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Does Poverty Matters in Maternal Health and Output Growth Nexus in sub-Saharan African Countries? A Panel ARDL Approach

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Abstract: This paper investigates the role of poverty in maternal health-output growth nexus in sub-Saharan African (SSA) countries. The study employs panel autoregressive distributed lag model (PARDL) and analysed a balanced panel data covering 21 countries from 1990 to 2018. The empirical results show that the coefficient on interaction between poverty and maternal health tend to be statistically significant both in the long run and short run. Although, the direction of the impact is positive in the long run but negative in the short run. This finding emphasizes that increased consumption expenditure reduces poverty which will in turn ameliorate maternal mortality rate leading to better maternal health in the long run.

Key words: Poverty, Maternal Health, Output Growth, Sub-Saharan Africa Countries, Panel ARDL.

1. Introduction

Women make up to 70 percent of labour force in Africa and are overrepresented in agricultural sector producing 80 percent of food in rural areas and as such death and disability of these women will constitute direct cost to the economy in these regions (Xundu, 2010). Maternal ill-health is mostly linked and associated with poverty, that is, most poor people find it difficult to access good health facilities due to reasons such as high cost of health care, location of clinics and high cost of transportation, limited number of trained health care workers and cultural barriers (Meyerhofer and Sahn, 2006). Despite the beneficial effects of keeping mothers in good health condition which include increase labour supply, productive capacity, and economic well-being of communities (Lule *et al.*, 2005), the rates of maternal mortality and morbidity and poverty are still high in developing countries especially in sub-Saharan African countries.

The availability of improved maternal health services will not only help to reduce the gap in numbers of maternal deaths between rich and poor people, but also reduce the economic effect on poor families, both of catastrophic payments owing to emergency care and of the death or disability of an important productive member of the household (Filippi *et al.*, 2006). Studies like World Bank (1999); Bloom and Sachs (1998); and Matthews Z. (2002) have showed that poverty and ill-health are intertwined and may have considerable impact on household income. This shows that poverty and low income can also cause ill-health (Pritchett and Summers, 1996). Women are not exempted from this vicious circle of poverty, rather they are at more risks due to the health challenges they face during and after pregnancy. Poverty and greater access to health care are identified by many scholars (Callister and Edwards, 2017; Meyerhofer and Sahn, 2006; Say, 2014; WHO, 2015) as the major determinants of maternal mortality and morbidity globally.

A number of extant literature on maternal health and output growth nexus (Amiri and Gerdtham, 2013; Kirigia *et al.*, 2006; Peter and Irekpitan, 2014; Trondillo, 2016) has continued to ignore the role of poverty as the probable source of high rate of maternal mortality and its consequence on output growth. Maternal health and poverty are interrelated and mutually interwoven. Maternal mortality is higher in women living in rural areas and among poorer communities WHO (2016). Poor women in remote areas are the least likely to receive adequate health care. This is especially true for regions with low numbers of skilled health workers, such as sub-Saharan Africa. WHO (2016) showed that millions of births in this region are not assisted by a midwife, a doctor or a trained nurse.

Several studies on poverty reduction and economic growth in Sub-Saharan Africa observed that reduction of poverty has significant positive impact on output growth (Basu and Mallick, 2008; McKay, 2013; Moser and Ichida, 2001; Odhiambo, 2011; Roemer and Gugerty, 1997). Also, Poverty and greater access to care are identified by many scholars like Say (2014), Callister and Edwards (2017), WHO (2015), Meyerhofer and Sahn (2006) as the major determinants of maternal mortality and morbidity globally. Studies like Odhiambo (2011), Nindi and Odhiambo (2015); Dhrifi (2014) and Dhrifi (2015) used per capita expenditure as proxy for poverty. This is consistent with the definition of poverty proposed by World Bank as the inability to attain a minimal standard of living when measured in terms of basic consumption needs (World Bank, 1990). This is due to unavailability of time series data on poverty in most developing countries.

Yet empirical research showing the combined shock effect of poverty and maternal health on output growth is limited in literature. Despite the beneficial effect of keeping mothers in good health condition, the rates of maternal mortality and morbidity and poverty in sub-Saharan African countries are still high. Thus, it is against this assertion that this study seeks to investigate the extent to which poverty matters in maternal health and output growth nexus in sub-Saharan Africa.

2. Literature Review

Maternal health refers to the health of women during pregnancy, childbirth and the post-partum period. It encompasses the health care dimensions of family planning, preconception, prenatal, and postnatal care in order to reduce maternal morbidity and mortality (WHO, 2012;2018). Maternal health includes prenatal care and postnatal care of the mother and of the child up to the age of five years (Fadeyi, 2007). Maternal health is also seen as a continuum of care for maternal, neonatal and child health, it requires access to care provided by families and communities, by outpatient and outreach services, and by clinical services throughout the lifecycle, including adolescence, pregnancy, childbirth, the post natal period, and childhood (Kerber *et al.*, 2007).

Poverty according to the World Bank encompasses not only material deprivation which is measured by an appropriate concept of consumption or in income but also low achievements in education and health. World Bank defines poverty in absolute terms as the situation of being unable or only barely able to meet the subsistence essentials of food, clothing, and shelter. They are counted as the total number living below a specified minimum level of real income—an international poverty line. That line knows no national boundaries, is independent of the level of national per capita income, and takes into account differing price levels by measuring poverty as anyone living on less than $1.25 per day or $2 per day in PPP dollars (Todaro and Smith, 2012).

Maternal mortality as defined by the World Health Organization refers to “the death of a woman while pregnant or within 42 days of a termination of a pregnancy, irrespective of the duration and site of the pregnancy, from any cause related to or aggravated by the pregnancy or its management but not from accidental and incidental causes” (Khama *et al.*, 2006; Ogunjuyigbe and Liasu, 2007; WHO, 2007).

Amiri and Gerdtham (2013) examined the impact of maternal and child health on economic growth using panel data analysis, granger casualty and data envelopment analysis on 180 countries- 42 High Income Countries (HIC), 38 Upper-Middle Income Countries (UMIC), 50 Lower Middle Income Countries (LMIC) and 50 Low-Income Countries (LIC). The study revealed that the relationships between maternal and child health outcomes and GDP run in both directions, with the majority running from maternal and child health to GDP. They also found evidence that the causal effects of GDP on maternal and child health outcomes are stronger in LICs and LMICs relative to HICs and UMICs, while the causal effect of maternal and child mortality on GDP is generally stronger in HICs and UMICs.

Spiteri and VonBrockdorff (2019) examined the relationship between economic development and health outcomes estimated using data on annual cardiovascular disease mortality in a panel of 27 European countries, over the period 2003 to 2014, together with per capita GDP levels in each country. The results showed that there is a statistically significant inverted U-shaped relationship, whereby as income increases mortality rates first rise, before declining at subsequent levels of development.

Dahlquist (2013) investigated whether economic growth reduces poverty: an empirical analysis of the relationship between poverty and economic growth by comparing economic development in 123 low- and middle-income countries across the globe from 2000 to 2009 using econometric cross-sectional regression analysis. Brazil is an example of a dual economy whose recent history is characterised by successful economic and public policies that have managed to reduce the level of extreme poverty. Structures of dualistic labour markets contribute to the preservation of the extreme poverty, thus they do have some explanatory power of the coexistence of poverty and growth.

Using different methods such as panel fixed effects and generalized methods of moments (GMM), Cruz and Ahmed (2018) investigated the impact of demographic change on economic growth and poverty. The study found that an increase in the working age population share and a reduction in the child dependency ratio are positively associated with an increase in GDP per capita growth with similarly positive effect on poverty reduction.

Skare and Druzela (2016) did a review on poverty and economic growth. They dwelt on the research issue of Kuznets (1955): The research found considerable variation in the poverty–reducing effectiveness of growth across time and authors. Also, their analysis speaks in favour of the fact that as growth occurs; poverty reduces no matter the level of inequality. The study concluded that growth is good for poverty alleviation but it is not enough. The extent to which growth reduces poverty depends upon how poverty is measured, and upon absorptive capacity of the poor, the pace and pattern of growth.

Ogundari and Awokuse (2018) examined the impact of human capital on economic growth in Sub-Saharan Africa (SSA) whether health status matters more than education. The study employed a dynamic model based on the system generalized method of moments (SGMM) and analysed a balanced panel data covering 35 countries from 1980–2008. The results showed that the two measures of human capital have positive effects on economic growth with health having relatively larger contributions than the impact of education.

Cole (2019) Using data for up to 134 developing countries between 1970 and 2015, revisited the effect of economic growth on health, focusing on infant mortality, life expectancy, and caloric consumption. The study employed two-stage models with instrumental variables. Results showed that five-year economic growth rates improve all three health outcomes, even after controlling for other important determinants and accounting for the possibility of reverse causality. Growth effects are largest for infant mortality rates.

Roemer and Gugerty (1997) examined the question of whether economic growth tends to reduce poverty in 26 developing countries for period of 5 years. They measured poverty by the incomes of the poorest 20 per cent and 40 per cent of the population. The analysis showed that an increase in the rate of per capita GDP growth translates into a one-for-one increase in the growth of average income of the poorest 40 per cent. GDP growth of 10 per cent a year is associated with income growth of 10 per cent for the poorest 40 per cent of the population. For the poorest 20 per cent the elasticity of response is 0.921; GDP growth of 10 per cent is associated with income growth of 9.21 per cent. These results give strong support to the proposition that growth in per capita GDP can be and usually is a powerful force in reducing poverty.

Using ARDL bounds testing approach to cointegration and ECM based granger causality methods, Nindi and Odhiambo (2015) examined the relationship between poverty reduction and economic growth in Swaziland during the period 1980–2011. The study found that economic growth does not granger cause poverty reduction in Swaziland either in the short-run or in the long-run. Rather, the study revealed a causal flow from poverty reduction to economic growth in the short run. These findings, nevertheless, are not unanticipated, given the high level of income inequality in Swaziland.

Using the ARDL-Bounds testing approach, Odhiambo (2011) investigated the dynamic relationship between economic growth, unemployment, and poverty reduction in South Africa from 1969–2006.The study found no evidence of a causal relationship between poverty reduction and economic growth in South Africa.

Ravallion and Chen (1997) carried out a study using cross-country regressions based on a sample of 62 developing countries. They showed that on average, a 1 per cent increase in per capita income led to a 3.1 per cent reduction in the proportion of people living below the conventional $1 a day threshold. They also found that the growth elasticity was even higher for lower poverty lines, suggesting that while growth overall helps the poor, it helps the extremely poor more than the moderately poor.

Moser and Ichida (2001) examined poverty reduction and economic growth in sub-Saharan Africa Employing a panel of 46 countries covering the period 1972-97. The study employed different techniques such as pooled OLS, standard generalised least squares, two-stage least squares (2SLS), fixed effect model and vector autoregression (VAR) model. The study confirmed a strong and robust relationship between economic growth and poverty reduction in sub-Saharan Africa, the analysis found that a 10 per cent increase in per capita GDP leads to a 1 & increase in life expectancy, a 3-4 per cent decline in infant mortality rates, and a 3-4 per cent increase in the rate of gross primary school enrolment. The results are robust for high- and low-income, as well as fast- and slow-growth, countries.

Kirigia *et al.* (2006) examined the effect of maternal mortality on GDP in WHO African region. The burden of maternal mortality on GDP was estimated using a double log econometric model. The study demonstrated that maternal mortality has a statistically significant negative effect on GDP.

Using ARDL econometric approach, Matthews O. *et al.* (2020) examined the long run effect of gender inequality, maternal mortality on inclusive growth in Nigeria using time series data spanning from 1985 to 2017. The results revealed that gender inequality and maternal mortality have negative impacts on inclusive growth in Nigeria.

Aftab. (2012) estimated the effects of poverty on pregnant women using hospital based cross-sectional data in obstetrics and gynaecology department of a tertiary hospital from Nov 2010 to April 2011. They interviewed 500 women between the ages of 14-45 who attended obstetric clinic for any problem or were admitted and the data were entered in a questionnaire. They used descriptive statistics and Chi-square for comparing categorical variables. The study showed poor educational, nutritional and other health indicators during pregnancy and post natal period in women of lower socioeconomic status as compared to those with upper socio economic status. They concluded that poverty is a key hindrance to women's wellbeing especially during pregnancy resulting in malnutrition, anaemia, low birth babies or foetal loss.

Fotso *et al.* (2009a) investigated maternal health in resources-poor urban settings, how women's autonomy influences the utilization of obstetric care services. They used primary data gathered from maternal health survey interview which was carried out on 1,927 woman out of (2482) in the slums of Nairobi, Kenya who had a pregnancy outcomes in 2004- 2005. The data were analysed using logistic regression model. They found that household wealth, education, and demographic and health covariate had strong relationships with place of delivery, the effects of women's overall autonomy, decision-making and freedom of movement. They also found that autonomy may not be a major mediator of the link between education and use of health services for delivery.

Fotso *et al.* (2009b) examined what does access to maternal care mean among the urban poor? Factors associated with use of appropriate maternal health services in the slum settlements of Nairobi, Kenya. A total of 1,927 women were interviewed, and 25 health facilities where they delivered were assessed. Ordered logit models were used to quantify the effects of covariates on the choice of place of delivery, defined as a three-category ordinal variable. The study revealed that apart from education and wealth, the main predictors of place of delivery was being advised during antenatal care to deliver at a health facility, pregnancy ''wantedness'', and parity. The influence of health promotion (i.e., being advised during antenatal care visits) was significantly higher among the poorest women.

Mojekwu and Ibekwe (2012) studied Maternal Mortality in Nigeria using simultaneous multiple regression and stepwise regression. The study found that delivery by a skilled health professional and educational attainment of women had more effect on maternal mortality ratio than the other factors. The study concluded that migration contributes significantly in improving births at hospitals, skilled birth assistance, and utilization of antenatal and postnatal care through the return flow of financial resources.

Klobodu *et al.* (2018) investigated the magnitude of the impact of maternal and child health on economic development in in 6 SSA countries using time series data from 1960-2012. The study employed vector error auto-regression models. The study found that the magnitude of child health to GDP per capita was generally huge than vice versa across countries in all income groups. The magnitude of the continuation of maternal health to GDPPC was higher than the impact of the reverse relationship for the lower middle-income countries and the upper middle-income countries. The study also revealed that the magnitude of the effect of GDPPC on maternal health was higher than the other way around only for the lower income countries.

Ebeh *et al.* (2020) examined poverty and maternal health in Nigeria (1986 to 2017) using vector error correction model and granger causality approaches. The study revealed that there exist long-run significant relationship between poverty and maternal health in Nigeria. The study further revealed that female literacy rate and female life expectancy at birth had a significant negative impact on maternal mortality rate. The granger causality tests revealed that there is bi-directional relationship between maternal health and poverty in Nigeria.

Izugbara and Ngilangwa (2010) examined women, poverty and adverse maternal outcomes in Nairobi, Kenya using secondary analysis of qualitative data of focus group discussions and in depth individual interviews. The results showed that urban poor women in Nairobi associate poverty with adverse maternal outcomes.

This study employs the Schumpeterian theory of growth to model the link between maternal health and output growth and the extent to which poverty matters in them. Howitt constructed a simple model illustrating the main ideas of Schumpeterian theory in 2005. The Schumpeterians are endogenous growth theorists and they believe that technological progress is endogenous and can vary from country to country. This theory emanated from the works of Aghion and Howitt (1998): Howitt (2000); Howitt (2002); Howitt (2005). Schumpeterian theorists attributed differences in growth rate between rich and poor countries to the rate of productivity growth and not rate of factors accumulation. The theory distinguished explicitly between physical and intellectual capital and also between saving, that causes growth in physical capital, and innovation, that causes growth in intellectual capital, which the first generation of endogenous growth theories lump together. It is based on the assumed creative destruction by arguing that new innovation leads to competitive edge by rendering obsolete previous innovation. It also considers the role of technology transfer- international diffusion of technology, a technology spill over a country enjoy from other country's innovation.

This theory implied that a country that is at the lower rand of the technology ladder can take advantage of the innovation that is been created already in other countries (Onisanwa, 2014). The difference between this theory and the neoclassical theory is that it assumes technological progress is endogenously determined. Unlike the neoclassical growth theory of Solow, the endogenous growth theories that predict growth rate is determined by the global technological progress. One of the advantages of the Schumpeterian theory over the neoclassical is that it attributed differences in growth rate between rich and poor countries to the rate of productivity growth and not rate of factors accumulation. Investment in research and development is significant to this end. Health is treated as a component of human capital and by this it contributes and predicts relative productivity and per capita GDP through productivity efficiency, skill accumulation, research efficiency and intensity, learning efficiency, school enrolment and savings (Howitt, 2005). Schumpeterian model identified six (6) channels through which the state of health in a country can affect its growth path. These channels are:

Productive efficiency, Life expectancy, Learning capacity, Creativity. Coping skills, and Inequality (Howitt, 2005).

3. Materials and Methods

Following the recent literature on maternal health and economic growth (Amiri and Gerdtham, 2013; Onisanwa, 2014; Trondillo, 2016) we take output growth as dependent variable and maternal mortality rate, female literacy rate, fertility rate, female life expectancy at birth, unemployment rate and poverty as explanatory variables. The model is specified in equation 1 below:

$$YG_{it} = \beta_0 + \beta_1 MMR_{it} + \beta_2 FLEB_{it} + \beta_3 FETR_{it} + \beta_4 UNEMP_{it} + \beta_5 FLTR_{it} + \beta_6 POVR_{it} + \lambda_i + \varepsilon_{it} \qquad 1$$

Equation (1) is our baseline model where *YG* representing output growth is measured using the Real Gross Domestic Product (GDP) per capita. *MMR* denotes Maternal Mortality Rate, *FLEB* is Female Life Expectancy at Birth, *FETR* is Fertility Rate, *UNEMP* is Unemployment Rate and *FLTR* is Female Literacy Rate. The term *i* represent each cross-sectional unit in SSA, *t* denoting time period, λ_i capture country specific effect, while ε_{it} is the error term. On the extent to which the level of poverty matters for the impact of *MMR* on output growth.

We further expanded equation (1) to include an interaction term between *MMR* and *POVR* (i.e., *MMR*POVR*).

$$\begin{aligned} YG_{it} = {} & \beta_0 + \beta_1 MMR_{it} + \beta_2 FLEB_{it} + \beta_3 FETR_{it} + \beta_4 UNEMP_{it} + \beta_5 FLTR_{it} + \beta_6 POVR_{it} + \\ & \beta_7 MMR * POVR_{it} + \lambda_i + \varepsilon_{it} \end{aligned} \qquad (2)$$

The emphasis in equation (2) is on the sign, magnitude and statistical significance of the interaction coefficient when compared to the sign, magnitude and statistical significance or otherwise of the coefficient on MMR. For a negative sign on the coefficient on interaction term, the indication is that increasing poverty is inducing the negative impact of MMR on economic growth and the reverse is likely to be the case when the sign is positive. Either of these positions however, depends on the outcome of the comparison with the coefficient on MMR.

3.1. Estimation Technique

The second objective of this study is to test whether the dynamics of the impact of MMR on output growth is sensitive to the level of poverty rate in SSA. To this end, the PARDL model in equation (2) was further extended to capture the role of poverty rate as shown below.

$$\Delta YG_{it} = \beta_{1i} + \sum_{j=1}^{p}\beta_{ij}\Delta YG_{i,t-j} + \sum_{k=0}^{q}\lambda_{ik}\Delta MMR_{i,t-k} + \sum_{k=0}^{q}\psi_{ik}\Delta POVR_{i,t-k} + \sum_{n=0}^{k}\gamma_{in}\Delta X_{i,t-n} + \delta_1 YG_{i,t-1} + \delta_2 MMR_{t-1} + \delta_3 POVR_{t-1} + \delta_4 X_{t-1} + \varepsilon_{1i,t} \quad (3)$$

$$\Delta YG_{it} = \beta_{1i} + \sum_{j=1}^{p}\beta_{ij}\Delta YG_{i,t-j} + \sum_{k=0}^{q}\lambda_{ik}\Delta MMR_{i,t-k} + \sum_{k=0}^{q}\psi_{ik}\Delta POVR_{i,t-k} + \sum_{k=0}^{q}\Psi_{ik}\Delta(MMR*POVR)_{i,t-k} + \sum_{n=0}^{k}\gamma_{in}\Delta X_{i,t-n} + \delta_1 YG_{i,t-1} + \delta_2 MMR_{t-1} + \delta_3 POVR_{t-1} + \delta_4 (MMR*POVR)_{t-1} + \delta_5 X_{t-1} + \varepsilon_{1i,t} \quad (4)$$

Equation (3.24) is an extended variant of the PARDL model in equation (2) and the essence is to control for the role of poverty rate (POVR) in the specification. However, while the variable for poverty rate was merely included as additional regressor in equation (3), it was later expanded in equation (4) such that the extent to which the level of poverty rate likely to influence the impact of MMR on economic growth is explicitly capture via an interaction between MMR and POVR.

The Error Correction Term (ECT) variants of equations (3) and (4) can be further represented as below while the underlying assumption remains as earlier discussed.

$$\Delta YG_{it} = \beta_{1i} + \sum_{j=1}^{p}\beta_{ij}\Delta YG_{i,t-j} + \sum_{k=0}^{q}\lambda_{ik}\Delta MMR_{i,t-k} + \sum_{k=0}^{q}\psi_{ik}\Delta POVR_{i,t-k} + \sum_{n=0}^{k}\gamma_{in}\Delta X_{i,t-n} + aECT_{t-1} + \varepsilon_{2i,t} \quad (5)$$

$$\Delta YG_{it} = \beta_{1i} + \sum_{j=1}^{p}\beta_{ij}\Delta YG_{i,t-j} + \sum_{k=0}^{q}\lambda_{ik}\Delta MMR_{i,t-k} + \sum_{k=0}^{q}\psi_{ik}\Delta POVR_{i,t-k} + \sum_{k=0}^{q}\Psi_{ik}\Delta(MMR*POVR)_{i,t-k} + \sum_{n=0}^{k}\gamma_{in}\Delta X_{i,t-n} + aECT_{t-1} + \varepsilon_{2i,t} \quad (6)$$

4. Result and Discussion

4.1. Unit Root Test Results

The suitability of the dynamic heterogeneous panel data model as earlier established in the context of this study was mainly informed by the probable non-stationarity feature of the variable under consideration. To this end, we herein follow the standard approach to modelling panel data with large time series (T) dimension by subjecting the relevant variables to unit root test. For robustness purpose, the present study considers four different types of panel unit root tests. As shown in Tables 1 and 2 for level and first difference tests, respectively, the first categories of panel unit root tests consider involves panel unit root with the null hypothesis of unit root with common process (Breitung, 2000; Harris and Tzavalis, 1999; Levin *et al.*, 2002).

The second category including Im *et al.* (2003), Maddala and Wu (1999) assumes unit root with individual unit root process, while the third also assumes unit root in the null hypothesis but in the presence of cross-section dependence (Pesaran, 2007). The fourth category however, tests the null hypothesis of no unit root with common unit root process (Hadri, 2000) (Lagrange Multiplier test). Based on their individual hypotheses and test regressions, these tests have been categorized into stationary (the fourth type) and nonstationary (first, second and third) tests.

Starting with MMR and output growth measured as log GDP per capita (LGDPPC) (YG), the unit root test results show that the latter is predominantly an [I(I)] series while the result is mixed in the case of the former particularly across the different panel unit root tests considered. Also, the poverty rate (POV) variable measured as log of private consumption expenditure is only stationary when the unit root test performed is ADF Fisher. However, while the order of integration also appears to be mixed for the control variables, particularly across the different unit root tests under consideration, it is instructive that the null hypothesis of unit root with cross-sectional dependence is only viable in the case of POV.

Table 1. Level Panel Unit Root Test results

Test method	*LGDPPC*	*LGPOV*	*MMR*	*LFETR*	*LFLEB*	*UNEM*	*FLTR*
Null Hypothesis: Unit root with common process							
LLC	-0.827	-0.571	1.666	-6.167***	-10.176***	-3.328**	-2.7687**
Breitung	6.625	9.404	-4.839***	7.686*	0.970	-3.676***	0.583
HT rho	0.921	0.958	0.677***	0.940	0.970	0.512***	-0.151***
Null Hypothesis: Unit root with individual unit root process							
IPS	-0.717	-0.448	-1.547	-2.253***	-1.181	-2.445***	-2.043***
ADF Fisher	5.287***	-1.931*	-0.880	2.646***	4.126***	1.573**	-0.945

Null Hypothesis: No unit root with common unit root process							
Hadri Z-stat.	65.345***	74.941***	13.406***	76.822***	67.117***	20.332***	41.638***
Null Hypothesis: Unit root in the presence of cross-section							
No. of Cross-section	21						
No. of Periods	29						
Total Observation	609						

Note: ***, **, and * indicate statistical significance at 1%, 5% and 10% respectively.

Table 2. First Difference Panel Unit Root Test Results

Test method	***LGDPPC***	***LGPOV***	***MMR***	***LFETR***	***LFLEB***	***UNEM***	***FLTR***
Null Hypothesis: Unit root with common process							
LLC	-8.151***	-7.655***	-11.494***	N/A	-1.893**	-0.151***	-11.441***
Breitung	-5.787***	-8.793***	N/A	-0.660***	-1.893**	N/A	-12.924***
HT rho	0.314***	-0.069***	N/A	0.586***	0.878	N/A	-0.415***
Null Hypothesis: Unit root with individual unit root process							
IPS	-3.097***	-3.358***	-3.698***	N/A	-0.685	N/A	N/A
ADF Fisher	-1.589**	2.872***	N/A	N/A	N/A	4.6950***	3.745***
Null Hypothesis: No unit root with common unit root process							
Hadri Z-stat.	21.067***	N/A	-1.630	N/A	N/A	-2.7766	-3.899
Null Hypothesis: Unit root in the presence of cross-section							
No. of Cross-section	21						
No. of Periods	28						
Total Observation	858						

Note: ***, **, * indicate statistical significance at 1%, 5% and 10% respectively, while NA implies non

4.2. Panel Co Integration Testing Results

The Pedroni's co integration test results reported in Table 3 indicate that except for panel v-statistics, panel rho-statistics, all other statistics are significant, so the null hypothesis of no co-integration is rejected. MMR, POVR, FETR, FLTR, FLTR, and UNEMP are co-integrated with GDPPC. Both panel PP-statistics and group PP-statistics have better properties; these two statistics are more reliable. The null hypothesis of no co-integration is rejected at 5% level by the panel PP-statistics within dimension and group PP-statistics between dimensions respectively. Also, the null hypothesis of no co integration is rejected at 1% and 5% levels of significance respectively. This result holds for panel ADF- statistics both at the within dimension and at group ADF-statistics between dimension. The Kao test also revealed the existence of co integration among the variables rejecting the null hypothesis of absence of co integration at 1% with T-statistic of -6.5395. We can therefore say that there exists a co-integration relation among the variables, hence a basis to consider both the short and long run dynamics of the nexus between MMR and output growth as demonstrated in the following subsection(s).

Table 3. Panel Co integration Test Results

Pedroni Alternative hypothesis: common AR coefs. (within-dimension)				
			Weighted	
	Statistics	Prob.	Statistics	Prob.
Panel v-Statistic	2.3628	0.0091	-1.0232	0.8469
Panel rho-Statistic	5.2913	1.0000	5.0723	1.0000
Panel PP-Statistic	-2.2299	0.0129	-0.2132	0.4156
Panel ADF-Statistic	-5.8669	0.0000	-1.0806	0.1399
Alternative hypothesis: individual AR coefs. (between-dimension)				
	Statistics	Prob.		
Group rho-Statistic	6.0400	1.0000		
Group PP-Statistic	-3.0474	0.0012		
Group ADF-Statistic	-1.7208	0.0426		
Kao Test Null Hypothesis: No Co integration				

	Statistics	Prob.		
ADF	-6.5395	0.0000		

Note: ***, **, * indicate statistical significance at 1%, 5% and 10% respectively.

4.3. Empirical Finding on the Extent to Which Poverty Matters in MMR-Output Growth Nexus

The quest here is to determine the extent to which the level of poverty rate in SSA matter for the impact of MMR on output growth. To achieve that, we interact the maternal mortality rate (MMR) and poverty rate variable as (MMR*POV), the Huasman test results in Table 4 revealed the DFE as suitable estimator compared to MG and/or PMG. The empirical result in table 4 also support the probable long run negative impact of MMR on output growth in SSA even when the model is expanded to include interaction term.

However, unlike our earlier finding where the evidence of significant impact of MMR on output growth appears to matter only in the long run, the empirical results in table 4 shows that when the estimated model was extended to include interaction term, then there is potential of direct and significant short run positive impact of MMR on output growth. On the extent which the impact of MMR on output growth is sensitive to the level of poverty rate in SSA, we find the coefficient on interaction term to be statistically significant both in the long run and short run. However, the direction of the impact is positive in the long run but negative in the short run. More so, the magnitude of the coefficient appears to be relatively higher in the long run at 0.89 compared to 0.17 in the short run. Intuitively, decline poverty rate via increasing private consumption expenditure may not immediately alter the negative impact of MMR on output growth except in the long run.

Table 4. Empirical Results

Long Run	**Mean Group (MG)**		**Pool Mean Group (PMG**		**Dynamic Fixed Effect (DFE)**	
	Coefficient	**Standard Error**	**Coefficient**	**Standard Error**	**Coefficient**	**Standard Error**
MMR	5.1730	4.7330	-1.1540	-1.5480	-1.4120***	0.1850
$FLEB$	5.3560	3.9740	-3.2800***	0.5690	0.5420*	0.2920
$FETR$	1.1230	0.9680	-4.4990***	0.5120	-0.0387	0.3980
$POVR$	0.2100*	0.1130	-0.0185	0.1080	0.4070***	0.0860
$UNEMP$	-0.9030	1.0050	0.0012	0.0054	0.0049	0.1230
$FLTR$	0.8030	0.5400	-0.6800***	0.1230	-0.3190	0.2410
$MMR*POVR$	-0.5650	0.5570	0.0658	0.1740	0.8910***	0.3320
ECM_{t-1}	-0.6470**	0.0824	-0.1540***	0.0452	-0.1490***	0.0180
$Constant$	-5.8710	7.4720	4.2810***	1.2490	0.2320	0.2220
Short Run						
ΔMMR	0.2040	1.0370	1.8680**	0.8430	1.7300***	0.4590
$\Delta FLEB$	-0.9920	2.6720	0.2080	1.1290	-0.2040	0.2370
$\Delta FETR$	0.2460	1.4990	0.1690	0.6200	-0.1690	0.2120
$\Delta POVR$	-0.0076	0.0390	0.2190**	0.0983	0.0729***	0.0241
$\Delta UNEMP$	-0.0271	0.0262	0.0314	0.0385	-0.0003	-0.0017
$\Delta FLTR$	-0.1330	0.1090	0.0171	0.0925	0.0357	0.0320
$\Delta MMR*POV$	-0.0106	0.1260	-0.2250**	0.1010	-0.1780***	0.0510
No. of cross Sections	21		21		21	
No. of Observation	567		567		567	
Hausman test - χ_k^2						
MG vs PMG: 7.52 (0.37)			**MG vs DFE**: 0.00 (1.00)		**PMG vs DFE:** 0.01 (1.00)	

Note: ***, **, and * indicate statistical significance at 1%, 5% and 10% respectively, while the value in parentheses is probability value for the Hausman test.

4.4. Summary of Findings

The study examined the extent to which poverty matters in maternal health-output growth nexus in this region and if there is causality between maternal health and output growth in this region. We employed a balanced panel data over 29 years (1990 -2018) for 22 countries. data were sourced from World Bank Development Indicators (WDI) online data base (WDI, 2018) on maternal mortality rate, fertility rate, female literacy rate, female life expectancy at birth, unemployment rate, and real GDP per capita (adjusted by PPP) covering the period.

The results of the unit root tests of Harris and Tzavalis (1999); Breitung (2000); Levin *et al.* (2002); Im *et al.* (2003), Maddala and Wu (1999) Hadri (2000) (Lagrange Multiplier test) and Pesaran (2007) showed that the variables were stationary at levels and first difference i.e. they are of mixed order of integration; I(0) and I(1).

From our models, we found that the variables used are co integrated, meaning that there is the presence of a long-run equilibrium relationship between maternal mortality rate, fertility rate, female life expectancy at birth, female literacy rate, unemployment rate and real GDP per capita. The coefficients on the error correction term (ECT) were all negative and significant across all the estimators which affirmed our pre –evidence of long run or co integrating relation between the maternal mortality rate (MMR) and output growth (YG) including the control variables captured in the nexus. It also showed that output growth will reverse to equilibrium state after a shock to it.

We studied these relationships further by delving into the issue of the role of poverty in the maternal health-output growth nexus by interacting maternal mortality rate with poverty. Our results point to the fact that the coefficient on interaction tend to be statistically significant both in the long run and short run. However, the direction of the impact is positive in the long run but negative in the short run. Meaning that poverty reduction through increasing private consumption expenditure may not immediately alter the negative impact of MMR on output growth except in the long run.

5. Conclusion and Policy Remark

The study examined the role of poverty between maternal health and output growth nexus in sub-Saharan Africa. It employed Panel Autoregressive Distributed Lag approach in testing for the role of poverty in the maternal health-output growth nexus in Sub-Saharan Africa.

The study used Real Gross Domestic Product per capita (discounted by PPP) as proxy for output growth, maternal mortality rate as proxy for maternal health. Other health variables used in the study were female life expectancy at birth, female literacy rate, fertility rate, unemployment rate, poverty proxied by per capita consumption expenditure.

The result of the co integrations tests Pedroni and Kao tests revealed that there exists long run association among the variables employed in the ARDL model, this was further confirmed by the coefficients of the error correction terms (ECT) which were all negative and statistically significant. The study also finds that poverty matters in maternal health output growth nexus only in the long run. Hence, increased consumption expenditure reduces poverty which will in turn ameliorate maternal mortality rate leading to better maternal health in the long run.

Government of the SSA should ensure that maternal mortality rate is reduced to the bearest minimum as specified in the sustainable development goals (SDGs). This can be made possible through provisions of good health care facilities for pregnant and nursing mothers, awareness campaign in the rural areas of the need to access good health during pregnancy and the postnatal period.

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