economies

MDPI

Article

Public Health Spending in Africa: Cyclicality, Asymmetries, and COVID-19

Abdalla Sirag [1] and Mohammed Gebrail [2,*]

[1] College of Economics and Management, Al Qasimia University, Sharjah 63000, United Arab Emirates; aomer@alqasimia.ac.ae
[2] Department of Politics and Public Administration, University of Konstanz, 78464 Konstanz, Germany
* Correspondence: mohammed.gebrail@uni-konstanz.de

Abstract

The COVID-19 pandemic has renewed the global focus on the role of public health spending, particularly in developing regions where fiscal space is mostly limited. Many African countries have started reassessing the health sector as a core economic resilience component. This study examines how government health expenditure responds to macroeconomic fluctuations in African countries. Attention was given to asymmetries between positive and negative periods of GDP growth and the impact of COVID-19 on these dynamics. The analysis uses annual data from 45 African economies from 2000 to 2022 and applies a panel NARDL framework to capture nonlinear and dynamic relationships. The sample is further disaggregated into low-income and middle-income groups. The results from the full sample indicate a procyclical pattern of health spending, where expenditure rises during economic expansions, but it discloses an acyclical relationship during recessions. Further analysis reveals that health spending in low-income countries follows a similar procyclical trend, while middle-income countries exhibit a countercyclical response to positive and negative growth shocks. Inflation consistently reduces health spending across the sample. The COVID-19 period has altered the cyclical pattern of health expenditure, at least in the short-run, especially for low-income countries. These findings highlight the need for more resilient and countercyclical fiscal strategies in the health sector, specifically during economic downturns, to ensure sustained investment.

Keywords: public health expenditure; macroeconomic shocks; cyclicality; asymmetry; COVID-19 pandemic; panel NARDL

Received: 5 August 2025
Revised: 20 September 2025
Accepted: 22 September 2025
Published: 29 September 2025

Citation: Sirag, A., & Gebrail, M. (2025). Public Health Spending in Africa: Cyclicality, Asymmetries, and COVID-19. *Economies*, *13*(10), 284. https://doi.org/10.3390/economies13100284

1. Introduction

The COVID-19 pandemic placed an extraordinary burden on public health systems worldwide, revealing structural weaknesses in financing and delivery especially in developing regions. In recent years, governments and international organizations have increasingly recognized that a robust health system is a vital foundation for macroeconomic stability. During the pandemic, many African countries began viewing the health sector as a critical economic driver, rather than merely a social service. This shift reflects the growing awareness of how underinvestment in health can amplify economic shocks and hinder recovery efforts.

Despite this renewed focus, health expenditure is developing, particularly across Africa, which remains vulnerable to the volatility of economic cycles. This vulnerability is partly due to structural weaknesses in public finances and the limited fiscal space available

to many governments. While fiscal theory suggests that government spending should ideally follow a countercyclical patter, which recommends increasing spending during recessions to cushion the economy and decreasing it during expansions to prevent overheating, in practice, this is not always the case. In many low- and middle-income countries, fiscal policy tends to follow a procyclical pattern due to institutional and budgetary constraints (Ouedraogo & Sourouema, 2018). Whether health spending follows this broader fiscal behaviour or exhibits a unique pattern remains an open question.

A growing body of literature has examined the impact of macroeconomic conditions on social spending. Some evidence suggests that unstable macroeconomic conditions, such as recessions and inflationary episodes, tend to lead to cuts in public health investment (Reeves et al., 2013; Ongaro et al., 2015; Liang & Tussing, 2019; Chakrabarty & Roy, 2021). In addition, it is emphasized that public health spending tends to increase during better economic conditions, such as higher GDP growth, stable prices, and higher government revenues (Behera et al., 2020). Another point of view emphasized the countercyclical role of health spending in times of crisis (Loayza & Pennings, 2020). This is in line with what Keynesians try to encourage policymakers to stimulate the economy during recessions. It is also argued that maintaining or improving the health budget, especially during economic downturns, is pivotal to preserving the human capital level (Stuckler et al., 2009). Nonetheless, most of the evidence in the past literature is related to global or high-income countries, with less focus on the less-developed African countries (see, Lledó et al., 2011). Given structural vulnerabilities in the region, such as high indebtedness, dependency on external aid, and weak institutional arrangements, it is not clear whether the patterns observed in other countries are actual in the context of Africa.

Although several empirical findings from developing economies have revealed the procyclicality of health spending, potential asymmetric responses of health spending to economic upturns and downturns are taken into consideration (Chen et al., 2013; Behera et al., 2020; Chakrabarty & Roy, 2021). For instance, Del Granado et al. (2013) found that health spending is affected more during recessions compared to booms. The study indicated that the nonlinear relationship between health spending and economic conditions could be due to the desire to preserve population health during a crisis such as COVID-19, and it could be due to a higher share of recurrent expenditure. Interestingly, the positive link between GDP growth and health expenditure becomes more positive and stronger as the development level of the country declines (Del Granado et al., 2013). Again, the inadequacy of studies addressing this issue in the case of African countries is highly significant. Recognizing these asymmetries, the study asks whether the effects of economic recessions on health spending are more persistent than the gains during booms. Accounting for nonlinearity is important, particularly in Africa, where few studies exist (e.g., Kavese & Phiri, 2021) and many countries face economic instability and limited fiscal space, making sound and comprehensive health financing a pressing concern.

More recent writings highlighted the fiscal policy response in many African countries during and after the pandemic (International Monetary Fund (IMF) (2021); World Bank, 2022). The increase in public health expenditure across African nations during the pandemic highlights how governments reacted to the health economic shock. Regardless of the impact of such policy changes on the health sector, similar changes may signal prioritization that may likely preserve public health and increase spending during recessions and reduce it during expansionary periods. However, whether this change was a temporary or a structural change in how health budgets respond to the economic cycle remains unclear. If public health spending continues to react negatively to GDP growth in recovery times, this would imply countercyclical behaviour after COVID-19. Such a structural change would have important policy implications for the sustainability of health financing in the

region. These earlier-mentioned reports are descriptive, with little empirical analysis to show how macroeconomic shocks translated into changes in health spending. In addition, while studies have investigated the impact of COVD-19 on health in many African economies, less attention has been paid to how behaviour might have changed after the crisis. Although Konuki and Villafuerte (2016) suggest more pronounced procyclicality of government expenditure especially after a global financial crisis and Calderón et al. (2017) found evidence of change to acyclical or countercyclical patterns in sub-Saharan African countries, the cyclical pattern of health spending remains uncovered. Therefore, the study addresses a critical gap in the literature by testing for asymmetries in the cyclical behaviour of public health spending and to what extent COVID-19 may have impacted the relationship between GDP growth and government health expenditure. This is significant to economic policymakers in many African states as it may offer some insights into whether the pandemic has altered long-run fiscal dynamics. Such evidence is needed to assess the potential sustainability of the gain in health investment witnessed during expansionary periods.

This paper aims to fill the gap in the literature by investigating the cyclicality and asymmetry in the relationship between GDP growth and public health expenditure across African countries. Using panel data from 45 countries over the period 2000–2022, the study employs a nonlinear panel estimation technique to distinguish between positive and negative changes in economic growth. It further introduces COVID-19 interaction terms to test whether the pandemic altered the historical spending patterns. In doing so, this study provides empirical evidence on whether health expenditure behaves procyclically, countercyclically, or asymmetrically—and how these patterns differ between income groups. In addition, this study differs from prior African work in two ways. First, we test asymmetry in cyclical behaviour using a panel NARDL-PMG setup, rather that assuming a single linear response. Second, we embed a COVID-19 regime directly in the asymmetric framework, so we can see whether expansions and contractions in GDP affected health budgets differently after 2020. Taken together, this lets us compare income groups within a common design and show how cyclical behaviour may have shifted around the pandemic.

The remainder of the paper is organized as follows. Section 2 reviews the literature on fiscal cyclicality and asymmetric adjustment in public health spending, with emphasis on developing economies and the COVID-19 period. Section 3 describes the panel NARDL specification and construction of the positive and negative growth partial sums, the COVID-19 interaction terms and the tests for long-run and short-run asymmetry, the estimation technique, and the data for 45 African countries (2000–2022). Section 4 reports the baseline results for the full sample and the income group subsamples, together with symmetry tests, diagnostic statistics, and discussion of the results in light of the literature. Section 5 summarizes the study and provides recommendations for policy and future studies.

2. Literature Review

The review is organized to follow the study's aims. We start with cyclicality and possible asymmetry in the spending–growth link. We then look at the COVID-19 period as a separate regime and ask whether the relationship shifted. Finally, we compare patterns across income groups to show where behaviour diverges.

2.1. Cyclicality and Asymmetry Public Health Spending

The economic literature has long theorized and established an apparent link between public spending and economic performance. Theoretically, we can trace the foundations linking public spending to economic growth back to the 1930s. Keynes (1937) was the first to relate public spending to economic performance. In this first account, public spending

has a part to play, but mainly in aggregate demand shortfall when the private sector cuts back. Even then, it sees public investment in infrastructure, education, and health as part of public spending that serves almost exclusively as a stabilizing tool. The neoclassical growth model appeared next on the scene in the 1950s. It was a lot tougher on public spending. According to more recent empirical evidence, public spending may still affect long-run productivity, especially when channelled into sectors like health and education that enhance human capital and institutional resilience (Jurgens, 2024).

Many country-specific and cross-country studies using a variety of datasets and methodologies have empirically examined the link between macroeconomic indicators and government health spending. The bulk of this research is divided into two categories: one focusing on high-income economies and another examining developing countries, including middle- and low-income nations. In high-income economies, various studies have discovered that governmental health expenditures respond to cyclical and structural economic conditions. Reeves et al. (2013), in a study covering 25 EU countries (1995–2010), found that spending in the social sector, including health, had a significant and positive effect on economic growth during both recessionary and expansionary periods. However, the effects varied significantly by type of spending. Stuckler et al. (2009), looking at a broader range of high-income countries, observed that during times of economic crisis, rising unemployment tended to increase mortality (e.g., via suicides, homicides, and alcohol-related deaths), but that increased investment in active labour market programmes tended to ameliorate those effects. In the United States, Bose (2015) and Raghupathi and Raghupathi (2020) found that health expenditure positively correlated with key macroeconomic indicators like personal income, GDP, and labour productivity. However, while health spending enhances labour productivity and personal consumption, it may also negatively affect multifactor productivity.

In lower-income African settings, the same co-movement with GDP can be sharper because revenue bases are narrow and volatile, so expansions raise collections quickly while downturns force abrupt retrenchment; this macro-fiscal sensitivity tends to feed directly into health budgets.

Although several empirical findings from developing economies have revealed the procyclicality of health spending, potential asymmetric responses of health spending to economic upturns and downturns are taken into consideration (Behera et al., 2020; Chakrabarty & Roy, 2021). For instance, Del Granado et al. (2013) found that health spending is affected more during recessions compared to booms. The study indicated that the nonlinear relationship between health spending and economic conditions could be due to the desire to preserve population health during a crisis such as COVID-19, and it could be due to a higher share of recurrent expenditure. Interestingly, the positive link between GDP growth and health expenditure becomes more positive and stronger as the development level of the country declines.

The relationship between health expenditure and the economy is often more delicate and cyclical in poorer countries. Liang and Tussing (2019) show that not letting health expenditure be quite so cyclically correlated with the economy can bring down mortality rates. This is especially the case in countries where social security is up to par and the kind of institutional quality one expects can protect health budgets from being influenced by health-reducing economic decisions during an economic downturn.

Mechanistically, Africa's limited fiscal space, shallow domestic capital markets, and reliance on earmarked external aid can generate downturn-dominant asymmetry: cuts arrive quickly when GDP falls (credit constraints bind), while increases during booms are slower because procurement, hiring, and donor disbursement schedules are sticky. However, inflation further accentuates nonlinearity by eroding the real value of nominal

health allocations and raising input costs (e.g., pharmaceuticals, wages), so the same percentage fall in growth can translate into a disproportionately large real cut to effective health spending.

Proposition 1. *In African economies, public health expenditure co-moves with GDP and exhibits recession-dominant asymmetry; negative shocks reduce spending more than positive shocks of similar magnitude increase it, particularly where stabilizing institutions are weak.*

2.2. COVID-19 and Cyclical Behaviour in Health Spending

The COVID-19 pandemic imposed a dual burden on governments, containing the health crisis while managing economic fallout. Kurowski et al. (2021) divided the world into two groups of countries based on IMF projections and lumped 126 in the first group. These countries are in a position to boost per capita government expenditure substantially over the next five years. The second group, with 52 countries in it, cannot. Most of these countries are very poor. For the first group of countries, keeping health expenditures growing at pre-pandemic rates requires slight adjustments in the budget shares going into health. For the second group of countries, it requires adjustments that are, to be blunt, absurd. Jurgens (2024) finds that rigid fiscal frameworks intensified procyclicality in public health investment, leading to sharper spending cuts during downturns, especially where rules prevented flexible responses. Supporting this, Shimul et al. (2023) highlight that health spending in developing countries reacts more sharply to income fluctuations than in wealthier nations. This underscores the limited fiscal resilience of many African economies during downturns.

Africa's constrained fiscal and public health dynamics result from limited fiscal space, high debt levels, and vulnerability to external shocks. Loayza and Pennings (2020) stress the importance of countercyclical fiscal frameworks to avoid having to make deep cuts in social expenditures during economic downturns. Studies looking empirically at Africa or Sub-Saharan Africa as a whole have confirmed that its condition is far from homogeneous in terms of both fiscal health and public health outcomes. For example, Iheoma (2024) finds that countercyclical fiscal interventions in Central and Western Africa helped protect health outcomes, especially where governments could shift resources quickly. However, in Eastern and Southern Africa, limited responsiveness to policy shocks suggests deeper structural constraints. Arize et al. (2024) make clear that poor health outcomes result from something more than just the amount of money allocated in the public finance system; they are also the outcome of just how well that system is governed. The results of Arthur and Oaikhenan (2017) and Chireshe and Ocran (2020) support the role of health expenditure in reducing mortality and improving life expectancy in Sub-Saharan Africa. Nonetheless, macroeconomic instability could threaten the gains after the COVID-19 pandemic, especially inflation, which is the looming worry for most economies. The World Bank (2022) warns that inflation could erode the real value of health budgets and overwhelm recovery efforts in Africa countries.

Given post-2020 price pressures and exchange rate pass-through, inflation shocks in Africa plausibly operate as a distinct regime driver, altering how GDP changes translate into real health outlays; therefore, health spending may look more countercyclical on paper (nominal increases during recovery) while real provision remains constrained.

Proposition 2. *The COVID-19 period (2020–2022) altered the growth–health link, strengthening the effect of downturns and muting the effect of expansions on health spending.*

2.3. Income Heterogeneity in Health Spending Cyclical Behaviour

Reeves et al. (2015) and Behera et al. (2020) confirm a direct association between macroeconomic volatility and the volatility of health spending. Jalles et al. (2024) provide cross-country evidence that fiscal responses to macroeconomic shocks are asymmetric and mediated by institutional quality and financial development, with low-income countries more prone to acyclical or procyclical behaviour during downturns. Building on this evidence, our study classifies African health expenditure responses into three empirically observed patterns—procyclical, countercyclical, and asymmetric—using tests that distinguish downturn-dominant effects from symmetric adjustments. This classification scheme enables a transparent mapping from the literature's mixed findings to our hypothesis testing and subsequent policy discussion.

Proposition 3. *In the African context, low- and lower-middle-income countries display more procyclical and asymmetric behaviour than middle-income countries, which show greater scope for countercyclical protection.*

3. Methodology

This section sets out the empirical design. We first specify a macro panel NARDL model for public health spending as a percentage of GDP, GDP growth rate, inflation rate, and show how GDP growth is split into positive and negative partial sums. We then describe the COVID-19 dummy (2020–2022) and how it interacts with the partial sums and inflation. Next, we outline the estimation strategy: pooled mean group for common long-run coefficients with country-specific short-run dynamics, and symmetry tests in the long-run and short run. Finally, we document the data definitions, unit of measurement, and transformations, together with coverage and sources.

3.1. Model Specification

This study examines the relationship between macroeconomic shocks and government health expenditure per capita in Africa, focusing on asymmetries in fiscal behaviour and possible shifts during the post-COVID-19 period. Following the literature on fiscal cyclicality and asymmetry (e.g., Del Granado et al., 2013; Behera et al., 2020; Chakrabarty & Roy, 2021), the empirical model allows for distinct effects of positive and negative GDP growth, as well as interaction terms to capture post-pandemic dynamics. The model is specified as follows:

$$PHE_{it} = \alpha_i + \beta_1 GDPG_{it} + \beta_2 DEF_{it} + u_{it} \quad (1)$$

where PHE_{it} is public health expenditure as a percentage of GDP, $GDPG_{it}$ stands for GDP growth rate, DEF_{it} is the GDP deflator, and u_{it} is the error term. As the above model is only able to show the linear effect of GDP growth on public health expenditure and treats the pre- and post-COVID-19 period in the same way, $GDPG_{it}$ is decomposed into partial sums[1] following Shin et al. (2014) as follows:

$$GDPG_{it} = GDPG^{+}_{it} + GDPG^{-}_{it}$$

where

$$GDPG^{+}_{it} = \sum_{j=1}^{t} max\left(GDPG_{ij}, 0\right)$$

and

$$GDPG^{-}_{it} = \sum_{j=1}^{t} min\left(GDPG_{ij}, 0\right)$$

Objective 1 (cyclicality). We start from a baseline, NARDL representation where public health spending depends on positive and negative changes in GDP growth and controls, as written in the following Equation (2). This sign of the long-run coefficient on GDP growth changes (or, equivalently, the asymmetry version of Equation (1) below) indicates procyclical ($\lambda_1 > 0$ and $\lambda_2 > 0$), countercyclical ($\lambda_1 < 0$ and $\lambda_2 < 0$), or acyclical ($\lambda_1 = 0$ and $\lambda_2 = 0$) behaviour.

Objective 2 (asymmetry). To allow positive and negative growth to have different effects, we use the NARDL with partial-sum decompositions (Shin et al., 2014), yielding Equation (2) with $GDPG^+$ and $GDPG^-$.

Objective 3 (COVID-19 change). In Equation (2), we also added COVID-19 interaction terms in levels (e.g., $GDPG^+ \times COVID$, $GDPG^- \times COVID$, and $DEF \times COVID$). We test H_0: $\lambda_5 = 0$, H_0: $\lambda_6 = 0$, and H_0: $\lambda_7 = 0$.

$$\begin{aligned} PHE_{it} = \delta_i + \lambda_1 GDPG^+_{it} + \lambda_2 GDPG^-_{it} + \lambda_3 DEF_{it} + \lambda_4 COVID_{it} + \lambda_5 GDPG^+ \times COVID_{it} \\ + \lambda_6 GDPG^- \times COVID_{it} + \lambda_7 DEF \times COVID_{it} + \mu_{it} \end{aligned} \tag{2}$$

where $GDPG^+_{it}$ and $GDPG^-_{it}$ are the cumulative positive and negative changes, respectively, derived using the partial sum decomposition of GDP growth as proposed by Shin et al. (2014), $COVID_{it}$ is a dummy variable which takes the value of zero before the pandemic and the value of one during and post-COVID-19 period. Whereas $GDPG^+ \times COVID_{it}$, $GDPG^- \times COVID_{it}$, and $DEF \times COVID_{it}$ are the interaction terms between their respective variables and COVID-19 dummy, and μ_{it} is the residual of the model. This model enables testing for fiscal asymmetry by comparing the long-run coefficients on positive and negative growth shocks. A formal symmetry test ($H_0 : \lambda_1 = \lambda_2$) is conducted to evaluate whether the effects of positive and negative GDP growth on health spending are equal in magnitude and/or sign. This model also allows testing both the asymmetric response of health expenditure to macroeconomic shocks and whether these dynamics changed in the wake of COVID-19.

3.2. Estimation Methods

Given the panel structure of the data, covering 45 African countries over 2000–2022, this study employs the Pooled Mean Group (PMG) estimator developed by Pesaran et al. (1999). For all the three objectives, the PMG estimator is used. The PMG estimator is suitable for dynamic heterogeneous panels, as it allows for heterogeneity in the short-run dynamics and error correction across countries, whereas it imposes homogeneity on the long-run coefficients. This is particularly relevant in our context, where health expenditure behaviour in the short-run may differ due to country-specific fiscal constraints, institutional capacities, or external aid dependencies, but the long-run responses to macroeconomic fundamentals like growth and inflation are expected to converge. The estimation can be sensitive to cross-sections correlation and missing data. Therefore, it is important to test for cross-sectional dependence (CD) as the PMG assumes the independence of individual units. In cases where CD is present, other estimators such as common correlated effects mean group (CCEMG) or pooled mean group (CCEPMG) are better alternatives.

The error correction representation of the PMG model is given as follows:

$$\begin{aligned} \Delta PHE_{it} = \eta_i + \theta_1 PHE_{i,t-1} + \theta_2 GDPG^+_{i,t-1} + \theta_3 GDPG^-_{i,t-1} + \theta_4 DEF_{i,t-1} + \theta_5 GDPG^+ \times COVID_{i,t-1} \\ + \theta_6 GDPG^- \times COVID_{i,t-1} + \theta_7 DEF \times COVID_{i,t-1} + \sum_{j=1}^{p-1} \theta_{8i} \Delta PHE_{i,t-j} + \sum_{j=0}^{q-1} \theta_{9i} \Delta GDPG^+_{i,t-j} \\ + \sum_{j=0}^{q-1} \theta_{10i} \Delta GDPG^-_{i,t-j} + \sum_{j=0}^{p-1} \theta_{11} \Delta DEF_{i,t-j} + \sum_{j=0}^{q-1} \theta_{12i} \Delta GDPG^+ \times COVID_{i,t-j} \\ + \sum_{j=0}^{q-1} \theta_{13i} \Delta GDPG^- \times COVID_{i,t-j} + \sum_{j=0}^{q-1} \theta_{14i} \Delta DEF \times COVID_{i,t-j} + e_{it} \end{aligned} \tag{3}$$

To assess asymmetry, the equality test is conducted in the long-run as $\theta_2 = \theta_3$, and the short-run as $\theta_{9i} = \theta_{10i}$. The final specification of the NARDL will be based on the symmetry test. For instance, if a symmetry test is rejected/not rejected in the long- and short-run, then NARDL will be estimated in asymmetric/symmetric fashion in both time frames. While if a symmetry test is rejected only in the short-run/long-run, then NARDL should be estimated in asymmetric fashion only in the short-run/long-run. The long-run coefficients are calculated as $-\theta_2/\theta_1$, $-\theta_3/\theta_1$, $-\theta_4/\theta_1$, $-\theta_5/\theta_1$, $-\theta_6/\theta_1$, and $-\theta_7/\phi_1$ for positive changes in GDP growth, negative changes in GDP growth, GDP deflator, positive changes interacted with the COVID-19 dummy, negative changes interacted with the COVID-19 dummy, and GDP deflator interacted with the COVID-19 dummy, respectively. The asymmetric behaviour of health is confirmed through the symmetry and test is rejected in the long- or short-run or both. If the long-run coefficient of the positive changes, $-\theta_2/\theta_1$, is positive and significant, it means public health expenditure rises in response to economic expansion, which indicates procyclical behaviour. However, a negative and significant coefficient of the positive changes would imply countercyclicality of public health spending while a positive coefficient's sign of GDP negative changes, $-\theta_3/\theta_1$, would support procyclicality and the negative sign signifies countercyclical pattern. The insignificance of any coefficient indicates acyclicality of health expenditure.

In model (3), interaction terms with the COVID-19 dummy account for potential structural changes in fiscal behaviour during the pandemic. If the interaction terms are statistically significant, this suggests that the relationship between growth and health expenditure or between inflation and health expenditure have changes post-COVID-19. Specifically, the coefficient $(-\theta_6/\theta_1)$ with a negative and significant sign, while a positive and significant coefficient was observed pre-pandemic $(-\theta_3/\theta_1)$, would suggest a move toward countercyclicality in during- and post-pandemic periods. This shift implies that African policymakers increased health spending during the crisis due to the pandemic-related pressures despite fiscal constraints. On the other hand, if $(-\theta_2/\theta_1)$ was significant and positive before, but $(-\theta_5/\theta_1)$ is negative and significant, then procyclicality is reversed post-COVID-19 pandemic. By comparing the coefficients of positive and negative changes in GDP growth with and without the interaction terms, it can be indicated whether the pandemic has introduced new asymmetries in the cyclical behaviour of public health spending.

3.3. The Data

This study uses a balanced panel dataset covering 45 African countries over the period 2000 to 2022. All core variables were downloaded from the World Bank, World Development Indicators (WDI) via WDI DataBank.[2] For transparency and replication, we report the exact WDI indicator codes and provide indicator-specific API links below. Our dependent variable is domestic general government health expenditure (% of GDP). The main driver is GDP growth (annual %); from this series we construct partial sums of positive and negative changes at the country level, following Shin et al. (2014). As a price-level control we use the GDP deflator (annual %) instead of consumer price index inflation due to data shortages across Africa. The COVID-19 dummy equals 1 for 2020–2022 and 0 otherwise. We include 2022 because recovery was staggered and many governments still faced pandemic-related budget pressures in that year. With annual data, separating 2022 from 2020 to 2021 would create very short subperiods and unstable estimates. All interaction terms and the partial-sum variables are constructed by the authors in Stata 17 as described in the Methodology section. To preserve coverage across the sampled African countries over 2000–2022, we do not include additional fiscal and institutional control indicators (debt, revenue, grants, ToT, exchange rates, governance) in the analysis. These series contain substantial gaps for many countries in the region, which would reduce

the balanced sample and affect PMG convergence. Table 1 summarizes the information about the variables used in the study, such as definitions, units, WDI indicator codes, transformations, and data sources.

Table 1. Data and measurement.

Variable (Symbol)	WDI Indicator Code	Definition/Unit	Transformations	Coverage
Gov't health exp. (PHE)	SH.XPD.GHED.GD.ZS	Domestic general government health expenditure (% of GDP)	None	2000–2022
GDP growth (GDPG)	NY.GDP.MKTP.KD.ZG	Annual GDP growth (%)	Used to build $GDPG^{+}$ and $GDPG^{-}$	2000–2022
Inflation, GDP deflator (DEF)	NY.GDP.DEFL.KD.ZG	Inflation proxy, annual % change in GDP deflator	None	2000–2022
Positive Growth patrial sum ($GDPG^{+}$)	(constructed)	Cumulative sum of max (GDPG, 0) by country	Author-constructed	2000–2022
Negative Growth patrial sum ($GDPG^{-}$)	(constructed)	Cumulative sum of min (GDPG, 0) by country	Author-constructed	2000–2022
COVID-19 dummy	(constructed)	1 for 2020–2022, else 0	Author-constructed	2000–2022
Interactions (e.g., $GDPG^{+} \times$ COVID)	(constructed)	Interaction of growth partial sums/deflator with COVID-19	Author-constructed	2000–2022

4. The Empirical Findings

This section presents the main empirical findings of the study, beginning with descriptive statistics and correlation patterns (Section 4.1), followed by unit root and cointegration tests (Section 4.2), the panel NARDL results of the full sample (Section 4.3), the panel NARDL results of the full low- and lower-middle-income sample (Section 4.4), and the panel NARDL results of the middle-income sample (Section 4.5). The pre-statistical testing is explained in Sections 4.1 and 4.2. The analysis presented in Sections 4.3–4.5 is structured around three guiding objectives. First, to examine whether public health spending in Africa follows a cyclical pattern. Second, to explore the presence of asymmetries in fiscal responses to positive and negative macroeconomic shocks. Third, to assess whether these dynamics shifted during the COVID-19 period. All variables are analyzed using macro panel data and relationships are interpreted in both statistical and economic terms both in the long- and short-run.

4.1. Descriptive Statistics and Correlation Matrix

Table 2 provides the descriptive statistics for the main variables used in the analysis. Public health expenditure (PHE) as a percentage of GDP exhibits moderate variation across the sample. The cumulative positive changes in GDP growth ($GDPG^{+}$) show a relatively wide dispersion, with a mean of 59.65 and a maximum reaching 231.2, suggesting repeated or prolonged periods of economic expansion in some countries. By contrast, cumulative negative GDP growth ($GDPG^{-}$) has a mean of −5.09, indicating fewer or shorter episodes of contractions, but the substantial minimum of −53.16 reflects the severity of economic downturns in some cases. Inflation (DEF) exhibits high volatility, with a standard error of 84, highlighting macroeconomic instability in parts of the region. The COVID-19

dummy has a mean of 0.13, indicating that roughly 13% of the observations correspond to the pandemic period. The interaction terms show considerable variability, especially $GDPG^{+} \times COVID$, which peaks at 231.2, consistent with strong post-COVID-19 rebounds in some countries.

Table 2. Summary statistics.

Variables	Obs	Mean	Std. Dev.	Min	Max
PHE	1035	1.683438	1.196526	0.0622103	6.754378
$GDPG^{+}$	1035	59.6533	41.97597	0	231.2243
$GDPG^{-}$	1035	−5.087738	8.864539	−53.16079	0
DEF	1035	11.65894	84.06511	−22.93232	2630.123
COVID	1035	0.1304348	0.336944	0	1
$GDPG^{+} \times COVID$	1035	13.19757	36.12909	0	231.2243
$GDPG^{-} \times COVID$	1035	−1.463478	5.977601	−53.16079	0
$DEF \times COVID$	1035	1.352857	9.578868	−13.99957	235.5154

Note: PHE = public health expenditure (% of GDP), $GDPG^{+}$ = positive partial sum, $GDPG^{-}$ = negative partial sum, DEF = GDP deflator (annual %), COVID = 1 for 2020–2022 and 0 otherwise, $GDPG^{+} \times COVID$ = interaction between positive partial sum and COVID-19 dummy, $GDPG^{-} \times COVID$ = interaction between negative partial sum and COVID-19 dummy, and $DEF \times COVID$ = interaction between GDP deflator and COVID-19 dummy.

Table 3 presents the correlation coefficients between PHE and the core explanatory variables. As expected, the correlation between $GDPG^{+}$ and $GDPG^{-}$ is negative (−0.288), a mechanical outcome of their construction. PHE shows a weak and negative correlation with $GDPG^{+}$ (−0.092) and slightly positive correlation with $GDPG^{-}$ (0.047), suggesting that health expenditure does not rise systematically during periods of expansion and may not fall sharply during contractions, pointing to potential asymmetry. Inflation is weakly and negatively associated with PHE (−0.060), hinting at a possible erosion effect of inflationary pressure on health spending. Interestingly, the COVID-19 dummy is positively correlated with PHE (0.109), reflecting the emergency of fiscal responses during the pandemic. The interaction terms provide further nuance: $GDPG^{+} \times COVID$ has a small positive correlation with PHE (0.057), while $GDPG^{-} \times COVID$ is negatively correlated (−0.088). Meanwhile, the interaction term between inflation and the COVID-19 dummy is weakly negative (−0.014), indicating inflationary shocks are less correlated with health spending. Most importantly, the correlation matrix results show no concerns of multicollinearity among independent variables but point toward the possibility of asymmetric health spending responses to GDP growth.

4.2. Unit Root and Cointegration Results

Table 4 summarizes the panel unit root test outcomes based on Im et al. (2003). The test is conducted with two specifications, namely constant only and constant with a linear trend. For the variables in levels, namely PHE, $GDPG^{+}$, and $GDPG^{-}$, the test fails to reject the null hypothesis of a unit root in both specifications, which may indicate these series are nonstationary at their levels. However, GDPG and DEF reject the unit root null hypothesis at 5% significance level, implying stationarity in these series. After differencing the variables whose null is not rejected in both specifications (ΔPHE, $\Delta GDPG^{+}$, and $\Delta GDPG^{-}$), the test strongly rejects the presence of a unit root at 5%, suggesting their stationarity. Hence, while GDP growth (GDPG) and inflation (DEF) appear stationary in levels, public health expenditure and the constructed positive and negative cumulative GDP growth series become stationary after first differencing. These findings justify using

panel ARDL framework, which accommodates variables of mixed integration orders, to estimate short-run dynamics and long-run equilibrium relationships.

Table 3. Correlation matrix.

	PHE	GDPG$^+$	GDPG$^-$	DEF	COVID	GDPG$^+$ × COVID	GDPG$^-$ × COVID	DEF × COVID
PHE	1							
GDPG$^+$	−0.092	1						
GDPG$^-$	0.047	−0.288	1					
DEF	−0.060	−0.059	−0.017	1				
COVID	0.109	0.383	−0.268	0.006	1			
GDPG$^+$ × COVID	0.057	0.456	−0.272	−0.007	0.943	1		
GDPG$^-$ × COVID	−0.088	−0.267	0.574	0.014	−0.632	−0.625	1	
DEF × COVID	−0.014	0.127	−0.207	0.096	0.364	0.330	−0.394	1

Note: PHE = public health expenditure (% of GDP), GDPG$^+$ = positive partial sum, GDPG$^-$ = negative partial sum, DEF = GDP deflator (annual %), COVID = 1 for 2020–2022 and 0 otherwise, GDPG$^+$ × COVID = interaction between positive partial sum and COVID-19 dummy, GDPG$^-$ × COVID = interaction between negative partial sum and COVID-19 dummy, and DEF × COVID = interaction between GDP deflator and COVID-19 dummy.

Table 4. Panel unit root test.

Variable	Constant	Constant and Trend
PHE	−1.576	−2.605 **
GDPG	−3.717 **	−4.262 **
GDPG$^+$	−1.655	−2.239
GDPG$^-$	−1.227	−1.881
DEF	−8.554 **	−8.408 **
ΔPHE	−5.109 **	−4.954 **
ΔGDPG$^+$	−4.985 **	−5.798 **
ΔGDPG$^-$	−2.975 **	−3.214 **

Note: ** denotes significant at 5%. The 5% critical values, according to Im et al. (2003), of intercept and intercept and trend, are −1.82 and −2.46, respectively. PHE = public health expenditure (% of GDP), GDPG$^+$ = positive partial sum, GDPG$^-$ = negative partial sum, DEF = GDP deflator (annual %).

Table 5 presents the panel cointegration test results based on the approaches of Kao et al. (1999), Pedroni (2004), and Westerlund (2008). Starting with the Kao test, all five test statistics strongly reject the null hypothesis of no cointegration at 1% significance level. Similarly, the Pedroni test statistics are also significant at 1% level, which further supports the presence of a long-run equilibrium relationship. Lastly, the Westerlund variance ratio statistic confirms these findings by rejecting the null hypothesis at 1% significance. Collectively, the consistent rejections across multiple tests confirm a stable and significant long run cointegrating the relationship between public health expenditures and macroeconomic variables considered in this analysis. Thus, the empirical analysis may safely employ panel error-correction modelling for the short-run dynamics.

Pesaran CD tests do not indicate cross-sectional dependence as the *p*-values of the standard CD test and the average absolute value CD test were 0.189 and 0.380, respectively (see the Appendix A Table A1). Given these outcomes, proceeding with PMG as our main estimator is appropriate.

Table 5. Panel cointegration tests.

Kao		Pedroni		Westerlund	
Modified Dickey–Fuller t	−5.806 (0.000)	Modified Phillips–Perron t	9.923 (0.000)	Variance ratio	4.338 (0.000)
Dickey–Fuller t	−4.474 (0.000)	Phillips–Perron t	2.8841 (0.002)		
Augmented Dickey–Fuller t	−3.077 (0.001)	Augmented Dickey–Fuller t	3.331 (0.001)		
Unadjusted modified Dickey–Fuller t	−6.076 (0.000)				
Unadjusted Dickey–Fuller t	−4.578 (0.000)				

Note: ( ) are *p*-values. The dependent variable is PHE.

4.3. Panel NARDL Results (Full Sample)

Table 6 reports the outcomes from the panel NARDL estimation, showing the long-run and short-run relationships. In the long-run, positive changes in GDP growth has a statistically significant positive impact on public health expenditure, with the coefficient equaling 0.0037, suggesting that sustained economic expansions tend to increase health spending over time. In contrast, negative cumulative GDP growth is not statistically significant, implying that health spending in the sampled African countries does not significantly decline in response to long-term cumulative downturns. These findings suggest the presence of asymmetric behaviour between GDP and public health expenditure in the long run, as health spending is procyclical during expansions but acyclical during contraction episodes. The inflation measure (DEF) is negative and significant, with the coefficient equaling −0.0041, highlighting inflation's adverse effects on public health expenditure on the region. Interestingly, the COVID-19 dummy and its interactions with economic variables are insignificant in the long run, indicating no permanent structural shifts due to the pandemic period.

In the short run, the error correction term (ECT) is significantly negative (−0.3502), confirming the convergence toward the long-run equilibrium at approximately 35% annually. This particular finding provides strong support to the earlier panel cointegration results. Short-run estimates reveal that changes in positive cumulative changes in GDP remain insignificant, while short-run contractions exhibit a negative but insignificant relationship with public health spending. Similarly, inflation exerts a significantly negative short-term effect (−0.0035, at 10%), reinforcing the long-run adverse relationship. Notably, the short-run COVID-19 dummy is positively significant at 5%, signifying an immediate fiscal expansion in health spending during the pandemic. However, the interactions of COVID-19 with positive and negative GDP changes yield significantly negative coefficients, which indicate that COVID-19 distinctly altered short-run fiscal responses to economic fluctuations, enhancing governments' responsiveness in health budgets during the crisis.

Overall, the panel NARDL results strongly confirm asymmetric short-run dynamics and long-run procyclicality in health spending during cumulative GDP growth periods, while underscoring that the COVID-19 pandemic notably changed short-run fiscal patterns in African economies. Using another health metric, namely public health expenditure per capita, as a dependent variable yields similar results (see Table A3, in the Appendix A).

Table 6. Panel NARDL.

Variable	Coefficient	Std. Err.
LR		
$GDPG^{+}$	0.0037 ***	0.0002
$GDPG^{-}$	−0.0045	0.0019
DEF	−0.0041 ***	0.0007
COVID	6.5047	8.7013
$GDPG^{+} \times$ COVID	0.0176	0.0782
$GDPG^{-} \times$ COVID	0.3141	0.2884
DEF × COVID	0.2047	0.5151
Symmetry test	[0.000]	
SR		
ECT	−0.3502 ***	0.0438
$\Delta GDPG^{+}$	0.0017	0.0049
$\Delta GDPG^{-}$	−6.9888	5.0592
ΔDEF	−0.0035 *	0.0020
ΔCOVID	8.1341 **	3.5096
$\Delta GDPG^{+} \times$ COVID	−0.4404 ***	0.1609
$\Delta GDPG^{-} \times$ COVID	−7.8639 **	3.2872
ΔDEF × COVID	−0.0575	0.0903
Intercept	0.4323	0.0671
Symmetry test	[0.167]	

Note: ***, **, * denote significant at 1%, 5%, 10%, respectively. PHE = public health expenditure (% of GDP), $GDPG^{+}$ = positive partial sum, $GDPG^{-}$ = negative partial sum, DEF = GDP deflator (annual %), COVID = 1 for 2020–2022 and 0 otherwise, $GDPG^{+} \times$ COVID = interaction between positive partial sum and COVID-19 dummy, $GDPG^{-} \times$ COVID = interaction between negative partial sum and COVID-19 dummy, and DEF × COVID = interaction between GDP deflator and COVID-19 dummy. Interactions in levels indicate long-run effects; short-run responses are read from differenced terms/ECT. The ARDL (1,0,0,0,0,0) is estimated, no lagged COVID-19 shocks.

4.4. Panel NARDL Results (Low- and Lower-Middle-Income Sample)

Table 7 presents the panel NARDL estimates specifically for low- and lower-middle-income African countries, highlighting differences from the overall regional results. In the long-run, cumulative positive GDP growth directly and significantly influences public health expenditure, with the coefficient equaling 0.0039, indicating that health budgets typically expand during sustained growth phases. Conversely, cumulative negative GDP growth remains insignificant, meaning that spending in the long run does not systematically shrink in response to economic downturns in low-income sub-groups. This is in line with the earlier outcome of the full sample, where procyclicality and acyclicality are observed during expansions and recessions, respectively. Inflation again reveals a strongly negative and significant long-run relationship, reaffirming inflation as a major constraint on health budgets among low-income nations. Notably, the COVID-19 dummy itself and most interaction terms are insignificant in the long-run, except for negative cumulative changes in GDP interacted with COVID-19, which is negative and significant. This particular result suggests that the pandemic has changed the effect of economic downturns to become negatively significant during the pandemic. This also reflects a more responsive fiscal stance under crisis conditions, where economic contractions are met with increased or protected health spending.

Table 7. Panel NARDL—low-income African countries.

Variable	Coefficient	Std. Err.
LR		
$GDPG^{+}$	0.0039 ***	0.0003
$GDPG^{-}$	−0.0015	0.0036
DEF	−0.0041 ***	0.0007
COVID	1.6465	1.8335
$GDPG^{+} \times$ COVID	0.0032	0.0158
$GDPG^{-} \times$ COVID	−0.2587 ***	0.0630
DEF × COVID	−0.1348	0.1089
Symmetry test	[0.139]	
SR		
ECT	−0.3589 ***	0.0490
$\Delta GDPG^{+}$	0.0032	0.0057
$\Delta GDPG^{-}$	−0.2371	0.1963
ΔDEF	−0.0024	0.0019
ΔCOVID	1.9429 **	0.8311
$\Delta GDPG^{+} \times$ COVID	−0.45544 **	0.1794
$\Delta GDPG^{-} \times$ COVID	−3.4874 ***	1.1257
ΔDEF × COVID	0.0510	0.0419
Intercept	0.4018 ***	0.0678
Symmetry test	[0.223]	

Note: ***, **, denote significant at 1%, 5%, respectively. PHE = public health expenditure (% of GDP), $GDPG^{+}$ = positive partial sum, $GDPG^{-}$ = negative partial sum, DEF = GDP deflator (annual %), COVID = 1 for 2020–2022 and 0 otherwise, $GDPG^{+} \times$ COVID = interaction between positive partial sum and COVID-19 dummy, $GDPG^{-} \times$ COVID = interaction between negative partial sum and COVID-19 dummy, and DEF × COVID = interaction between GDP deflator and COVID-19 dummy. Interactions in levels indicate long-run effects; short-run responses are read from differenced terms/ECT. The ARDL (1,0,0,0,0,0) is estimated, no lagged COVID-19 shocks.

Turing to the short-run results, the error correction term is negative and highly significant (−0.3589), confirming the presence of a cointegration relationship. The estimated speed of adjustment suggests that roughly 36% of the previous year's deviation from the long-run path is corrected within a year. The effects of positive and negative GDP growth are not statistically significant on their own. However, the COVID-19 dummy and its interaction with positive GDP growth and negative GDP growth are negative and highly significant. Precisely, the significant short-run dummy (1.9429) suggests that emergency health spending may have temporarily surged during the early pandemic years, due to donors' support or reprioritizing pandemic-related needs in the national budgets. However, the interaction with positive and negative GDP growth are negative and statistically significant, with a relatively larger coefficient for $GDPG^{-}$ (−3.4874), indicating a decline in health spending when the economy is at boom and a sharp increase in public health spending during crisis-induced downturns. This pattern reveals a notable improvement in fiscal responsiveness across economic downturns but decline in upturns during the pandemic. The behaviour observed is countercyclicality of health spending during crisis times. This is possibly reflecting increased budget flexibility, reallocation of funds, or rising revenues due to external aids. The short-run effect of inflation and its interaction term with COVID-19 dummy on health spending appear to be insignificant.

It is worth mentioning that when public health expenditure per capita was used as a dependent variable, results were found to be similar to those of the PMG (see Table A3, in the Appendix A).

4.5. Panel NARDL Results (Middle-Income Sample)

Table 8 reports the long-run and short-run estimates of the panel NARDL model for middle-income African countries. The results reflect how government expenditure responds to macroeconomic conditions and how these responses may have evolved during the COVID-19 period. In contrast to the pattern observed among low-income countries, the results here reveal countercyclical behaviour in the long run. Both positive and negative GDP growth shocks are associated with significant reductions in government health spending, with coefficients of −0.0077 and −0.0604, respectively. A one-percentage-point rise in GDP growth is associated with a 0.0077-percentage-point fall in public health spending as a share of GDP. The effect is very small and close to zero in practical terms. By contrast, the response to negative shocks is larger in absolute value, which points to a downturn-dominant asymmetry: contractions matter more for the health spending share than expansions. This suggests that, on average, governments in middle-income African countries tend to slightly reduce health spending during economic upturns but considerably rise it during economic crises, such as the COVID-19 pandemic. The result also shows that inflation, measured by GDP deflator, exerts a significant and negative long-run effect on health spending, underscoring the vulnerability of health budgets to price pressures. In inflationary environments, the real value of public health allocations tends to erode, diminishing the government's capacity to sustain expenditures. Although the coefficient on the COVID-19 dummy is large, it is not statistically significant, suggesting no clear structural shift in the level of health spending attributable to the pandemic period alone. Similarly, the interaction terms in the long run do not reach statistical significance, indicating that the long-run fiscal response to macroeconomic variables remained consistent during the COVID-19 years.

The short-run adjustment coefficient (ECT) is negative and significant at the 5% level (−0.2984), confirming that deviations from the long-run equilibrium are gradually corrected. This supports the existence of a long-run relationship. The short-run results reveal a different dynamic. While the contemporaneous effects of both positive and negative GDP growth are insignificant, the interaction between positive GDP growth and the COVID-19 dummy is positive and statistically significant. This suggest that during the pandemic, governments in middle-income African countries were more likely to increase health spending in response to growth episodes, pointing to a temporary shift toward more expansionary and responsive fiscal behaviour in the health sector. The remaining short-run interaction terms are not statistically significant, indicating that the crisis did not notably alter short-term responses to contractions or inflation. The absence of a short-run COVID-19 dummy reflects its omission due to collinearity.

Taken together, these results suggest that, in normal time, health spending in middle-income African economies tends to follow a countercyclical fiscal pattern, reacting negatively to both economic booms and recessions. However, during the COVID-19 crisis, there is some evidence of greater short-term responsiveness, especially when economies experienced growth. This may reflect the exceptional measures undertaken to reinforce health systems during the pandemic. Nonetheless, the lack of significant long-run shifts implies that these adjustments were not sustained beyond the crisis. Replacing the dependent variable with public health expenditure per capita leaves the results essentially unchanged (Appendix A Table A3).

Table 8. Panel NARDL—middle-income African countries.

Variable	Coefficient	Std. Err.
LR		
$GDPG^{+}$	−0.0077 **	0.0033
$GDPG^{-}$	−0.0604 ***	0.0115
DEF	−0.0605 ***	0.0099
COVID	530.9325	523.511
$GDPG^{+} \times$ COVID	1.4276	123.7647
$GDPG^{-} \times$ COVID	111.0984	580.235
DEF × COVID	−149.0131	113.7135
Symmetry test	[0.000]	
SR		
ECT	−0.2984 **	0.1393
$\Delta GDPG^{+}$	−0.0089	0.0103
$\Delta GDPG^{-}$	204.802	204.8523
ΔDEF	0.0004	0.0074
$\Delta GDPG^{+} \times$ COVID	88.6039 **	38.2655
$\Delta GDPG^{-} \times$ COVID	316.8464	217.7792
ΔDEF × COVID	−6.8524	135.4674
Intercept	1.0683 *	0.5649
Symmetry test	[0.317]	

Note: ***, **, * denote significant at 1%, 5%, 10%, respectively. ΔCOVID was omitted due to collinearity. PHE = public health expenditure (% of GDP), $GDPG^{+}$ = positive partial sum, $GDPG^{-}$ = negative partial sum, DEF = GDP deflator (annual %), COVID = 1 for 2020–2022 and 0 otherwise, $GDPG^{+} \times$ COVID = interaction between positive partial sum and COVID-19 dummy, $GDPG^{-} \times$ COVID = interaction between negative partial sum and COVID-19 dummy, and DEF × COVID = interaction between GDP deflator and COVID-19 dummy. Interactions in levels indicate long-run effects; short-run responses are read from differenced terms/ECT. The ARDL (1,0,0,0,0,0) is estimated, no lagged COVID shocks.

5. Discussion of the Findings

As stated earlier, this study set out to investigate the cyclical behaviour of public health spending in response to macroeconomic conditions in Africa, with emphasis on GDP growth asymmetries and the moderating role of the COVID-19 pandemic. The results from the full sample of 45 African countries offer a broad view of how government health expenditure has responded to macroeconomic fluctuations in the past two decades. At the aggregate level, the long-run coefficient on positive GDP growth is positive and statistically significant, while the coefficient on negative growth is negative but insignificant. This signals a pattern of procyclicality in health spending, as the government tends to increase health expenditure during economic booms. However, the insignificant negative growth during recessions indicates acyclicality of health spending by governments. These findings provide support for asymmetric cyclical behaviour of health spending in Africa, which is in line with Del Granado et al. (2013). Also, the results appear to match the predictions of Jalles et al. (2024) that low-income countries tend to have procyclical or acyclical fiscal behaviour. However, inflation appears to reduce health spending in the long run, with a significant negative coefficient of GDP deflator, suggesting that rising prices might squeeze fiscal space available for health investment.

One of the clearest messages that emerged from the analysis is that the COVID-19 pandemic changed this behaviour. Although the interaction terms between positive and

negative GDP growth and the COVID-19 dummy were insignificant in the long run, both interaction terms were significant and negative in the short-run. This may indicate the inverse effect of the pandemic on health spending behaviour. As GDP growth rises or declines, health expenditure diminishes or improves, respectively, which is in line with the countercyclical pattern. This is not surprising and actually affirms the documented fiscal efforts by many African economies during the pandemic time (International Monetary Fund (IMF) (2021); World Bank, 2022). But, this finding, being only significant in the short run, raise a significant question regarding the sustainability of such fiscal behaviour in the future. Also, one may wonder to what extent the aggregation of the entire sample, given the large differences, may have impacted the outcomes of the regression. To explore these issues, the sample is split two based on income classification using the 2024 World Bank criteria. Here, countries grouped as low-income included both low-income and lower-middle-income economies, while the middle-income group included African countries classified as upper-middle-income and high-income. This allowed us to look beyond averages and explore structural differences across income levels.

In the low-income group, the results supported a procyclical pattern in the long run, particularly in response to positive GDP growth. The positive and significant coefficient of positive growth indicates that economic expansion tends to translate into higher health spending. However, the negative GDP growth term was not significant, showing that while spending increases with growth, it does not fall when growth slows down. This type of asymmetry has been discussed in earlier studies, such as Del Granado et al. (2013), Liang and Tussing (2019), and Chakrabarty and Roy (2021), and may reflect policy-driven or donation efforts to avoid cutting health budgets too intensely during bad times. Furthermore, the COVID interaction with negative growth tells a different story. Controlling for the pandemic, governments in the low-income group became concerned with downturns, and health spending was more likely to expand. This may point to the pandemic's role in expanding fiscal space, especially where reserves or external financing were available.

On the other hand, the middle-income group displayed a clear pattern of countercyclicality in public health spending. The results indicated that negative GDP growth was associated with an increase in government health expenditure, while positive growth led to a reduction; both effects were statistically significant in the long run. This points to behaviour where governments in these countries are more inclined to increase health spending during periods of economic slowdown, reducing it when the economy improves. The countercyclical fiscal policy during economic downturns is evident in major middle-income countries such as South Africa as observed by Khambule (2021). Such a pattern may reflect deliberate policy choices made to buffering vulnerable populations during recessions such as COVID-19. This is in line with Jalles et al. (2024) who argued that severe crises such as COVID-19 trigger more countercyclical responses, especially in countries with greater fiscal capacity and stronger institutions. Another possible explanation to the countercyclicality in the middle-income group could be due to institutional mechanisms that prioritize health during periods of economic distress. At the same time, the reduction in government health spending during economic expansions could be linked to creating more fiscal space in the future or related to the reallocation of resources toward other development goals. Although the interaction terms with the COVID-19 dummy in the long run did not show a significant effect, the short-run outcomes reveal that during the pandemic, health expenditure became more responsive to positive growth. This may suggest that, despite an overall countercyclical orientation, governments took advantage of short-lived recovery phases during the crisis to enhance health sector support. It should be noted that these results are averages, and country heterogeneity in fiscal and institutional setting may limits generalization even within Africa.

6. Conclusions

The COVID-19 pandemic brought new attention to the critical role of public health systems as pillars of human well-being and as integral components of economic stability and resilience. As the crisis unfolded, health sector weaknesses could generate widespread economic disruptions, prompting a shift in how many African governments perceive public health investment. Rather than being viewed as merely a social service, health spending has begun to be recognized as a vital economic driver with the potential to mitigate shocks, maintain productivity, and support long-term development. This study examines how public health expenditure in African economies responds to macroeconomic fluctuations, with particular attention to asymmetries and their effects during economic expansions and recessions. Also, it highlights how these dynamics may have shifted in the aftermath of the COVID-19 pandemic. Using annual data from 45 African countries from 2000 to 2022, the analysis applied a panel NARDL approach to account for potential nonlinearities in fiscal behaviour. The model incorporated long-run and short-run dynamics and interaction terms to assess whether the pandemic altered the relationship between macroeconomic conditions and government health spending.

The findings of this study show that the relationship between macroeconomic conditions and government health spending in Africa is not uniform. When all countries in the sample were considered together, the results showed a significant effect of positive growth on public health spending of about 0.0037, indicating clear procyclical behaviour in the long run, with health spending increasing during periods of positive economic growth. However, the effect of negative growth on health spending was -0.0045 but insignificant. This asymmetry suggests cyclical behaviour during economic recessions. When the sample was divided by income level, the results became interesting. In low-income countries, the long-run results supported procyclicality in the positive response to GDP growth, with a coefficient value of 0.0039, and the absence of a cyclical relationship during economic contractions. In contrast, middle-income countries showed a different pattern. There, the coefficients of both partial positive sum of GDP growth (-0.0077) and partial negative sum of GDP growth (-0.0604) were negatively associated with health spending, which suggests a countercyclical pattern in public health spending. The study also found that the COVID-19 period played a role in shaping these relationships. Note that all COVID-19 effects refer to 2020–2022. Reported interaction coefficients reflect long-run changes in that window; short-run responses are those implied by the immediate adjustment and the ECT. For low-income countries, the crisis improved the negative impact of economic contractions on health spending. In middle-income countries, while the long-run remained unchanged during the pandemic, there was some evidence that short-run responses became more supportive of health spending during the pandemic, especially in positive growth states. Regarding the effect of inflation, the various analyses conducted in this study showed an adverse association with health spending in the long run. The estimated adjustment speeds of the short-run dynamics are -0.3502 (all countries), -0.3588 (low/lower-middle), and -0.2984 (middle-income), which are very similar across the three models.

This study contributes to a deeper understanding of how African government health spending responds to macroeconomic fluctuations. It looks at the general output pattern of health spending, compares countries based on their income levels, and considers the effects of the COVID-19 crisis. The findings show that health is no longer seen only as a social issue, it is increasingly being recognized as an economic factor that can support stability or create risks when shocks happen. If governments invest less in health during difficult times, the damage may broadly affect the economy. These results create space for future studies to explore why some countries respond better than others to economic shocks. Researchers can also look into how institutions and policy choices shape that response.

It is also necessary to understand how countries can keep health spending stable during inflation, revenue shortages, or when they rely on foreign aid.

The findings of this study suggest several important policy recommendations. First, it is to stabilize the health budget across the economic cycle. Governments in African countries, especially low-income ones, should aim to reduce the procyclical nature of health spending. This can be achieved by designing fiscal frameworks that protect health budgets during economic downturns, for example, through the use of countercyclical buffer rules or health-specific stabilization funds. Second, it is to strengthen budget flexibility, which is critical during an economic crisis. The COVID-19 crisis showed that many governments struggled to maintain or increase health spending when economic conditions worsened. Thus, policymakers should build more flexibility into their public finance systems to allow rapid reallocation of resources toward health during emergencies, without harming other significant services. Third, it is to improve the resilience of health financing to changes in the price level. Given the negative impact of inflation on health expenditure, governments need to adjust health budgets in absolute terms and ensure that essential services are protected from price volatility. This may include automatic inflation-adjustment mechanisms for core health allocations. Fourth, it is to build strong institutional capacity and data systems. The long-term improvement in public health financing requires stronger institutional quality, better public financial management, and more reliable health expenditure tracking. These systems help governments respond strategically to shocks and plan better for future crises. Finally, sustaining and supporting health investment is vital even if countercyclicality is observed. While this behaviour reflects a deliberate effort to protect health during crises, there is a risk that important health gains could be reversed when the economy improves. Policymakers might want to sustain health investment during growth periods, rather than reducing it, to ensure continued progress in service delivery, system preparedness, and long-term health outcomes.

The study has several limitations. First, we use annual and country-level data; higher-frequency or subnational data could capture short-run adjustments and within-country heterogeneity more precisely. Second, our inflation measure is GDP deflator; future studies could test using CPI or health-specific price indices. Third, while PMG accommodates heterogeneous short-run dynamics, it imposes common long-run slopes; extensions with time-varying parameters, threshold, or estimating methods that handle cross-sectional dependence could be enlightening. Lastly, to incorporate the direct and moderating effects of economic and institutional factors such as governance, fiscal rules, and debt constraints on the cyclicality of health spending, and probably links spending cyclicality to health outcomes. Taken together, the panel estimates reflect average patterns and should not be over-generalized to fragile states or resource-rich countries; the income group split and health metric checks mitigate but do not completely remove this concern.

Author Contributions: Conceptualization, A.S. and M.G.; methodology, A.S.; software, A.S.; validation, A.S. and M.G.; formal analysis, A.S.; investigation, A.S.; resources, A.S.; data curation, A.S.; writing—original draft preparation, A.S. and M.G.; writing—review and editing, A.S. and M.G.; visualization, A.S.; supervision, A.S.; project administration, A.S.; funding acquisition, M.G. All authors have read and agreed to the published version of the manuscript.

Funding: This Open Access publication was supported by the Publication Fund of the University of Konstanz. Mohammed Gebrail gratefully acknowledges funding from the Alexander von Humboldt Foundation and support from the Zukunftskolleg.

Data Availability Statement: The data used in this research are obtained from World Development Indicators: https://databank.worldbank.org/source/world-development-indicators (accessed on 1 July 2025).

Acknowledgments: The authors are grateful to the three anonymous reviewers for their valuable time and constructive feedback on this paper.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

Table A1. Pesaran's test of cross-sectional dependence.

Test	***p*-Value**
Standard CD	0.189
Average absolute value CD	0.380

Table A2. List of countries.

Algeria	Ethiopia	Morocco
Angola	Eswatini	Mozambique
Benin	Gabon	Namibia
Botswana	Gambia, The	Niger
Burkina Faso	Ghana	Nigeria
Burundi	Guinea	Senegal
Cabo Verde	Guinea-Bissau	Seychelles
Cameroon	Kenya	Sierra Leone
Chad	Lesotho	South Africa
Central African Republic	Liberia	Sudan
Congo, Dem. Rep.	Madagascar	Tanzania
Congo, Rep.	Malawi	Togo
Cote d'Ivoire	Mali	Tunisia
Egypt, Arab Rep.	Mauritania	Uganda
Equatorial Guinea	Mauritius	Zambia

Table A3. Panel NARDL—(PHE per capita).

	All Countries		**Low-Income**		**Middle-Income**	
Variable	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**	**Coefficient**	**Std. Err.**
$GDPG^{+}$	0.0089 ***	0.0006	0.0081 ***	0.0006	0.0386 ***	0.0048
$GDPG^{-}$	−0.0058	0.0041	0.0097	0.0063	−0.2699 ***	0.0961
DEF	−0.0015	0.0017	−0.0053 ***	0.0018	0.0801 **	0.0334
COVID	2.1996	11.322	4.4481	9.7758	850.7845	-
$GDPG^{+} \times$ COVID	−0.0438	0.0988	−0.0451	0.0828	−1.566748	6.495081
$GDPG^{-} \times$ COVID	−0.2622	0.4151	0.5505 *	0.2852	121.4111	-
DEF × COVID	−0.2314	0.5167	0.0395	0.3663	−120.0345 *	63.9369
Symmetry test	[0.000]		[0.056]		[0.001]	

Note: ***, **, * denote significant at 1%, 5%, 10%, respectively.

Table A4. Panel NARDL—middle-income African countries (standardized).

Variable	Coefficient	Std. Err.
LR		
$GDPG^{+}$	−0.3179 ** (−0.3179)	0.14805
$GDPG^{-}$	−0.4821 *** (−0.421)	0.0961
DEF	−0.4677 *** (−0.4677)	0.0765
COVID	208.2922 (70.3403)	570.2848
$GDPG^{+} \times$ COVID	128.4842 (49.6035)	584.5278
$GDPG^{-} \times$ COVID	29.9473 (19.5900)	515.5137
DEF × COVID	1026.788 ** (327.5744)	489.3266
Symmetry test	[0.032]	
SR		
ECT	−0.2995 **	0.1378
$\Delta GDPG^{+}$	−0.3955 (−0.3955)	0.4558
$\Delta GDPG^{-}$	9.6367 (9.6366)	10.0616
ΔDEF	0.0035 (0.0035)	0.0570
ΔCOVID	−114.2529 (−38.5832)	156.8358
$\Delta GDPG^{+} \times$ COVID	−1149.309 (−443.7104)	1164.02
$\Delta GDPG^{-} \times$ COVID	127.6962 (83.5326)	116.1174
ΔDEF × COVID	−421.8496 (−134.5819)	281.8608
Intercept	0.1057	0.1269
Symmetry test	[0.323]	

Note: ***, ** denote significant at 1%, 5%, respectively. The variables in the model are standardized, except the dummy variable. Between ( ) are the standardized coefficients.

Notes

[1] Note that the partial positive and negative sums are decomposed based on the level of GDP growth not on the changes in GDP growth.

[2] The access point: https://databank.worldbank.org/source/world-development-indicators; Date: 20 July 2025.

References

Arize, A., Kalu, E. U., Lubiani, G., & Udemezue, N. N. (2024). Public health expenditure and sustainable health outcomes in 45 Sub-Saharan African countries: Does government effectiveness matter? *Economies*, *12*(6), 129. [CrossRef]

Arthur, E., & Oaikhenan, H. E. (2017). The effects of health expenditure on health outcomes in Sub-Saharan Africa (SSA). *African Development Review*, *29*(3), 524–536. [CrossRef]

Behera, D. K., Mohanty, R. K., & Dash, U. (2020). Cyclicality of public health expenditure in India: Role of fiscal transfer and domestic revenue mobilization. *International Review of Economics*, *67*(1), 87–110. [CrossRef]

Bose, S. (2015). Determinants of per capita state-level health expenditures in the United States: A spatial panel analysis. *Journal of Regional Analysis and Policy*, *45*(1), 20.

Calderón, C., Chuhan-Pole, P., Lopez-Monti, R. M., & Calderon, C. (2017). *Cyclicality of fiscal policy in Sub-Saharan Africa: Magnitude and evolution*. World Bank Policy Research Working Paper 8108. World Bank Group.

Chakrabarty, H. S., & Roy, R. P. (2021). Pandemic uncertainties and fiscal procyclicality: A dynamic non-linear approach. *International Review of Economics & Finance*, *72*, 664–671.

Chen, G., Inder, B., Lorgelly, P., & Hollingsworth, B. (2013). The cyclical behaviour of public and private health expenditure in China. *Health Economics*, *22*(9), 1071–1092. [CrossRef] [PubMed]

Chireshe, J., & Ocran, M. K. (2020). Health care expenditure and health outcomes in sub-Saharan African countries. *African Development Review*, *32*(3), 349–361. [CrossRef]

Del Granado, J. A., Gupta, S., & Hajdenberg, A. (2013). Is social spending procyclical? Evidence for developing countries. *World Development*, *42*, 16–27. [CrossRef]

Iheoma, C. G. (2024). Impact of fiscal policy shocks on health outcomes in Sub-Saharan Africa: A panel structural VAR approach. Global Health Economics and *Sustainability*, *2*(4), 3454. [CrossRef]

Im, K. S., Pesaran, M. H., & Shin, Y. (2003). Testing for unit roots in heterogeneous panels. *Journal of Econometrics*, *115*(1), 53–74. [CrossRef]

International Monetary Fund (IMF). (2021). *Fiscal monitor: Strengthening the credibility of public finances*. International Monetary Fund (IMF).

Jalles, J. T., Kiendrebeogo, Y., Lam, R., & Piazza, R. (2024). Revisiting the countercyclicality of fiscal policy. *Empirical Economics*, *67*(3), 877–914. [CrossRef]

Jurgens, E. (2024). *Fiscal rules and procyclicality of public investment in Europe*. SSRN 5064999. Available online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=5064999 (accessed on 4 August 2025).

Kao, C., Chiang, M. H., & Chen, B. (1999). International R&D spillovers: An application of estimation and inference in panel cointegration. *Oxford Bulletin of Economics and Statistics*, *61*(S1), 691–709. [CrossRef]

Kavese, K., & Phiri, A. (2021). Fiscal cyclicality in South African public expenditures: Do asymmetries explain the inconsistencies? *The Journal of Developing Areas*, *55*(2). Available online: https://muse.jhu.edu/pub/51/article/772621 (accessed on 4 August 2025). [CrossRef]

Keynes, J. M. (1937). The general theory of employment. *The Quarterly Journal Of Economics*, *51*(2), 209–223. [CrossRef]

Khambule, I. (2021). COVID-19 and the counter-cyclical role of the state in South Africa. *Progress in Development Studies*, *21*(4), 380–396. [CrossRef]

Konuki, M. T., & Villafuerte, M. M. (2016). *Cyclical behavior of fiscal policy among Sub-Saharan African countries*. International Monetary Fund.

Kurowski, C., Evans, D. B., Tandon, A., Eozenou, P. H. V., Schmidt, M., Irwin, A., Cain, J. S., Pambudi, E. S., & Postolovska, I. (2021). *From double shock to double recovery: Implications and options for health financing in the time of COVID-19*. World Bank.

Liang, L. L., & Tussing, A. D. (2019). The cyclicality of government health expenditure and its effects on population health. *Health Policy*, *123*(1), 96–103. [CrossRef]

Lledó, V. D., Yackovlev, I., & Gadenne, L. (2011). A tale of cyclicality, aid flows and debt: Government spending in Sub-Saharan Africa. *Journal of African Economies*, *20*(5), 823–849. [CrossRef]

Loayza, N., & Pennings, S. M. (2020). *Macroeconomic policy in the time of COVID-19: A primer for developing countries*. World Bank Research and Policy Briefs 147291. World Bank Group.

Ongaro, E., Ferré, F., & Fattore, G. (2015). The fiscal crisis in the health sector: Patterns of cutback management across Europe. *Health Policy*, *119*(7), 954–963. [CrossRef] [PubMed]

Ouedraogo, R., & Sourouema, W. S. (2018). Fiscal policy pro-cyclicality in Sub-Saharan African countries: The role of export concentration. *Economic Modelling*, *74*, 219–229. [CrossRef]

Pedroni, P. (2004). Panel cointegration: Asymptotic and finite sample properties of pooled time series tests with an application to the PPP hypothesis. *Econometric Theory*, *20*(3), 597–625. [CrossRef]

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled mean group estimation of dynamic heterogeneous panels. *Journal of the American statistical Association*, *94*(446), 621–634. [CrossRef]

Raghupathi, V., & Raghupathi, W. (2020). Healthcare expenditure and economic performance: Insights from the United States data. *Frontiers in Public Health*, *8*, 156. [CrossRef]

Reeves, A., Basu, S., McKee, M., Meissner, C., & Stuckler, D. (2013). Does investment in the health sector promote or inhibit economic growth? *Globalization and Health*, *9*(1), 43. [CrossRef] [PubMed]

Reeves, A., Gourtsoyannis, Y., Basu, S., McCoy, D., McKee, M., & Stuckler, D. (2015). Financing universal health coverage—Effects of alternative tax structures on public health systems: Cross-national modelling in 89 low-income and middle-income countries. *The Lancet*, *386*(9990), 274–280. [CrossRef] [PubMed]

Shimul, S. N., Kabir, M. I. U., & Kadir, F. (2023). Resiliency of healthcare expenditure to income shock: Evidence from dynamic heterogeneous panels. *Frontiers in Public* Health, *11*, 1085338. [CrossRef] [PubMed]

Shin, Y., Yu, B., & Greenwood-Nimmo, M. (2014). Modelling asymmetric cointegration and dynamic multipliers in a nonlinear ARDL framework. In *Festschrift in honor of Peter Schmidt: Econometric methods and applications* (pp. 281–314). Springer.

Stuckler, D., Basu, S., Suhrcke, M., Coutts, A., & McKee, M. (2009). The public health effect of economic crises and alternative policy responses in Europe: An empirical analysis. *The Lancet*, *374*(9686), 315–323. [CrossRef]

Westerlund, J. (2008). Panel cointegration tests of the Fisher effect. *Journal of Applied Econometrics*, *23*(2), 193–233. [CrossRef]
World Bank. (2022). *Africa's pulse: Analysis of issues Shaping Africa's economic future*. World Bank Group.