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Health Development Assistance Fluctuations (External Shock) and Health Outcome Indicator in Sub-Saharan African Countries

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Abstract: **Most of the sub-Saharan African countries' health sectors finances heavily depend on health development assistance from developed countries (external donors) and these health aids tend to be highly fluctuated during economic and financial crises, economic downturns and meltdown. All these unforeseen circumstances result into instability in the health aids channel into the region and this seems to pose a danger of lower long-run growth in health sectors and ultimately, resulting into poor human development indicators in the region. In sub-Saharan African countries (SSACs), its indices of human capital development are among the worst at a global space despite being the largest health development assistance recipients in the world. Employing the panel constructed data set of twenty (20) sub-Saharan African countries from 1990-2021; and impulse response function and forecast error variance decomposition, this paper investigates how fluctuations in health development assistance affect health outcome indicator proxy life expectancy at birth (LEB) in SSACs. The results indicate that health development assistance fluctuations or shocks have positive effect on LEB and have a significant variance decomposition on LEB in the region. This signals that health development assistance fluctuations or shocks are either compulsory or sufficient to describe the transformations that occur in the health outcome indicator of the region. The study concludes that health development assistance fluctuations improve LEB marginally in the region. The study recommends among others, promotions of domestic factors; restructuring and annual increments of public expenditure allocations to the health sectors by various governments of the region.**

Keywords: **Health Development Assistance; Health Outcome Indicator; Health Development Assistance Fluctuations and Life Expectancy at Birth (LEB).**

1. INTRODUCTION

It is generally believed that a foundational goal of all societies is good health. Empirical proof showed from all indications that economic development of a nation in no small measure is significantly escalated by its health, and in other way round (Atun & Fitzpatrick, 2005). Viewing health from Bloom and Canning (2000; 2003) points, both health and education are seen as straight constituents of human welfare and equally as an embodiment of human capital that enhances individual's potentiality. So to put it in the words of Muysken *et al*., (2003), higher investment in health is anticipated to result into better health outcomes. To this end, the quest for better health should not in any way be pinned to an upgraded economy; rather quantum to upgrade health will in itself boost or add to economic growth (Alsan, Bloom & Canning, 2006)).

The report of Global Health Data Exchange (GHDE) (2017) that sub-Saharan African countries (SSACs) recorded more than 87 percent of global disease burden but with only 35 percent of global spending on health as at 2015 justifies the claim of Negeri and Halemariam (2016) that SSACs are the biggest recipients of health development assistance (HDA) (it signals that the largest global diseases burdens occur in the region with meager resources at the disposal of its governments to combat these health related challenges hence the massive deployment of health aid to the region). In the recent time, HDA tends to be highly fluctuated because of economic and financial crises that have engulfed many countries in the world and this has seriously affected many developing countries especially those countries that always substitute domestic government health expenditure with health development assistance (HDA). According to World Bank (2006), bilateral health development assistance surged from a yearly annual average of US$2.2 billion (3.8% of the sum) during 1997-99 to US$ 2.9 billion (6.8%) in 2002 but fluctuating trends are being witnessed of recent. Kruk, Kujawski, Moyer, *et. al* (2016) asked the likely planned pathway for HDA in some health related focus areas since the total HDA have remained static in the recent years.

According to the President of African Development Bank (AfDB) during the 35th African Union Assembly in Ethiopia, he states unequivocally that "the most essential and long-lasting lesson from Covid'19 pandemics for African continent is the necessity to erect resistant apparatus against external shocks (health aids inclusive) particularly in the areas of healthcare and financial security". Olalere and Munyua (2020) in their own opinion opine that health development assistance has crushed government resources and established donor reliance- which is hindering the transformation of countries with reducing donor funding and insufficient plans of actions to counter-balance this change in resources.

The implications according to Biju (2020) if HDA declines, is that African countries will continue to be threatened by a combination of high level disease rates, consequential negative effect on the long-run health growth and development and increase health-related challenges like mortality, morbidity, neo-natal, short life expectancy at birth and others in the region. This necessity to find out the consequential effect that HDA shocks may transmit to health outcome indicators in the region arises due to the unpredictable nature of health development assistance (external shock) and other external economic variables that can result into shocks transmission.

Health Development Assistance (HDA) is defined as foreign or overseas resources which may be in financial or in-kind, channel or deploy into a recipient country (developing country) from external sources (developed countries) to assist the health-related activities in the developing countries (Institute for Health Metrics and Evaluation (IHME), 2011). Health outcome is a change in the health status of an individual, group or population which is ascribable or attributable to an organized or designed intervention or sequences of interventions, not minding of whether such an intervention was aimed to change health status (Asiedu *et al.*, 2015). Health outcome indicator is referred to as the measure to evaluate the "changes" observed at the population as a "result" of given interventions (Mainz, 2003). Health development assistance fluctuations (external shock) deal with the variations in the health aids that are channeled from the developed countries or donor agencies to developing countries and these variations may result because of many factors. Some of the factors are donors' economic growths or decline, new funding sources, epidemic of diseases like Severe Acute Respiratory Syndrome (SARS), Ebola outbreaks in East African countries, Coronavirus (Covid'19), technological innovations in health sector and others.

In the view of Abere and Akinbobola (2020) "external shocks (external economic variables fluctuations) occur when unforeseeable or incalculable change or alteration in an external or exogenous factor influences endogenous economic variables. Therefore, it is a common believed that health sector that relies on foreign resources are more endangered to external shocks than others that do not depend on it. It is a popular norm among policymakers to attribute unpredictability in health outcome in SSACs to external shocks though external shocks are not the only factors responsible for this unpredictability.

Despite this massive deployment of health aid to the developing region yet human development indicators have been the worst among its peers when compare with other regions globally. Specifically, SSACs is the second among other regions having highest infant mortality of 88.03 infant deaths per 1,000 live births as at mid-2021 (O'Neill, 2021) (Asia is ranked first), highest neonatal deaths rate among the regions of the world (27 deaths per live 1,000 live births) as at 2019, (World Health Organization (WHO), 2020) and the highest under-five deaths among the regions of the world as at 2019 (for male 81 per 1000 live births and for female was 70 per 1000 live births (World Bank, 2021) and that the regions also recorded least life expectancy at birth among the rest regions of the world as at mid-2020 (62 years for male and 65 for female) (Statista, 2021). This study intends to contribute to the big push theory-human capital nexus of the human capital formation in development economic literature by exploring the transmission mechanisms through which health development assistance fluctuations or variations affect health outcome indicator in sub-Saharan African countries.

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Health development assistance fluctuations/dynamics and health outcome indicator have not received attention at all in empirical literature. Most of the studies however focused on the impact of health development assistance on health outcome indicators. To be candid, research on the impact of health development assistance fluctuations (external shocks) on any health outcome indicator of the economy is rare. Unarguably, urgent attention is consequently needed to look into the subject of health development assistance fluctuations or dynamics from the health outcome indicator perspective for SSACs. This study is essential and distinctive for several reasons. Firstly, it is the first attempt at addressing non-monetary welfare measure (health outcome indicator) effect of health development assistance disequilibrium due to the external shock using datasets from SSACs. Secondly, it considers the effect of HDA fluctuations on health outcome indicator. Thirdly, it covers 1990-2021 period, the era of the emergency of the new actors joining forces together with the traditional donors towards combating diseases in SSACs and periods in which the world experiences financial crisis, global meltdown crisis and dreaded Covid'19 pandemic outbreaks. The effects these crises (shocks) have on health aid channeled and the aftermath effects of the fluctuations in health aid channeled on health outcome indicator are of utmost imperative to this study.

2. THEORETICAL AND EMPIRICAL REVIEW OF LITERATURE

The Big Push Theory has gained importance within the theoretical debate of foreign aid. The Big Push theory; according to Rosenstein Rodan (1943) claims that the dormancy or idleness experience by the developing countries' economies could be overcome, subdued or brought under control through enormous or large capital investment from foreign countries (foreign aid).

Existing studies on health development assistance (HDA) only beamed their searchlights on the impact of HDA on health outcome indicators in developing countries and SSACs. Some of the works which concentrate on the impact or effect of health development assistance (health aid) on health outcome indicators without considering its fluctuations are: Global Burden of Disease Health Financing Collaborator Network (2020), Kotsadam, Ostby, Rustad, Tollefsen, and Urdal (2018), Lu, Li, and Patel (2018), and many others. This simply implies that no single effort has so far been made on the impact of health development assistance fluctuations on human welfare in any developing country. For this reason, it is of utmost imperative that the work be carried-out focusing on the region.

Among the works on the effects of external shocks (e.g oil price shock, foreign direct investment shock and others) on health outcome indicators which are not related to health development assistance fluctuations are: Hill & Cogill (2010), Venkataramani & Fried (2011) and Oduyemi & Owoeye (2020).

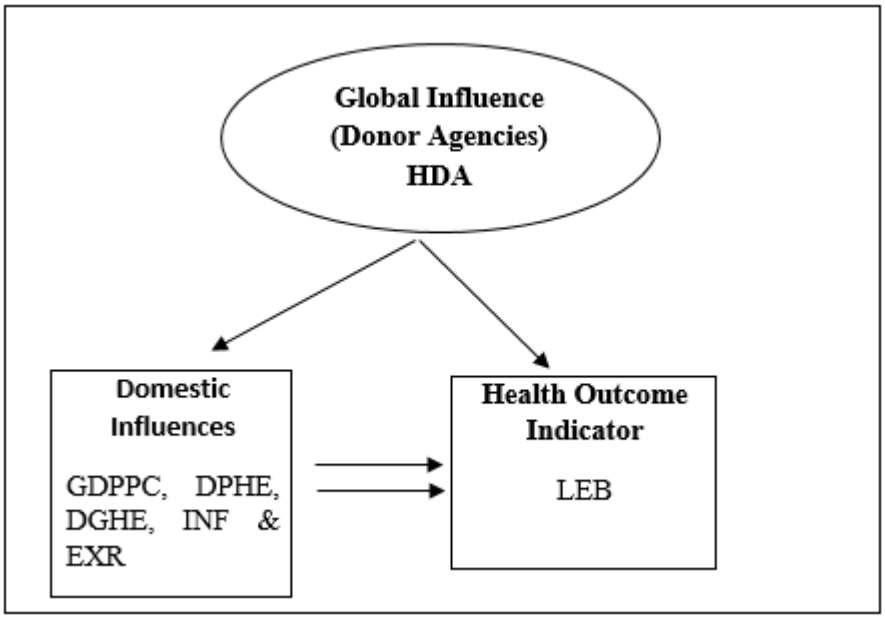

Figure 1. Relationship between external shocks and Health Outcome Indicator and also relationship between internal shocks and health outcome indicator.

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Note. HDA= Health Development Assistance; LEB= Life Expectancy at Birth, GDPPC = Gross Domestic Product Per Capita, DPHE = Domestic Private Health Expenditure, DGHE = Domestic Government Health Expenditure, INF = Inflation rate, EXR =Exchange rate

The conceptual framework depicted in Figure 1 illustrates how external shock from world influential economies may affect health outcome indicator in the developing countries of SSACs. Thus, SSACs health outcome indicator variable is depicted to be influenced by global factors (external economic variable factor). This global factor has direct influence on SSACs health outcome indicator variable through health development assistance received and likewise the domestic factors.

3. MODEL SPECIFICATION

Following the theoretical model of Rosenstein Rodan (1943) of which health outcome indicator (development) is determined by health development assistance (HDA) and other endogenous variables; the implicit functional model for this study is stated thus:

$$\ln HOI_{(i,t)} = \beta_0 + \beta_1 lnHDA_{(i,t)} + \beta_2 lnGDPPC_{(i,t)} + \beta_3 DPHE_{(i,t)} + \beta_4 DGHE_{(i,t)} + \beta_5 INF_{(i,t)} + \beta_6 lnEXR_{(i,t)} + \beta_7 lnFDI_{(i,t)} + \beta_8 lnPREDFEM_{(i,t)} + \beta_9 POP_{(i,t)} + + \beta_{10} GOEF)_{(i,t)} + \varepsilon_{(i,t)} + \mu_{1(i)} + \mu_{2(t)} \ldots\ldots\ldots (1)$$

Equation (1) is the long-run determinants of log of health outcome indicator (*ln*HOI).

Life expectancy at birth (LEB) is the measure to represent health outcome indicator in this study, the reason is premised on the fact that it is one of the commonest used measures in the literature.

$$LEB_{(i,t)} = \beta_0 + \beta_1 lnHDA_{(i,t)} + \beta_2 lnGDPPC_{(i,t)} + \beta_3 DPHE_{(i,t)} + \beta_4 DGHE_{(i,t)} + \beta_5 INF_{(i,t)} + \beta_6 lnEXR_{(i,t)} + \beta_7 lnFDI_{(i,t)} + \beta_8 PREDFEM_{(i,t)} + \beta_9 POP_{(i,t)} + \beta_{10} GOEF)_{(i,t)} + \varepsilon_{(i,t)} + \mu_{1(i)} + \mu_{2(t)} \ldots\ldots (2)$$

Where *LEB* represents health outcome indicator as measured by the life expectancy at birth (number of years an individual will live on earth if the present health influencing factors remain the same) (*LEB* is not being logged because it is in years), *lnHDA* is the log of health development assistance received, it is included to know the total amount of health aid received from donors, *lnGDPPC* is measured by the Gross Domestic Product Per Capita (it is included to know the actual amount of per capita income based on the country's annual economic activities divided by the population of a country), *DGHE* is the Domestic Government Health Expenditure (it is included to represent the share government yearly devote to the growth of health sector of a country), *DPHE* is the Domestic Private Health Expenditure (it is included to represent the private partners yearly commitments to the growth of health sector of a country), INF is the inflation rate (it is included to account for changes in the general price level), *lnEXR* is measured by the exchange rate (it is included to measure currency appreciation or depreciation in a country) *lnFDI* is measured by the foreign Direct Investment (it is included to measure the impact of foreign direct investment on the health sector of the region), *PREDFEM* is the Primary Education of female (it is included to the know the impact of female primary education on life expectancy at birth), POP is the Population ages between 15-64 (it is included to know the influence of working population on the health outcome indicator of a country), GOEF is a measure for Government Effectiveness, ($\beta_1 \ldots \beta_{10}$, parameters or slopes), β_0= constant term in country *i* at time *t*, *i* =1, 2, …, 20 (number of countries), *t*=1, 2, 3,4 (number of time units), $\varepsilon(i,t)$ is an error term, $\mu_1(i)$ and $\mu_2(t)$ are country- and time-specific effects, respectively.

INF and other variables that already appear in its rate form and percentages are used directly while the logarithmic forms of the *HDA, GDPPC, EXR and FDI* variables are utilized and the nominal forms of institutional quality (GOEF) is integrated into the estimated model in line with Iyoboyi and Pedro (2014).

In a bid to assess the shocks transmission of health development assistance fluctuations and other external economic variable fluctuations on life expectancy at birth, based on the theoretical propositions from Ngalawa and Viegi (2011), the following model is presented thus:

Assuming that SSACs health outcome indicator can be described according to the following structural equation in a long form vector autoregressive (VAR):

$$FY_t = C_0 + B_1 Y_{t-1} + B_2 Y_{t-2} + \ldots\ldots B_p Y_{t-p} + \pi_i X_t + Z\varepsilon_t \ldots\ldots (3)$$

where F is an invertible $(k \times k)$ matrix describing the contemporaneous relationship among the variables; Y_t is a $(k \times 1)$ vector of endogenous variables such that $(Y_t = Y_{1t}, Y_{2t}, \ldots \ldots Y_{nt})$; C_o is a $(k \times 1)$ vector of constants; B_i is a $(k \times k)$

matrix of coefficients of lagged endogenous variables ($for\ every\ i = 1 \ldots \ldots \ldots \ldots p$); π_i and X_t are the coefficient and vector of the exogenous variable, respectively, capturing external shock. Z is a $(k \times k)$ matrix whose non-zero off-diagonal elements allow for direct effects of some shocks on more than one endogenous variable in the system and ε_t is an uncorrelated vector of error terms (white-noise structural disturbances).

The Vector Autoregressive model was estimated using six endogenous variables, namely *LEB*, *GDP Per Capita (GDPPC*), *Domestic Government Health Expenditure (DGHE), Domestic Private Health Expenditure (DPHE), Inflation (INF) and Exchange Rate (EXR)* and one exogenous variables namely, Health Development Assistance. The inclusion of this exogenous variable is to represent external economic variable that opens the economy component of the model that links the SSACs economy with the rest of the world.

4. ESTIMATION METHOD

This study considers sub-Saharan African countries' health outcome indicator to be an integral of developing countries' health outcome indicator compared with the global influences which are represented by health development assistance and foreign direct investment. So, the rationalization of the appropriateness of the use of the Panel Structural Vector Autoregressive *(PSVAR)* technique is hinged on the recognized limitations for the external factor which is considered to be contemporaneously exogenous to the regional health outcome indicator variable used in this study and this provides confirmation for the appropriateness of the employment of PSVAR technique in the work. However, some researchers like Antonio (2022), Yaqing, Hongbing and Xiaolu (2021) had employed PSVAR approach as a method of examining shocks transmission amidst variables and given needed information on impulse response functions together with forecast error variance decomposition (FEVD). The main important advantage finds in this technique lies in its capability to give feedback, shock transmission on variables, and dynamic relationships among economic, social variables in this work. Thus, this study beams its searchlight on how external shock or fluctuation may pass through HDA received to the health sector outcome in SSACs.

Thus, multiplying equation (2) by an inverse of $F\ gives$:

$$Y_t = F^{-1}{}_{C_o} + F^{-1}B_1Y_{t-1} + F^{-1}B_2Y_{t-2} + \cdots F^{-1}B_pY_{t-p} + F^{-1}\pi_iX_t + F^{-1}Z\varepsilon_t \ldots. (4)$$

One can denote

$$F^{-1}{}_{C_o} = C,\ F^{-1}B_i = A_i\ for\ i = 1 \ldots.p,\ F^{-1}\pi_i = \alpha i\ and\ F^{-1}Z\varepsilon_t = \mu_t.$$

Hence, equation (3) becomes:

$$Y_t = C + A_1Y_{t-1} + A_2Y_{t-2} \ldots \ldots.. + A_pY_{t-p} + \alpha_iX_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (5)$$

The difference between equations (3) and (4) is that, the first one is called a structural VAR or primitive system where all variables have immediate effects on each other while the second is called a reduced form structural VAR or a VAR in standard form in which no variable has a direct contemporaneous (immediate) effect on another in the model and the error term (μ_t) is a composite of shocks in Y_t (Enders, 2004).

Equation (4) can be rewritten in short form as:

$$Y_t = B(L)Y_t + C(L)X_t + \mu_t \ldots\ldots\ldots\ldots\ldots\ldots \quad (6)$$

where:

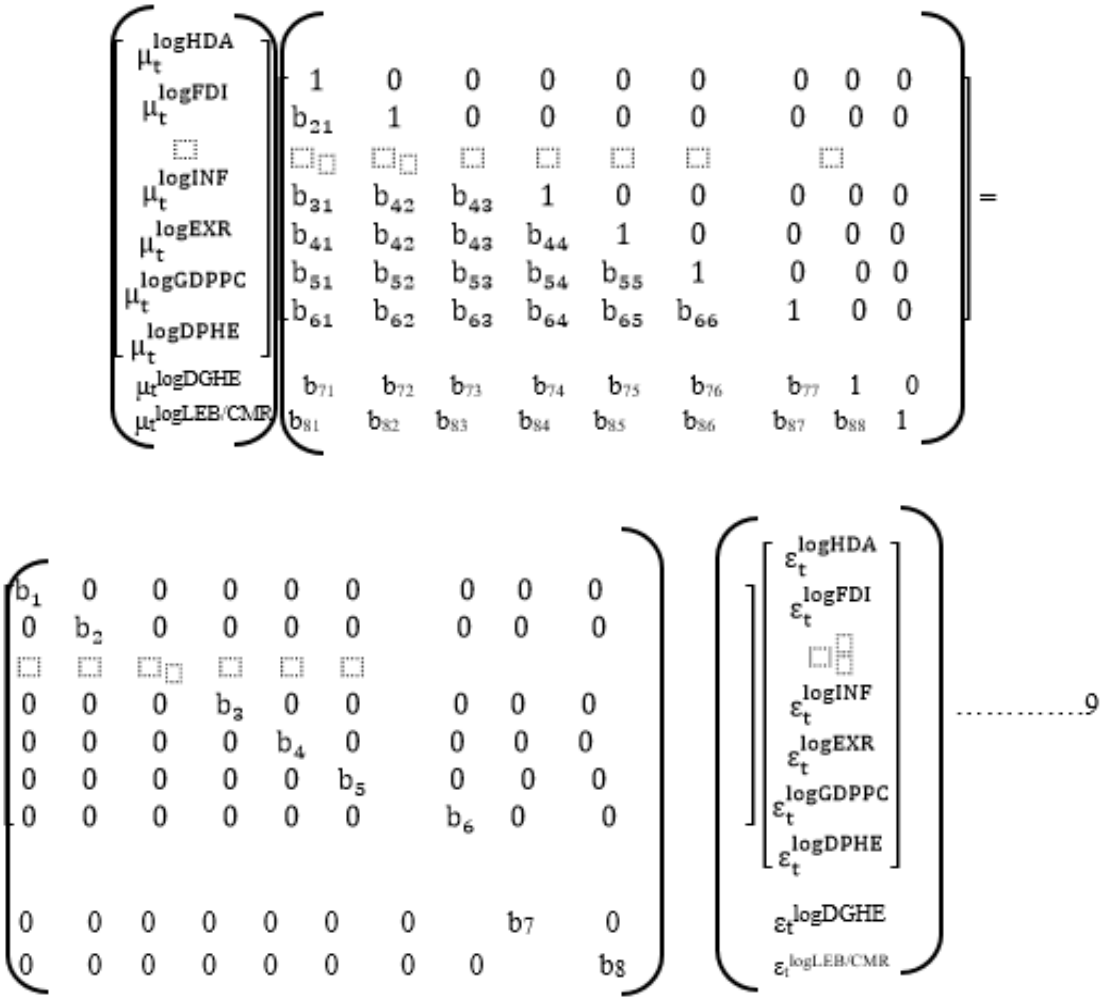
$$Y_t = [INF, EXR, GDPPC, DPHE, DGHE, LEB] \ldots\ldots\ldots\ldots\ldots (7)$$

$$X_t = [HDA] \ldots\ldots\ldots\ldots\ldots\ldots \quad (8)$$

where Y_t are domestic variables such that; INF, EXR, GDPPC, DPHE, DGHE and LEB. The exogenous variable is: HDA.

Equation (7) is a vector of the SSACs domestic (endogenous) variables to be used in the study; and changes in health outcome indicator and equation (8) represents the vector of exogenous variable that controls for external shock. The structural shocks in equation (3) are identified according to the following scheme. The ordering of variables in equ.(8) is established on the study by Ushie, Adeniyi and Akongwale (2013). Normally, the positioning of the variables is carried-out

in a way that the deliberation is firstly given to the smallest endogenous variables while the utmost endogenous variables are given priority last.



The first matrix on the left hand side of system of equations (9) is the A-matrix which pertains to the non-recursive restrictions in the model while the first matrix on the right hand side shows the B-matrix, also known as the diagonal matrix. The terms $\mu_t^{logHDA}, \mu_t^{logFDI}, \mu_t^{logINF}, \mu_t^{logEXR}, \mu_t^{logGDPPC}, \mu_t^{logDPHE}, \mu_t^{logDGHE}$ and μ_t^{logLEB} are residuals in the reduced form disturbances to both the foreign and the domestic variables and further represent unexpected movements (given information in the system) of each variable; and $\varepsilon_t^{logHDA}, \varepsilon_t^{logFDI}, \varepsilon_t^{logINF}, \varepsilon_t^{logEXR}, \varepsilon_t^{logGDPPC}, \varepsilon_t^{logDPHE}, \varepsilon_t^{logDGHE}$ and ε_t^{logLEB} are the structural shocks associated with the respective equations.

The way variables impact each other depend on their position in the identification scheme and their ordering in the model. The PSVAR, with the ordering of variables given by rows 1 to 8 intuitively assumes that shocks are transmitted from the developed countries to the domestic economy of the developing countries.

Hence, this study beams its searchlight on how external passes through external economic variables to health outcome indicator in sub-Saharan African countries.

The dynamic interactions of health development assistance shocks on health outcome indicator of health aid dependent sub-Saharan African countries was evaluated through the employment of Impulse response function (IRF) which tracked the effect of each variable's response to one standard deviation increase in health outcome indicator and also the employment of forecast error variance decomposition analysis tracked the percentage of change in a particular variable in conjunction with self-shock against the shocks to the remaining variables in the system.

5. DESCRIPTION AND MEASUREMENT OF VARIABLES

Life Expectancy at Birth: It is the number of years a newly-born infant would live if the current figures of death rate at the time of its birth were to stay the same throughout its life. Total number of years is the measure use to determine it.

Health Development Assistance: It is defined as a monetary and in-kind donation put together by institutions or major development agencies whose main aim is to provide advancement assistance towards the improvement of health in developing countries of the world. It is measured in US Dollars.

Foreign Direct Investment: It is the totality of equity capital, reinvestment of earnings, and other capital of cross-border investment which is related with a resident in one economy having control or a significant degree of influence on the management of an enterprise that is resident in another economy. It is net inflows measured in current U.S. dollars.

Inflation rate: It is the rate at which prices rise or increase over time, thereby resulting in a fall in the purchasing value of a unit of money in the country. It is measured by the consumer price (annual percentage) index.

Exchange rate: It is the rate at which a country's currency is interchanged with another country's currency. It is measured as an annual average based on monthly averages.

Gross Domestic Product Per Capita (GDPPC): It is a metric that determines a country's domestic output per individuals living in a country. It is measured by dividing the GDP of a country by its population. It is measured as the percentage of GDP.

Domestic Government Health Expenditure: It is the share of current domestic general government resources used to fund health expenditure as a share of the economy as measured by GDP.

Domestic Private Health Expenditure: It is defined as the contribution to the total current health expenditure which is financed from local private sources. It is measured as the percentage of the current health expenditure.

Primary education of female: It is the percentage of total admission (enrollment), regardless of age, to the number of inhabitants (population) of the age bracket (group) that adequately equal with the level primary education in a country.

Population ages 15- 64: It is a measure of the aggregate number of individuals who are productively among the citizens of a country (population. It is estimated as the percentage of the total number of people in a country (within the age bracket of 15-64).

Scope and Sources of Data

This study of SSACs health development assistance fluctuations spans between 1990-2021. This covers the various eras in which huge and small health development assistance have been deployed to the growth and development of heath sectors of SSACs. The study employs the cross-sectional and annual time series secondary data from all the selected countries of SSACs. Data were extracted from World Development Indicators for Life Expectancy at Birth, Domestic Private Health Expenditure, GDPPC, Population ages 15- 64, Inflation Rate, Exchange Rate, Foreign Direct Investment. Data for health development assistance were sourced from Financing Global Health database while data on Government Effectiveness and Domestic Government Health Expenditure were sourced from Worldwide Governance Indicators database and Global Health Expenditure database.

6. ESTIMATED RESULTS

Descriptive Statistics of Data Series

Agun, (2009) states that the descriptive statistics of the data-set employed are premised on its capability to defeat the difficulty of multi-collinearity among the explanatory variables of the model that is potent enough to render the regression results to be prejudiced. The descriptive statistics of the data series provides details information about the sample statistics in a study.

From Table 1 in Appendix, the descriptive statistics shows that all the data series manifest a high level of consistency as their mean values lie between the maximum and the minimum value of the series.

Lag order selection for PSVAR and autocorrelation

The determination of suitable lag length is important in the evaluation of PSVAR model, the reason being that a wrong lag length selection can hinder substantially the interpretation of PVAR estimates. In Table 1, the selection criteria considered in this study are LR, AIC, SC and HQ. The study employed lag three (3) for the purpose of estimation.

Table 1: Optimal lag selection results of information criteria

Lag	Information Selection Criteria			
	LR	AIC	SC	HQ
0	NA	86.32	86.40	86.35
1	13975.58	60.30	61.35	60.71
2	2316.86	56.26	58.27*	57.05
3	476.95*	55.77*	58.74	56.93*

Note: * indicates lag order selected by the criterion and LR is the sequentially modified LR test statistic (each test at 5% level), AIC is the Akaike information criterion, SC is the Schwarz information criterion, and HQ is the Hannan-Quinn information criterion.

To determine the zero serial autocorrelation, Arellano Bond test was employed. Table 2 below shows that there is evidence to reject the hypothesis of zero autocorrelation between successive values of the error term for the case of first order serial autocorrelation, and that for the case of second order serial autocorrelation there is no evidence to reject the null hypothesis of zero serial correlation between successive value of the error term. Hence the model is freed of second order serial autocorrelation.

Table 2: Arellano-Bond Test Result

Order	**Z-statistics**	**Probability**
1	-2.47	0.014
2	-0.94	0.349

Source: Author's Computation, (2022).

Panel Unit Root Test Results

It has often been confirmed that most cross sectional ant time series data are non-stationary at levels due to the fact that some variables are considered either to be too small or manifest too large nature such that their probability of moving back to their expected average value (mean) is nearly equal to nil. This situation brings about the significance of undertaking the unit root test or stationarity test any time-series data are being utilized by a researcher. This current study employed Levin-Lin-Chu (LLC), Im-Pesaran-Shin (IPS) and Fisher test (FT) to test for stationarity. The table shows that life expectancy at birth, domestic private health expenditure, domestic government expenditure, inflation rate, exchange rate, primary education of female enrolment and population age of 15 and 64 are stationary at level, i.e., they are integrated of order zero i.e I(0) while Health Development Assistance, Gross Domestic Product Per Capita (GDPPC), Foreign Direct Investment and Government Effectiveness became stationary after first difference. Contrarily, the unit root table reveals mixed results for health outcome indicator variable. The variables display I(0) and I(1) order of integration indicating that they have different order of integration and this involves the employment of Kao and Fisher tests to investigate the existence of long-run relationships between HDA and LEB.

Table 3: Panel Unit Root Test Result

Variables	level			first difference			Remark
	LLC	IPS	FISHER	LLC	IPS	FISHER	
LEB	-8.36104*	-3.58567*	91.9705*	---	---	---	I(0)
HDA	-3.40953*	-1.28548	49.8369	-29.7005*	-31.9191*	579.259*	I(1)
GDPPC	-1.58365	2.48156	21.9235	-17.4829*	-16.3378*	297.747*	I(1)
DPHE	-3.95503*	-3.33607*	69.3006*	---	---	---	I(0)
DGHE	-3.07711*	-3.11350*	71.0858*	---	---	---	I(0)
INF	-6.43150*	-9.14803*	186.743*	---	---	---	I(0)
EXR	-7.37885*	-4.98317*	93.5621*	---	---	---	I(0)
FDI	-1.72546	-1.13444	10.085	-14.6343*	-25.4874*	444.836*	I(1)
PREDFEM	-3.79732*	-2.24636*	82.1832*	---	---	---	I(0)
POP	-9.29053*	-4.64545*	105.289*	---	---	---	I(0)
GOEF	-0.09938	-12.8669	28.108	-21.7937*	-28.1583*	456.178*	I(1)

NOTE: T*hese variables HDA, GDPPC, FDI and EXR are in natural log forms.*

(*) connote rejection of unit root hypothesis at (5%) level of significance level

Source: Author's Computation, (2022)

Table 4 below clearly shows the succinct of panel co-integration tests of Kao and Fisher carried-out co-integration study. Results shows validation for the rejection of null hypothesis of 'no co-integration' between life expectancy at birth (LEB) and its corresponding determining variables. The result shows -1.665149 ($p < 0.05$) for Kao ADF stat, while Fisher result stood at 197.6 ($p< 0.05$) and 76.48 ($p< 0.05$) for trace and max eigen stats respectively, hence, there is a strong proof in support of co-integration between life expectancy at birth and its recognized determinants.

Table 4: LEB Related Series

Panel co-integration tests result for LEB and CMR

Model	**Test**	**Stats.**	**Stat. Value**	**Prob.**
LEB	Kao test	(ADF-stat)	-1.665149*	0.0479
	Fisher test	(Trace stat)	197.6*	0.0000
		(Max-eigen stat)	76.48*	0.0002

***Note*: *** *connote significance at 5% level of significance; (Fisher test reports test concerning the rejection of 'at most' 1 and 2 co-integrating equation for LEB, thus suggesting the existence of at least 1 and 2 co-integration equation for model LEB.*

Source: Author's Computation (2022).

Impulse Response of Panel Structural VAR Results

In this study, impulse response functions (IRF) shows the direction, magnitude and the time-path of health outcome indicator (LEB) appearing from the shocks in Health Development Assistance (HDA), Gross Domestic Product Per Capita (GDPPC), Domestic Private Health Expenditure (DPHE), Domestic Government Health Expenditure (DGHE), Inflation rate (INF),

Exchange rate (EXR), Primary Education of Female (PREDFEM), Foreign Direct Investment (FDI), Population age 15-64 (POP) and Government Effectiveness (GOEF). Figure 1 shows response of life expectancy at birth to innovative shock in health development assistance and other explanatory variables.

Figure 1 indicates that in all the time horizons in both short and long runs, life expectancy at birth reacts positively and increasingly to a standard deviation shock that occurs in health development assistance. The result portrays that a shock to health development assistance results into a positive effect on life expectancy at birth. This positive effect of health development assistance on LEB in sub-Saharan African countries is in the performance range of 0.1 percent to 0.7 percent in all the entire 20 years' periods. In particular, a standard deviation shock in health development assistance prompts life expectancy at birth to increase to 0.3% in the 5th period and it gradually jumps up to 0.7% in the 20th period. It signifies that reductions in health development assistance still enhance life expectancy at birth in sub-Saharan African countries in the periods considered in this study. Health development assistance reductions still end in expanded health inputs, drugs and services and hereafter lead to ameliorated LEB across the region. It is rested on the grounded fact that reduced health development assistance to sub-Saharan African region boosts more health input facilities in the zone which wrap up in an enhanced or expanded LEB in sub-Saharan African countries.

Similarly, life expectancy at birth also remain to be positively related to GDP per capita shock in all the time periods but begins to fall slightly in the 14th period until the end. A standard deviation shock in Gross domestic product per capita pushes life expectancy at birth to expand from 0.10% in the 5th period to 0.12 in the 10th and reduces to 0.11% in the 20th period. It is anticipated to be so because shock in GDPPC will reduce the purchasing power of the citizens to afford more health inputs and improved healthy nourishments. On a contrary note, domestic private health expenditure shock (DPHE) on life expectancy at birth is negative in the short term but this negative value disappears in the 12th period and maintains the positive value in the remaining horizons.

The study further portrays that life expectancy at birth also reacts negatively to domestic government health expenditure (DGHE) shock in all the periods. It is anticipated the reason being the fact that reductions in the domestic government health expenditure, diversionary play out by the government officials will result in the limited provisions of public health input facilities e.g drugs, services and will dwindle LEB in the region. Moreover, the result shows that life expectancy at birth reacts positively to one standard deviation shock in inflation within the 1st and 2nd periods but eventually reacts negatively in all the latter time periods. General price decreases may have been responsible for its positive reaction in the 1st and 2nd periods and later general price increases may have as well accounted for the negative reaction of LEB in the longer horizons. Life expectancy at birth to shock in inflation varies from 0.01 percent in the 2nd period to -0.07% in the 20th period. On a contrary note, shock in exchange rate results into a positive LEB in all the periods. The result implies that LEB is enhanced when the domestic currencies of the involved countries in sub-Saharan African countries rise at the cost of dollar (domestic currencies appreciation). Oduyemi and Owoeye (2020) finding is in tandem with this. On a similar note, this work further discloses that life expectancy at birth reacts positively in all the horizons to a standard shock in foreign direct investment (FDI), the effect varies from 0.01 percent to 0.25 percent. However, a standard shock in PREDFEM results into negative percent for LEB in the 1st and 5th periods and after all the negative value disappears and becomes positive in the latter horizons. The importance of primary education of female attainment which brings awareness to their household health status does not reflect in the short period but its importance manifests in the longer period through improvement in LEB. Life expectancy at birth, as indicated by the result, signals negative reaction to shock in population ages 15-64 in the short and long run periods. This implies that a shock to working population (15-64) reduces income in the region and hence its negative effect on LEB in the region. Its negative values range from -0.12% in the first period to -0.08 % in the longer horizons. Life expectancy at birth, in a similar manner, has negative reaction to government effectiveness (Institutional quality) in all the time horizons even though the impact is tiny as it varies between -.05% and -.09%. Life expectancy at birth's reaction to shock in GOEF is in agreement with the assertion of Whitford and Pozzi (2014) which states that health aid (health development assistance) only enhances growth (health outcome indicators inclusive e.g LEB) in a nation where good and sound government's institutional frameworks are practiced.

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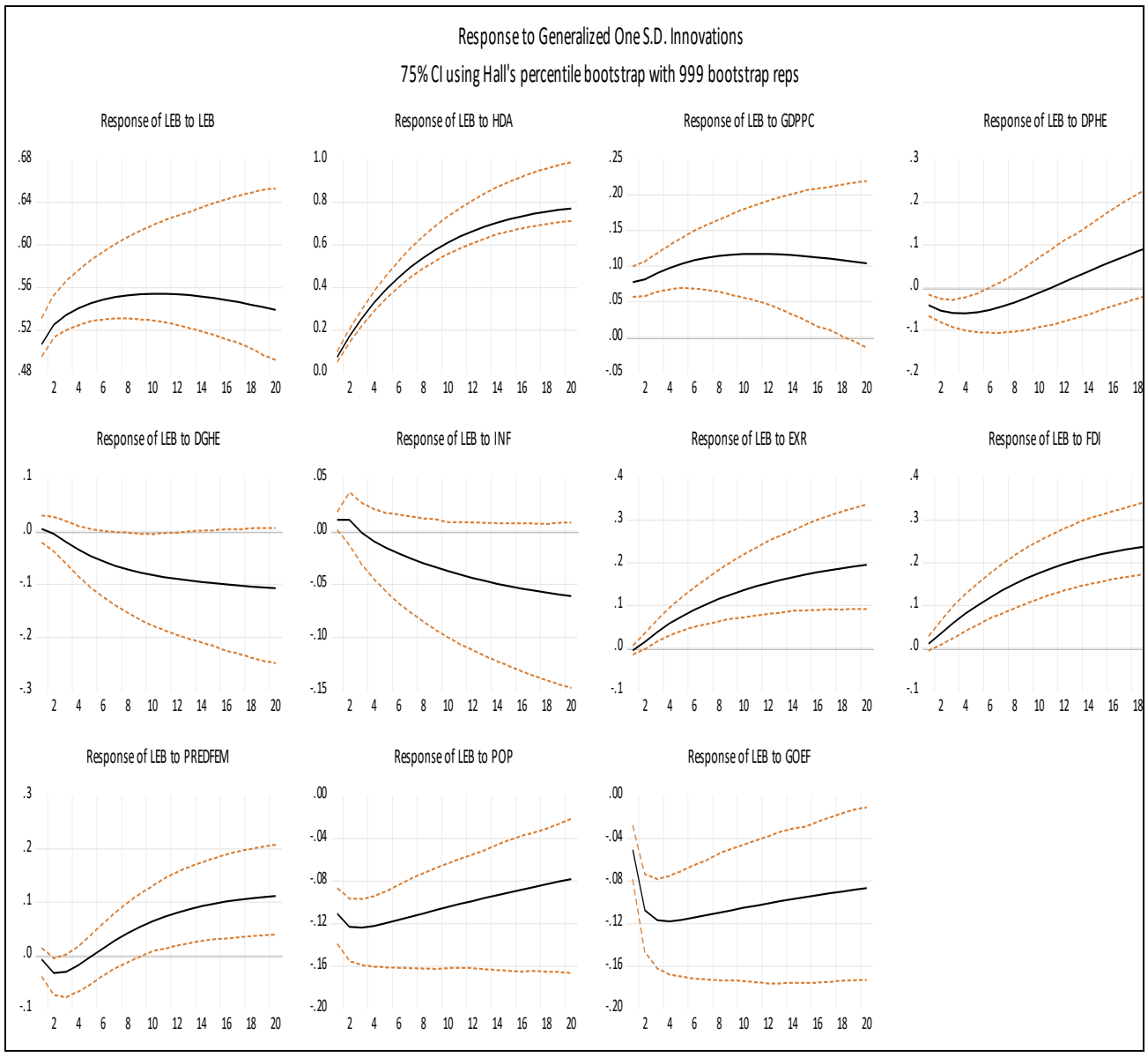

Figure 1: SSACs Impulse Response Function of life expectancy at birth to HDA and other explanatory variables

Response to structural one standard deviation innovations in LEB to external shocks (HDA and FDI) and other explanatory variables.

Note. LEB=life expectancy at birth; GDPPC= gross domestic product per capita; DPHE= domestic private health expenditure; DGHE= domestic government health expenditure; INF= inflation rate; EXR= exchange rate; FDI= foreign direct investment; PREDFEM= primary education of female; POP= population ages 15-64; GOEF= government effectiveness.

Variance Decomposition of Panel Structural VAR Results

This study employs forecast horizons of 1, 5, 10 ,15 and 20 ahead to evaluate the forecast error variance for each variable that is trackable to self-shock and to shocks in other explanatory variables in the model. The variance decomposition of panel structural VAR results below illustrates the account of forecast error variance of individual variable explained by the innovations to the structural equations. Table 5 reveals that LEB's own shock accounts for 90% of its forecast error variance in the 1st period and it slowly declines to 54.62% in the 10th period and its greater contribution further moderately declines in extended periods as it is responsible for roughly 45% and 40% in the extended periods of 15th and 20th. The table in addition discloses that POP ages 15-64 is briefly a main contributor in the forecast error decomposition of life expectancy

at birth in the 1st horizon while health development assistance (HDA) turns into main contributor starting from the 5th period to the remaining periods. Health Development Assistance, in the 1th, 5th and 10th, is responsible for 1.84%, 18% and 34% and its contribution rises very much in the extended horizons as it is responsible for about 42% and 47% of the forecast error variance of LEB in the 15th and 20th periods, appropriately. So, health development assistance is a primary contributor to variance decomposition of life expectancy at birth in nearly all the periods.

On a contrary note, population ages 15-64 is responsible for 4% in the 1st period nevertheless its contribution drops slowly in the extended or latter horizons as it accounts approximately for 1.82% and 1.44% in the 15th and 20th horizons, subsequently. Gross domestic product per capita contributes 2.10% in the 1st period nevertheless its additional influence slightly drops to 2.06% in the 5th horizon and this in furtherance declines to 1.96%, 1.75% and 1.55% in the 10th and longer horizons of 15th and 20th. So, health development assistance, population ages 15-64 and gross domestic product per capita hereafter account for significant percentage of life expectancy at birth forecast error variance throughout the periods. In addition, foreign direct investment is responsible for less than 1% in the 1st period notwithstanding this lower percentage its influences jump up in the subsequent horizons. In particular, foreign direct investment accounts for scarcely 0.03% in the forecast error variance of life expectancy at birth in the 1st horizon nevertheless its influences jump up slowly in the 15th and 20th periods as it accounts for about 3.51% and 4.18%, proportionately.

Domestic private health expenditure accounts for 0.61% and 0.78% in the 1st and 5th horizons, nevertheless, this slightly drops and jumps up in the 15th and 20th periods.to 0.27% and 0.43%. The results further reveal that the influences of domestic government health expenditure to forecast error variance of life expectancy at birth are 0.01% and 0.02% in the 1st and 5th periods and its influences slowly jumps up to 0.74% and 0.86% in the 15th and 20th periods. In a similar vein, inflation is responsible for 0.04% and 0.03% in the 1st and 5th horizons and this slowly jumps up to 0.16% and 0.22% in the 15th and 20th periods. Furthermore, exchange rate is responsible for 0.01% and 0.53% in the forecast error variance decomposition in life expectancy at birth in the 1st and 5t periods and this slowly jumps up to 1.43% in the 10th period and further hikes to 2.07% and 2.55% in the 15th and 20th periods. Primary education of female accounts marginally for 0.02% in the forecast error variance of life expectancy at birth in the 1st period and is slightly responsible for 0.12% in the 5th period and its contributions are further responsible for 0.50% and 0.72% in the subsequent horizons of 15th and 20th. Government effectiveness (institutional quality) accounts for almost 1% of the forecast error variance in life expectancy at birth in the 1st horizons and its contributions jump up tentatively to its climax of almost 2.78% in the 5th period and hereafter drops slowly in the subsequent periods as it accounts for almost 1.4% in every horizon of 15th and 20th, proportionately. Towards this end, Table 5 indicates the greater contributions of health development assistance shock (external shock) ahead of foreign direct investment (FDI) (another external shock) and domestic variables influences (economic variables (GDPPC, INF and EXR), social economic variables (DPHE, DGHE, PREDFEM and POP) and institutional variable (GOEF)) on health outcome indicator (proxy by life expectancy at birth) in sub-Saharan African countries. Table 5 signals that the influences of health development assistance fluctuations or shocks to the dependent variable (health outcome indicator proxied by life expectancy at birth) are more than other independent variables' influences starting from 5th period. It signals that health development assistance fluctuations or shocks contribute more significantly to the variation in LEB than other explanatory variables in Sub-Saharan African countries in all the horizons. If more additional concentration is focused towards it, greater contributions will also be derived from it.

Table 5: Results of Variance Decomposition with Structural Factorization: Variance Decomposition of LEB to HDA and other Explanatory Variables.

Period	LEB	*ln*HDA	*ln*GDPPC	DPHE	DGHE	INF	*ln*EXR	*ln*FDI	PREDFEM	POP	GOEF
1	90.14	1.84	2.10	0.61	0.01	0.04	0.01	0.03	0.02	4.30	0.90
5	70.81	18.02	2.06	0.78	0.20	0.03	0.53	1.06	0.12	3.62	2.78
10	54.62	33.56	1.96	0.42	0.55	0.10	1.43	2.51	0.23	2.48	2.16
15	45.38	42.08	1.75	0.27	0.74	0.16	2.07	3.51	0.50	1.82	1.38
20	39.85	46.84	1.55	0.43	0.86	0.22	2.55	4.18	0.72	1.44	1.38

Note. LEB=life expectancy at birth; GDPPC= gross domestic product per capita; DPHE= domestic private health expenditure; DGHE= domestic government health expenditure; INF= inflation rate; EXR= exchange rate; FDI= foreign direct investment; PREDFEM= primary education of female; POP= population ages 15-64; GOEF= government effectiveness.

7. DISCUSSION OF FINDINGS

The study found that impulse response shows that a shock to health development assistance results into positive effect on life expectancy at birth in all the periods (short, intermediate and longer) while the result for forecast error variance of life expectancy at birth reveals that in the short, intermediate and longer-time horizons, health development assistance fluctuations or shocks do responsible for greater percentage of change in life expectancy at birth of sub-Saharan African countries sampled in this study. The long run of 20 horizons considered in this study indicates that health development assistance fluctuations is responsible for the greatest (46.84%) of the forecast error variance decomposition in life expectancy at birth in the region. This implies that health development assistance fluctuations or shocks are not detrimental to the health outcome indicator used in this study (LEB). Premised on this fact, it is clear that negative health development assistance shocks do not pose any significant danger to the health outcome indicator in the region. The low forecast error variance of life expectancy at birth in the 1st period to health development assistance fluctuations in the region could have been accounted for by many factors. One, investment share of health development assistance allocated to life enhancing area of the people in these selected countries may be minimal. This implies that various governments of these countries did not invest much of the health development assistance in those life-enhanced health-related areas and this is in support of the finding (low health aid allocation) of ReCom Brief (2013). Second, Weiss and Pollack (2017) points out that embezzlement or looting of health development assistance by the government officials will hamper the expected improvements in health infrastructure and public health services and that this negative attitude and ugly trend will make health development assistance in the region less effective or unfruitful in the areas of promoting growth and development. The implication of embezzlement or looting of health development assistance received in the region is that government ineffectiveness reigns in most of the selected SSACs in this study. Third, diversions, misallocations or misappropriations of health development assistance from donors by these countries to other health targeted areas instead of investing it in the area of life enhancing health related area.

A positive shock of per capita income on health outcome indicator (LEB) is reasonable, the fact remains that higher income in a country allows households to take possessions of more goods and services, health inputs and drugs inclusive, all these result in the improvement of the household's health and in general ameliorates the standard of living and population's health in the region. Also, the positive shock of per capita income on LEB may have resulted because of the meager financial allocations to health sectors by most of the governments of sub-Saharan African countries which obliges or pressurizes people of the region to devote certain percentages of their income to meet their health needs. Domestic private health expenditure has larger negative impact than the positive impact on LEB while domestic government health expenditure shocks have negative impacts on life expectancy at birth in the region in all the horizons. It implies that shock in domestic private and government health expenditures resulted in almost reduction in LEB in the region. Inflation shocks also lead to negative life expectancy at birth. It implies that during general increases in the prices of goods and services in the selected countries, real income reduces and people get in their possessions less goods and services, health inputs inclusive and this reduces life expectancy at birth. Nevertheless, life expectancy at birth improves with the exchange rate shocks. This indicates that life expectancy at birth only improves when local currencies of the selected countries appreciate at the expense of dollar. Exchange rate appreciation (local currency appreciation) affords people to have access to cheaper consumable and non-consumable locally produced and imported products, medical facilities and drugs inclusive.

Similarly, positive foreign direct investment shocks improve life expectancy at birth. It implies that increase inflows of foreign direct investment results in higher employment opportunities, income and outputs growth and per capita income in the region and this makes people to have command over larger goods and services, health inputs, goods and services inclusive which in turn improves the health of the people of sub-Saharan African countries together with the living conditions of the people and hence improved LEB in the region. Trailing behind this is the positive and negative LEB which result from primary education of female shocks in the region. This suggests that shock in the number of female having elementary education in the region (awareness about their own and family members' health status) leads to mixed results (positive and negative values). Life expectancy at birth in the region worsens in the short period but improves in the intermediate and longer horizons. The effect of population ages 15-64 shock on LEB is negative. It indicates that decline in this population bracket has negative impacts on the outputs growth and per capita income in the region. This reduces the amount of goods and services individuals can afford and command in the region and hence results in lower standard of livings, lower population health and lower life expectancy at birth. Finally, the effect of government effectiveness shock (institutional quality) on life expectancy at birth is also negative. It implies that governments of sub-Saharan African

countries are less efficient and effective in proper monitoring of judicious applications of health development assistance received in the life enhancing focus area, thereby leading to embezzlements, diversions, misappropriations and misallocations of health aids. This results into reductions in the available health inputs and services, and hence deteriorated population health of the people of the region.

8. CONCLUSION AND RECOMMENDATIONS

The study x-rays the impact of health development assistance fluctuations (shocks) on life expectancy at birth in SSACs over the period 1990-2021 through the employment of PSVAR estimation technique which involves impulse response and forecast error variance decomposition. The study finds that health development assistance fluctuations (shocks) have enhancing impact on LEB in SSACs. Hence, health development assistance fluctuations (shocks) are of a fact either necessary or sufficient to describe the turnarounds that occur in health outcome indicators in SSACs. Hence, governments of SSACs need to promote their domestic factors that can boost their revenues and allow huge budgetary allocations to their health sectoral growth in the region so as not continue depending on HDA. Thus, health development assistance fluctuations play a significant role in transmitting shocks to the health sectors of SSACs. Also, most of the sub-Saharan African countries health systems are heavily dependent on out-of-pocket payments and governments health sectors spending in financing their health sectors. These mentioned two sources of financing health sectors in SSACs are parts of their governments fiscal systems which rely on the generated revenues from various productive sectors of their economies. When health development assistance fluctuations result into more available health resources (if it is not cornered or siphoned) in the region, it can help enhance health inputs and services and improvements in the health outcome indicators in the region. Also, the positive impact shock of per capita income on LEB may have resulted because of the meager financial allocations to health sectors by most of the governments of SSACs which obliges or pressurizes people of the region to devote certain percentages of their income to meet their health needs.

The subsequent recommendations are set forth in view of the recognized issues relating to the transmission mechanism through which health development assistance fluctuations affect health outcome indicators in sub-Saharan African countries (SSACs). Governments of SSACs should aggressively work towards the promotions of domestic factors that can boost their outputs growth (GDP) as these will result into increased budgetary allocations to the health sectors in the region and gradually face out their reliance on health aids from donors. The HDA fluctuations to the variance decomposition of LEB is significant one and its impulse response to LEB is also important so any factors (like embezzlements, diversions, misallocations and misappropriations) that may make it less significant have to be checkmated in the region. Due to the emanated results of Domestic Governments Health Expenditure (DGHE) fluctuations to LEB in the region in this study (manifestation of insufficient or acute financial allocations to the sector in the region), it is imperative and instructive that the various governments of SSACs should endeavour to jack-up and monitor their budgetary allocations to their various health sectors in their various fiscal policies as this will result into better growth of the sector. Governments effectiveness and efficient institutions that guarantee proper and efficient utilizations of allocated resources to their various health sectors' focal areas are required and this will enhance and guarantee the attainments of Millennium Development Goals in the region. Improved human capital development for medical, para-medical and other health personnels or workers should further be strengthened by the various governments of the region as this will guarantee additional values to the improvements of various health sectors of the region. Restructuring and annual increments of public expenditure allocations to the health sectors by various governments of the region in order to allow and guarantee more availability of health inputs (like health facilities, medical drugs, modern laboratories, modern equipment and others), more and better improved trained medical workers in the region.

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