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Health performance and economic growth in sub-Saharan Africa: new evidence based on quantile regressions

Simplice A. Asongu[1] and Nicholas M. Odhiambo[2]

Abstract

The present study investigates the nexus between health performance dynamics and economic growth in 43 countries in sub-Saharan Africa for the period 2004-2018. Four health performance dynamics are used, notably: total life expectancy, male life expectancy, female life expectancy and risk of maternal death. The empirical evidence is based on quantile regressions in order to put into perspective the conditional distribution of economic growth.

The following findings are established: (i) total life expectancy and male life expectancy increase economic growth exclusively in the 10th and 90th quantiles of economic growth; (ii) female life expectancy boosts economic growth in the 90th quantile of economic growth and (iii) the risk of maternal death reduces economic growth in the 75th and 90th quantiles of economic growth. Policy implications are discussed. The study complements the literature on the nexus between health performance and economic growth by assessing the nexuses throughout the conditional distribution of economic growth.

Keywords: Military health performance; economic growth; sub-Saharan Africa; quantile regression

JEL Classification: D31; I10; I32; K40; O55

1. Introduction

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The motivational elements upon which the present study is articulated are twofold, notably: (i) the importance of economic growth in view of achieving objectives underlying the sustainable development goals (SDGs) agenda and (ii) the gap in the extant literature on the nexus between macroeconomic factors and economic growth[3]. These underpinning elements are expanded in the following paragraphs in the same chronological order as highlighted.

First, the growth of an economy is essential for the achievement of a plethora of SDGs, not least because the reduction of poverty and promotion of inclusive development from a broad standpoint is contingent on economic prosperity as well as the equal distribution of the fruits of the corresponding economic prosperity (Koengkan *et al*., 2022; Santiago *et al*., 2022). Specifically, in SSA, it is posited by Ravallion (2013) and Bicaba *et al*. (2017) that if most SDGs are to be achieved in SSA by the year 2030, economic growth rates as those experienced over the past two decades must be sustained. The present exposition, which is based on assessing the importance of health performance in economic growth, is also premised on a gap in the extant literature on the nexus between macroeconomic factors and economic growth.

Second, the extant literature on the nexus between macroeconomic factors and economic growth can be discussed in three main strands, notably: (i) poverty and economic growth (Ravallion, 2012; López & Servén, 2015; Fosu, 2015; Marrero & Servén, 2018; Asongu & Kodila-Tedika, 2017, 2018; Asongu & le Roux, 2019; Nwani & Osuji, 2020; Cerra *et al*., 2021; Asongu *et al*., 2021a; Ofori *et al*., 2021) ; (ii) income inequality and economic growth (Galor & Moav, 2004; Berg *et al*., 2012; Cingano, 2014 ; Halter *et al*., 2014; Kraay, 2015; Berg & Ostry, 2017; Berg *et al*., 2018 ; Brueckner & Lederman, 2018; Erman & teKaat, 2019 ; Aiyar & Ebeke, 2020; Cerra *et al*., 2021) and (iii) health performance and economic growth, especially as it pertains to the nexus between health expenditure on economic growth (Mayer, 2001; Gyimah-Brempong & Wilson, 2004; Huang *et al*., 2010; Mehrara *et al*., 2011; Amiri & Ventelou, 2012; Elmi & Sadeghi, 2012; Kouassi*et al*., 2018; Somé *et al*., 2019) and the linkage between health outcomes and economic prosperity (Bloom *et al.*, 2001, 2004; Acemoglu *et al*., 2007; Haung *et al*., 2010; Kimani-Murage, 2013; Bain *et al*., 2013; Amiri & Gerdtham, 2013; Usman *et al*., 2015; Somé *et al*., 2019).

[3]Economic prosperity and economic growth are used interchangeably throughout the study.

Given the above, health is increasingly acknowledged across the world as relevant in macroeconomic and individual prosperity (Piabuo & Tieguhong, 2017; Somé *et al*., 2019; Alhassan *et al*., 2020, 2021; Balsalobre-Lorente *et al*., 2020). Accordingly, there is some consensus within the remit of policy and academic circles on the importance of health access as a human right (Bloom *et al*., 2001; Well, 2007; Kouassi *et al*., 2018). However, the literature on the relevance of health performance in economic growth when existing levels of economic growth are considered is sparse, as apparent in the engaged literature in Section 2.3. Of these extant studies that are critically discussed in Section 2, the closest to the present positioning is Kouladoum(2023) which has assessed the effect of inclusive education on health performance in SSA to conclude that inclusive education promotes health performance in terms of life expectancy in the region.

In light of the above, of the considered studies in the extant literature, there is one main similarity with Kouladoum (2023) as well as two distinctive features with the underlying study. On the similarity front, both studies focus on SSA, while on the distinctive front, two differences are worth articulating: (i) the positioning of the study and (ii) the estimation approach. On the one hand, in terms of positioning, the present study is focused on the effect of health performance on economic growth instead of the impact of inclusive development on health performance as in the underlying study. It follows that the outcome variable of the underlying study is the independent variable of interest in the present exposition. Moreover, beyond considering life expectancy as the health performance indicator, the present study also engages the risk of maternal death as a complementary health performance indicator for robustness.

On the other hand, in terms of empirical strategy, instead of focusing on the mean value of the outcome variable (i.e., on a static outcome variable) from which the corresponding policy implications are based, the present study considers an estimation technique that allows the outcome variable to vary such that the nexus between health performance and economic growth is assessed throughout the conditional distribution of the outcome variable. In this sense, low, intermediate and high initial levels of the outcome variable are articulated. In essence, the estimation approach is oriented such that the response of economic growth to health performance depends on initial levels of economic growth. Within this remit, from a policy standpoint, it is argued that blacked policies on the nexus between health performance and economic growth are unlikely to succeed unless such policies are contingent on initial

levels of economic and, thus, tailored differently across countries with various initial levels of economic growth. Such an empirical positioning also departs from Odhiambo (2021) which does assess the nexus between health expenditure and economic growth throughout the conditional distribution of economic growth.

The remainder of the research is organized based on the following structure. Section 2 provides insights into the literature review surrounding linkages between poverty, inequality, health performance and economic growth. The data and methodology are engaged in Section 3, while Section 4 provides the empirical results and corresponding discussion. The study concludes in 5 with implications and future research directions.

2. Literature on poverty, income inequality, health and economic growth

2.1 Poverty and economic growth

The extant studies on the linkage between economic prosperity and poverty have reached a consensus, especially as it pertains to how poverty is unfavorable to long-term economic growth externalities (Cerra et al., 2021; Asongu& Eita, 2023). According to López and Servén (2015), from a panel of 85 nations from 1960 to 2000, an increase in the poverty rate by 10% reduces per capita income by approximately 1%. Accordingly, when the poverty rate grows, the corresponding investment rate in countries with comparatively low financial development reduces. Moreover, the negative influence of poverty on economic growth also depends on extant poverty levels. In another study, Marrero and Servén (2018) focused on a panel of 158 nations with data from 1960 to 2010. They established that in countries where poverty levels are below the median, poverty insignificantly influences economic prosperity, while in above-median countries, when the poverty headcount is reduced by 10%, economic growth increases by between 0.5% and 1.2% annually.

Ravallion (2012), in another research, has focused on 90 nations with data from 1991 to 2004 to show two distinctive characteristics that are inhibiting catch-up in poverty. This is amid comparative results showing that despite a global prospect in the reduction of poverty, cross-country variations in the rate of poverty are not characterized by catch-up (Cerra et al., 2021). Moreover, as argued by Cerra et al. (2021), in the presence of high poverty levels, economic growth has fewer incidences of reducing poverty, while according to López and Servén (2015), poverty mitigates economic prosperity. Asongu and Eita (2023) have assessed the conditional incidence of income inequality, poverty and severity of poverty on economic

growth for the period 1980 to 2019 using the quantile regression strategy to establish that the negative response of economic prosperity to poverty is a decreasing function of economic prosperity. Accordingly, the relevance of poverty in dampening economic prosperity reduces as economic prosperity increases.

2.2 Inequality and economic growth

In accordance with Cerra *et al*. (2021), the effect of income inequality on economic growth depends on the sectors of the economy. According to Erman and teKaat (2019) who have examined the effect of income inequality on industrial value added from 22 industries in 86 countries between 1980 and 2012. The findings of the study show that industrial growth rate is boosted by high inequality levels, especially in scenarios in which physical and capital resources are intensive, whereas, in the case of high use of skilled labour, the growth of industries is reduced by high income inequality levels. The underlying findings have been broadly confirmed by Galor and Moav (2004) at the country level.

Employing fixed effects regressions, Cingano (2014) has shown that economic growth is negatively affected by income inequality for the period 1970-2010 in a sample of 30 OECD (Organization for Economic Cooperation and Development) nations. It is also established by Berg *et al*. (2018), using a panel of developing and developed countries, that economic growth is negatively influenced by income inequality. Furthermore, the redistributive or moderating channels through taxes and transfers insignificantly influence economic prosperity. Moreover, Cerra *et al*. (2021) have shown that the income-growth nexus is contingent on initial levels of economic development. Brueckner and Lederman (2018), in another research, show that whereas economic growth could be favorably driven by extant income inequality, especially in poor transitional countries, the underlying income inequality no longer significantly affects economic prosperity in scenarios of higher average income levels.

Concerning the time horizon, it is established by Halter *et al*. (2014) that inequality favorably affects short-run economic prosperity. However, in the long term, the net impact of the inequality-growth nexus is negative. The extant literature maintains that economic prosperity duration spells are reduced by inequality in income levels (see Berg *et al*., 2012; Berg & Ostry, 2017), with a significant proportion of results coming from the difference of time as opposed to cross-country differences. It has also been established by Aiyar and Ebeke (2020)

that the negative incidence of inequality in income levels on economic prosperity considerably depends on the relevance of intergenerational mobility in the nexus. For instance, in countries that are characterized by higher intergenerational mobility, the negative incidence of economic growth of inequality can be reversed, especially given that the poor are provided with better opportunities for improved living standards. Kraay (2015), while acknowledging the lack of robust results on the linkage between income inequality and economic prosperity, provides insights surrounding endogeneity and weak instrument concerns beyond the underlying specification issues.

2.3 Health and economic growth

Consistent with the extant literature on the nexus between health and economic growth (Somé *et al*., 2019), the nexus between health dynamics and economic prosperity can be discussed in two main strands, notably: (i) the linkage between health expenditure and economic growth, and (ii) the connection between health outcomes and economic growth. The two strands are expanded in the same chronological order as highlighted in what follows.

The nexus positive nexus between health expenditure and economic growth is broadly confirmed by causality findings, notably: Elmi and Sadeghi (2012), who have shown that bidirectional causality is apparent in the nexus between health spending and long-run economic prosperity in developing nations for the period 1990-2009. Moreover, in a panel of 14 Southern African countries between 1995 to 2012, it has also been established by Kouassi *et al*. (2018) that the relationship is cointegrated.

There are also contradictory findings in the extant literature, as apparent from a study by Amiri and Ventelou (2012), who have shown that both in the long and short terms, health spending does not affect GDP. Moreover, there is another strand of literature that has shown causality from GDP to health expenditure, notably: Mayer (2001) on evidence of substantial causality between health expenditure and GDP in 18 countries in Latin America and Mehrara *et al*. (2011) with evidence of causality flowing from economic prosperity to expenditure for health purposes in countries that are wealthy in oil for the period 1971-2007.

In the second strand on the nexus between health outcomes and economic growth, Bloom *et al*. (2001, 2004) have established that health outcomes in terms of life expectancy are positively linked to economic growth. Conversely, Acemoglu *et al*. (2007) have not

confirmed the empirical evidence that life expectancy engenders an increase in per capita economic prosperity. Amiri and Gerdtham (2013) investigate how child and maternal health influence economic prosperity for the period 1990-2010 in 170 countries to show that a bidirectional nexus is apparent between GDP and the health standards of the child and mother with evidence of more significant causality from the latter to the former. Another group of researchers (e.g., Bain *et al*., 2013; Kimani-Murage, 2013) has looked into the relationship to establish that malnourished children negatively influence economic prosperity in Africa. According to Huang *et al*. (2010), economic growth in Africa is decreased by reduced life expectancy resulting from HIV/AIDS (i.e., Human immunodeficiency virus infection and acquired immunodeficiency syndrome) infections in 38 countries for the period 1980-2004. Usman *et al*. (2015) show in Nigeria, using data from 1961 to 2012, that a one-directional causality from life expectancy to economic prosperity is apparent. Somé *et al*. (2019), who consider both health expenditure and health outcome variables within the remit of 48 African countries for the period 2000-2015, concluded that governments should increase health spending both in terms of quality and quantity in order to engender externalities in economic prosperity.

Consistent with the narrative in the introduction and Section 2, while there is a substantial bulk of literature on the nexus between health measures and economic growth, such a nexus has not been considered when existing levels of economic growth are taken into account. Moreover, in the light of more contemporary extant health economics literature, this study has clearly articulated in the introduction how its positioning departs from Kouladoum(2023).

3. Data and methodology

3.1 Data

The study focuses on 43 countries in Sub-Saharan Africa based on data for the period 2004-2018[4]. The sampled countries and corresponding periodicity are motivated by constraints in the availability of data at the time of the study, notably; it is a combination of two datasets from Ngono (2021) and Kouladoum (2023) which are originally extracted from the Financial Access Surveyof the International Monetary Fund and the World Development Indicators

[4] The 43 countries are: "Angola, Benin, Botswana, Burkina Faso, Burundi, Cabo Verde, Cameroon, Central African Republic, Chad, Comoros, Congo Democratic Republic, Congo Republic, Côte d'Ivoire, Equatorial Guinea, Ethiopia, Gabon, Gambia, Ghana, Guinea, Guinea-Bissau, Kenya, Lesotho, Madagascar, Malawi, Mali, Mauritania, Mauritius, Mozambique, Namibia, Niger, Nigeria, Rwanda, Sao Tome and Principe, Senegal, Seychelles, South Africa, South Sudan, Sudan, Tanzania, Togo, Uganda, Zambia and Zimbabwe".

(WDI) of the World Bank. Accordingly, the mobile money variable originally from the former source is obtained from Ngono (2021) while the health performance indicators which are originally from the latter sourceor WDI are obtained from Kouladoum (2023).

Consistent with the motivation of the study and contemporary economic growth literature (Asongu& Eita, 2023), the outcome variable is the gross domestic product (GDP) growth rate. Still in line with the motivational elements articulated in the introduction, four main independent variables of interest are employed in the study, namely: total life expectancy, female life expectancy, male life expectancy and risk of maternal death. The choice of these variables is consistent with contemporary literature on health performance (Kouladoum, 2023).

In order to account for variable omission bias, the following factors are included in the conditioning information set in order to account for omitted factors, notably: mobile money, trade in services, inflation, savings, education and credit access. The variables have been documented in the extant economic growth literature to influence economic prosperity (Asongu, 2015;Efobi*et al*., 2019; Tchamyou*et al*., 2019b; Nyasha *et al*., 2021). The anticipated signs from the control variables are clarified in what follows.

First, mobile money innovations have been documented to drive economic growth and inclusive development in Africa (Asongu & Odhiambo, 2022). Hence, a positive sign on economic growth is anticipated. Second, while trade in services is expected to boost economic prosperity because the balance of trade is a constituent of GDP if the balance of trade is negative (i.e., more import of services compared to export of services), the opposite effect can be apparent. Third, while low and stable inflation is worthwhile for economic prosperity, extremely high levels of inflation and associated volatility are not conducive for economic growth, as apparent in the extant literature on the incidence of ambiguity (i.e., reflected by inflation) on individual and domestic economic prosperity (Kelsey & le Roux, 2017, 2018).

Fourth, while savings can drive economic prosperity, such a positive nexus is contingent on the ability of financial institutions to transform the mobilised savings into credit for economic operators (Tchamyou, 2019). Fifth, whereas education is naturally expected to boost economic prosperity (Asiedu, 2014), the overall incidence can also be contingent on the quality of education as well as on whether the outcome of education is employment. Hence, in situations in which high enrolment rates are not associated with employment, education may

not engender the expected positive nexus with economic growth. Sixth, while credit access drives economic growth, if financial institutions are characterised by concerns of surplus liquidity, the opposite effect can also be apparent (Tchamyou *et al*., 2019a).

The definitions and related sources of the variables are provided in Appendix 1,while Appendix 2 provides insights into the summary statistics. It is apparent from the summary statistics that the mean values of the variables involved in the regressions are comparable and by extension, it is obvious from the attendant standard deviations that reasonably estimated linkages can be expected from the regressions. Appendix 3 discloses the summary statistics that are used to inform the study of potential concerns of multicollinearity that are likely to influence the incidence of the independent and control variables on the economic growth outcome variable. Consistent with the extant literature on multicollinearity, a maximalist threshold of 0.700 is adopted as the cut-off point for the establishment of evidence of multicollinearity (Asongu *et al*., 2020, 2021b). It follows that, as apparent in Appendix 3, no correlation pair among the control variables on the one hand and, on the other hand, among independent variables of interest and control variables, exceed the 0.700 threshold.

3.2 Methodology

Following the elements of motivation provided in the introduction, especially as it pertains to departing from Kouladoum (2023), which is closest to the present positioning, the empirical strategy adopted in this study is one that is tailored to investigate linkages between health performance dynamics and economic growth when existing levels of economic growth are put in perspective. In other words, the empirical strategy is designed to assess the nexus between health performance and economic growth throughout the conditional distribution of economic growth. Given the underlying insights, the quantile regression (QR) estimation approach is selected because it has been documented in the extant QR-centric literature to assess nexuses between the independent variables of interest and the outcome variable when extant levels of the outcome variable are taken into consideration (Billger & Goel, 2009; Tchamyou & Asongu, 2017).

It is also imperative to emphasize that approaches to estimating panel data, such as the generalized method of moments, fixed effects regressions and ordinary least squares, *inter alia*, are premised on the average values of the outcome variable. However,in the light of the objective of this study, an estimated technique is required that examines the investigated

linkages throughout the conditional distribution of economic growth (Asongu& Eita, 2023). One shortcoming of the QR approach is that it is largely used to have global impacts and, therefore, country studies are required in order to establish policy implications that are country focused.

It is also worthwhile to articulate the perspective that, relative to the ordinary least squares (OLS) approach that is founded on the normal distribution of error terms, the QR approach is not based on the underlying assumption of error terms that are distributed normally. Furthermore, the attendant assumption is not characteristic of the QR approach because the considered parameters are examined throughout the conditional distribution of the outcome variable (Keonker & Hallock, 2001; Koenker & Bassett, 1978; Asongu, 2017). Accordingly, the θ^{th} quantile estimator of economic prosperity is derived by solving for the optimization problem in Equation (1), which is disclosed without subscripts for simplicity in the presentation.

$$\min_{\beta \in R^k}\left[\sum_{i\in\{i:y_i\geq x_{i'}\beta\ \}}\theta\left|y_i-x_{i'}\beta\right|+\sum_{i\in\{i:y_i<x_{i'}\beta\ \}}(1-\theta)\left|y_i-x_{i'}\beta\right|\right], \quad (1)$$

where $\theta\in(0,1)$. Relative to the OLS approach that is largely based on reducing the sum of squared residuals, a multitude of quantiles are examined at the conditional distribution of economic growth. To put the underlying into more perspective, based on the considered estimation approach, quantiles such as that 10th and 25th (with θ=0.10 or 0.25, respectively) are estimated by examining the residuals approximately.

In the light of the above, the conditional quantile of economic growth or y_i given x_i is:

$$Q_y(\theta / x_i) = x_{i'}\beta_\theta \quad (2)$$

where for the relative θ^{th} quantiles that are assessed, parameters that feature unique slopes are investigated. This formulation is orthogonal to $E(y/x)=x_{i'}\beta$ in the slope related to the OLS slope based on which the parameters are assessed at the mean values of the conditional distribution of economic prosperity (Asongu *et al*., 2021c). Accordingly, in Eq. (2), the dependent variable y_i is the economic prosperity indicator while x_i contains a constant term, *total life expectancy, male life expectancy, female life expectancy, risk of maternal death*, *mobile money, trade in services, inflation, savings, education and credit access*[5].

[5]We used the econometric software Stata 13.0 in our study and corresponding Stata command used is qreg.

4. Empirical results

4.1 Presentation of results

The empirical findings are provided in this section in Tables 1-2. Whereas Table 1 is concerned with the linkages between total life expectancy, male life expectancy and economic growth, Table 2 is focused on nexuses between female life expectancy, risk of maternal death and economic growth. Specifically, in Table 1, the left-hand side (LHS) focuses on the linkage between total life expectancy and economic growth, while the right-hand side (RHS) is concerned with the linkage between male life expectancy and economic growth. In the same vein, the LHS of Table 2 focuses on female life expectancy and economic growth, while the corresponding RHS is concerned with the linkage between the risk of maternal death and economic growth.

Table 1: Total life expectancy, male life expectancy and economic growth

	Dependent variable: Economic growth											
	Total life expectancy (TotalLE)						Male life expectancy (MaleLE)					
	OLS	Q.10	Q.25	Q.50	Q.75	Q.90	OLS	Q.10	Q.25	Q.50	Q.75	Q.90
Constant	3.204	-3.774	2.306	3.550	3.698	**7.604****	2.362	-6.293	1.948	2.168	4.618	**7.718****
	(0.426)	(0.600)	(0.665)	(0.420)	(0.499)	**(0.043)**	(0.581)	(0.414)	(0.744)	(0.636)	(0.413)	**(0.046)**
TotalLE	**0.117***	**0.194***	0.068	0.090	0.135	**0.116****	---	---	---	---	---	---
	(0.094)	**(0.077)**	(0.396)	(0.178)	(0.104)	**(0.040)**						
MaleLE	---	---	---	---	---	---	**0.127***	**0.244****	0.074	0.103	0.122	**0.111***
							(0.078)	**(0.034)**	(0.400)	(0.130)	(0.145)	**(0.050)**
Oaa1	**0.002****	**0.003***	**0.003****	**0.002****	0.0005	0.00007	**0.001***	0.002	**0.003****	**0.002****	0.0006	-0.0001
	(0.043)	**(0.081)**	**(0.026)**	**(0.024)**	(0.721)	(0.935)	**(0.052)**	(0.244)	**(0.031)**	**(0.026)**	(0.641)	(0.910)
Tradeserv	-0.0009	0.006	0.006	-0.043	0.026	**0.077***	-0.006	-0.005	-0.014	-0.048	0.055	**0.087****
	(0.981)	(0.940)	(0.921)	(0.397)	(0.675)	**(0.071)**	(0.882)	(0.946)	(0.825)	(0.353)	(0.383)	**(0.045)**
Inflation	**-0.112*****	-0.094	**-0.155*****	**-0.119*****	**-0.127*****	**-0.105*****	**-0.115*****	-0.097	**-0.152*****	**-0.134*****	**-0.115****	**-0.108*****
	(0.000)	(0.123)	**(0.001)**	**(0.002)**	**(0.007)**	**(0.001)**	**(0.000)**	(0.126)	**(0.003)**	**(0.001)**	**(0.015)**	**(0.001)**
Savings	-0.063	0.062	0.020	-0.046	**-0.128****	**-0.157*****	-0.062	0.024	0.005	-0.027	**-0.130****	**-0.149*****
	(0.245)	(0.410)	(0.710)	(0.325)	**(0.030)**	**(0.000)**	(0.261)	(0.754)	(0.925)	(0.554)	**(0.028)**	**(0.000)**
Education	**-3.850***	**-7.719****	-2.838	-2.669	-2.507	**-4.188*****	**-3.335***	**-6.406***	-2.049	-2.138	-2.865	**-4.055****
	(0.058)	**(0.013)**	(0.207)	(0.152)	(0.277)	**(0.009)**	**(0.090)**	**(0.053)**	(0.419)	(0.274)	(0.233)	**(0.014)**
Credit	**-0.036****	-0.0001	-0.023	-0.011	**-0.064*****	**-0.076*****	**-0.034****	-0.007	-0.027	-0.010	**-0.067*****	**-0.077*****
	(0.024)	(0.996)	(0.313)	(0.559)	**(0.008)**	**(0.000)**	**(0.026)**	(0.816)	(0.263)	(0.589)	**(0.004)**	**(0.000)**
R^2/Pseudo R^2	0.470	0.369	0.348	0.338	0.292	0.360	0.475	0.381	0.351	0.339	0.294	0.363
Fisher	**26.53*****						**28.21*****					
Obs	65	65	65	65	65	65	65	65	65	65	65	65

*,**,***: significance levels of 10%, 5% and 1% respectively. OLS: Ordinary Least Squares. R^2 for OLS and Pseudo R^2 for quantile regression. Lower quantiles (e.g., Q 0.1) signify nations where economic growth is least. TotalLE: Total life expectancy. MaleLE: Male life expectancy. Oaa1: Number of active mobile money agents per 100 000 adults. Tradeser: Trade in services. Obs: observations.

In both tables, the linkages between health performance and economic growth are assessed throughout the conditional distribution of economic growth such that initial levels of economic growth are put in perspective. It follows that initial levels of economic increase as one moves from the 10^{th} quantile to the 90^{th} quantile. In other words, the 10^{th} shows countries with the lowest economic growth, while the 90^{th}quantile shows countries with the highest economic growth. Compared to the corresponding OLS estimates, especially as it pertains to the significance, the sign of the significance and the magnitude of significance, the

justification for the choice of the QR technique is sound because the QR estimates are distinct from the attendant OLS estimates. It follows that estimates at the mean value of economic growth, as apparent in the OLS estimates, are distinct from estimated coefficients throughout the conditional distribution of economic growth, as apparent in the QR estimates.

Table 2: Risk of maternal death, female life expectancy and economic growth

	Dependent variable: Economic growth											
	Female life expectancy (FemaleLE)						**Risk of maternal death (RiskMD)**					
	OLS	Q.10	Q.25	Q.50	Q.75	Q.90	OLS	Q.10	Q.25	Q.50	Q.75	Q.90
Constant	4.086	-0.981	2.466	3.841	7.781	**7.268****	**11.261*****	2.923	6.423	**10.569****	**20.079*****	**20.216*****
	(0.276)	(0.887)	(0.632)	(0.351)	(0.145)	**(0.042)**	**(0.006)**	(0.588)	(0.129)	**(0.010)**	**(0.000)**	**(0.000)**
FemaleLE	0.106	0.078	0.067	0.088	0.075	**0.125****	---	---	---	---	---	---
	(0.115)	(0.468)	(0.398)	(0.168)	(0.359)	**(0.025)**						
RiskMD	---	---	---	---	---	---	-0.083	0.143	0.599	-0.181	**-1.246****	**-1.277*****
							(0.881)	(0.880)	(0.417)	(0.794)	**(0.037)**	**(0.007)**
Oaa1	**0.002****	**0.003***	**0.003****	**0.002****	0.001	0.0003	0.001	0.001	0.002	**0.004****	-0.0008	-0.001
	(0.035)	**(0.091)**	**(0.025)**	**(0.015)**	(0.258)	(0.740)	(0.299)	(0.561)	(0.294)	**(0.040)**	(0.661)	(0.420)
Tradeserv	0.004	0.038	0.007	-0.046	0.024	0.064	0.032	0.057	-0.016	0.065	**0.161****	**0.151*****
	(0.920)	(0.634)	(0.901)	(0.343)	(0.695)	(0.123)	(0.504)	(0.560)	(0.831)	(0.370)	**(0.010)**	**(0.002)**
Inflation	**-0.109*****	**-0.145****	**-0.154*****	**-0.119*****	**-0.108****	**-0.101*****	-0.063	-0.109	-0.058	**-0.160***	**-0.164****	**-0.173*****
	(0.000)	**(0.018)**	**(0.000)**	**(0.001)**	**(0.021)**	**(0.001)**	(0.362)	(0.402)	(0.565)	**(0.098)**	**(0.045)**	**(0.008)**
Savings	-0.065	0.101	0.020	-0.045	**-0.115***	**-0.166*****	-0.072	0.111	-0.036	0.021	-0.074	**-0.097****
	(0.227)	(0.185)	(0.720)	(0.310)	**(0.050)**	**(0.000)**	(0.266)	(0.247)	(0.627)	(0.765)	(0.208)	**(0.039)**
Education	**-4.307****	-3.820	-3.081	**-3.016***	**-4.048***	**-4.274*****	-5.424	-3.986	-2.963	**-6.759****	**-9.763*****	**-8.733*****
	(0.043)	(0.195)	(0.160)	**(0.086)**	**(0.074)**	**(0.005)**	(0.118)	(0.337)	(0.358)	**(0.030)**	**(0.000)**	**(0.000)**
Credit	**-0.037****	-0.003	-0.024	-0.011	**-0.047***	**-0.076*****	-0.027	0.010	-0.023	-0.025	**-0.098*****	**-0.102*****
	(0.025)	(0.899)	(0.295)	(0.552)	**(0.052)**	**(0.000)**	(0.206)	(0.813)	(0.505)	(0.433)	**(0.001)**	**(0.000)**
R^2/Pseudo R^2	0.464	0.359	0.345	0.337	0.290	0.358	0.329	0.246	0.286	0.254	0.237	0.349
Fisher	**24.84*****						**7.89*****					
Obs	65	65	65	65	65	65	58	58	58	58	58	58

*,**,***: significance levels of 10%, 5% and 1% respectively. OLS: Ordinary Least Squares. R^2 for OLS and Pseudo R^2 for quantile regression. Lower quantiles (e.g., Q 0.1) signify nations where economic growth is least. Oaa1: Number of active mobile money agents per 100 000 adults. Tradeser: Trade in services. Obs: observations.

The following findings are established in Tables 1-2: (i) total life expectancy and male life expectancy increase economic growth exclusively in the 10^{th} and 90^{th} quantiles of economic growth; (ii) female life expectancy boosts economic growth in the 90^{th} quantile of economic growth and (iii) the risk of maternal death reduces economic growth in the 75^{th} and 90^{th} quantiles of economic growth. Most of the control variables are significant and consistent with the narrative in the data section.

4.2 Further discussion of results

In order to further discuss the established results, these findings are further engaged in this section in three main strands, especially as it pertains to: (i) the positive nexus between health performance and economic growth; (iii) the nexus between maternal health and economic growth and (iii) the insignificant nexuses between health performance and economic growth. These strands are discussed in the same chronological order as highlighted.

First, the positive nexus between health performance and economic growth is consistent with a strand of extant health economics literature, notably: Somé *et al*. (2019), who have shown that both health expenditure and health outcomes promote economic growth; Elmi and Sadeghi (2012) on the bidirectional nexus between economic growth and health spending; Kouassi*et al*. (2018) on a long run cointegrated nexus and Bloom et al. (2001, 2004), Haung *et al*. (2010) and Usman *et al*. (2015)on a positive linkage between life expectancy and economic growth.

Second, the findings on the negative nexus between the risk of maternal death and economic growth are broadly consistent with another strand of the extant literature, notably Amiri and Gerdtham (2013), who have established that maternal and child health influence economic prosperity.

Third, with respect to the insignificant findings, which are more apparent in the middle quantiles of the conditional distribution of economic growth, it is worth mentioning that the insignificant findings are in line Acemoglu et al. (2007), who do not confirm the positive connection between increased life expectancy and growth in per capita income and Amiri and Ventelou (2012) who have shown that health spending does not affect GDP both in the long and short terms.

5. Conclusion and policy recommendations

The present study has investigated the nexus between health performance dynamics and economic growth in 43 countries in sub-Saharan Africa for the period 2004-2018. Four health performance dynamics are used, notably: total life expectancy, male life expectancy, female life expectancy and risk of maternal death. The empirical evidence is based on quantile regressions in order to put into perspective the conditional distribution of economic growth. The following findings are established: (i) total life expectancy and male life expectancy increase economic growth exclusively in the 10^{th} and 90^{th} quantiles of economic growth; (ii) female life expectancy boosts economic growth in the 90^{th} quantile of economic growth and (iii) the risk of maternal death reduces economic growth in the 75^{th} and 90^{th} quantiles of economic growth. Policy implications are discussed in what follows.

First, given that most of the significant nexuses are largely at the extreme points of the conditional distribution of economic growth, it implies that economic policy that is informed by econometric regressions based on mean values of the economic growth dynamics can be

misplaced, not least, because the nexuses should be contingent on initial levels of economic growth. It follows that blanket health-growth policies founded on average values of economic growth (i.e., neglecting extreme values of economic growth) are unlikely to succeed unless such policies are contingent on initial levels of economic growth and hence, tailored differently across countries with various levels of economic growth. In summary, low, intermediate and high-growth countries respond differently to health performance dynamics and hence, should be taken into account in policy formulation and implementation. In other words, in the assessment of how health performance is relevant in promoting economic prosperity, countries should first be classified into low, intermediate and high-growth countries, not least, because as apparent from the corresponding findings, the response of economic growth to health performance dynamics depends on extant levels of economic growth.

Second, based on the findings, more policy effort should be placed on countries with intermediate levels of economic growth in order for the anticipated positive incidence of health performance on economic growth to be realized. In essence, the considered policy measures could consist of enhancing health performance measures in countries with intermediate levels of economic growth on the one hand, and/or enhancing existing levels of economic growth to the 90^{th} quantile in order to engender the anticipated positive relevance of health performance on economic growth. The underlying can be achieved by simultaneously engaging measures designed to promote health performance with measures aimed at boosting economic growth such that, ultimately, with enhanced levels of the relevant health performance dynamics and economic growth, a positive nexus between the corresponding health performance dynamic and economic prosperity can be expected.

Third, male life expectancy is a more accurate driver of total life expectancy compared to female life expectancy. This is essentially because compared to female life expectancy, the findings of male life expectancy in terms of significance are more reflective of those of total life expectancy. The policy implication is that male life expectancy is a more accurate measure of total life expectancy compared to female life expectancy. In other words, in policy formulation, especially as it pertains to driving economic prosperity, policy makers should be more reliant on male health performance compared to female health performance.

Fourth, measures should be put in place in order to increase both the quantity and quality of health services to women, especially during pregnancy, not least because poor health

infrastructure and conditions of maternal health services are likely to increase the risk of maternal death and by extension, reduce economic prosperity. In summary, health measures that are designed to keep more women alive obviously engender more prospects for economic prosperity. Such policies can entail, *inter alia*, overseeing the health of pregnant women from the time they are pregnant to when they give birth. In other words, measures should be designed to carter for the health of women throughout the pregnancy cycle.

This study obviously leaves space for further studies, especially in relation to understanding how other economic sector indicators drive economic prosperity. Moreover, beyond macroeconomic sectors, dwelling on microeconomic studies can also be worthwhile in informing policy makers on how living standards can be improved at the microeconomic level. If follows that understanding how household health insurance and other individual health performance measures affect household income is a research step in the suggested direction. One principal drawback of the quantile regression approach is that it is designed to assess global incidences of how the independent variables of interest affect the outcome variables. Hence, it is also worthwhile to assess if the established findings withstand empirical scrutiny from country-specific standpoints buildings on the relevant, robust country-specific estimation techniques.

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Appendices

Appendix 1: Definitions and sources of variables

Variables	Definitions	Sources
GDP growth	Gross Domestic Growth (GDP) growth	WDI (World Bank)
Total life expectancy	Life expectancy at birth, total (years)	WDI (World Bank)
Male life expectancy	Life expectancy at birth, male (years)	WDI (World Bank)
Female life expectancy	Life expectancy at birth, female (years)	WDI (World Bank)
Risk of maternal death	Lifetime risk of maternal death (%)	WDI (World Bank)
Active agents 1	Number of active mobile money agents per 100 000 adults	Financial Access Survey
Trade in services	Trade in services (% of GDP)	WDI (World Bank)
Inflation	Inflation, consumer prices (annual %)	WDI (World Bank)
Savings	Gross savings (% of GDP)	WDI (World Bank)
Education	School enrollment, secondary (gross), gender parity index (GPI)	WDI (World Bank)
Credit	Domestic credit to private sector by banks (% of GDP)	WDI (World Bank)

WDI: World Development Indicators. GDP: Gross Domestic Product.

Appendix 2: Summary Statistics

	Mean	S.D	Min	Max	Obs
GDP growth	4.467	5.168	-46.082	37.998	637
Total life expectancy	58.905	6.458	42.595	74.514	645
Male life expectancy	57.086	6.102	40.418	71.300	645
Female life expectancy	60.720	6.889	44.846	80.200	645
Risk of maternal death	2.704	1.770	0.082	9.716	602
Active agents 1(Oaa1)	171.339	227.829	0.000	1046.332	125
Trade in services	17.755	15.084	2.855	114.719	560
Inflation	8.114	18.556	-8.974	379.999	625
Savings	18.462	11.965	-19.902	57.850	506
Education	0.880	0.206	0.332	1.388	380
Credit	18.906	17.242	0.007	106.260	620

SD: Standard Deviation. Min: Minimum. Max: Maximum. Obs: observations.

Appendix 3: correlation matrix (uniform sample size: 58)

	GDPg	TotLE	MaleLE	FemaleLE	RiskMD	Oaa1	Tradeserv	Inflation	Savings	Educ	Credit
GDPg	1.000										
TotLE	0.090	1.000									
MaleLE	0.167	0.988	1.000								
FemaleLE	0.007	0.986	0.950	1.000							
RiskMD	0.323	-0.535	-0.444	-0.615	1.000						
Oaa1	0.130	0.127	0.134	0.113	-0.139	1.000					
Tradeserv	-0.047	0.427	0.393	0.454	-0.355	0.329	1.000				
Inflation	-0.296	0.263	0.251	0.270	-0.442	0.100	0.052	1.000			
Savings	-0.341	-0.080	-0.101	-0.054	0.037	-0.143	-0.187	0.428	1.000		
Educ	-0.430	-0.005	-0.123	0.113	-0.621	0.218	0.341	0.315	0.147	1.000	
Credit	-0.184	0.375	0.292	0.456	-0.485	-0.124	0.444	-0.200	-0.144	0.188	1.000

GDPg: Gross Domestic Product growth. TotalLE: Total life expectancy. MaleLE: Male life expectancy. FemaleLE: Female life expectancy. RiskMD: Risk of maternal death. Oaa1: Number of active mobile money agents per 100 000 adults. Tradeser: Trade in services. Educ: Education.