under five survival as outcome variable. DEA_USR2: Efficiency scores from multiple input DEA model with under five survival as outcome variable. DEA_ISR1: Efficiency scores from single input DEA model with infant survival as outcome variable. DEA_ISR2: Efficiency scores from multiple input DEA model with infant survival as outcome variable.*

**Discussion**

In general, the findings of the study suggest the presence of some level of FSH across countries in SSA. Such FSH can be derived by improving efficiency in the use of health expenditure. The individual country analysis suggests that SSA countries have some potential fiscal space for health (or potential savings on health expenditure). This conforms with the findings of Hernandez de Cos and Moral-Benito [12] who found that potential efficiency gains in the health sector and the savings in health expenditure, thereof, are high. Similar conclusions were also drawn by Belay and Tandon [5] in the case of Nepal and Okwero et al. [1] in the case of Uganda. The findings suggest that a good alternative to increasing health expenditure could be by improving efficiency in health care system management. For countries where resources are available for investment in the health sector, the two (increased health spending and improved efficiency) could be complementary. Otherwise, the former could follow the latter for better results. The findings also support the argument that governments should go beyond increasing health expenditure to ensuring that these resources are used efficiently. Similarly, debates about health spending need not focus only on raising spending but also improving efficiency of the spending. In this regard, increasing health expenditure can be considered as a necessary condition to health outcome improvement while improving efficiency becomes a sufficient condition.

The results also suggest that the magnitude of efficiency savings vary with the efficiency model estimated. Estimates from the SFA model were lower than those from the DEA models. This is due to the fact that the SFA models produce relatively higher efficiency estimates. This implies lower inefficiency levels and hence lower potential for efficiency gains in terms of expenditure. In the DEA models it was also observed that the results from the single input specification were slightly higher than that of the multiple input specifications. However, the rank (in terms of performance) of the individual countries was consistent across the models. The Spearman rank correlation also suggests strong resemblance in the two model specifications. This suggests that the multiple input specifications may not be superior but a way to check the robustness of the model.

Many developing countries such as SSA face unlimited social and economic challenges with very limited resources. This problem of scarcity cripples progress and development of many sectors of the economy, including the health sector. Cutting wastes by improving efficiency and savings (in economic terms) should become an essential public sector strategy. Such improvements create fiscal space that provides avenue for governments to

raise additional resources for the health sector.

This evidence calls for cogent attempts by governments to improve efficiency in the health sector. The introduction of appropriate policies, effective monitoring and evaluation and appropriate remuneration for health sector workers could play important roles in improving health system efficiency. Novignon [30] provided evidence to show that reduced corruption, quality public sector institutions and access to health care are significant factors in reducing health system inefficiencies. Checking such wastages will also likely trigger increased domestic and external financial support. Moreover, in SSA countries where resources are limited, the findings of the study provide a good basis for policy makers to improve accountability in the health sector. Funds directed to the sector should be closely monitored to ensure the desired outcomes are achieved. Policy makers can also reduce inefficiencies by tying funding to performance at the various levels of the health sector. This will likely force managers at the various levels to respond to the call for improved efficiency. Some researchers have recommended the adoption of performance-based financing (PBF) or output-based aid (OBA) models where health sector institutions are reimbursed based on performance [31]. Moreover, Mitton et al. [32] noted that in the face of limited resources, priority setting and appropriate resource allocation will be crucial for effective health system management.

## Conclusion

The purpose of the study was to examine potential fiscal space for health through efficiency gains in health expenditure. Using data from 45 SSA countries in 2011, the DEA and SFA models were employed to estimate health expenditure efficiency. Efficiency gains were therefore computed as potential savings in health expenditure from improved efficiency.

The results showed potential saving in health expenditure in SSA. This indicates potential fiscal space for health that could be explored if health system management was improved. The estimates for savings in health expenditure were sensitive to the model used.

In general, the results confirm the need for governments in the region to improve efficiency in the use of health expenditure. Improving efficiency of health expenditure is particularly important in the sense that most countries face daunting economic challenges, hence available fiscal space for health in government budgets are very limited. The potential savings from improved health expenditure efficiency, therefore, provide an effective alternative that can be explored.

A limitation of the study lies in its inability to complement the results from aggregated data with micro level data. While health production functions in the current study were based on health spending and other health sector related variables as inputs, there are important factors beyond the control of the health sector but cannot be observed at the aggregate level [33]. Complementing such aggregate analysis with micro level analysis could be beneficial for policy.

**Competing Interest**

Authors declare they have no competing interest.

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