World Academy of Science, Engineering and Technology
International Journal of Economics and Management Engineering
Vol:14, No:9, 2020

Maternal Health Outcome and Economic Growth in Sub-Saharan Africa: A Dynamic Panel Analysis

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***Abstract*—**Maternal health outcome is one of the major population development challenges in Sub-Saharan Africa. The region has the highest maternal mortality ratio, despite the progressive economic growth in the region during the global economic crisis. It has been hypothesized that increase in economic growth will reduce the level of maternal mortality. The purpose of this study is to investigate the existence of the negative relationship between health outcome proxy by maternal mortality ratio and economic growth in Sub-Saharan Africa. The study used the Pooled Mean Group estimator of ARDL Autoregressive Distributed Lag (ARDL) and the Kao test for cointegration to examine the short-run and long-run relationship between maternal mortality and economic growth. The results of the cointegration test showed the existence of a long-run relationship between the variables considered for the study. The long-run result of the Pooled Mean group estimates confirmed the hypothesis of an inverse relationship between maternal health outcome proxy by maternal mortality ratio and economic growth proxy by Gross Domestic Product (GDP) per capita. Thus increasing economic growth by investing in the health care systems to reduce pregnancy and childbirth complications will help reduce maternal mortality in the sub-region.

***Keywords*—**Economic growth, maternal mortality, pool mean group, Sub-Saharan Africa.

I. Introduction

FOR the past decades, the Sub-Saharan African countries have been stressed with poverty, access to quality health care, education, epidemic, hunger, infant mortality and maternal mortality. The United Nations statistics for Africa, 2015 reports that Sub-Saharan Africa (SSA) is the only region in the world where the population living below $1.25 a day has increased constantly from 290 million in 1990 to 445 million in 2010 [1]. According to the World Bank report 1994, no country or region could achieve high economic development with a population having high maternal mortality, low life expectancy and persistent sickness of its workforce [2].

Maternal mortality is one of the major elements of economic performance both at micro and macro levels. The inclusion of maternal mortality as a target for development and sustainability shows the strong association between maternal mortality and economic growth, and its importance in poverty reduction [3], [4]. The setting of specific target to reduce maternal mortality by 75% by 2015 and 70% by 2030 is to help reduce inequalities that exist between and within poor and developed countries and also show how it contributes to the losses to social and economic development [4], [5]

It is estimated that 303,000 women die from pregnancy and child birth related complications that are preventable, and developing countries account for roughly 302,000 representing 99% of the global estimate [4]. The rate of death of women aged between 15 yrs and 49 yrs in poor economies is estimated to be 15 times higher than that of developed or rich countries and also within countries, women from low income countries has a higher life time risk of dying when pregnant or immediately after childbirth [6]. The global maternal mortality estimates at 1990 was 385 per 100,000 live birth, by 2000 it was estimated to be 341 maternal deaths per 100,000 live birth and in 2015 it finally declined to 216 maternal deaths per 100,000 live birth. Despite the global progress, maternal mortality is still very high in SSA. In 1990, maternal mortality estimate for SSA was 987 which is three times the global estimate, by 2000 it was about 846 and in 2015 it was estimated to be 546 maternal deaths per 100,000 live birth which is also more than half of the global estimate [7], [8].

In SSA, the economic contribution of women to their families cannot be exaggerated, in the sense that; the death of women of reproductive age who are in active labour force contributes to a decrease in household investments accrued through mobilization of resources and personal savings [9]. Hence, reducing maternal mortality in developing economies should be seen as a major policy issue for economic development, since reduction of maternal mortality through intervention and investment in health will result in an increase in GDP which measures economic growth [10]. It is very necessary to concentrate on the economic effect of maternal mortality, which is measured by GDP, one of the major indicators of economic development. The impact of maternal mortality on economic growth in SSA should be of great interest to development professionals and policy makers. Thus in SSA, the loss of a woman has greater effect on household, the community and the economy at large, since women in the region assist their families through productive labour as part of their contribution to the national economy. According to [11], even with the global economic crisis in 2007 and 2008, the SSA region grew by 3% behind East Asia as the next fastest growing sub-region in the world. However, the WHO report on maternal mortality estimates shows that 18 countries in SSA still have high maternal mortality ratio raging between 500 to 999 deaths per 100,000 live births [7]. There is still gap in the literature which attempted to investigate the short run and long run effect of maternal mortality on the economy and also examine the burden of maternal deaths on economic

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growth in SSA. This study seeks to examine empirically, the short run and long run relationship between maternal mortality and economic growth in SSA and also find evidence for the hypothesis of a negative relationship between maternal mortality and economic growth by using current data.

This paper consists of five sections. The first section specifies the research gap and the purpose of the study. The second section discusses the theoretical and empirical literature of the study. The third section is on the methodological framework of the study. The fourth section discusses the results and major findings of the paper, and the fifth section focuses on the conclusion and policy implication of the study

II. Literature Review

The relationship between economic growth and maternal mortality has been an important area of research, both theoretically and empirically. This section of the paper provides a review on the link between growth and health, empirical studies on growth and maternal mortality; and the theoretical framework for the study

A. The Link between Health and Economic Growth

Since the early 1990s, numerous studies have tried to determine the factors that affect economic growth; and among these studies, health has been identified as one of the variables that significantly explain economic growth from the statistics point of view. Sustainable growth hinges on capital accumulation which is obtained through quality education, good health status, new knowledge acquisition and training process. Lopez et al. [12] have stated that the improvement in human capital is link to high capital investment which contributes to an increase in health and educational status. The importance of human capital was linked to only education, until the mid-1990s when authors such as Foge [13]; Barro and Sala [14] observed the impact of indicators such as nutrition and health on real GDP per capita. The investigation of the relationship between economic growth and health by these economists contributed to other studies concentrating on the connection between Growth and other variables such as health and wealth.

It is argued by Lopez et al. [12] that good health plays an important role in total wellbeing; and from the economic perspective, quality health has a positive impact on individual output and economic growth. This effect is through increase in human capital. Improved health, leads to high labour productivity which is contributed by a reduction in productive days lost due to paid sick leave, injury and weakness. However, having effective labour market is premised on having workforce that is healthy, energetic, physically and mentally fit. According to Scheffler [15], reducing the number of active labour force employed into manual jobs makes it difficult to handle the positive spillover effect of poverty. An improvement in health and health related indices will motivate individuals in society to accumulate more funds by means of mortality reduction and improvement in life expectancy. Thus, when labour force output and economic growth is indirectly improved, physical capital and savings in society is also expected to increase [16].

It is very necessary to understand the causal relationship between health and wealth; and also observe how these two variables relate to each other. The presence of endogeneity between these variable makes it very vigorous to analyse. Even though in the literature, good health is seen as a type of human capital that is positively related to productivity, income in the form of GDP per capita also has positive effect on health to some extent. Lopez et al. [12] have further stated that higher income is positively related to consumption of health associated goods like nutritious food and quality medicine. This will enhance standard of living and indirectly improve productivity in the work place. In the empirical literature, it has been observed that analysis on the causal relationship between health and per capita income is associated with statistical inconsistency and biasedness. This situation occurs when estimating the effect of the relationship between health and economic growth. The effect of the relationship between economic growth and health can be analysed either by an exogenous or endogenous growth models. Since this can occur during changes to stable state or within an environment with time based optimization, it will be very beneficial to examine their relationship with caution. The need to examine the relationship between maternal mortality and economic growth is drawn from the theory underpinning the relationship between health and economic growth, discussed in the theoretical literature. The link between maternal mortality and economic growth can be argued based on this theory. Improvement in maternal health care reduces maternal mortality levels. Reducing maternal mortality will indirectly increase maternal productivity and in effect increase economic growth.

B. Empirical Relationship between Maternal Mortality Economic Growth

The effect of maternal mortality on economic growth continues to demand attention both in the economics and public health literature, since there is some disagreement in the empirical literature. Many articles have been published over the past few decades arguing on the effect of maternal mortality on economic growth. Kiringa et al. [9] studied the effect of maternal mortality on economic growth measured by GDP in WHO Africa region using double log econometric model. The result of their analysis which was based on a cross-sectional data from UNDP and World Bank on 45 countries from the WHO Africa region showed that maternal mortality has significant effect on GDP per capita. The study also revealed that the maternal mortality of one person in the WHO Africa region will reduce per capita GDP by USD 0.36 every year. The result of their analysis further showed that effect of maternal mortality on economic growth measured by GDP per capita is negative and statistically significant.

Thompson and Sofo [17] used panel models such as Pooled Ordinary Least Square (Pooled OLS) and Least Square Dummy Variable (LSDV) regression model to investigate the effect of maternal mortality on economic growth in Africa.

The analysis of their study is based on panel data on 42 African countries. Data for their study were sourced from WHO, UNICEF, WDI and African year statistic book 2013. The results of their study demonstrated a significant negative relationship between maternal mortality and GDP per capita. Their study also showed that LSDV regression model is a robust model for estimating GDP loss associated with maternal mortality in Africa. The result of their study confirmed findings of previous studies [18], [19], [9]. Buor and Bream [20] also found that maternal mortality has significant effect on economic growth; they measured economic growth using GNP and GNI per capita.

Trondillo [21] explored the effect of maternal mortality and infant mortality on GDP per capita, using panel data for 193 UN countries spanning from 1960 to 2013. He fitted the panel data to a lag logarithm function regression. The result of his analysis showed that both maternal mortality and infant mortality predict GDP per capital. The analysis further established a significant negative relationship between maternal mortality and economic growth measured by GDP per Capita. He further observed that there are other factors which influence economic growth in UN countries, but the effect of maternal morality and infant mortality cannot be neglected, since they have significant effect of 2.32% to 4.81% on GDP per capita.

Another study by Amiri and Gerdtham [22] examined the impact of Maternal and Infant mortality on economic growth using the Baro framework, Grander Causality and DEA analysis on panel data for 170 countries from WHO database, spanning between 1990 and 2010. Their findings revealed that both maternal mortality and infant mortality have impact on economic growth. The empirical results showed that in 58% of the countries numbering 105, infant mortality has an impact on economic growth, while in 68 countries representing 40%, maternal mortality has an impact on economic growth. In 19 of the countries a two way relationship was found between maternal mortality and economic growth from the causality analysis. The study also showed no relationship between maternal mortality and economic growth among 33 countries, representing 33% of the sample. This result contradicts previous findings on the subject [2], [18], [23].

Another study is conducted in Sudan by Mohammed [24] to investigate the factors that influence maternal mortality. He analysed the relationship between maternal mortality and other explanatory variables affecting maternal mortality using OLS, cointegration methods of Johansen and ARDL bounds tests and Granger causality analysis. The OLS regression showed that GDP has significant effect on maternal mortality and the ARDL bound test for cointegration also established a long run relationship between maternal mortality and GDP. The results of the study also showed a bidirectional relationship between maternal mortality and economic growth measures such as GDP and GDPP.

Another study conducted by Sede and Irekpitan [25] examined the effect of economic growth on maternal mortality, using time series data from 1980 to 2015. The result of their analysis based on Grossman [26] model on health found no significant effect of economic growth measured by GDP on maternal mortality in Nigeria. However, unemployment rate was found to have significant effect on maternal mortality. Some of the results of their studies support the findings of Amiri and Gerdtham [3].

Further studies are conducted by Ensor et al. [27] to explore the effect of economic recession on maternal mortality and under-five mortality. They sampled 14 developed and developing countries. The results of their analysis based on the first difference logarithm model showed that economic recession is inversely related with maternal mortality and under-five mortality. The analysis further revealed a significant relationship between maternal mortality, under-five mortality and economic development between the period 1936 and 1965 but not afterwards. The analysis on individual countries showed some economic changes due to maternal mortality and under-five mortality. Individual countries such as Japan and UK were exposed to economic shocks in the post war era and nations like UK, Italy and US were slightly affected by economic shocks. The study established a negative relationship between maternal mortality, under-five mortality and economic recession and rather failed to explore the effect of income on maternal mortality over the period of study

C. Theoretical Framework

The neo-classical growth model, also known as exogenous growth model developed by Solow-Swan [28] assumed a production function with a diminishing return to capital, the degree of saving and population growth are measured as exogenous. According to Hashmati [29], in the neo-classical growth model developed by Solo and Swan [28], the level of per capita income across countries is measured by the degree of savings and population growth. In the Solow and Swam model, it is assumed that countries with increasing saving rate will have increasing per capita income if other factors remain unchanged and the long term economic growth also remains unchanged. Solow and Swan based on their model concluded that the introduction of exogenous technological changes can create long term growth, even if it does not exist.

The simple neo-classical model is expressed as follows

$$Q = AK^{\lambda}L^{\mu} \quad (1)$$

where Q represents total production, A represents total factor productivity, K represents capital input and L; labour input, the coefficients λ and μ represent output elasticity for labour and capital.

Solow and Swan observed that a rise in capital input will result in a rise in output and labour productivity, and changes in total factor productivity will lead to changes in labour productivity. However, when labour input increases, labour productivity will decrease because of diminishing return to scale. The Solow and Swan model is one of the early models developed to explain growth, but did not include other growth determining factors such as human capital. Due to this deficiency of the neo-classical growth model developed by Solo and Swan [28], Mankiw et al. [30] introduced another growth model known as the human capital augmented Solow and Swan model by adding variables such as education attainment. The inclusion of the human capital variable in the Solo and Swan model by Mankiw et al. [30] is meant to explain the variations in the degree of output across countries. The assumption is that countries with higher investment in education (human capital) are expected to have higher income levels, compared to countries with no investment in education.

The simple human capital augment Solo model is expressed as:

$$Q = K(t)^{\lambda} H(t)^{\mu} [A(t)L(t)]^{1-\lambda-\mu} \quad (2)$$

where Q represents Output, K(t) represents capital at time t, H(t) represents heath at time t, A(t)L(t) represents productivity augmented labour. The terms $\lambda,\mu\ \varepsilon(0,1)$ and $\lambda+\mu\ \varepsilon(0,1)$ represent time. This means that the three factors of production; Physical capital (K), human capital (H) and productivity–augmented labour (AL) in the production functions displays constant return to scale.

The growth model for the study is based on the human capital augmented model developed by Mankiw et al. [30]. The specified growth model which captures the relationship between maternal mortality and economic growth is extended further to add variable that are probable of affecting the long run economic growth in Sub-Sahara Africa countries.

III. Methodology

This section discusses the empirical structure of the model that captures the relationship between maternal mortality and economic growth, data analysis, sources and data type

A. Model Specification

In order to examine the relationship between maternal mortality and growth empirically, a panel data and modelling technique are adopted. According to Baltagi [31], panel data are appropriate since they capture both the time series and cross-sectional information in the data. They also increase the number of observation, the degrees of freedom and co-linearity among independent variables. However, Green [32] and Gujarati [33] argued that panel data improve empirical based analysis and make modelling of the activities of cross-sectional units easier than convectional time series analysis. To safeguard the data against cross-sectional dependency, endogeneity and heterogeneity a dynamic ARDL model is used to analyse the long run and short run relationship between maternal mortality and economic growth

To be able to explore the relationship between maternal mortality and economic growth, an augmented Solow and Swan model in the form of a Cobb Douglas production function is expressed as given in (3):

$$Y_t = K(t)^{\lambda} H(t)^{\mu} [A(t)L(t)]^{1-\lambda-\mu} \quad (2)$$

where Y_t represents aggregate output at time t, K(t) represents aggregate capital at time t, H(t) represents heath at time, A(t)L(t) represents productivity augmented labour. The terms $\lambda,\mu\ \varepsilon(0,1)$ and $\lambda+\mu\ \varepsilon(0,1)$ represent time.

The Cobb Douglas function is expressed in a regression analysis which is based on a panel regression framework by Mankiw et al. [30], Barro and Sala [14]; and David and Ampah, [34]. This is shown in (4):

$$GDPPP_{it} = GFCF_{it}^{\beta_1} MMR_{it}^{\beta_2} LEXP_{it}^{\beta_3} GEXP_{it}^{\beta_4} EDU_{it}^{5} LF_{it}^{\beta_6} NFDI_{it}^{\beta_7} \quad (4)$$

where GFCF is gross fixed capital formation, MMR is maternal mortality ratio, LEXP is life expectancy at birth, GEXP is government expenditure, EDU is mean years of schooling, LF represents labor force and NFDI is net foreign direct investment. By taking a logarithm of the variables in (2), a log-linear growth model is estimated, which is expressed in (5):

$$\Delta GDPPP_{it} = \propto_{it} + \beta_1 GFCF_{it} + \beta_2 lnMMR_{it} + \beta_3 LEXP_{it} + \beta_4 GEXP_{it} + \beta_5 EDU_{it} + \beta_6 LF_{it} + \beta_7 NFDI_{it} + \varepsilon_{it} \quad (5)$$

B. Data Type and Sources

The study used panel data set for 35 SSA countries spanning between 1990 and 2015. The study targeted all the 47 SSA countries. However due to data challenges only 35 countries were included in the empirical analysis. The data set on labour force, gross capital fixed formation, government expenditure, life expectancy at birth, infant mortality and net foreign direct investment were sourced from World Development Indicator of the World Bank [44], and Mean Year of Schooling data is sourced from UNDP [45]. 35 SSA countries included in the analysis are Benin, Botswana, Burkina Faso, Burundi, Cameroon, Central Africa Republic, Chad, Comoros, Congo, Cote d'Ivoire, Democratic Republic of Congo, Gabon, Gambia, Ghana, Guinea, Guinea Bissau, Kenya, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Senegal, Sierra Leone, South Africa, Sudan, Tanzania, Togo, Uganda, and Zimbabwe.

The study primarily relies on secondary data drawn from World Bank (World Development Indicator), WHO and UNDP databases. The data for the study are annual series data from 1990 to 2015 for 35 SSA countries.

C. Model Estimation

The study will estimate (3) using the ARDL dynamic panel error correction and Kao test for cointegration. The use of the dynamic error correction method is to separate the possible short-run and long-run effect of maternal mortality on economic growth. The ARDL model is appropriate since its regression is conducted by three different estimators, namely; Pool Mean Group (PMG), mean group estimation (MGE) and dynamic fixed effect (DFE) estimation. The panel ARDL estimation procedure gives room for country specific heterogeneity problem. This is because, when the measurement associated with cross-sectional and time series is reasonably large, the basic assumption on the homogeneity of the slope parameters related to the normal panel regression may not be accurate. Another advantage is that when estimating regression parameter with ARDL, the results are still valid even if the independent variables are endogenous. Again, the dynamic error model can be estimated using ARDL model which incorporate both the short-run and long run dynamics without any loss of information in the long-run.

TABLE I
DESCRIPTION OF VARIABLES IN THE MODEL

Variable	Description	Sources
GDP per capita (GDPPP)	GDP per capita measures the annual percentage growth rate of GDP divided by mid-year population which is based on constant 2010 U.S Dollars	WDI
Gross Fixed Capital Formation (GFCF)	Gross fixed capital formation is a measure which consists of plant, machinery and buying of equipment. It includes construction of roads, schools, offices, hospitals, commercial and industrial buildings.	WDI
Labour Force (LF)	LFs measure the percentage of the population aged between 15 and 64 who are active and productive.	WDI
Maternal Mortality Ratio (LMMR)	LMMR is a measure for women who die during pregnancy and after child birth per 100,000 live birth.	World Bank and WHO
Government Expenditure (GEXP)	Measured as general government final consumption expenditure	WDI
Net Foreign Direct Investment (NFDI)	NFDI is a measure of the sum of equity capital received from foreign in investors in an economy	WDI
Education (EDU)	Measured as mean years of schooling	UNDP
Life Expectancy at birth (LEXP)	LEXP at birth measured as the number of years a newborn infant would live if prevailing patterns of mortality at the time of its birth were to stay the same throughout its life.	WDI

D. Model Estimation Procedure

The study examines the long run and short run relationship between maternal mortality and economic growth using the ARDL framework of error correction model proposed by [35] and further modified by [36]. The first step is to test for the time series properties of the data by applying the Pesaran, Shin and Smith (IPS) [37], Fisher-Type Chi-Square and Levin, Lin and Cho test [38]. The purpose of these tests is to make sure that all the variables included in the analysis are integrated of an order applicable to the method of estimation. The next step is to test for short-run and long run relationship among the variable by using Kao [39] cointegration test.

E. ARDL Model Specification

The empirical analysis of long-run relationship and dynamic interactions of the variable for the study will be estimated using the ARDL model developed by [35] and further modified by [36]. The next stage of the ARDL estimation procedure is to test for the existence of cointegration among the variables. The study will use the Kao [39] test for cointegration before using the ARDL technique to determine the short run and long run relationship between economic growth and maternal mortality. The cointegration among the variable is determined by (5), which is specified as

$$\Delta GDPPP_{it} = b_0 + b_1 GDPPP_{it-1} + b_2 GFCF_{it-1} \; b_3 lnMMR_{it-1} + b_4 LEXP_{it-1} + b_5 GEXP_{it-1} + b_6 EDU_{it-1} + b_7 LF_{it-1} + b_8 NFDI_{it-1} + \sum_{i=1}^{p} \beta \Delta GDPPP_{it-j} \sum_{j=1}^{p} \delta \Delta GFCF_{it-j} + \sum_{j=1}^{p} \gamma \Delta lnMMR_{it-j} \sum_{j=1}^{p} \varphi \Delta LEXP_{it-j} \sum_{j=1}^{p} \sigma \Delta GEXP_{it-j} + \sum_{j=1}^{p} \phi \Delta EDU_{it-j} + \sum_{j=1}^{p} \theta \Delta LF_{it-j} + \sum_{i=0}^{p} \Omega \Delta NFDI_{it-j} + \mu_i + \varepsilon_{it} \quad (6)$$

where b_1, b_2, b_3, b_4 b_5, b_6 and b_7 represent the long-run multipliers, Δ represents the first difference operator, the coefficients $\beta, \delta, \gamma, \varphi, \sigma, \phi, \theta$ and Ω represent the short-run parameters. The parameter b_o is the drift constant term and p is the optimal lag length selected by Akaike's Information Criterion (AIC) and ε_{it} represent the white noise error term which is approximately N(0, σ^2)

F. The Long-Run and Error Correction Model

The long-run and error correction estimate of the ARDL model for the study and their asymptotic standard error are derived by (7) and (8):

$$\Delta GDPPP_{it} = \emptyset_0 + \sum_{j=0}^{p} \beta_1 GDPPP_{it-j} + \sum_{j=0}^{p} \beta_2 GFCF_{it-j} + \sum_{j=0}^{p} \beta_3 lnMMR_{it-j} + \sum_{j=0}^{p} \beta_4 LEXP_{it-j} + \sum_{j=0}^{p} \beta_5 GEXP_{it-j} + \sum_{j=0}^{p} \beta_6 EDU_{it-j} + \sum_{j=0}^{p} \beta_7 LF_{it-j} + \sum_{j=0}^{p} \beta_8 NFDI_{it-j} + \nu_{it} \quad (7)$$

$$\Delta GDPPP_{it} = \mu_0 + \sum_{j=0}^{p} \delta_{1j} \Delta GDPPP_{it-j} + \sum_{j=0}^{q} \delta_{2j} \Delta GFCF_{it-j} + \sum_{j=0}^{r} \delta_{3j} \Delta lnMMR_{it-j} + \sum_{j=0}^{s} \delta_{4j} \Delta LEXP_{it-j} + \sum_{j=0}^{t} \delta_{5j} \Delta GEXP_{it-j} + \sum_{j=0}^{u} \delta_{6j} \Delta EDU_{it-j} + \sum_{j=0}^{v} \delta_{7j} \Delta LF_{it-j} + \sum_{j=0}^{w} \delta_{8i} \Delta NFDI_{it-j} + \lambda ECT_{it-j} + \mu_i + \psi_{it} \quad (8)$$

where λ represents the speed of adjustment and ECT_{it-j} represents the error from the long run model estimated.

IV. EMPIRICAL RESULTS AND DISCUSSION

Table II presents a summary statistics of the variables in the study. The summary statistics are the minimum and maximum values, mean standard deviation, skewness, kurtosis, normal distribution, sum and sum square deviation. The mean value for GPD per capita, gross fixed capital formation, LF, LMMR, governments expenditure, NFDI, EDU and LEXP are 1.169%, 19.363% of GDP, 69.155% of total LF, 689 death per 100,000 live birth, 3.014% of GDP, 3.889 years and 54.529 years per 1,000 adults. The results showed that variables such as GDP per capita, LMMR and NFDI deviate narrowly from their mean. GDP per capital deviates on average from its mean by 5.197%, LMMR deviates from its mean by 406 deaths per 100,000 live birth and NFDI deviates from its mean by 5.392% and EDU by 2.131 years. The summary statistics results showed that variables such as gross fixed capital formation, LF and LEXP have high standard deviation, signifying a wide deviation from their means. The value of maternal mortality ranges between 23 and 2900 death per 100,000 live birth which is very high. The normal distribution, reported by Jarque-Bera statistic, shows that all variables are not normally distributed. A glance through the descriptive characteristics of the variables revealed that EDU and LF are leptokurtic, whiles GDP per capita, gross fixed capital formation, LEXP, LMMR, GEXP and NFDI are platykurtic having a kurtosis values greater than three. The total number of observation for the empirical analysis is 910 as indicated in the summary statistics results.

A. Results of the Panel Unit Root Test

The time series properties of the variables used in a time series analysis need to be investigated in order to safe guard against false results. The recommended test for verifying the stationarity of the variables is the unit root test. This study employed three panel unit root test, namely; Levin, Lin and Cho (LLC) [38], Im, Pesaran, Shin and Smith [37] and Fisher-Type Chi-square to ascertain the non-stationarity of the series. The assumption of these tests is that each individual variable included in the analysis are non-stationary on the basis of the null hypothesis. However, it also gives room for the individual effect, time effect and perhaps the time trend of the coefficients. The result for unit root test conducted at both level and first difference for LLC [38], Pesaran, Shin and Smith (IPS) [37] and Fisher-Type Chi-square shows that all the variables are stationary. The results presented in Table III shows that GDP per capita (GPPP) and NFDI are stationary at level, I(0) and GEXP, LF, LMMR, EDU and LEXP are also stationary at first difference or integrated at order one, I(1), indicating that an ARDL method can be used to investigate the relationship between the dependent and independent variables.

TABLE II
SUMMARY STATISTICS FOR SSA-35 COUNTRIES

	GDPPP	GFCF	LF	MMR	GEXP	NFDI	EDU	LEXP
Mean	1.169	19.363	69.155	689.557	14.097	3.014	3.889	54.529
Median	1.568	18.917	71.762	648.000	13.428	1.591	3.400	54.701
Maximum	37.536	60.018	91.542	2900.000	74.270	50.018	10.100	74.353
Minimum	-47.503	-2.515	42.220	23.000	0.911	-8.589	-1.400	27.610
Std. Dev.	5.197	8.525	12.457	406.132	7.007	5.392	2.131	6.823
Skewness	-1.299	1.021	-0.317	2.104	3.091	4.345	0.555	-0.129
Kurtosis	20.203	5.775	2.196	11.355	24.182	29.428	2.703	3.926
Jarque-Bera	11477.020	450.074	39.752	3318.162	18460.780	29346.580	50.016	35.013
Probability	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
Observations	910	910	910	910	910	910	910	910

Source: Eviews 10

TABLE III
RESULTS OF THE PANEL UNIT ROOT TEST

Variable	Statistic	Value	Probability	Order of integration	Conclusion
GDPP	LLC t*	-7.057	0.000	I(0)	Stationary
	Im, Pesaran and Shin W	-8.671	0.000	I(0)	Stationary
	ADF - Fisher Chi-square	175.589	0.000	I(0)	Stationary
GFCF	LLC t*	-9.887	0.000	I(1)	Stationary
	Im, Pesaran and Shin W	-10.565	0.000	I(1)	Stationary
	ADF - Fisher Chi-square	204.977	0.000	I(1)	Stationary
LF	LLC t*	-1.1986	0.000	I(1)	Stationary
	Im, Pesaran and Shin W	-2.1631	0.000	I(1)	Stationary
	ADF - Fisher Chi- square	73.0703	0.000	I(1)	Stationary
LMMR	LLC t*	-3.769	0.000	I(1)	Stationary
	Im, Pesaran and Shin W	-3.217	0.000	I(1)	Stationary
	ADF - Fisher Chi-square	89.282	0.000	I(1)	Stationary
GEXP	LLC t*	-4.306	0.000	I(1)	Stationary
	Im, Pesaran and Shin W	-13.543	0.000	I(1)	Stationary
	ADF - Fisher Chi-square	279.075	0.000	I(1)	Stationary
NFDI	LLC t*	-3.169	0.001	I(0)	Stationary
	Im, Pesaran and Shin W	-3.385	0.000	I(0)	Stationary
	ADF - Fisher Chi-square	90.316	0.001	I(0)	Stationary
EDU	LLC t*	-3.701	0.000	I(1)	Stationary
	Im, Pesaran and Shin W	-8.516	0.000	I(1)	Stationary
	ADF - Fisher Chi-square	175.914	0.000	I(1)	Stationary
LEXP	LLC t*	-30.132	0.000	I(1)	Stationary
	Im, Pesaran and Shin W	-31.549	0.000	I(1)	Stationary
	ADF - Fisher Chi-square	679.484	0.000	I(1)	Stationary

Source: Eviews 10

B. Panel Cointegration Test

Prior to estimating the long run relationship between the variables for the study, the Kao [39] cointegration test was used to examine the equilibrium relationship among the series. The Kao [39] cointegration assumes a null of no cointegration and offers a cointegration test that is based on residuals. The Kao [39] cointegration test permits the cointegration vector to vary across the panel group, in addition to dynamic and fixed effect difference across panel groups. The cointegration hypothesis of no cointegration test is based on the error term of the panel regression model for ADF and AD unit root test. Table IV presents the Kao cointegration test results.

TABLE IV
KAO PANEL COINTEGRATION TEST RESULT

	t-Statistic	Probability
ADF	-8.938	0.000
Residual variance	46.727	
HAC variance	16.207	

Source: Eviews 10

In Table IV, the result for the Kao [39] panel cointegration test for the null hypothesis of no cointegration is rejected at 1% significant level. This indicates that all the variables considered for the empirical analysis are cointegrated and their short and long run relationship can be estimated using the Panel ARDL Model.

C. Results of the Panel PMG-ARDL

TABLE V
RESULT OF PMG-ARDL (3,2,2,2,2,2,2,2)

Variable	Coefficient	Std. Error	t-Statistic	Probability
Long Run Equation				
GFCF	0.102	0.012	8.563	0.000***
LF	-0.048	0.070	-0.683	0.495
LMMR	-0.014	0.003	-5.572	0.000***
GEXP	0.034	0.012	2.802	0.0054**
NFDI	0.259	0.018	14.346	0.000***
EDU	0.645	0.144	4.490	0.000***
LEXP	0.388	0.092	4.239	0.000***
Short Run Equation				
COINTEQ01	-1.1450	0.1993	-5.7461	0.000***
D(GDPPP(-1))	0.1832	0.1251	1.4647	0.1442
D(GDPPP(-2))	0.0992	0.0793	1.2501	0.2123
D(GFCF)	0.2434	0.1625	1.4975	0.1354
D(GFCF(-1))	-0.1042	0.1214	-0.8587	0.3913
D(LF)	-24.0257	7.3607	-3.2640	0.0012**
D(LF(-1))	19.7151	8.1048	2.4325	0.0156
D(LMMR(-1))	-0.0132	0.0382	-0.3452	0.7302
D(GEXP)	-0.4577	0.1937	-2.3624	0.0189**
D(GEXP(-1))	-0.4212	0.2082	-2.0231	0.044**
D(NFDI)	-0.8135	0.5628	-1.4455	0.1495
D(NFDI(-1))	-0.8033	0.4089	-1.9647	0.0505*
D(EDU)	0.4428	5.7739	0.0767	0.9389
D(EDU(-1))	4.6672	6.0159	0.7758	0.4385
D(LEXP)	9.4840	13.0304	0.7278	0.4673
D(LEXP(-1))	-0.8657	12.4653	-0.0695	0.9447
C	-33.8713	6.5659	-5.1586	0.000***

Note: ***, **, * represents Significant level at 1%,5% and10% respectively
Source: Eviews 10

The ARDL estimation is carried out by three different regression estimators, namely; PMG, DFE Estimators and Mean Group (MG) estimators. The Pooled Mean Group panel [35] estimator is employed in this study since is appropriate, especially for panels with large N and T. Table V presents the short and long run estimates for the variables considered in the empirical analysis for the study.

The Panel PMG-ARDL was used to investigate the short run and long run dynamics between the dependent variable and its predictor variables. A critical look at the results of the PMG-ARDL model presented in Table V shows that almost all the long run results are significant as compared to the short run results. The only long variable which is not significant is LF. This shows that the long run results are more robust as compared to the short run results and thus, the discussion shall focus on the long run LMMR, LEXP and other control variables on economic growth considered in the empirical analysis. The result of the error correction term (ECT_{t-1}) in Table IV, which is a measure of the convergence of the model to equilibrium, shows that the predictor variables converge to their long term route by a magnitude of -1.140. The coefficient and the statistically significance of the error correction term (ECT_{t-1}) confirms the equilibrium relationship between the dependent and explanatory variables. This indicates that when GPPP is in disequilibrium the scheme adjusts back to equilibrium at a rate of approximately 114% annually. The coefficient value of -1.140 represents high level of adjustment to equilibrium. The long run PMG-ARDL panel model results showed that maternal mortality influences economic growth measured by GPPP negatively in the long run. The results also indicate that coefficient of LMMR is statistically significant at 1%, and the effect is negative as expected by the theory. When LMMR for SSA countries considered in the study increases by a percent, GPPP will decrease by 1.4%. This also means that in the long run a 1% increase in GPPP will reduce SSA sub-region will reduce maternal mortality 1.4%. This result is in line with findings of [40] and [19] who found that maternal mortality influences economic growth negatively in developing countries such as SSA. The results indicate that pregnancy and childbirth complications could be reduced if women are treated and properly diagnosed during pregnancy and after childbirth. Thus improvement in maternal health care services will affect economic growth in the long run. The results on LEXP confirms the prior sign of positive relationship between LEXP at birth and economic growth since the coefficient of LEXP in the long run is positive and statistical significant. The coefficient of 0.388 indicates that 1% increase in LEXP will increase economic growth measured by GPPP by 38.8%%. This means that increasing adult longevity in SSA region through investment in the health care system will increase economic growth. This result is consistent with the findings of previous studies [43]. The long run results on gross fixed capital formation (GFCF) and GEXP are positive and statistically significant. They influence economic growth positively at 1% significant level. The result confirms the findings of [41], [42], and [30]. The long run result for NFDI (GFCF) confirms the prior expectation that NFDI contributes to economic growth positively. This specifically shows that increasing NFDI in SSA will increase economic growth by 29.5% since there is large amount of foreign investment direct to developing countries of which

SSA is not an exception. The positive and statistically significant effect of EDU measured by mean years of schooling supports the result of studies such as [43] and [41]. They found EDU to positively influence economic growth. These results also support the assumption of the Slow-Swan augmented model, which states that countries with high investment in EDU have high income levels.

V. Conclusion and Policy Implications

This study examines the long run and short run relation between economic growth measured by GPPP and maternal mortality using panel dataset for 35 SSA countries spanning between 1990 and 2015. We also tested for the stationarity of the variables and the long run cointegration relationship of the variables considered in the study. The panel unit root test by LLC [21], Pesaran, Shin and Smith (PSS) [17] and Fisher-Type Chi-square showed that the variables used in the study are I(0) and I(1) variables. The panel coitegration test conducted using Kao [39] cointegration test showed that the variables are cointegrated in the long run. The run results according to PMG-ARDL estimator showed negative and statistically significant relationship between maternal mortality and economic group in SSA. This result is line with the theory on the relationship between health and economic growth, and the empirical finding of previous studies [9], [24]. The error correction coefficient (-1.1450) which is negative and significant statistically confirms the existence of a long run relationship between economic growth and maternal mortality. The results of the empirical analysis have shown that a cause of maternal mortality, a health indicator that measures economic performance will contribute to underdevelopment in SSA. However, policy makers should increase capital investment into health care services, such as maternal health care services and interventions to reduce maternal mortality since it reduction will contribute significantly to economic growth in the SSA region

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