Public Health Expenditure and Economic Growth in Tanzania: Evidence from Autoregressive Distributed Lag And Causality Approaches

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Abstract

This article investigates the effect of public health expenditure on economic growth in Tanzania using time series data from 1980 to 2017, extracted from the World Bank database. Co-integration and Autoregressive Distributed Lag Model in Error Correction Model framework was employed in the analysis. The results revealed a significant positive effect of the lag of public health expenditure on economic growth in the short-run, while there was an insignificant effect of the relationship in the long-run. The study also found that improvement in health status has a significant positive impact on economic growth, supported by the causality results. Concerning the causality test, it was found that there was a bidirectional relationship between public health expenditure and economic growth; and between health status (infant mortality) and economic growth. This strictly signifies the effectiveness of government spending on health on economic growth, through enhancing worker productivity and output. Besides, rising household consumption expenditure was found to have a significant positive impact on boosting economic growth in Tanzania. However, the revealed insignificant long-term coefficient of public health expenditure on economic growth should not necessarily be taken as a reason to reallocate health expenditure from the health sector. Based on the findings, the study recommends that for Tanzania to sustain its economic growth, it needs to pay attention to measures that would improve the health of its citizens through allocating adequate budgetary expenditure to the health sector. Nevertheless, this has to go hand in hand with the establishment of a strong institutional system to ensure effective utilization of the allocated resources.

Keywords: *public health expenditure, economic growth, co-integration, Tanzania*

1. Introduction

Sustainability of economic growth depends much on the strength of human capital of a country. Health has long been valued as a critical aspect for improving individuals' welfare and economic growth of a country (Bloom et al., 2004; Sahnoun, 2018). There is a theoretical argument that increasing human capital through health spending can achieve such growth. Thus, healthy workers have economic growth benefits; therefore, this requires extensive

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government involvement to ensure adequate health investment to improve people's health status. Many countries have designed different strategic plans and reforms to reconcile societal health needs and economic development as declared under the Sustainable Development Goals (SDGs). However, the level of health investment needed to achieve a substantial healthy population for increasing productivity, and ultimately income per capital, have remained a big challenge, especially for emerging economies (Tandon & Cashin, 2010).

Over the past decades, Tanzania has made a considerable effort in reforming the healthcare system aimed at improving the health status of the citizens. The central goal has been to provide basic primary health care to achieve universal health coverage (UHC). However, despite the commitment to increase investment in health, the share of public spending on health has remained relatively minimal and fluctuates over time. In Tanzania, the health sector has been less prioritized in terms of budget allocation compared with other sectors such as infrastructure and education (WHO, 2010). Available statistics show that in the past ten years (2008-2017), the average share of the government budget on the health sector was at around 8.9% of the total government budget. Subsequently, it was found to decline in 2018 to an average of 7.0% of the total budget (Lee et al., 2018). In terms of GDP, public health expenditure increased from 2.56% of GDP in 2011/13 to 3.5% in 2015/16 (URT & UNICEF, 2018). This was lower than the 5% of GDP suggested by United Nations (UN) to achieve UHC and economic wellbeing. Also, Tanzania's spending on health is still less than half the 15% recommended in the Abuja Declaration (Mcintyre et al., 2017). As emphasized in the health-led-growth hypothesis, health is wealth.

Figure 1 presents a trend analysis of government health expenditure and per capita GDP in Tanzania from 2000 to 2016. It provides a clear picture of the behaviour of the trend in economic growth given the budget expenditure allocated to health. As suggested in Wagner's theory (1883) of increasing state activities, as income (GDP per capita) increases, the share of public expenditure in various sectors of an economy is expected to grow too. Therefore, a country should increase the percentage of its public spending on health due to increase in real income. This has not been the case for Tanzania, as shown in Figure 1.

Despite efforts made by the government to allocate expenditure on health, its contribution towards improved health status is marginally low, and thus it has not been possible to determine the magnitude of its impact on economic growth over time. Literature investigating the growth impact of health investment provides mixed and inconclusive results (Cooray, 2009:13; Pritchett & Summers, 1996). While some studies have found a positive effect of health expenditure on economic growth, others have surprisingly found a weak or negative relationship. In the case of Tanzania, literature relating to health and economic growth is relatively scarce. Existing studies on human capital have been restricted to the education component, leaving a gap on the specific effect of

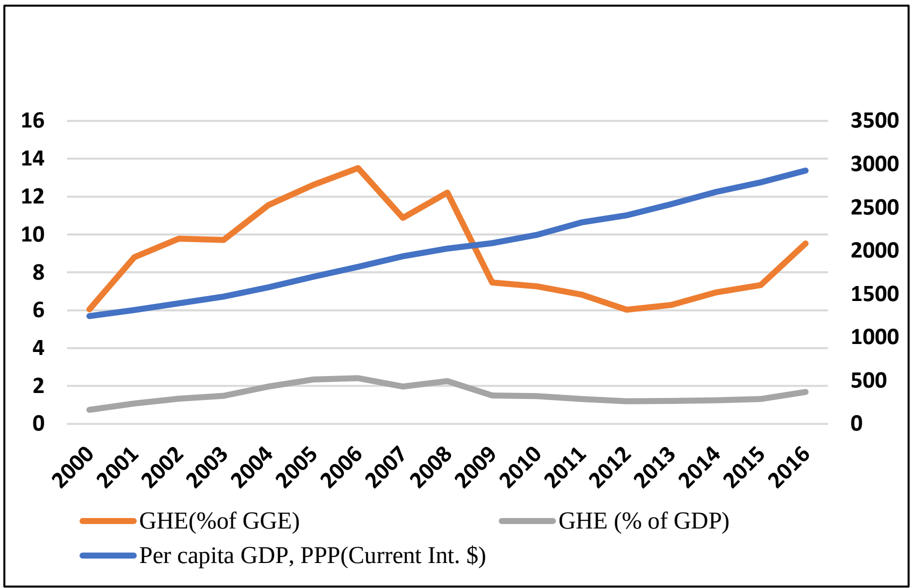

Figure 1: Trends of Public Health Expenditure and per Capita GDP for Tanzania 2000-2016

Source: World Development Indicators (2019)

health on economic growth. However, there has been an outcry in the community on the failure to access good quality healthcare services, which consistently affects the population's overall health outcomes.

Theories relating to health and economic growth have been widely emphasized in related literature. The debates of these theories started in the seminal work by Mushkin (1962) under the potential hypothesis known as the 'health-led-growth' hypothesis. This hypothesis advocated health investment as a key aspect to increasing health capital stock, which is necessary for achieving individuals' wellbeing and economic growth. Similarly, emphasis was given by the Keynesian school of thought proposed by Keynes in 1937, which suggested the possibility of a positive relationship between public expenditure and economic growth through the multiplier effect on aggregate demand. He advocated that the size of government spending can boost economic growth through increased employment opportunities, profitability and investments. Therefore, economic returns from investment in health are accounted for from their positive progress on worker productivity and the reduction of various health constraints such as mortalities.

Barro and Sala (1992) demonstrate that public expenditure is productive if it positively impacts the rate of economic growth. This is supported by Wagner (1980), who postulates that increasing spending on state activity is a significant way to enhance the economic output of a country. In the endogenous growth theories, improved health capital has been noted to contribute to boosting economic growth. The idea integrates the substantial notion of the positive impact of human capital on economic growth as postulated by famous growth economists such as Romer (1989) and Barro (1996); and is in line with empirical evidence from Becker (1964), the earliest known health economist. Indeed, apart from these theoretical arguments, various empirical studies have attempted to examine the relationship between human capital and economic growth worldwide.

Globally, the relationship between health investment and economic growth has received much attention in the literature. Although the literature provides supportive evidence in line with the theoretical expectation regarding the relationship between health investment and economic progress, other previous studies provide mixed and inconclusive evidences. Bloom et al. (2004) analysed the effect of health on economic growth and found a significant positive impact of health on aggregate output. Likewise, Trondillo (2016) provided a growth of GDP per capita attributed to the improvement of child and maternal health in 193 UN member countries. In a related study, Atun et al. (2016) reported significant economic returns from increasing public health investment. Further, in another study, Arthur (2015) found health to have a strong and significant contribution to the economic growth in Sub-Saharan Africa. The results are consistent with a good number of other similar studies such as Erçelik (2018), Esen and Çelik Keçili (2021), Somé et al. (2019), Amiri and Gerdtham (2013). These studies concluded that increasing health investment increases workers' productivity capacity, and ultimately the growth of aggregate output level.

In contrast, other authors surprisingly found no evidence as far as the relationship between health and income (GDP) growth is concerned. Following Acemoglu and Johnson (2007), there is no evidence of any effect of increased life expectancy on per capita income growth. However, the results are inconsistent with the study by Aghion et al. (2011) who found that increasing life expectancy positively impacted per capita GDP growth in OECD countries. The linkage between health expenditure and economic growth was analysed in Nigeria by Karim (2016) using the ARDL procedure, who found a weak contribution of health expenditure on aggregate growth of output. The author suggests that inadequate and inefficient investment, along with high population growth in Nigeria, might possibly be the reason to explain this weak involvement. Moreover, Eggoh et al. (2015) reported contradicting shreds of evidence regarding the nexus between health investment and economic growth in 49 African countries between 1996 and 2010. Dynamic panel analysis results negatively correlate public health expenditure and economic growth. Moreover, these results were consistent with recent results by Yang (2020), which revealed a negative impact of national health expenditure on the economic growth in 21 developing countries between 2000 and 2016.

In Tanzania, there is scanty evidence of the economic returns of health investment. Most existing growth studies in Tanzania have focused on the broad case of government expenditure on economic growth (Kapunda & Topera, 2013; Kwendo & Muturi, 2015; Kyissima et al., 2017), leaving a gap to analyse a specific case of different components of expenditure on economic growth. Their results are mixed and inconclusive compared to the existing studies relating to government expenditure and growth. For example, Kapunda and Topera (2013) examined the effect of various expenditure compositions such as health, defence, agriculture, and the general public service on economic growth for the period 1965 to 2010. The study reveals that expenditure on health had an insignificant relationship with economic growth over the period. In the same line, Kwendo and Muturi (2015) studied the effect of government expenditure on growth in the East African Community (EAC) countries. Using the fixed-effect model, health and consumption expenditure were found to be significantly positive in influencing economic growth in the EAC member countries.

Despite extensive studies related to health investment and economic growth worldwide, only a few studies have been conducted in developing countries, including Tanzania. The literature reviewed indicates mixed and contradicting evidences on the subject in question, with no agreement regarding the economic benefits of investing in health. Given the heterogeneity found in previous literature of different countries regarding the economic impact of investing on health, it may not be too easy to make any firm conclusion regarding the impact of government investment on health in Tanzania. Therefore, this concern was the main reason for the current study, to find out whether the allocated public expenditure share of GDP on health stimulates short-run and/or long-run economic growth in Tanzania. This study, therefore, attempted to examine the effect of public health expenditure on economic growth to fill the existing gap in literature, and provide novel knowledge regarding the nexus between health investment and economic growth in Tanzania. The main argument here is that although health is regarded as a consumption good that adds to wellbeing, it is also an investment good to increase the productive power of individuals and, consequently, the economy. The study examined the direction of causality between public health expenditure and per capita GDP as a proxy for economic growth.

2. Methodology

2.1 Theoretical Framework

The relationship between health and economic growth has gained significant attention in literature (Romer, 1996). Besides technological advancement, the health of the labour force can play an important role to increase output growth. The inclusion of the health capital variable in the growth production function started during the neoclassical model. These ideas were consistent with Grossman's theory (1972), which suggests that health capital is a critical input to increase income growth. The current study adopted the famous Mankiw, Romer, and Weil's (MRW) theoretical framework concerning public health expenditure and economic growth. The theory assumes that capital accumulation includes both physical and human capital in terms of health and education, in explaining growth (Mankiw et al., 1992). Besides education being crucial to increasing labour productivity, better health has a potentially positive and significant impact on economic growth. Indeed, it has been noted that unhealthy people are usually inactive and inefficient in economic activities (Grossman, 1972).

This article explicitly includes public health expenditure as an input factor in the growth production function; expressed in the Cobb-Douglas form. In this case, per capita GDP, a proxy of economic growth, was expressed as a function of physical capital (K), human capital (H), labour hours input (L), and technological progress (A). Thus, the model is formulated as in equation 1:

$$Y = AK^{\alpha}H^{\beta}L^{1-\alpha-\beta} \; \alpha, \beta \in (0,1) \text{ and } \alpha + \beta \backslash < 1 \qquad (1)$$

Where, Y denotes the outcome variable (per capita GDP), which captures the economic growth; K denotes physical capital accumulation; H represents human capital factor measured by public health expenditure (% of GDP). L indicates the labour input factor. A measures the technological advancement in the country, usually capturing L and A which are assumed to be exogenously determined. The assumption of decreasing returns to scale holds for the two parameters accounted for in this regard, and the following restrictions are imposed on model 1, that $\alpha, \beta(0,1)$ and $(\alpha + \beta) < 1$ decreasing returns to scale for all capitals.

For ease of estimation, the study proceeded by taking logarithms on both sides of the Cobb-Douglas equation (1) to derive a regression model, and the results are as expressed in equation (2):

$$\ln Y = \ln A + \alpha \ln K + \beta \ln H + (1 - \alpha - \beta) \ln L \qquad (2)$$

The empirical model is then modified as presented in model 3:

$$\ln Y = \ln A + \alpha \ln K + \beta \ln H + \ln L - \alpha \ln L - \beta \ln L \qquad (3)$$

Manipulating model equation (3) can yield:

$$\ln Y - \ln L = \ln A + \alpha(\ln K - \ln L) + \beta(\ln H - \ln L) \qquad (4)$$

Equation (4) is converted into per capita terms by dividing by L (the labour hour), and the result is presented in equation (5).

$$\ln\frac{Y}{L} = \ln A + \alpha \ln\frac{K}{L} + \beta \ln\frac{H}{L} \qquad (5)$$

Finally, the regression form of the model derived can therefore be present in equation (6):

$$\ln y = \ln A + \alpha \ln k + \beta \ln h \qquad (6)$$

Where, the variable k stands for the stock of physical capital proxied by Gross Capital Formation (GCF); and h is the human capital factor measured by public health expenditure. A is the technological change usually referred to as the Solow residual, and is assumed to evolve from economic variables such as trade, foreign direct investment (FDI), and inflation; which indicate the macro-economic stability of the economy (Adu, 2013). The alpha (α) denotes the elasticity of GCF, and β indicates the elasticity of public health expenditure.

2.2 Estimation Model

Following the analysis of the effect of public health expenditure on economic growth in Tanzania, the current study controls for other economic growth determinants such as household final consumption expenditure, which usually has a multiplier effect on economic growth—gross capital formation (GCF)—as a measure of physical capital. Other control variables such as infant mortality rate (IMR) and foreign direct investment (FDI)—which capture health status and macroeconomic stability, respectively—were also included in the model. This leads to an empirical model of the determinants of economic growth as presented as in equation (7):

$$\ln GDPpc_t = \beta_0 + \beta_1 \ln Phexp_t + \beta_2 \ln GCF_t + \beta_3 \ln IMR_t + \beta_4 \ln HHc_t + \beta_5 FDI_t + \varepsilon_t \qquad (7)$$

Where, $GDPpc$ indicates per capita income, a measure of economic growth (in PPP, inter \$); $Phexp$ denotes public health expenditure of GDP; GCF is the gross capital formation at constant local LCU (local currency); IMR stands for the infant mortality rate per 1,000 live births, a proxy for health status; HHc captures household final consumption expenditure (% GDP); FDI is foreign direct investment, net flow (BoB, current US\$); and ε is the random error term, which is assumed to be independent and normally distributed. Lastly, t is the time factor covering the period from 1980 to 2017, and $\beta_i s$ are the coefficients of different variables in the empirical model.

2.3 Estimation Procedure

In the time-series nature of study, maintaining the stationarity status of the data is very crucial. In this regard, the study implemented the Augmented Dickey-Fuller (ADF) unit root test (Dickey & Fuller, 1979) for testing the stationarity of the variables. Then, a co-integration test was performed based on the results of the unit root test. As per the stationarity results, the study employed the Autoregressive Distributed Lag (ARDL) bound test procedure to check the relationship of the variables under investigation. The ARDL bound co-integration test was adopted based on the fact that the approach is suitable for a small sample size, and appropriate when analysing variables with different integrating orders [either $I(0)$ or $I(1)$] in the exact estimation. Moreover, the ARDL procedure is ideal for correcting endogeneity issues that may arise in an analysis to avoid spurious results. According to Pesaran et al. (2001), ARDL can allow for an unrestricted number of lags; and can minimize the missing variable bias effect.

After confirming the existence of the co-integration of the variables in the series, the study further proceeded with estimating the coefficient of the short- and long-run using error correction version of the ARDL model representation. Therefore, the ARDL bound test model to check for the co-integration relationship of the variables, requires an estimation of $ARDL(p,q)$ model of the following form:

$$\begin{aligned}\ln GDPpc_t = {} & \beta_0 + \beta_1 \ln GDPpc_{t-1} + \beta_2 \ln Phexp_{t-1} + \beta_3 \ln GCF_{t-1} \\ & + \beta_4 \ln IMR_{t-1} + \beta_5 \ln HHc_{t-1} + \beta_7 \ln FDI_{t-1} \\ & + \sum_{i=0}^{q} \varphi_{1i}\, \Delta \ln GDPpc_{t-i} + \sum_{i=0}^{q} \varphi_{2i}\, \Delta \ln Phexp_{t-i} \\ & + \sum_{i=0}^{q} \varphi_{3i} \Delta \ln GCF_{t-i} + \sum_{i=0}^{q} \varphi_{4i} \Delta \ln IMR_{t-i} \\ & + q \sum_{t-i} \sum_{i=0}^{q} \varphi_{6i} \ln F_{t-it} \qquad (8)\end{aligned}$$

Where, Δ Indicates the first-difference operator; $\varphi_{ji} (j = 1,2, \ldots .7)$ refers to the short-run coefficients; $\beta i's$are the long-run coefficient parameters; q denotes the optimal lag chosen; $t - i$ is a lag length selected and $\varepsilon_t$is the white noise residual term.

The logarithmic form of variables is used to ease the interpretation of the elasticity coefficient of the variables. The variables lag evades spurious regression results since it is common when using annual time series data. From the ARDL bound test results, if the calculated F statistics is greater than the upper bound I(1), the null hypothesis of no co-integration should be rejected in favour of the alternative hypothesis. If this is the case, there exists co-integration of the variables in the series; and, therefore, the study proceeded to estimate the coefficients of the short- and long-run using an error correction version of the above ARDL model (8).

In the study, all the necessary diagnostic tests were conducted to ascertain the goodness of fit for the regression model, and to confirm the non-spuriousness of the estimated results for valid inference. The study performed all practical tests such as stability, serial correlation, heteroskedasticity, and normality tests. Each of these tests had its own corresponding statistics. The stability test was performed using CUSUM's cumulative sum of recursive residuals and the cumulative sum of squares of recursive residuals (CUSUMSQ).

2.4 Data
In examining the relationship between public health expenditure and economic growth, the study used annual time series data from 1980 to 2017, taken from the 2019 World Development Indicators database (WDI) of the World Banks. Per capita GDP is used as the proxy for economic growth, which is the outcome variable. Apart from the public health expenditure, our key variable of interest, the study controls for several other macroeconomic variables that are theoretically thought to affect economic growth such as gross capital formation (GCF), household final consumption expenditure (HHc), foreign direct investment (FDI) and health status indicator in this case proxy by infant mortality rate (IMR). However, all variables were expressed in a logarithmic form.

3. Empirical Results and Discussion
3.1 Descriptive Statistics Results
Table 1 describes the variables used to examine the effect of public health expenditure on economic growth in Tanzania. The descriptive results indicate an average of $1395.3 per capita over the period, with a maximum of $2809.07 per capita. Accordingly, the results show that Tanzania spent an average of 2.499% of its GDP on public health expenditure, which is minimal and less of the 5% of GDP recommended by the UN to achieve universal health coverage (UHC), and fulfil equity goals. However, the maximum share recorded in 2006 was 4.76% of GDP in the health sector. Also, analysis shows that Tanzania spent about 64% on household final consumption expenditure out of income (GDP). Further, health status measured by infant mortality rate estimated at an average of 80.7 deaths per 1,000 live births over the analysed period, with a minimum of 39 deaths and a maximum of 111.7 deaths per 1,000 live births. The trend of infant mortality rate is seen to decrease considerably in recent years. The descriptive statistics of the variables of interest are clearly presented in Table 1.

Table 1: Summary Statistics of the Variables

	GDPpc	Phexp	GCF	IMR	HHc	FDI
Mean	1395.338	2.499	25.603	80.668	63.937	5.09e+08
Min	644.977	1.01	13.19	39.1	17.5	-8.42e+06
Max	2809.07	4.76	35.52	111.7	80.92	2.09e+09
Std. Dev	662.04	0.944	6.55	27.38	12.463	6.15e+08
Skewness	0.8058	0.4405	-0.4023	-0.02558	-1.6635	3.78e+17
Kurtosis	2.351	2.7176	2.1014	1.3942	6.7094	3.01591
Obs	38	38	38	38	38	38

Source: Word Bank, 2019

3.2 Unit Root Test Results

Following the results from the ADF unit root test for determining the integration order of the variable in the series, the findings present a mixture of integrated order zero [i.e., I (0)] and integrated of first-order [i.e., I (1)] for the variables. Hence, it demonstrates that the variables exhibit stationarity at the level I(0) and others at the first difference I(1), indicating that the variables have different orders of integration as summarized in Table 2.

Table 2: Augmented Dickey-Fuller Test

Variable (log)	Test statistics [P-value]				Order of Integration
	Level		1st Difference		
	Intercept	*Intercept +Trend*	*Intercept*	*Intercept +Trend*	
GDP per capita	0.376 [0.9806]	-1.973 [0.6163]	-2.630* [0.0870]	-2.641 [0.2616]	I(1)
Public health expenditure	-1.969 [0.3003]	-1.838 [0.6861]	-5.124 *** [0.0000]	-5.126 *** [0.0001]	I(1)
Gross capital formation	-2.099 [0.2450]	-2.032 [0.5839]	-5.490 *** [0.0000]	-5.532 *** [0.0000]	I(1)
Infant mortality rate	-2.604 [0.0921]	-3.849** [0.0142]	NA	NA	I(0)
Household final consumption expenditure	-4.532 *** [0.0002]	-4.524*** [0.0014]	NA	NA	I(0)
Foreign direct investment	-12.1*** [0.0000]	-10.065*** [0.0000]	NA	NA	I(0)

Source: Word Bank, 2019. Where *** shows a rejection at a 1% level of significance. S indicates the variable is stationary.

The ADF test results in Table 2 show that infant mortality rate (IMR), household final consumption expenditure (HHc), and foreign direct investment (FDI) are stationary at level. The remaining variables such as GDP per capita, public health expenditure and gross capital formation are stationary at first difference. Given the mixture of I (0) and I (I) integration order of the variables, the study proceeded with co-integration test using the ARDL bound testing model.

3.3 Lag Length Selection

After confirming different orders of integration of the variables in the series, a co-integration bound test for the existence of long-run co-integration relationship was performed. Usually, a prior co-integration bound test using the ARDL model, a maximum lag selection is very crucial. The study determined full lag length with an appropriate criterion based on Akaike Information Criterion (AIC); and the results are presented in Table 3. The maximum lag length of 3 was appropriate, as shown, based on AIC. Though there are various criteria for lag length selection, the Akaike Information Criterion (AIC) and Schwaz Information Criterion (SBIC) are the most popular.

Table 3: Optimal Lag Selection Based on AIC

Lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-30.2249	NA	NA	NA	3.4e-07	2.13088	2.22274	2.40023
1	199.714	459.88	36	0.000	3.9e-12	-9.2773	-8.63429	-7.391
2	289.349	179.27	36	0.000	2.1e-13	-12.4323	-11.2381	-8.930
3	446.359	199.1*	36	0.000	1.3e-14*	-17.432*	-15.136*	-10.699*

Notes: * indicates lag order selected by the criterion. **LR**: sequential modified LR test statistic (each test at 5% level). **FPE**: Final prediction error. **AIC:** Akaike information criterion. **SC:** Schwarz information criterion. **HQ:** Hannan-Quinn information criterion

Source: Computed from the data (WDI, 2019)

3.4 Co-integration Results

Since the variables are integrated of different orders, the study employed an ARDL bounds testing procedure to check for the existence of a long-run equilibrium relationship between the variables using a maximum lag of three (lag 3). The decision criterion used was based on Pesaran, Shin, and Smith (2001), testing the null hypothesis of no co-integration against the alternative that variables are co-integrated. If the computed F-statistic value is greater than the upper bound I(0) of the critical values, the null hypothesis should be rejected, indicating that there exists a co-integration. If the F-statistic is less than the lower bound I(0) critical values, then the conclusion is that there is no co-integration among the variables. But if the F-statistic falls between the upper and lower bound, no conclusion can be made.

The ARDL bound test results, as indicated in Table 4, show the computed F-statistic value of 10.738, which is higher than the upper bound critical (UBC) value of I (1) at different levels of significance (1%, 5%, and 10%). With these results, the null hypothesis of no co-integration should be rejected, and it could be concluded that there is a long-run co-integration relationship among the variables. This implies that the variables have a long-run equilibrium relationship.

Table 4: ARDL Bound Test Results

K	F-statistics	lag (AIC)	Significance level	Bounds critical values		Decision
				I(0)	I(1)	
			1%	3.41	4.68	Co-integration
5	10.738	3	5%	2.62	3.79	
			10%	2.26	3.35	

Notes: Hypothesis: Ho: No co-integration

Source: Word Bank, 2019. Bound critical values from Pesaran et al. (2001).

3.5 Autoregressive Distributed Lag (ARDL) Results

The study employed the ARDL method to examine the coefficients of the short-run and long-run relationship of the variables. This involves estimating model (1.8) using ARDL in error correction version of the model. The ARDL results for the short- and long-run elasticities are presented in Tables 5 and 6. The probability of the error correction term (ECT) is negative as expected, and statistically significant at a 1% level. The ECT's coefficient indicates that the speed of adjustment towards equilibrium is approximately 14.8%, though it is relatively low. The results reveal that one period lagged GDPpc is the most significant determinant of the current value of GDPpc in Tanzania. The coefficient of 1.54 shows that a 1% increase in one period lagged GDPpc significantly leads to over 154% increase in GDPpc in the short run at a 1% level. The results also show that one period lagged public health expenditure has a positive and significant impact on per capita GDP at 1% level. This indicates that a 1% increase in lagged public health expenditure contributes to a 0.061% rise in per capita GDP in the short run. The results are consistent with those of the studies by Bloom et al. (2004) and Cooray (2013).

Table 5: ARDL Short-run Coefficient Estimates

ΔLog GDPpc(-1)	1.542277	0.1507338	10.23	0.000	***
ΔLnGDPpc(-2)	-1.08089	0.2392846	-4.52	0.000	***
ΔLnGDPpc(-3)	0.3902886	0.1337632	2.92	0.008	***
PHE	-0.0244511	0.0142216	-1.72	0.100	
PHE(-1)	0.0612698	0.014714	4.16	0.000	***
lnGCF	0.0186331	0.0150468	1.24	0.229	
lnIMR	-1.685698	0.4086912	-4.12	0.000	***
lnIMR(-1)	0.5455192	0.6939658	0.79	0.440	
LnIMR(-2)	2.969829	0.7118246	4.17	0.000	***
lnIMR(-3)	-2.008836	0.4039494	-4.97	0.000	***
lnHHc	0.0458375	0.0095702	4.79	0.000	***
lnFDI	-0.0000259	0.0013092	-0.02	0.984	
cons	1.563302	.5841222	2.68	0.014	***
ECT(-1)	-0.148329	0.0516057	-2.87	0.009	***

Notes: R-squared = 0.9997; Adj R-squared = 0.9995; F(12, 22) =5566.48; Prob > F =0.0000; Log likelihood = 120.62324; Root MSE =0.0097

Source: Word Bank, 2019

The results also indicate that health status is a significant determinant of economic growth in Tanzania both in the short- and long run. From the findings, health status is statistically significant in affecting GDP per capita at 1% level. A 1-unit coefficient reduction in infant mortality rate decreases per capita GDP by 1.68 and 1.2 in the short-run and long-run, respectively. The growth effect of better health might arise from improved labour efficiency due to producing healthy workers, and hence can lead to increased productivity. The results are consistent with those from Bloom and Canning (2003); and support Mushkin's health-led growth hypothesis, which emphasizes better health capita as a potential tool for the economic growth of a country. Household final consumption expenditure indicates that spending on household consumption was a dominant factor in boosting economic growth in Tanzania. The coefficient shows that a 1% increase in a household's final consumption expenditure contributes to increasing economic growth by 4.58% and 30.9% in the short- and long-run, respectively. The obtained results are consistent with the theory that household consumption leads to economic growth, and are in line with other studies such as Aryusmar (2020). The long-run coefficient estimates are summarized in Table 6.

Table 6: ARDL Long-run Coefficients

Sample (adjusted): 1983- 2017
Included observations: 35 after adjustments

Regressors	Coefficient	Standard Error	t-Statistic	Prob>t	Sign
Log Public health expenditure (PHE)	0.2481829	0.1563856	1.59	0.127	
Log Gross capital formation (GCF)	0.1256203	0.0803441	1.56	0.132	
Log Infant mortality rate (IMR)	-1.208035	0.0892268	-13.54	0.000	***
Log Household consumption expenditure (HHc)	0.3090257	0.0995734	3.10	0.005	***
Log Foreign Direct Investment (FDI)	-0.0001746	0.0088224	-0.02	0.984	

Source: Word Bank, 2019

Although theoretical and empirical evidence suggests that increasing share of income was devoted to capital formation as an avenue towards boosting economic growth, the study found an insignificant relationship between the two variables. The results are consistent with those of a similar study by Onyinye et al. (2017) done in Nigeria. Besides, the foreign direct investment variable was found to have an insignificant impact on economic growth, like the previous findings by Agbloyor et al. (2014). Moreover, the low level of investment characterized the health sector in Tanzania probably rationalizes the insignificant finding of public health expenditure on growth revealed in the long-run. However, they are consistent with Udeorah and Joseph (2018), who concluded that there was no significant contribution of health care expenditure on economic growth in Nigeria.

3.6 Causality Test Results

The study attempted to check the causal relationship between public health expenditure and economic growth. From the co-integration results that confirm the long-run relationship among the variables, the primary concern for the causality test was in the direction of causality of the long-run relationship. The results, as summarized in Table 7, found a significant bidirectional relationship between public health expenditure and per capita GDP growth. In the same way, infant mortality rate was found to have a two-way causality with per capita

GDP. This is an indication that increasing public health expenditure can boost economic growth, the same way as raising economic growth can influence public expenditure allocation on health. Moreover, the rest of the other variables were found to be statistically significant at 1% level.

Table 7: Granger Causality Results

Lags: 4			
Null hypothesis	**Chi2**	**df**	**Prob > chi2**
DlnGDPpc does not Granger Cause DlnPhexp	341.34	4	0.000
DlnPhexp does not Granger Cause DlnGDPpc	16.39	4	0.003
DlnGDPpc does not Granger Cause DlnGCF	68.76	4	0.000
DlnGCF does not Granger Cause DlnGDPpc	32.162	4	0.000
DlnGDPpc does not Granger Cause lnHHc	204.45	4	0.000
LnHHc does not Granger Cause DlnGDPpc	9.062	4	0.060
DlnGDPpc does not Granger Cause LnIMR	132.2	4	0.000
LnIMR does not Granger Cause DlnGDPpc	18.159	4	0.001
DlnGDPpc does not Granger Cause lnFDI	121.23	4	0.000
LnFDI does not Granger Cause DlnGDPpc	16.445	4	0.002

Source: World Bank, 2019.

3.7 Diagnostic Tests Results

Performing a diagnostic tests to check whether the assumptions are fulfilled is crucial when analysing time-series data. Numerous diagnostic tests were done, including testing for serial correlation, heteroskedasticity, and normality test. Their results are summarized in Table 8. Besides, the study checked for model stability using the CUSUM and CUSUM of square. This is a graph to visualize the model's functional form, as presented in Figure 2. Following the test results for serial correlation, heteroskedasticity and normality as indicated in Table 8, with their respective statistical tests, all p-values are greater than 5% level. This shows that the underlying model is free from autocorrelation and heteroskedasticity issues. Further, the residuals are normally distributed as observed from the Jarque-Bera test with a p-value of 0.5916.

Table 8: Diagnostic Test Results

Null hypothesis	**Test statistic**	**Results**	**Prob>chi2**
No serial correlation	Durbin's alternative test	$\chi^2(2)$ =5.862	0.1185
Homoscedasticity	Cameron & Trivedi's decomposition of IM-test	$\chi^2(34)$ =35.00	0.4204
Normality	Jarque-Bera test	$\chi^2(1)$ = 1.05	0.5916
	R^2	0.9997	
	Adj. R-Square	0.9995	
	Prob>F	0.0000	

Source: Word Bank, 2019

In examining the stability of the long- and short-run coefficients of the variables, the study established the cumulative sum of recursive residuals (CUSUM) and the cumulative sum of square (CUSUMSQ) as proposed by Brown et al. (1975). Figure 2 is illustrative.

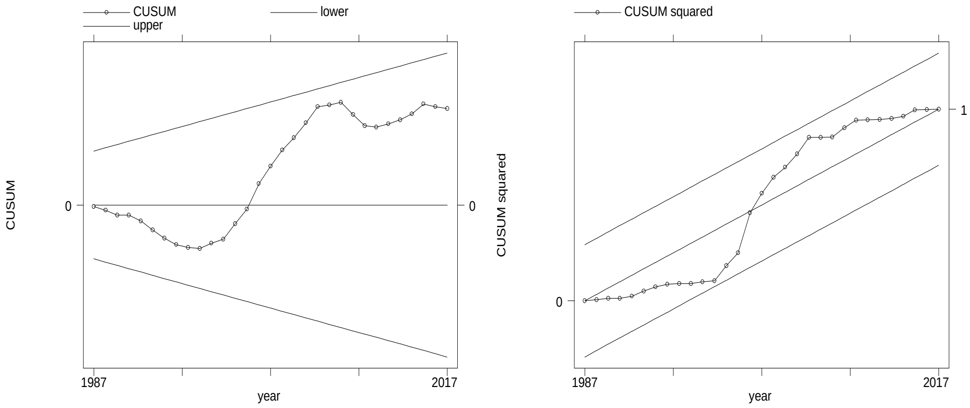

Figure 2: CUSUM Test (Left) and CUSUM Squares Test for Parameters Stability (Right)

Source: World Bank, 2019.

The model was significantly robust and stable since the CUSUM and CUSUMSQ lines lie within the critical bounds of 5% level. Thus, the null hypothesis about the stability of the coefficients in the model is retained. Neither CUSUM nor CUSUMSQ plots crossed the critical bounds at the 5% level. Thus, no evidence of any significant structural instability was noticed in the model. Therefore, it was concluded that the estimated coefficients of the ARDL model were effective with stable recursive residuals, and valid inferences can be made.

4. Conclusion and Policy Implications

This study sought to examine the effect of public health expenditure on Tanzania's economic growth between 1980 and 2017. The study included other control variables such as household consumption expenditure, foreign direct investment to control the effect of new technological spill-overs, and infant mortality as a measure of health status. The findings generally demonstrated that one period lagged GDPpc is among the major factors that determine economic growth (GDPpc) in Tanzania. The results revealed a significant impact of one lagged public health expenditure in the short-run, while the long-run estimates provide an insignificant effect of public health expenditure on the economic growth of Tanzania. However, a possible explanation is that public resources are always allocated inefficiently or inequitably in public sectors, in this case, the health sector. In other words, the quality of public health expenditure is relatively low overall, hence the failure to sustain the healthcare system and to reduce its budget deficits. Another possible explanation for an insignificant long-run effect of public health expenditure is that Tanzania has not done enough to ensure that efficient and good quality public health resources are allocated to the health sector. However, it should be noted that raising expenditure alone is not enough to produce better health status.

Further, the results showed that improvement in health status proxy by infant mortality rates has significant impact on the per capita GDP of Tanzania in both the long- and short-run. Better health status is known to have a positive effect on the productivity capacity of an individual through increasing time to engage in productive activities, and hence contribute to increasing productivity. With these findings, the study suggests that Tanzania should strongly focus on raising public health investment to sustain and achieve substantial economic growth gains. Therefore, the suggested health-led-growth hypothesis has been confirmed in Tanzania through these results.

Due to a rapid population growth in Tanzania, which imposes a burden on the available limited health resources due to increasing demand for public health care, greater government involvement in allocating adequate health budgets is imperative. The study recommends that Tanzania should focus on improving health status in general, and child health in particular. This can be done through allocating reasonable and effective public health resources, and not just focusing only on expanding large-scale infrastructure. Since residence health status positively contributes to enhancing economic growth, the study hereby suggests that Tanzania should ensure that its citizens get improved health care by making laws and regulations that ensure public health inputs are adequately met and equally distributed to satisfy public health needs. This will guarantee that workers comply with social production effectively and efficiently, and continue stimulating robust economic growth and development. Understanding economic returns of better health, the country can forgo other economic goals for health goals. As far as the significant role of household final consumption expenditure on economic growth is concerned, the study suggests that the government should pay greater attention on the proportion of its budget on household final consumption expenditure to attain a robust growth of the economy in Tanzania.

The allocation and utilization of public health resources intensely depend on the country's quality of governance and institutional efficiency. The study proposes that similar researches should be done in the future to account for potential variables—such as quality governance and democracy—to provide more insights on the efficacy of public health spending on economic growth.

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