The Effect of Corruption on the Nexus Between Public Health Expenditure and Economic Growth in Sub-Saharan Africa

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Government expenditure on health is an essential factor for the growth of any economy. However, the health system in sub-Saharan Africa (SSA) has not been receiving enough attention. The direct effect of public health expenditure and corruption on economic growth, as well as the role of corruption in the relationship between public health spending and economic growth in 32 sub-Saharan African countries from 2000 to 2022, is examined by this study using fixed effect and the Generalised Method of Moments (GMM) as an estimation technique. The results show that both public health expenditure and corruption negatively impact economic growth, while the joint effect of public health spending and corruption enhances economic growth in SSA. Furthermore, the findings reveal that inflation hurts economic growth whereas gross capital formation and trade openness have a positive effect on economic growth. It is recommended that the government should formulate policies that will control corruption and raise the level of institutional quality in the SSA region.

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Introduction

The nexus between public health spending and economic growth has drawn the attention of policymakers and researchers in recent decades, especially in developing regions such as sub-Saharan Africa (SSA). Health, as an important part of human capital, has a direct impact on the level of production, the stability of economic activities, and the long-term economic growth of any country or region (Karaman et al. 2020). Therefore, investment in health is crucial for any country or region in achieving the goals of improving the well-being of its population, re-

ducing poverty, and also attaining sustainable economic growth and development (Boachie and Ramu 2015; Grossman 1972; World Bank 1993). Health expenditure, according to the World Health Organisation (2022), can be defined as the final consumption of health goods and services (i.e., current health expenditure), including personal health care (curative care, rehabilitative care, long-term care, ancillary services and medical goods) and collective services (prevention and public health services as well as health administration).

Health expenditure can either be private or public spending on healthcare services, infrastructure, and resources (World Bank 2022). Public health spending, which is the focus of this study, is the expense incurred by the government at all levels (local, regional and central) of a country on healthcare services, infrastructure, and resources in order to improve the health status of the people (United Nations 2021). Heavy investment in health is vital in SSA, where there is a prevalence of health challenges such as infant and maternal mortality, infectious diseases, and malnutrition (World Bank 2022; UNICEF 2021). Despite this, various factors are affecting the capability of public health spending to positively enhance economic growth (Kurniawan et al. 2020).

Corruption is one of the factors identified that weakens the possible gains of health spending in SSA (World Health Organization 2022; Di Tella and Savedoff 2001). Corruption leads to the diversion of funds meant for providing health goods and services to private pockets, which results in inadequate provision of healthcare goods and services. According to Makar et al. (2023), the existence of corruption in the healthcare sector destroys public health trust, restricts access to important health services, and leads to a reduction in the overall quality of healthcare services. Similarly, Šumah (2018) stated that corruption prevents improvement in health outcomes, which is necessary to foster a healthy and productive workforce (human capital) and boost economic growth.

Many studies have investigated the connection between public health spending and economic growth (e.g. Aboubacar and Xu 2017; Adewara 2021; Adewara and Oloni 2012; Akinbode et al. 2021; Odhiambo 2021). Similarly, several studies have examined the impact of corruption on economic growth (e.g. Aidt et al. 2008; Cieślik and Goczek 2018; Malanski and Póvoa 2021; Spyromitros and Panagiotidis 2022). In addition, some studies have considered the role of corruption in the relationship between government spending and economic growth (e.g. d'Agostino et al. 2016; Nguyen and Bui 2022). However, studies have not paid attention

to the intermediary role of corruption in the relationship between public health spending and economic growth in SSA. According to Hodge et al. (2011) and d'Agostino et al. (2016), corruption can indirectly affect economic growth through government expenditure.

However, whether corruption will enhance or reduce the impact of public health expenditure on economic growth in SSA is not known. There are two hypotheses on the effect of corruption in the literature. The first hypothesis is 'sand the wheels', which emphasises that corruption hinders economic growth, creates new distortions, and erodes institutional trust. For instance, corruption can limit the efficiency of public health expenditure through misallocation of funds and leakages, thereby harming economic growth. Dzhumashev (2014) and Keefer and Knack (2007) stated that corruption limits the efficiency of government expendit;re. Piabuo and Tieguhong (2017) stated that the positive impact of public health spending on economic growth can be negatively affected due to the prevalence of corruption. Many empirical studies, such as Qehaja et al. (2023), Beylik et al. (2022), Adewara (2021), Adewara and Oloni (2012) and Piabuo and Tieguhong (2017), have suggested that countries where the level of corruption is low tend to have better health outcomes and stronger economic growth, while there is a significant reduction in the returns on public health expenditure in countries or regions where the level of corruption is high (Uche 2020; Rispel et al. 2016). Corruption can also lead to the diversion of public health expenditure from investment in both physical and human capital for private gains, and thereby harm economic growth. D'Agostino et al. (2016) emphasised that a low level of corruption can reduce the level of the negative impact of government expenditure on economic growth. Corruption can serve as an obstacle to economic growth through public health, as it can allow government officials to allocate expenditure to unviable projects where they can collect bribes. Makar et al. (2023) likewise claimed that corruption can lead to poor health outcomes, which would negatively affect labour productivity and absenteeism and reduce the potential for human capital development.

In contrast to the first hypothesis, the second hypothesis, 'grease the wheels', places interest in the potential benefits of corruption. According to this viewpoint, corruption can be used to get around institutional flaws and advance progress. For example, some studies, such as Aidt et al. (2008), Méon and Weill (2010) and Huang (2016), have shown that corruption is not a threat to economic growth in countries with weak

institutional quality, like SSA countries. Some studies have argued that corruption can enhance economic growth directly or indirectly through 'grease the wheels', which implies that corruption in some instances helps to remove obstacles and foster innovation, growth and development (Egger and Winner 2005; Kato and Sato 2015; Leff 1964; Lui 1985; Méon and Weill 2010). Based on this perspective, it can be argued that corruption might not be a threat to the growth impact of health expenditure in SSA. Corruption could positively enhance the growth impact of public health expenditure by avoiding bureaucratic delays in disbursing funds, which is common in developing countries. In line with this, Acemoglu and Verdier (1998) stated that corruption can be desirable as it works somewhat like a piece rate for bureaucrats, which increases the provision efficiency of government services.

As the SSA region continues to face poor health outcomes, low labour productivity, and slow economic growth in spite of huge investments in the healthcare system in the region, there is a need to investigate the role of corruption in the relationship between public health expenditure and economic growth. Therefore, the objective of this study is to examine both the direct effect of public health expenditure and corruption on economic growth as well as their indirect effect on economic growth. This study will contribute to the literature in the following ways. First, this study will examine the direct impact of corruption and public health expenditure on economic growth in SSA countries. Second, this study will examine the role of corruption on the effect of public health expenditure on economic growth in SSA by considering the joint effect of corruption and public health expenditure on economic growth in SSA. As stated earlier, most of the previous studies have focused on the interaction effect of government expenditure and corruption on economic growth without considering public health expenditure. However, knowing the role of corruption in the relationship between public health expenditure and economic growth in SSA will assist policymakers in formulating policies that will enable public health expenditure to have an optimal impact on economic growth.

The other sections of the study are organised in this order. Section 2 deals with the literature review. Section 3 presents the methodology of the study. Section 4 highlights the estimation procedure. Section 5 focuses on the analysis of the study. Section 6 deals with the conclusion and recommendation of the study.

Literature Review

The review of literature in this section is divided into three parts. The first part of the review focuses on the studies that examine the relationship between health expenditure and economic growth. The second section focuses on the studies that examine corruption and economic growth. The third part of the review are the studies that focus on government health spending, corruption and economic growth.

GOVERNMENT HEALTH SPENDING AND ECONOMIC GROWTH

Employing data between 1995 and 2011, Apanisile and Akinlo (2014) studied how health-related inputs and outcomes affected the economic growth of thirty SSA nations. Using GMM methodologies, the results of their findings showed that there is a negative relationship between government spending and the growth of the economy in the region. Halici-Tülüce et al. (2016) carried out an investigation on the nexus between private health spending and public health spending on economic growth in twenty-five high-income countries from the period between 1995 and 2012 and nineteen low-income countries between 1997 and 2009. Their findings showed a negative nexus between private healthcare financing and economic growth, whereas it was revealed that government health spending affects economic growth positively. Aboubacar and Xu (2017) examined the relationship between health spending and economic growth in sub-Saharan Africa from 1995 to 2014 using the Generalised Method of Moments technique. Their findings indicated that the association between healthcare financing and the growth of the economy is positive and statistically significant. Ali and Ogeto (2020) found that both public and private health spending had a positive and significant impact on economic growth in 38 SSA countries from 2000 to 2016 using the linear dynamic Generalised Method of Moments–Instrumental Variable (GMM-IV) method for analysis. Yusuf (2020) investigated the effect of government health expenditure on economic growth in Nigeria. Ordinary Least Squares (OLS) regression was employed to analyse data between 1981 and 2016. The findings showed that government health financing has a positive impact on economic growth. Beylik et al. (2022) looked at the relationship between health expenditure measures and economic growth in 21 OECD nations. They analysed the data using the Driscoll-Kraay standard method, and their results demonstrated a

positive relationship between healthcare expenditures and economic growth of the countries examined. Qehaja et al. (2023) evaluated the association between government healthcare spending and growth of the economy in Western Balkan nations between 2000 and 2020. The result revealed that government healthcare spending has a positive effect on local economic growth. Piabuo and Tieguhong (2017) did a comparative analysis of the effects of health spending on economic growth between the CEMAC (Central African Economic and Monetary Community) countries and five other African nations that have ratified the Abuja Declaration. The study found that health spending has a positive and significant impact on economic growth in both samples. Furthermore, it was found that both sets of nations had a long-term correlation between health spending and economic growth. Akinola and Ohonba (2025) investigated the interrelation between government expenditure, health outcomes, and economic growth in Nigeria, using data spanning from 1980 to 2021. The study employed the ARDL model and found that real government recurrent expenditure contributed to growth in both the short and long-term. The study equally found that health sector output similarly exhibits a positive and significant effect on economic growth across both time frames. Odhiambo (2021) examined the causal relationship between health expenditure and economic growth in SSA for the period 2008–2017. The study considered both public health expenditure and private health expenditure. Using a panel ECM-based Granger causality model, the study found a unidirectional causality from public health expenditure to economic growth in the low-income countries, while no causality was found in the middle-income countries. However, a short-run causality from economic growth to private health expenditure is found to prevail in middle-income countries, but no causality is found to exist in low-income countries.

Based on the findings from the studies reviewed, the first hypothesis is stated as:

H1 Government expenditure has a positive impact on economic growth in SSA.

CORRUPTION AND ECONOMIC GROWTH

The nexus between corruption and economic growth in 46 SSA countries was evaluated by Ceesay (2019). The study found that the growth

of the economy is impeded in the presence of corruption. Machoski and de Araujo (2020) investigated the effects of corruption on the growth of the economy in Brazil. The study examined data gathered between 2009 and 2010 from the Office of the Comptroller General audits in the health and sanitation domains using quartile and OLS regressions. The conclusion of the study demonstrated that corruption had a detrimental effect on both public health and economic progress. Kurniawan et al. (2020) analysed data from 2009 to 2018, using the multiple linear regression technique. Their findings demonstrated that whereas the development of humans has a positive and considerable influence on economic growth, corruption does not have a noticeable impact. Hoinaru et al. (2020) conducted a study on the effect of corruption and the shadow economy on economic and sustainable development. They employed pooled OLS, random effect and fixed effect as techniques of analysis for data obtained from 185 countries between 2005 and 2015. The results showed that corruption negatively impacts economic and sustainable development. Spyromitros and Panagiotidis (2022) examined the effect of corruption on economic growth in 83 developing countries between 2012 and 2018 using Autoregressive (AR1) and FMOLS as analysis techniques. Their findings showed that the impact of corruption on economic growth is negative in different regions. Makar et al. (2023) investigated the effect of corruption on economic growth in Nigeria. Data from 1986 to 2019 was analysed using the Johansen cointegration test and vector error correction tests. The results suggested that corruption has a negative impact on economic growth in the long run. Lucarelli et al. (2024) examined the impact of corruption on economic growth in 8 Balkan countries using Autoregressive Distributed Lag (ARDL). The findings showed that in the short-term, corruption has the tendency to improve economic growth, while in the long-term corruption has a detrimental impact on economic growth. Gebresilassie et al. (2024) examined the nexus between corruption and economic growth in 37 SSA countries between 2012 and 2022. Using a two-step system GMM as a method of data analysis, the results of their findings showed that corruption and government intervention are detrimental to economic growth.

Hence, hypothesis 2 is stated as:

H2 Corruption has a negative effect on economic growth in SSA.

GOVERNMENT EXPENDITURE, CORRUPTION AND ECONOMIC GROWTH

Nguyen and Bui (2022) analysed the role of corruption control in the relationship between government expenditure and economic growth. The study consisted of 16 emerging markets and developing economies (EMDES) in Asia over the period 2002–2019. The study employed GMM and a threshold model for the analysis. The study found that government expenditure has a negative effect on economic growth. Similarly, corruption control is found to have a negative impact on economic growth. The study found that the interaction term of government expenditure and corruption control reduces the level of the negative impact of these two factors on economic growth. The results from threshold estimation show that government expenditure will enhance economic growth when control of corruption is above the threshold level of 0.01. Iliyasu and Muhammed (2023) examined the role of corruption on the relationship between government expenditure and economic growth in Nigeria during the period from 1990 to 2020. The study employed ARDL, FMOLS and DOLS estimation techniques. Individually, government expenditure contributes to economic growth in the long-run, while its effect is insignificant in the short-run. The study also found that corruption is hindering economic growth in Nigeria. Regarding the joint effect of government spending and corruption, the study found that low corruption enhances the effect of government expenditure on economic growth. D'Agostino et al. (2016) investigated the interaction of government spending and corruption on economic growth for the period 1996–2010. The study applied GMM on a panel of 106 countries and found that interaction between corruption and both investment and military spending produced a negative impact on economic growth. Okunlola et al. (2024) considered the role of corruption and conflict in the relationship between government expenditure and economic growth in 15 ECOWAS (Economic Community of West African States) nations during the period from 1999 to 2021. POLS, FMOLS, and DOLS estimations were employed in obtaining the results. The results showed that government expenditure enhances economic growth in ECOWAS countries. It was also found that low corruption enhances the impact of government expenditure on economic growth.

Evidence from the literature reviewed shows that studies have not considered the role of corruption on the relationship between public health expenditure and economic growth in SSA. Also, evidence from the stud-

ies that considered the role of corruption on the relationship between government expenditure and economic growth is mixed. Some studies found that corruption acts as 'sand the wheels', while other studies found that corruption acts as 'grease the wheel' in the relationship between government expenditure and economic growth.

Hence, the third hypothesis is stated as:

H3 Corruption augments public health expenditure to positively affect economic growth.

Methodology

Endogenous growth models capture the process through which economic growth and development are affected by investments in public health. These models have emphasised the significance of human capital to the growth of the economy. Economic growth as regards the level of savings and population growth is explained by neoclassical growth models. Solow (1956) posited that every other thing being equal, countries will have higher per capita income as a result of higher savings. The major determinants of per capita income across countries according to Solow's model are the rate of savings and population (Hashmati 2001). A theoretical model was built by Buchanan (1965) urging government agencies to enhance government expenditure on health not depending on demand. Inadequate delivery of healthcare services, according to this theory, should not be limited to scarcity of healthcare services, but factors like inequitable distribution of health workers, reduction in quality of healthcare delivery, overcrowding, infrastructure, etc., should also be considered.

Hence, the total output of the economy generated by the Cobb-Douglas production function is considered by this study in the following form:

$$Y_{it} = A\left(K_{it}^{\alpha}\left(HL_{it}\right)^{1-a}\right)^{1-\gamma} G_{it}^{\gamma}, \quad 0 < a < 1, 0 < \gamma < 1, \tag{1}$$

where A refers to technology, K_{it} represents capital input, L_{it} stands for the labour input, H_{it} sands for the human capital, and G_{it} represents government spending on health. Assuming that usually all variables are measured in per-capita terms, divide Y_{it} by L_{it}. Subscript i denotes cross-sectional units measured for dated periods and the subscript t signifies time.

$$y_{it} = A\left(k_{it}^{\alpha}\left(H\right)^{1-a}\right)^{1-\gamma} G_{it}^{\gamma}, \tag{2}$$

where $y_{it} = Y/L$ and $k_{it} = K/L$ depict output and capital per capita, respectively.

Logarithms of both sides of the equation are taken as:

$$\ln y_{it} = \ln A + \alpha(1 - \gamma)\ln k_{it} + (1 - \alpha)(1 - \gamma)\ln H_{it} + \gamma \ln G_{it}. \quad (3)$$

Apart from physical and human capital and expenditure on health, output is also influenced by other factors at a given period of time; all these factors are captured in 'A' (Solow residual). In particular, Ductor and Grechyna (2013) posited that 'A' could reflect the state of progress in technology in the real sector, and the institutions' quality. Corruption in the economy is depicted as 'A' in order to achieve the objective of this study. Therefore, by substituting corruption (COR) for A and HEXP for G in equation (3) and by adding lag of GDP, it becomes:

$$\ln y_{it} = COR_{it} + \alpha(1 - \gamma)\ln k_{it} + (1 - \alpha)(1 - \gamma)\ln H_{it} + \gamma \ln HEXP_{it}. \quad (4)$$

It is evident from Aizenman et al. (2013), Adewara and Oloni (2012) and Adeusi and Aluko (2015) that there are various other factors that are significant determinants of the economic growth. Trade openness (OPEN) and inflation (INF) are added to the model to serve as control variables. The error term is also included in the equation in order to express the equation in econometrics form. Therefore, the equation to be examined becomes:

$$\begin{aligned} \ln y_{it} = {} & COR_{it} + \alpha(1 - \gamma)\ln k_{it} + (1 - \alpha)(1 - \gamma)\ln H_{it} \\ & + \gamma \ln HEXP_{it} OPEN_{it} + INF_{it} + \varepsilon_{it}. \end{aligned} \quad (5)$$

Examination of the effect of corruption on the nexus between government health spending and economic growth is the main aim of this study. This hypothesis is tested by adding an interaction term of government health spending and corruption to equation (5).

$$\begin{aligned} \ln y_{it} = {} & \alpha_1 COR_{it} + \alpha_2 \ln HEXP_{it} + \alpha_3 (COR_{it} \cdot \ln HEXP_{it}) \\ & + \alpha(1 - \gamma)\ln k_{it} + (1 - \alpha)(1 - \gamma)\ln H_{it} + \gamma OPEN_{it} \\ & + INF_{it} + \varepsilon_{it}. \end{aligned} \quad (7)$$

Equation (6) will be estimated using a fixed-effects model and random effect.

However, to provide a robust check for fixed effect and random effect estimations, this study employed the GMM technique. Therefore, the lagged dependent variable is added to equation 6 and it becomes:

$$\ln y_{it} = y_{it-1} + \alpha_1 COR_{it} + \alpha_2 \ln HEXP_{it} + \alpha_3 (COR_{it} \cdot \ln HEXP_{it}) + \alpha(1-\gamma)\ln k_{it} + (1-\alpha)(1-\gamma)\ln H_{it} + \gamma OPEN_{it} + INF_{it} + \varepsilon_{it}. \quad (7)$$

Estimation Procedure

A difference GMM that makes use of instrumental variables to verify the GMM of corresponding moment condition was recommended by Arellano and Bond (1991) so as to reduce the problem of endogeneity. This method is adopted to eliminate the individual fixed effect in order to continue with the first difference of the regression equation. Subsequently, the lagged variable will be considered as the corresponding instrumental variable of the endogenous variable in the difference equation. However, according to Bond et al. (2001), this method suffers from weak instrument problems, mainly in a fixed sample, thereby resulting in poor estimates. A system GMM estimator in which GMM is applied to a system of two equations – an equation in differences instrumented by lagged levels and an equation in levels instrumented by lagged differences – was introduced by Arellano and Bover (1995) and Blundell and Bond (1998) in order to solve this problem. The problems of heterogeneity, omitted variable bias, error of measurement and possible endogeneity issues that often affect growth models when using static models can be resolved using system GMM (Bond et al. 2001).

We employed unbalanced panel data from 2000 to 2022. The period was chosen because of the availability of data. The variables include:

- GDP growth (annual %) – this is the annual percentage growth rate of GDP at market prices based on constant local currency.
- Corruption (COR) – this measures the level of corruption within the political system and concern with corruption in the form of excessive patronage, nepotism, job reservations, and 'favour-for-favours'. Corruption from the International Country Risk Guide is rated between 0 and 6. A score of 6 signifies a low level of corruption, while a low score of 0 indicates a high level of corruption.
- Public Health expenditure (HEXP) – this is the current health expenditure per capita (current US$).
- Gross Capital Formation (GCF) as a % of GDP – this is the addition to the fixed assets of the economy plus net changes in the level of inventories.
- Human capital (HUM) – this is measured by the total labour force in millions.

- Trade openness (OPEN) – this is the addition of imports and exports of goods and services as a % of GDP.
- Inflation (INF) – this is the consumer price index (annual %).

The data on GDP per capita, human capital, health expenditure, trade openness and inflation are sourced from the World Development Indicators (WDI). Data on corruption is from the International Country Risk Guide (ICRG). The descriptive statistics of the variables are presented in table 1. The list of the SSA countries used for this study is in the appendix.

The results in table 1 show that the series have a high level of consistency, as the values of their mean and median are constantly within the least and highest values of these series. The deviations of actual data from their mean values are very small, as shown by the relatively low standard deviations for all the series. It was also revealed from the result that all the variables except inflation are kurtoses, as their kurtoses are below three.

Results

CORRELATION MATRIX

To determine the possible direction of association among the variables, the correlation matrix is obtained and presented in table 2. Generally, the results in table 2 showed that the coefficients in terms of magnitude are mixed, as some are positive and some are negative. The correlation matrix shows that public health expenditure is negatively correlated with economic growth. Similarly, corruption, human capital, openness and inflation are positively correlated with economic growth. Gross capital formation and public health expenditure have an inverse correlation with economic growth.

TABLE 1 Descriptive Statistics of the Variables

	Mean	Median	Max	Min	Std. Dev.	Skew.	Kurtosis	Obs.
GDP	0.653	0.722	1.332	−1.471	0.334	−2.292	11.740	372
COR	2.691	2.500	6.000	1.000	1.148	0.589	2.991	372
HEXP	1.702	1.603	2.841	0.638	0.448	0.803	3.065	372
GCF	9.536	9.526	10.810	8.087	0.595	−0.189	2.928	372
HUM	6.708	6.860	7.723	5.589	0.547	−0.526	2.204	372
OPEN	1.766	1.758	2.087	1.525	0.135	0.192	2.036	372
INF	0.644	0.726	2.037	−1.393	0.482	−0.889	4.798	372

TABLE 2 Correlation Matrix

Variables	GDP	COR	HEXP	GCF	HUM	OPEN	INF
GDP	1.0000						
COR	0.070699	1.0000					
HEXP	−0.1944	0.02766	1.0000				
GCF	−0.02765	0.06328	0.09437	1.0000			
HUM	0.1445	−0.0841	−0.2550	−0.0889	1.0000		
OPEN	0.17337	−0.1001	−0.5400	−0.35435	0.05987	1.0000	
INF	0.05875	0.0810	−0.0931	−0.11437	0.26325	0.01217	1.0000

PANEL UNIT ROOT TEST

This study performs the panel unit root test. The test is conducted because it is crucial to ascertain if the variables are stationary or not. To accomplish this, two different panel unit root tests, namely, Augmented Dickey–Fuller (ADF Fisher) and Philips–Perron (PP Fisher), are employed. The results are shown in table 3. The results of the test showed that GDP, COR, HEXP and INF are stationary at level, while other variables such as GCF, HUM and OPEN are only stationary at first difference. The results showed that none of the variables are I(2).

TABLE 3 Panel Unit Root Test Results

Variables	ADF Fisher		PP Fisher		
	Level	1st Diff	Level	1st Diff	
GDP	382.672***	762.242***	399.323***	1295.47***	I(0)
COR	135.027***	283.028***	198.407***	323.804***	I(0)
HEXP	86.69986***	367.672***	152.432***	393.321***	I(0)
GCF	46.97327	322.872***	46.5680	363.925***	I(1)
HUM	29.750499	262.771***	25.0301	266.266***	I(1)
OPEN	46.4982	290.146***	23.87769	295.758***	I(1)
INF	233.002***	572.364***	232.819***	832.570***	I(0)

NOTE *** signifies significance at 1% levels.

PANEL CO-INTEGRATION ANALYSIS

After the determination of the variables' stationarity, we performed a cointegration test. This is needed in determining if the variables employed have a long-run relationship among them. This study considered the Pedroni cointegration test. The results of the co-integration test are shown in table 4, and the results of panel v-statistics, panel rho-statistics, panel pp-statistics, panel adf-statistics, group rho-statistics, group

TABLE 4 Pedroni Cointegration Test

GDP, COR, HEXP, GCF, HUM, OPEN, INF	Test	Intercept and trend Within
	Panel-v	−230.29986
	Panel-rho	3.5502
	Panel-pp	−3.2696***
	Panel-adf	−2.12658***
	Group-rho	4.6995
	Group-PP	−8.1224***
	Group-ADF	−1.8251***

NOTE *** indicates significance at 1%.

PP-statistics, and group ADF-statistics rejected the null hypothesis of no cointegration, as four out of the seven statistics are significant. Therefore, it could be concluded that there is a long-run relationship among the variables based on the results of the cointegration tests.

PUBLIC HEALTH EXPENDITURE, CORRUPTION AND ECONOMIC GROWTH

The result of the effect of corruption on the nexus between government health spending and economic growth in sub-Saharan Africa between 2000 and 2022, using a fixed effect estimation, is presented in table 5.

Table 5 consists of three models.

- Corruption and the interaction term are excluded in model 1. In model 2, only the interaction term is excluded. The coefficient of corruption in model 2 is insignificant, while it is positive and significant in model 3. This indicates that corruption has a positive effect on economic growth according to fixed-effect estimation. The coefficient of the interaction term in model 3 is negative but insignificant.
- Public health financing has a significant positive relationship with economic growth in all the models. The coefficient of public health financing is significant at 1% in model 1 and at 5% in models 2 and 3. This suggests that a 1% increase in public health spending will lead to a 0.35108%, 0.3403% and 0.3281% increase in economic growth in models 1, 2 and 3, respectively.
- The coefficient of GCF in all the models is positive and significant at 1%. According to this finding, a 1% increase in GCF will increase economic growth by 0.4471%, 0.4951% and 0.49765% in models 1, 2 and 3, respectively.

TABLE 5 Public Health Expenditure, Economic Growth, and Corruption

	FIXED EFFECT Model 1	FIXED EFFECT Model 2	FIXED EFFECT Model 3
C	−3.5251 (−0.9096)	−2.67437 (−0.5914)	−2.760595 (−0.610095)
COR	– –	−0.0060 (−0.27106)	0.0113*** (0.31798)
HEXP	0.3508*** (2.8920)	0.3403** (2.4272)	0.3281** (2.3163)
HEXP*COR	– –	–	−0.0100 (−0.6272)
GCF	0.4471*** (4.1683)	0.4951*** (3.87549)	0.49765*** (3.8823)
HUM	−0.4792 (0.9147)	−0.6342 (−1.0323)	−0.6193 (−1.0064)
OPEN	1.5430*** (3.8517)	1.42106*** (3.06768)	1.4181*** (3.05986)
INF	−0.0309 (−0.6993)	−0.0292 (−0.5764)	−0.03768 (−0.70766)
Hausman test	53.09 (0.0000)	42.82 (0.0000)	42.82 (0.0000)
No. of observations	481	371	390
No. of countries	32	32	32

NOTES The *t*-values for all the estimations are in brackets. The significance of the individual coefficients at the 1%, 5%, and 10% levels are represent ed by ***, ** and *, respectively.

- The coefficient of human capital is negative but not statistically significant in all the models.
- The coefficient of trade openness is positive and significant at 1% in all the models. This implies that trade openness significantly enhances economic growth in SSA.
- The coefficient of inflation is negative in all the models, but it is not significant. The Hausman test indicates that the fixed effect model is preferable to random effect results, as it is significant in all the models.

To provide a robust check for static estimation in table 5, this study employed the GMM technique to estimate the effect of corruption on the relationship between health expenditure and economic growth in SSA. This study employs GMM due to the weakness of static estimations to handle the problem of autocorrelation and heteroscedasticity.

Table 6 presents the results of the two-step system Generalised Method of Moment (GMM). It comprises three models. In model 1, corruption and the interaction term are excluded. In model 2, corruption is included while the interaction term is excluded. In model 3, both corruption and the interaction term are included in the estimation.

- The coefficient of public health expenditure is positive but insignificant in model 1. However, it has a negative sign and is significant in models 2 and 3. Although the negative impact of government health spending on economic growth is contrary to a priori expectation, the negative impact may be due to inappropriate allocation and misappropriation of public funds in the health system.
- From table 6, corruption negatively and significantly impacts economic growth in SSA. This is based on the negative coefficient of corruption in models 2 and 3. This finding contradicts the fixed effect results where the coefficient of corruption is positive. The possible reasons might be that the fixed effect results might be suffering from an autocorrelation problem.
- The impact of the coefficient of the interaction term on economic growth is significant and positive at 1%. This finding suggests that corruption does not limit the growth impact of public health spending in SSA. This finding suggests that control of corruption enhances the effect of health spending on economic growth in SSA.
- The coefficient of GCF is insignificant in models 1 and 2, but it is positive and significant at 10% in model 3. This suggests that GCF enhances economic growth according to model 3, as economic growth will increase by 0.0601% at a 1% increase in GCF.
- The coefficient of human capital in all the models is insignificant. The coefficient of trade openness is significant and positive in all the models. The coefficient of trade openness is significant at 1% in models 1 and 3, while it is significant at 5% in model 2. This shows that trade openness enhances economic growth in SSA.
- The coefficient of inflation is not significant in models 2 and 3, but it is negative and significant at 5% in model 1. This shows that inflation hurts economic growth in SSA.

On the diagnostics tests of the panel estimates, the p-values of first-order autocorrelation (AR(1)) are significant in all the models, which confirms the presence of first-order autocorrelation in the models. The p-values of second-order autocorrelation AR(2) in models 1, 2 and 3 are

TABLE 6 Public Health Expenditure, Economic Growth and Corruption

	GMM Model 1	GMM Model 2	GMM Model 3
LAG GDP	−0.1074**	−0.33218***	−0.280796***
	(−2.12879)	(−5.7260)	(−6.0340)
HEXP	0.24655	−0.25326***	−0.2952***
	(1.370696)	(−2.85655)	(−6.0800)
COR	-	−0.065980***	−0.08970***
		(−5.85218)	(−10.22217)
HEXP*COR	-	-	0.0389***
			(3.3989)
GCF	−0.0089	0.0404	0.0601*
	(−0.18109)	(0.71657)	(1.8120)
HUM	−0.15768	0.0880	0.0373
	(−1.67109)	(1.0972)	(0.6152)
OPEN	0.8845***	0.31547*	0.3724***
	(5.0491)	(1.72346)	(2.98439)
INF	−0.13546**	−0.09327	−0.04985
	(−2.41546)	(−1.6750)	(−0.87349)
AR(1)	0.002	0.003	0.003
AR(2)	0.184	0.633	0.860
Hansen Test (*p*-values)	0.063	0.407	0.459
No. of observations	426	329	329
No. of countries	32	32	32
No. of groups	31	31	31
No. of instruments	24	30	30

NOTES The *t*-values for all the estimations are in brackets. The significance of the individual coefficients at the 1%, 5%, and 10% levels are represented by ***, ** and *, respectively. The Arellano–Bond test of first-order and second-order autocorrelation are represented by AR(1) and AR(2), respectively. LAG GDP represents lagged GDP; all other acronyms are explained in previous tables.

0.184, 0.633 and 0.860, which are insignificant. The insignificance of the p-value of AR(2) implies that second-order autocorrelation is absent in the model. The presence of the first-order autocorrelation and the absence of second-order autocorrelation meet the condition of the validity of GMM estimations. The p-value of the Hansen test is insignificant, which implies that the model is correctly specified and the instruments used are valid. Also, the number of instruments is kept below the number of groups, which also satisfies the validity of GMM estimates.

DISCUSSION

This study obtained a slight difference between fixed effect and system GMM. The differences are due to the issue of autocorrelation and heter-

oscedasticity, which the static estimations are weak to control; in such case, this study based its conclusion on the GMM estimations. According to Bond et al. (2001), the system GMM is capable of addressing issues like heterogeneity problems, omitted variable bias, measurement error, and potential endogeneity problems which static methods could not address in growth models. The study obtained conflicting results from fixed and GMM estimations on the impact of public health spending on economic growth. While the fixed effect supports a positive connection between public health expenditure and economic growth, the GMM confirms a negative association. The negative effect of public health spending on economic growth does not support the hypothesis one (H1) of this study. The negative effect of GMM estimation is in line with Aisa and Pueyo (2006) and Eggoh et al. (2015), as they found a negative relationship between public health expenditure and economic growth. The possible reasons why public health spending has a negative impact on economic growth in SSA might be due to wasteful or misallocated public health expenditure. The misallocation of public health expenditure on ineffective and unviable healthcare programmes and projects will harm economic growth, as the effect of that spending will not yield the expected outcomes in the economy. Also, the frequent abandoning of projects due to changes in government or political stability might likely affect the impact of public health expenditure on economic growth in the region. The lack of continuity of projects will lead to a waste of resources and time. This finding is very significant in the SSA region, as previous studies are primarily focused on the general government expenditure on economic growth.

From the fixed-effect estimation, the study found that corruption enhances economic growth while it has a detrimental effect on economic growth in GMM estimation. However, we based our conclusion on the GMM estimations because of its ability to effectively handle the problems of autocorrelation and heteroscedasticity. The negative effect of corruption on economic growth based on GMM estimation supports the hypothesis two (H2) of this study. The negative effect of corruption on economic growth found in this study is consistent with Akinlo et al. (2021), Farag et al. (2013), Ceesay (2019) and Makar et al. (2023), who found that corruption impedes economic growth. This is an indication that corruption limits the allocation of government resources, which in turn can inhibit economic growth. This finding contradicts studies which claim that in developing countries whose institutional quality is

weak, corruption can be directly useful in 'greasing the wheels' in economic growth.

The study found that the interaction of corruption and public government expenditure enhances economic growth in SSA. This indicates that corruption enhances the impact of public health expenditure on economic growth in SSA, which might be due to the current low level of corruption. This finding supports the hypothesis three (H3) of this study. Based on this finding, it shows that corruption is directly harmful to economic growth while it is beneficial to the growth impact of public health expenditure. This finding is in line with Iliyasu and Muhammed (2023), who found that corruption promotes the effect of government spending on economic growth in Nigeria. This finding suggests that corruption is not harmful to the impact of public health spending on economic growth but rather enhances the growth impact of public health expenditure, i.e 'greasing the wheels'. The possible reason for this might be that corruption is helpful in overcoming inefficiency resulting from bureaucratic bottlenecks which slow down the execution of health projects and implementation of health policies. Also, the level of the corruption in SSA might not so high to the point where it can cause public health expenditure to negatively impact economic growth.

The positive effect of human capital on economic growth is insignificant. This finding contradicts Akinlo and Oyeleke (2020) and Riaz et al. (2022), who found that human capital impacts economic growth positively. However, this finding is consistent with Karambakuwa et al. (2019), who found that human capital has an insignificant effect on economic growth in SSA. Karambakuwa et al. (2019) explained that human capital development has been improving in the region over the years. However, the improvement of human capital might not have significant impact on economic growth without building proper supporting structures. Also, Ahsan and Haque (2017) stated that the relevance of human capital in enhancing economic growth in the SSA region is contingent on the level of development. This implies that economies in the SSA region need to attain a certain level of development before reaping the economic rewards of human capital development.

The results also reveal that physical capital enhanced the growth of the economy in sub-Saharan Africa during the period under study. This finding is in line with Kadir et al. (2018), Adewara and Oloni (2012), Akinlo and Oyeleke (2020), Mhaka and Runganga (2023), and Bhattacha-

rjee et al. (2022), who found a positive relationship between physical capital and economic growth. This finding indicates the importance of physical capital in economic growth in SSA. Garzarelli and Limam (2019) stated that physical capital is the primary driver of economic growth in SSA. Availability of infrastructure, such as good roads, storage facilities, electricity and health facilities, can reduce the cost of production and thereby boost the national output. Also, infrastructure can promote efficiency in the economy.

The positive effect of trade openness on economic growth in the region shows that trade is a major driver of economic and social improvements because there will be higher results, such as greater access to international markets, foreign investment and technology. Trade openness is very germane to the growth of productivity in sub-Saharan Africa. This is evident from the results obtained from the two estimations. Trade openness can promote economic growth by boosting productivity. Trade openness offers the economies in the SSA region the opportunity to export their products to other countries, which can lead to an increase in output and further investment.

The results show that inflation harms economic growth. This is in line with Xesibe and Nyasha (2020), Dada and Akinlo (2023), Adewara and Oloni (2012), Mandeya and Ho (2021), and Gokal and Hanif (2004), but in contrast to Mhaka and Runganga (2023), who found that inflation impacts economic growth positively. This finding is also consistent with Phiri (2018), who found that inflation harms economic growth when inflation is above the threshold level of 5.30%. Inflation hurts economic growth because it creates price instability and reduces purchasing power, thereby weakening economic growth. It was also revealed in the results that corruption and the interaction of public health spending and corruption have mixed impacts.

Conclusion

This study uses fixed-effect and GMM estimations to examine how public health spending affects economic growth in 32 SSA nations between 2000 and 2022 when corruption is present. It was revealed from GMM estimation that public health spending impacts economic growth negatively in sub-Saharan Africa during the period of study. The study found that corruption harms economic growth in SSA according to GMM estimation. The results also showed that interaction of corruption with public health expenditure enhances economic growth. Human capital is

found to be insignificantly impacted by economic growth. Both physical capital and trade openness impact economic growth positively, while inflation has an inverse relationship with economic growth.

In line with findings from this study, the following recommendations are suggested.

- First, the negative effect of public health expenditure on economic growth suggests that an increase in public health spending may not always lead to economic growth except where the public health funds are effectively used. Therefore, governments in the SSA region must ensure that the funds allocated to the improvement of the healthcare system are effectively utilised and channelled to projects that will enhance economic growth. Governments in SSA need to ensure that there is accountability and transparency in the healthcare system to minimise mismanagement and waste. Additionally, the public should have access to clear and widely disseminated information regarding the allocation of funds to the health sector. Policymakers need to implement digital financial systems, routine audits, community oversight, and e-procurement to track healthcare spending. These will enable health expenditure to produce a healthy workforce and higher productivity, and hence economic growth. A well-utilised health expenditure can also improve health infrastructure which can attract businesses and investors and thereby create jobs and promote economic growth.
- Second, the direct negative impact of corruption on economic growth suggests that policymakers in SSA need to improve the quality of control of corruption in the region. Corruption has been one of the major obstacles to economic growth in the SSA region and requires necessary actions to reduce it. Appropriate punishment must be administered to corrupt officials rather than the selective punishment whereby some corrupt individuals are untouchable. This will create fear and promote accountability and efficiency in the management of funds. The mechanism for effective monitoring of allocation of funds and execution of projects across sectors in the economy needs to be adopted. This will ensure that the government's resources will be allocated more efficiently and also contribute significantly to stimulating private investment, which is an important prerequisite for improving economic growth.
- Third, since this study found that corruption enhances the impact of public health spending on economic growth, policymakers need to

strengthen institutional quality, particularly government efficiency, political stability, effective regulation and bureaucracy reduction, while targeting the reduction of corruption in the region. Strong institutional quality will help to remove bureaucracy, administrative bottlenecks and other obstacles that can limit the impact of public health spending on economic growth. Any policy that targets the reduction of corruption without improving the institutional quality variables will cause public health expenditure to have an undesirable effect on economic growth.

This study has some limitations which are related to the scope of this study, the number of countries and the measurement of corruption. This study could not cover the period before the year 2000 and the period after 2022 due to data availability. Therefore, it restricted the period of this study to 23 years. Similarly, the study included 32 sub-Saharan African countries out of a possible 54 countries. The limitation is due to the unavailability of data for some of the sub-Saharan countries. Some sub-Saharan African countries have experienced war in previous years, which affects data availability in those countries. Also, the use of corruption data from ICRG shows that future studies need to consider alternative measures.

Based on the focus of this study and its limitations, this study highlights some areas for future research. It might be interesting for future studies to consider this topic based on income classifications in sub-Saharan Africa. This will enable us to discover if the influence of corruption on the relationship between public health expenditure and economic growth depends on the level of incomes in sub-Saharan Africa.

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Appendix

List of Countries

Angola	Mali
Botswana	Mozambique
Burkina Faso	Namibia
Cameroon	Niger
Côte d'Ivoire	Nigeria
Democratic Republic of Congo	Republic of the Congo
Ethiopia	Rwanda
Gabon	Senegal
Gambia	Sierra Leone
Ghana	South Africa
Guinea	Sudan
Guinea Bissau	Tanzania
Kenya	Togo
Lesotho	Uganda
Madagascar	Zambia
Malawi	Zimbabwe