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The impact of public debt on economic growth in Côte d'Ivoire: New evidence from linear and non-linear ARDL approaches

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Abstract
This study examines the symmetric and asymmetric impact of public debt on economic growth in Côte d'Ivoire using time series data from 1972 to 2021. The analyses were performed using both linear and nonlinear autoregressive distributed lag (ARDL) models. The study also utilised the bounds F-test for cointegration, the Brock-Dechert-Scheinkman (BDS) nonlinearity test, and the Wald test for asymmetries. The findings of the bounds F-test provide support for both linear and nonlinear cointegration. The BDS test results indicate that the series are nonlinear, while Wald test results revealed an asymmetric relationship between public debt and economic growth in Côte d'Ivoire in the short run and symmetric relationship in the long run. Estimation results for the symmetric ARDL regression model provide no evidence of a statistically significant impact of public debt on economic growth, regardless of whether the analysis was conducted in the short run or long run. The NARDL findings indicate that, on average, positive changes to public debt lead to economic decline in the long run, while negative changes cause an economic upturn in the short run. The findings also show that GDP growth responds rapidly and strongly to negative changes in public debt. Therefore, the study encourages the government of Côte d'Ivoire to be cautious about public debt rise because it was established that they have a negative impact on economic growth. Negative changes in the public debt can serve to minimise the uncertainties in the business environment, thus promoting private, public, and foreign direct investments.

Keywords: ARDL, Côte d'Ivoire, economic growth, NARDL, public debt.

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Introduction

The severity of the debt crisis in Africa continues to be a major global socioeconomic concern. Significant economic upswings or downturns brought on by large fluctuations in public debt ratios provide difficulties for policymakers around the world. The difficulties are caused by the impact of public debt on a number of macroeconomic variables, including domestic interest rates, inflation, public and private consumption, public and private investment, private savings, fiscal and monetary changes, access to new and cheap credit lines, total factor productivity, International Monetary Fund (IMF) lending decisions, timing and size of financing and more (see, for instance, International Monetary Fund, 2022a; Kose et al., 2021; Saungweme, Odhiambo, 2019; Barro, 1980; Domar, 1944). For instance, Barro (1980) contended that shocks related to government debt have an expansionary impact on output and a negative influence on the unemployment rate. However, it was established that monetary policy shocks had a greater impact on output and unemployment than debt shocks (Barro, 1980). Domar (1944) examined debt and the problems of deficit funding and concluded that carrying a heavy debt load is largely a challenge to achieving a rising national income and that the country's debt load decreases in direct proportion to income growth. It is, therefore, imperative to comprehend how changes in the public debt are anticipated to affect real gross domestic product (GDP) over the short- to long-term in order to make prudent policy responses and forward-looking assessments.

In 2021, regional debt trends differed substantially, with advanced and emerging economies experiencing a decline and low-income countries experiencing a considerable increase (International Monetary Fund, 2022a; b). The rise in public debt in low-income nations is a result of governments' expansionary and discretionary fiscal policy actions taken in response to the covid-19 health crisis, global economic downturn and inflationary pressures (International Monetary Fund, 2022a; Kose et al. 2021). This surge in public debt, notably in Africa, raises concerns about the medium- to long-term economic growth prospects, increasing the already severe public debt burden and jeopardising efforts to reduce poverty on the continent. In light of the covid-19 health shock, which caused a large downturn in the global economy and an increase in debt levels, this study re-examines the link between public debt and economic growth in one of the Sub-Saharan African economies.

The empirical literature on the symmetric impact of public debt on economic growth is extensive and has been rising over time. The findings vary depending on the estimation modelling technique utilised, model specification, and the time frame considered, among other variables (see, for example, Saungweme, Odhiambo, 2021; Gómez-Puig, Sosvilla-Rivero, 2018; Ahlborn, Schweickert, 2016). There is also an ample body of literature that support the nonlinear relationship between public debt and economic growth. These studies, which looked for threshold effects, discovered that public debt contributed positively to economic growth at lower levels and negatively at higher levels and that the growth optimising level of public debt

differed across analysed economies (see Mupunga Le Roux, 2015; Baum et al., 2012; Minea, Parent, 2012; Reinhart, Rogoff, 2010a; b).

Despite the existence of a wealth of literature on the relationship between public debt and economic growth, the asymmetric impact and the magnitude of both positive and negative debt changes remain highly unknown, and literature is still in its infancy (see, for example, Abate, 2023; Jusuf, Mohd, 2023; International Monetary Fund, 2022a; Mosikari, Eita, 2021). Using a NARDL technique, Jusuf and Mohd (2023) looked into the asymmetric effect of foreign public debt on economic growth in Nigeria from 1980 to 2020. According to the study, an increase in the stock of foreign public debt of 1%, ceteris paribus, resulted in an increase in economic growth of 0.6 %. Similarly, a percentage point fall in the stock of foreign public debt was associated with an increase in economic growth of 0.32 %.

Abate (2023) used data covering the years 1982–2018 to evaluate the nature of the relationship between Ethiopia's state debt and economic growth. An NARDL approach, multiple thresholds nonlinear ARDL model, and an instrumental variable regression model with a quadratic specification were among the techniques used in the study. According to the findings, there is evidence to suggest that there is an asymmetric link between public debt and economic growth. Contrary to existing literature, the findings indicate that while the impact of a modest and negative shock to debt is undesirable, a substantial positive shock to debt is favourable to economic growth. The findings also show that debt has a threshold effect and that it only helps Ethiopia's economy expand when it is significantly below 66.8% of GDP or 36.3% of GNI.

The International Monetary Fund (2022a) examined the effects of unexpected changes in public debt on real GDP for 178 countries between 1995 and 2020. The study used forecast errors in public debt to detect exogenous changes in public debt and then analysed how a change in the debt-to-GDP ratio would affect real GDP. The findings were mixed. On the one hand, the findings show that for countries with a high initial debt level or a rising debt trajectory over the five preceding years, the impact of an unexpected increase in public debt on the real GDP level is typically negative. On the other hand, an unexpected increase in public debt increases real GDP for countries that have a low-income level or completed the highly indebted poor countries (HIPC) debt relief initiative.

Mosikari and Eita (2021) investigated the asymmetric relationship between public debt and GDP growth in Namibia using data spanning the years 1980-2019. The study used the non-linear autoregressive distributed lag approach to ascertain the asymmetrical impact of public debt on GDP growth. The results show that GDP growth is negatively associated with rising public debt levels and positively linked with falling debt levels. The results also revealed that GDP growth is more sensitive to changes in negative debt than to changes in positive debt.

In contrast to past studies, this current study examines both symmetric (linearity) and asymmetric (nonlinearity) effects of public debt on economic growth in Côte d'Ivoire. The asymmetric ARDL model incorporates additional excellent qualities while preserving the merits of the conventional ARDL (see Pesaran et al., 2001). For instance, the NARDL technique enables public debt to be decomposed into positive and negative partial sums of squares and examines the magnitude of their effects on economic growth. The method also permits the inclusion of the potential for nonlinear impacts of both positive and negative changes in other explanatory variables (Shin et al., 2014). Furthermore, the asymmetric ARDL model's cumulative dynamic multipliers shed light on how asymmetric debt shocks influence growth in

response to the previously identified long-run equilibrium from the dynamics of disequilibrium (Shin et al., 2014). Therefore, it is essential to comprehend the asymmetric impact of public debt on economic growth in designing an economic system that supports sustainable economic growth and public debt sustainability in Cote d'Ivoire.

Cote d'Ivoire is a lower-middle income country whose exports are still heavily composed of a small number of raw materials, including cocoa, raw cashew nuts, coffee, rubber, timber, petroleum products, and gold, making it particularly vulnerable to changes in the price of these commodities on a global scale (World Bank, 2020). Three major phases may be identified in Cote d'Ivoire's economic history: the 1960-1979 boom, the 1980-2003 crisis, and the 2004-2021 growth and recovery phase. Between 1960-79, the country's economy grew strongly on average by 7.4%, driven mostly by the commodity price boom, political stability, and massive public investment (Keho, 2017). Between 1980 and 2003, the country experienced a number of economic and political crises, including drought, low commodity prices on international markets, rapidly rising debt-related costs, socio-political instability, and suboptimal domestic revenue performance, all of which had a negative impact on the country's growth prospects (World Bank, 2007; International Monetary Fund, 2003). From 2004, the economy grew at rates of 5.0% (2.6%), 5.8% (3.4%), and 7.2% (4.6%), between 2004-2021, 2008-2021, and 2012-2021, respectively (World Bank, 2022). The covid-19 pandemic, however, had a negative impact on the domestic economy in 2020, causing disruptions to trade, notably with the country's key trading partners, and reducing foreign funding flows, which caused real growth to drop to 1.9% (World Bank, 2022).

From a public debt front, the country is currently considered to be in the moderate debt distress category following a debt relief of 60% (almost US$7.7 billion) in 2012 (International Monetary Fund, 2022c; 2012). However, over the period of 2016 to 2021, the country's debt stock dramatically grew, raising red flags about potential debt-related problems in the future. The rise was caused by a growing recourse to commercial foreign borrowing, including to finance an increase in public investment and social spending in the context of the National Development Plan 2015-2020 framework and the covid-19 crisis (International Monetary Fund, 2022d). In December 2021, the public debt as a percentage of GDP was 53.5%, up from 33.5% in 2017 (International Monetary Fund, 2022d; World Bank, 2022). Commercial creditors, including members of the Paris Club and non-members like China, India, Saudi Arabia, and Kuwait, hold about half of the total debt stock, and nearly 90% of that debt is in the form of Eurobonds (International Monetary Fund, 2022d). France is the major bilateral creditor, followed by the United States and Germany. The World Bank, the IMF, and the African Development Bank are the major multilateral creditors. Debt from these multilateral creditors has surged since 2020 and made up approximately 29% of the country's total foreign public debt in 2021, primarily due to the country's response to the covid-19 pandemic (International Monetary Fund, 2022c; d).

The rest of the research is arranged as follows: the next Section discusses the public debt and economic growth trends in Côte d'Ivoire. It is followed by model specification and estimation techniques in Section 3. The empirical analysis is presented in Section 4, while the main conclusions and policy implications are summed up in the last Section.

Public debt dynamics and economic growth patterns in Côte d'Ivoire

The Côte d'Ivoire debt problem during the review period can be considered as being caused by a number of factors. Among them is the government's excessive borrowing between the 1970s through the 1990s to cover for the country's capital and recurrent financial demands (International Monetary Fund, 1998). During that time, the government chose to implement extensive development programs and budgetary policies that were quite expansionary, especially during periods of commodity boom (International Monetary Fund, 1998). Unfortunately, these spending patterns persisted in the 1980s, during economic downturns, causing the government to turn to foreign borrowing in order to keep implementing its programs in the face of declining export revenues (African Development Bank, 2005). As the budgetary imbalances worsened, the government's capacity to make its outstanding debt service payments weakened, which exacerbated additional debt problems, including inflationary pressures and exchange rate misalignments (International Monetary Fund, 2012; 2000). Another factor that contributed to Côte d'Ivoire debt crisis during the 1980s was the rise in foreign interest rates because the country had made significant use of commercial borrowing (Greene, Khan, 1990; Krumm, 1985). Figures 1 and 2 present public debt and economic growth trends in Côte d'Ivoire over the period 1980-2021.

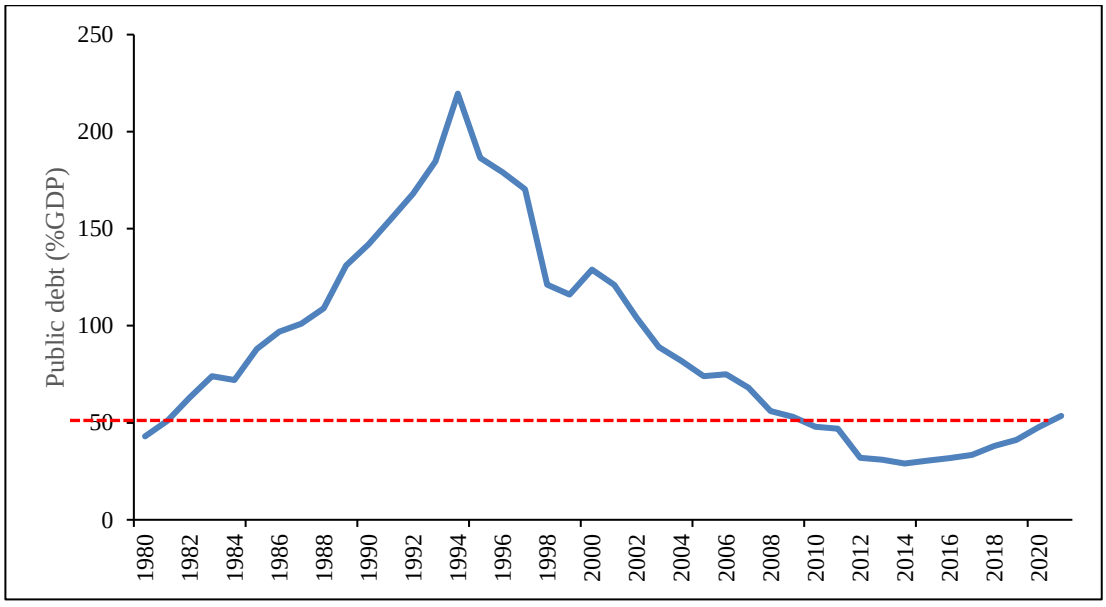

Figure 1 Public debt trend in Côte d'Ivoire (1980-2021)

Source: Authors' compilation using the World Bank (2022) and International Monetary Fund (2022d, 2012, 2000) data.

Figure 1 shows how quickly public debt increased, from less than 50% of GDP in 1979 to a peak of 219% of GDP in 1994, consisting of 184% of foreign public debt and 35% of domestic public debt (International Monetary Fund, 2000). The average debt-to-GDP ratio from 1988 to 2000 was 154.7% (World Bank, 2022). However, the foreign public debt component decreased between 1995 and 1999, falling from US$16 billion to around US$12 billion in absolute terms and from 158% to 98% as a share of GDP (International Monetary Fund, 2000). This decline is mostly attributable to the 1998 partial debt relief and restructuring by the London Club (International Monetary

Fund, 2012). The sharp rise that became apparent between 1999 and 2000 was driven by both commercial loan defaults and the sharp output decline brought on by political instability (World Bank, 2007).

The World Bank and IMF, Paris Club and non-Paris Club bilateral creditors' debt relief initiatives between 2002 and 2012 led to the drastic decline in foreign public debt as evidenced by the falling public debt/GDP trend in Figure 1. During the interim phase, the Paris Club HIPC interim debt relief was provided through debt rescheduling, swaps and cancellation in accordance with the Cologne provisions. By 2007, the Paris Club has either cancelled or rescheduled a debt of approximately US$1.4 billion, followed by multilateral creditors with US$711.4 and non-Paris Club creditors with $17.3 million (International Monetary Fund, 2012). Overall, the stock of foreign public debt was decreased by US$3.1 billion under the HIPC Initiative, with 43% from Paris Club, 27% from bilateral creditors, 23% coming from multilateral creditors, and the remaining 7% from other bilateral and commercial creditors (International Monetary Fund, 2012).

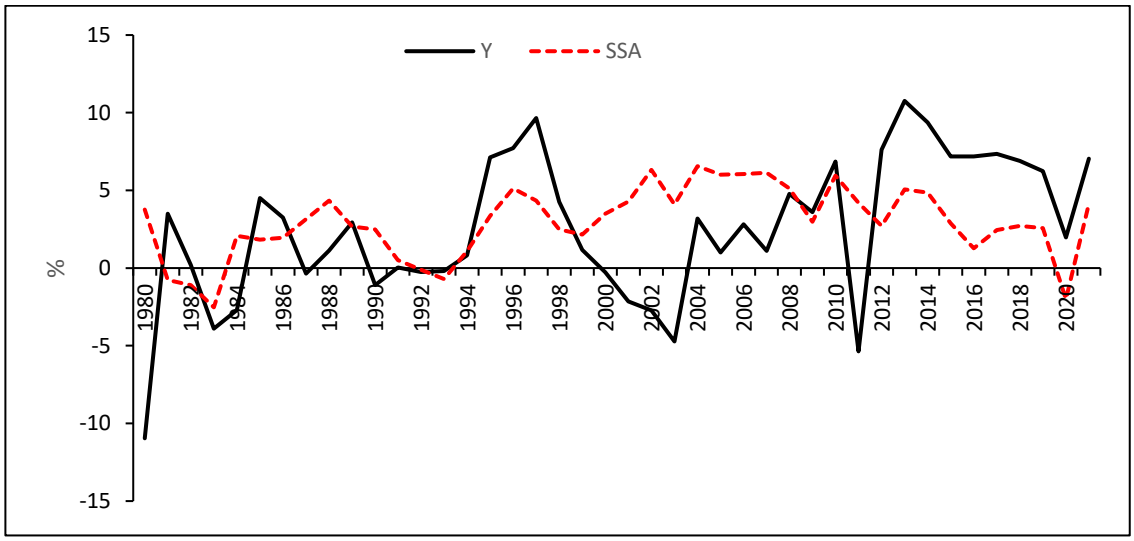

Figure 2 GDP Growth rate in Côte d'Ivoire (1980-2021)
Source: Authors' compilation using the World Bank (2022) data.

Figure 2 shows that economic growth largely remained below the SSA average between 1980-2011. However, political stability and public investment, facilitated by the extensive debt relief under the heavily indebted poor countries and multilateral debt relief initiatives, and reforms to strengthen the business climate, have enabled a strong pickup in economic activity between 2012 and 2021. Real GDP grew from 0.7% between 2000-2011 to 7.2% between 2012 and 2021 (World Bank, 2022). In Figure 2, the notable strong economic rebound in Côte d'Ivoire in 1994 was brought about by a currency devaluation, accompanied by several economic policies, including Competitiveness Sector Adjustment Programme (PASCO), the Financial Sector Adjustment Programme (PASFI) and the Health and Human Resource Adjustment Programme (PAS-RH) (African Development Bank, 2005). These reforms enabled the government in restoring the country's financial sustainability on both the domestic and foreign fronts. GDP growth slowed to 1.9% in 2020 due to covid-19 induced lower exports and a decline in both foreign direct investment and foreign financial flows, signifying the need to increase economic resilience to externally unfavourable shocks (World Bank, 2021).

Figures 1 and 2 seem to depict an inconsistent picture of how public debt and economic growth in Côte d'Ivoire relate to one another. However, a close examination of the figures suggests that there is a negative correlation between the variables, with economic booms and recessions being accompanied by a reduction and an increase in the debt/GDP ratio, respectively. The next step in this research is to look at the symmetric and asymmetric relationships between public debt and economic growth in this country.

Data, model specification and estimation techniques

In this analysis, annual time series data from 1972 through 2021 were used. The World Bank Development Indicators, an online World Bank database, and the International Monetary Fund global debt database were used to get the data. Table 1 presents the definitions of the variables, measurements, and a priori expected sign for each variable.

Table 1 Definitions of variables and expected signs

Variables	Definitions of variables (Measurements)	Expected signs
Economic Growth (Y)	Annual GDP per capita growth (%)	
Public debt (PD)	Central government debt (% of GDP)	-
Investment (INV)	Gross fixed capital formation (% of GDP)	+
Gross domestic savings (GDS)	Gross domestic savings (% of GDP)	+
Trade openness (TO)	Exports +Imports (% of GDP)	+
Inflation	Consumer price index inflation (annual %)	-/+

To examine the symmetric dynamic relationship between public debt and economic growth in Côte d'Ivoire, the following theoretical model framework is specified:

$$Y_t = f(PD, INV, GDS, TO, INF) \quad (1)$$

where all variables are as defined in Table 1.

The choice of independent variables in model 1 is underpinned by theory. The debt overhang theory argues that the accumulation of public debt crowds out private sector investment (Myers, 1977). Contrarily, government expenditure financed by deficits rather than taxes has a more favourable multiplier impact on the economy (Barro, 1980). Investment boosts productivity across many economic sectors, both formally and informally (African Development Bank, 2022). Public investment stimulates economic activity through short-term effects on aggregate demand; it raises total factor productivity and has a crowding-in effect on private investment (Makuyana, Odhiambo, 2019).

The Modigliani and Ando (1957) Life Cycle Hypothesis presents the potential impact of savings on economic growth. The hypothesis contends that financial factors, including interest rates, inflation rates, the availability of financial instruments, and initial wealth levels, have a direct impact on both saving throughout working life and spending after retirement. These factors are important because they have a dynamic impact on how households choose to invest and consume throughout the course of time. Grossman and Helpman (1990) claim that trade openness can spur economic growth by easing access to goods and services, improving resource allocation efficiency, and enhancing total factor productivity through the spread of technology and knowledge (see also Barr, Sala-i-Martin, 1997). Depending on whether money is completely neutral, a substitute for capital, or a complement to

capital, the impact of inflation on economic growth might be neutral, positive, or negative (see Ndoricimpa, 2017).

Equations 2 and 3 give the linear ARDL model specifications. Symmetric ARDL model specification:

$$\begin{aligned}\Delta y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta y_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta PD_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta INV_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\,\Delta GDS_{t-i} \\ + \sum_{i=0}^{n} \alpha_5 \Delta TO_{t-i} + \sum_{i=0}^{n} \alpha_6 \Delta INF_{t-i} + \sigma_1 y_{t-1} + \sigma_2 PD_{t-1} + \sigma_3 INV_{t-1} \\ + \sigma_4 GDS_{t-1} + \sigma_5 TO_{t-1} + \sigma_6 INF + \mu_{1t}\end{aligned} \tag{2}$$

where: α_0 = constant; $\alpha_1 - \alpha_6$ and $\sigma_1 - \sigma_6$ = short-run and long-run regression coefficients, respectively; Δ = change; n = lag lengths; μ_{1t} = white-noise error term; t = time period.

ECM symmetric ARDL model specification:

$$\begin{aligned}\Delta y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta y_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta PD_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta INV_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\,\Delta GDS_{t-i} \\ + \sum_{i=0}^{n} \alpha_{5i} \Delta TO_{t-i} + \sum_{i=0}^{n} \alpha_{6i} \Delta INF_{t-i} + \omega_1 ECM_{t-1} + \mu_{2t}\end{aligned} \tag{3}$$

where: α_0 = constant; $\alpha_1 - \alpha_6$ and ω_1 = regression coefficients; ECM_{t-1} = error-correction term lagged once. The other variables and symbols remain as earlier defined in Table 1 and equation 2.

The standard linear specifications (2) and (3) are unable to capture the asymmetric relationship between public debt and economic growth. Accordingly, in line with Shin et al. (2014), the study incorporates the NARDL technique to account for both short-run and long-run asymmetric dynamics between variables. Thus, following Shin et al. (2014), public debt (PD_t) can be decomposed into partial sums of positive (PD_t^+) and negative (PD_t^-) changes as follows:

$$Y_t = \delta^+ PD_t^+ + \delta^- PD_t^- + X_t + \mu_{3t} \tag{4}$$

where:

$$PD_t^+ = \sum_{j=1}^{t} \Delta PD_t^+ = \sum_{j=1}^{t} \max(\Delta PD_j; 0) \tag{5}$$

$$PD_t^- = \sum_{j=1}^{t} \Delta PD_t^- = \sum_{j=1}^{t} \min(\Delta PD_j; 0) \tag{6}$$

Using equations (5) and (6), the nonlinear autoregressive distributive lag model can be given as NARDL model specification:

$$\begin{aligned}\Delta Y_t = \delta_0 + \sum_{i=1}^{p} \delta_{1i}\Delta Y_{t-i} + \sum_{i=0}^{q1} \delta_{2i}^{+}\Delta PD_{t-i}^{+} + \sum_{i=0}^{q2} \delta_{3i}^{-}\Delta PD_{t-i}^{-} + \sum_{i=0}^{q3} \delta_{4i}\Delta INV_{t-i} \\ + \sum_{i=0}^{q4} \delta_{5i}\,\Delta GDS_{t-i} + \sum_{i=0}^{q5} \delta_{6i}\Delta TO_{t-i} + \sum_{i=0}^{q6} \delta_{7i}\Delta INF_{t-i} + \alpha_1 Y_{t-1} + \alpha_2^{+} PD_{t-1}^{+} \\ + \alpha_3^{-} PD_{t-1}^{-} + \alpha_4 INV_{t-1} + \alpha_5 GDS_{t-1} + \alpha_6 TO_{t-1} + \alpha_7 INF_{t-1} + \mu_{3t}\end{aligned} \tag{7}$$

where: Δ = change; p; $q1 - q6$ = optimal lag order; δ_0 = constant; $\delta_1 - \delta_7$= short-run coefficients; $\alpha_1 - \alpha_7$ = long-run coefficients; μ_{3t} = white noise error term.

The critical values for the linear and nonlinear ARDL models are the same. Cointegration is ascertained by comparing computed F-statistic to the upper and lower critical bounds from Pesaran et al. (2001) critical values. An asymmetric

cointegration test is present if the joint null hypothesis, $\alpha_1 = \alpha_2^+ = \alpha_3^- = \alpha_4 = \alpha_5 = \alpha_6 = \alpha_7 = 0$ is rejected.

NARDL ECM representation:

$$\Delta Y_t = \delta_0 + \sum_{i=1}^{p} \delta_{1i}\Delta Y_{t-i} + \sum_{i=0}^{q1} \delta_{2i}^{+}\Delta PD_{t-i}^{+} + \sum_{i=0}^{q2} \delta_{3i}^{-}\Delta PD_{t-i}^{-} + \sum_{i=0}^{q3} \delta_{4i}\Delta INV_{t-i} + \sum_{i=0}^{q4} \delta_{5i}\,\Delta GDS_{t-i} + \sum_{i=0}^{q5} \delta_{6i}\Delta TO_{t-i} + \sum_{i=0}^{q6} \delta_{7i}\Delta INF_{t-i} + \emptyset ECM_{t-1} + \mu_{4t} \quad (8)$$

To confirm convergence to long-run equilibrium following a shock or short-term disequilibrium, the coefficient of the error correction term (∅) is anticipated to be negative and statistically significant. According to Shin et al. (2014), the asymmetric cumulative dynamic multiplier is used to assess how GDP growth responds to changes (an increase or decrease) in public debt using the following representation:

$$\mathrm{m_h^+} = \sum_{\mathrm{j=0}}^{\mathrm{h}} \frac{\partial \mathrm{y_{t+j}}}{\partial \mathrm{x_t^+}} \quad (9)$$

$$\mathrm{m_h^-} = \sum_{\mathrm{j=0}}^{\mathrm{h}} \frac{\partial \mathrm{y_{t+j}}}{\partial \mathrm{x_t^-}} \quad (10)$$

where: as h → ∞, $\mathrm{m_h^+} \rightarrow \mathrm{L^+}$ and $\mathrm{m_h^-} \rightarrow \mathrm{L^-}$; Long-run coefficients: $\mathrm{L^+} = -\rho\mathrm{x^+}/\rho\mathrm{y}$ and $\mathrm{L^-} = -\rho\mathrm{x^-}/\rho\mathrm{y}$.

The current study makes use of time series data, so it is necessary to pre-test each variable for unit root in order to prevent spurious regressions and to determine the order of integration for each variable. According to Pesaran et al. (2001) and Shin et al. (2014), ARDL and NARDL models require that no variable be integrated of an order higher than one. To determine the order of integration, the study uses the Dickey-Fuller Generalised Least Square (DF-GLS) and Phillips-Perron (PP) approaches. After ascertaining the order of integration for each variable, the study then conducts a cointegration test and, consequently, the validity of the ARDL and NARDL processes. Furthermore, this study undertakes nonlinearity tests in the series using the Brock-Dechert-Scheinkman (BDS) test, which was first developed by Brock et al., 1996). The null hypothesis of linearity, under various BDS statistical dimensions (m = 2, 3, 4, 5, 6), is put to the test. The Wald test is also included in this study to check for both short- and long-run asymmetries. The study then applies the above specified models 2, 3, 7 and 8 to estimate the symmetric and asymmetrical long- and short-run effects of public debt on economic growth. Finally, the study carries out a battery of post diagnostic tests, including tests for normality, heteroscedasticity, autocorrelation, misspecification of the functional form, model stability and apparent asymmetries in the adjustment patterns traced by the dynamic multipliers.

Empirical analysis

Stationarity results reported in Table 2 show that the variables have different integrating orders. While it was found that GDP growth and inflation were stationary in levels [I(0)], public debt, investment, savings and trade openness all became stationary after the first differencing [I(1)]. The findings support the applicability of the ARDL and NARDL analyses since the order of integration is a mixture of no more than one.

The BDS test findings shown in Table 3 indicate that the series are nonlinear in all of the BDS dimensions. This has been confirmed by the BDS test statistics for all the

variables, which have been found to be statistically significant at 1%. This finding shows that the relationship between total public debt and economic growth in the current study is best examined using a nonlinear model.

Table 2 Stationarity test for all variables

Variable	Dickey-Fuller Generalised Least Square (DF-GLS)			
	Level		First Difference	
	Without Trend	With Trend	Without Trend	With Trend
Y	-4.205***	-4.469***	__	__
PD	-0.283	-0.419	-2.957***	-3.084*
INV	-1.473	-1.721	-5.028***	-5.467***
GDS	-1.032	-2.488	-6.355***	-6.376***
TO	-1.840*	-3.102*	__	__
INF	-3.439***	-4.291***	__	__
	Phillips-Perron (PP)			
	Level		First Difference	
	Without Trend	With Trend	Without Trend	With Trend
Y	-4.189***	-4.380***	__	__
PD	-0.869	-0.919	-6.392***	-6.538***
INV	-1.681	-1.562	-5.553***	-5.634***
GDS	-2.577	-2.508	-6.618***	-6.603***
TO	-1.611	-3.627**	-8.039***	-7.975***
INF	-3.778***	-5.419***	__	__

Notes: *, ** and *** denotes stationarity at 10%, 5% and 1% significance level.

Table 3 BDS test for nonlinearity

Variables	BDS Statistic									
	Dimension 2		Dimension 3		Dimension 4		Dimension 5		Dimension 6	
	BDS Statistic	P-value	BDS Statistic	P-value	BDS Statistic	P-value	BDS Statistic	P-value	BDS Statistic	P-value
Y	0.031***	0.000	0.067***	0.000	0.078***	0.000	0.078***	0.000	0.074***	0.000
PD	0.171***	0.000	0.287***	0.000	0.357***	0.000	0.391***	0.000	0.404***	0.000
INV	0.126***	0.000	0.204***	0.000	0.241***	0.000	0.257***	0.000	0.255***	0.000
GDS	0.086***	0.000	0.130***	0.000	0.164***	0.000	0.171***	0.000	0.166***	0.000
TO	0.094***	0.000	0.135***	0.000	0.176***	0.000	0.188***	0.000	0.191***	0.000
INF	0.098***	0.000	0.179***	0.000	0.230***	0.000	0.255***	0.000	0.260***	0.000

Notes: *** denote statistical significance at 1% level.

Table 4 presents the findings of the cointegration tests based on the ARDL and NARDL bounds testing methods. The estimated ARDL and NARDL models have F-statistics of 7.917 and 9.674, respectively, and these values are statistically significant at the 1% level, as shown in Table 4. This result indicates that the variables included in the linear and nonlinear models have a cointegrating relationship.

Table 4 Bounds F-test for cointegration results

ARDL Model				NARDL Model			
F-Statistic		Cointegration Status		F-Statistic		Cointegration Status	
7.917***		Cointegrated		9.674***		Cointegrated	
Pesaran et al. (2001), p. 300, Table CI(iii) Case III	Asymptotic critical values for ARDL Model						
	10%		5%		1%		
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
	2.26	3.35	2.62	3.79	3.41	4.68	
	Asymptotic critical values for NARDL Model						
	10%		5%		1%		
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)	
	2.12	3.23	2.45	3.61	3.15	4.43	

Notes: *** denote statistical significance at 5% level.

The Wald test results presented in Table 5 indicate that the corresponding p-value of the Wald F-statistic (W_{LR}) is above 0.05, indicating that the levels of public debt and their positive and negative partial sum of square effects on economic growth are equal in the long run. Furthermore, with a p-value of the F-statistic (= 0. 014) that is less than 0.05, the Wald test results (W_{SR}) show an asymmetric relationship between public debt and economic growth in Côte d'Ivoire in the short run. This suggests that the effects of rising and falling public debt levels on economic growth are different in the short run.

Table 5 Long- and Short-Run Asymmetry Results

Test	F-statistic	P-value	Decision
W_{LR}	0.446	0.509	symmetric
W_{SR}	6.656**	0.014	asymmetric

Notes: W_{LR} is long-run asymmetric test; WSR is short-run asymmetric test; ** signifies significance at 5% level.

Table 6, Panels A and B, presents the long-run and short-run results, respectively, for both ARDL and NARDL models.

Table 6 Results of long-run and short-run estimation

Dependent Variable is Y				
Panel A: Long-Run Results				
	ARDL		NARDL	
Regressor	Coefficient	T-ratio [p-value]	Coefficient	T-ratio [p-value]
PD	0.014	0.578 [0.567]	__	__
PD^+	__	__	-0.077*	-1.986 [-0.055]
PD^-	__	__	-0.063	-1.636 [0.110]
INV	-0.012	-0.061 [0.952]	-0.137	-0.741 [0.463]
GDS	0.671***	2.957 [0.006]	0.469**	2.626 [0.013]
TO	0.075	0.835 [0.409]	-0.050	-0.498 [0.622]
INF	-0.491**	-2.595 [0.014]	-0.407**	-2.339 [0.025]
Panel B: Short-Run Results				
	ARDL		NARDL	
Regressor	Coefficient	T-ratio [p-value]	Coefficient	T-ratio [p-value]
C	-13.858***	-7.113 [0.000]	1.141*	2.012 [0.052]
ΔPD	-0.062	-1.324 [0.194]	__	__
ΔPD^+	__	__	0.069	0.941 [0.353]
ΔPD^-	__	__	-0.311***	-4.726 [0.000]
ΔINV	1.024***	4.876 [0.000]	1.134***	6.015 [0.000]
ΔGDS	0.591***	2.750 [0.009]	0.380**	2.618 [0.013]
ΔTO	0.066	0.866 [0.392]	-0.041	-0.487 [0.629]
ΔINF	-0.432**	-2.688 [0.011]	-0.330**	-2.661 [0.012]
$ECM(-1)$	-0.880***	-7.355 [0.000]	-0.811***	-8.871 [0.000]

Test Statistic	ARDL	NARDL
R- Squared	0.657	0.719
R-Bar-Squared	0.632	0.693
F-Statistic [Prob]	26.170 [0.000]	27.528 [0.000]
DW Statistic	2.069	2.175
Akaike info criterion	5.121	4.960
Schwarz info criterion	5.282	5.155

Notes: *, ** and *** denote statistical significance at 10%, 5% and 1% levels, respectively. _+ and _- denotes positive and negative shocks.

Estimation results for the symmetric ARDL regression model, presented in Table 6 (Panels A and B), provide no evidence of a significant impact of public debt on economic growth, regardless of whether the analysis was conducted in the short run or long run. Further, the NARDL results show that positive changes in public debt (PD^+) have a significant negative impact on economic growth, but only in the long

run. The findings imply that, on average, positive changes to public debt lead to economic decline in the long run. Additionally, negative changes in public debt, signifying a downward debt trajectory, lead to economic growth in the short run only and have no significant effect on economic growth in the long run. Thus, negative changes in the public debt can serve to lessen the uncertainty in the business climate, which will increase private, public, and foreign direct investments (see also, International Monetary Fund, 2022b). In the main, the results show that GDP growth is negatively associated with rising public debt levels and positively linked with falling debt levels. Also, the results indicate that negative shocks in public debt have a strong impact on economic growth in Côte d'Ivoire. Overall, based on these findings, the analysis acknowledges the fact that the debt trajectory of Côte d'Ivoire can be a critical factor in determining the country's future growth prospects. The results are in line with earlier research by the International Monetary Fund (2022a) for countries with a high initial debt level and an upward trajectory in debt over the past five years, as well as Mosikari and Eita (2021) for Namibia.

In accordance with additional findings in Table 6 (Panels A and B) for ARDL and NARDL models, the coefficient of investment is positive and statistically significant in the short run, pointing to a positive impact of investment on economic growth in Côte d'Ivoire. The coefficient of savings in both ARDL and NARDL models is positive and statistically significant, regardless of whether the estimation is carried out in the long run or in the short run. These findings imply that savings have a significant role in promoting economic growth in Côte d'Ivoire. This result is consistent with the earlier expectations made by the study and the underlying economic theory. Furthermore, the results show that the coefficient of inflation in both ARDL and NARDL is negative and statistically significant in both the long run and short run. This implies that inflationary forces have a severe negative impact on the growth process of the country. Contrary to expectations, both symmetric and asymmetric models found the coefficient of trade openness to be statistically insignificant. Finally, in both ARDL and NARDL models, the coefficients of the error term lagged by one period, ECM(1), are negative, as anticipated, and statistically significant at the 1% level of significance. According to this, in the event of an economic shock, economic growth would return to equilibrium at a rate of 88% and 81% per annum in the ARDL and NARDL models, respectively.

In Table 6, the p-values of the computed F-statistic for the estimated ARDL and NARDL models are less than the 1% significance level. This implies that the coefficients are jointly significant, indicating that the sample data are sufficient to support the conclusion that the two regression models adequately describe the data. It is further confirmed that the regression models offer the best fit for the observed data values by the adjusted R-square values of 63% and 69% for the ARDL and NARDL models, respectively. Lastly, the Durbin-Watson values of 2.069 and 2.175 signify the absence of first-order autocorrelation.

The findings in Table 7 indicate that normality, heteroscedasticity, and autocorrelation have p-values that are above 0.05, implying that the estimated parameters in the two models are consistent and reliable. However, since the p-value for the functional form in the ARDL model was found to be statistically significant at the 10% significance level, a NARDL model was also used in the analysis.

The study also plotted the Cumulative Sum of Recursive Residuals (CUSUM) and Cumulative Sum of Squares of Recursive Residuals (CUMUMSQ) for ARDL and NARDL models to test for model stability, and the findings are shown in Figure 3. The CUSUM

and CUSUMSQ graphs are within the bounds at a 5% significance level, implying that all the models pass the stability test, confirming the consistency and reliability of the estimated results.

Table 7 Diagnostic tests results

LM Statistics	ARDL	NARDL
Normality	2.813 [0.245]	4.441 [0.109]
Serial Correlation	0.118 [0.733]	0.886 [0.422]
Heteroscedasticity	1.158 [0.350]	1.108 [0.382]
Functional Form	3.306 [0.078]*	2.294 [0.139]

Notes: Normality test using the Jarque-Bera test; Serial correlation using the Lagrange Multiplier test; Heteroscedasticity using the Breusch-Pagan-Godfrey test and Functional form; the value in parenthesis is p-values. * Signifies significance at 10% level.

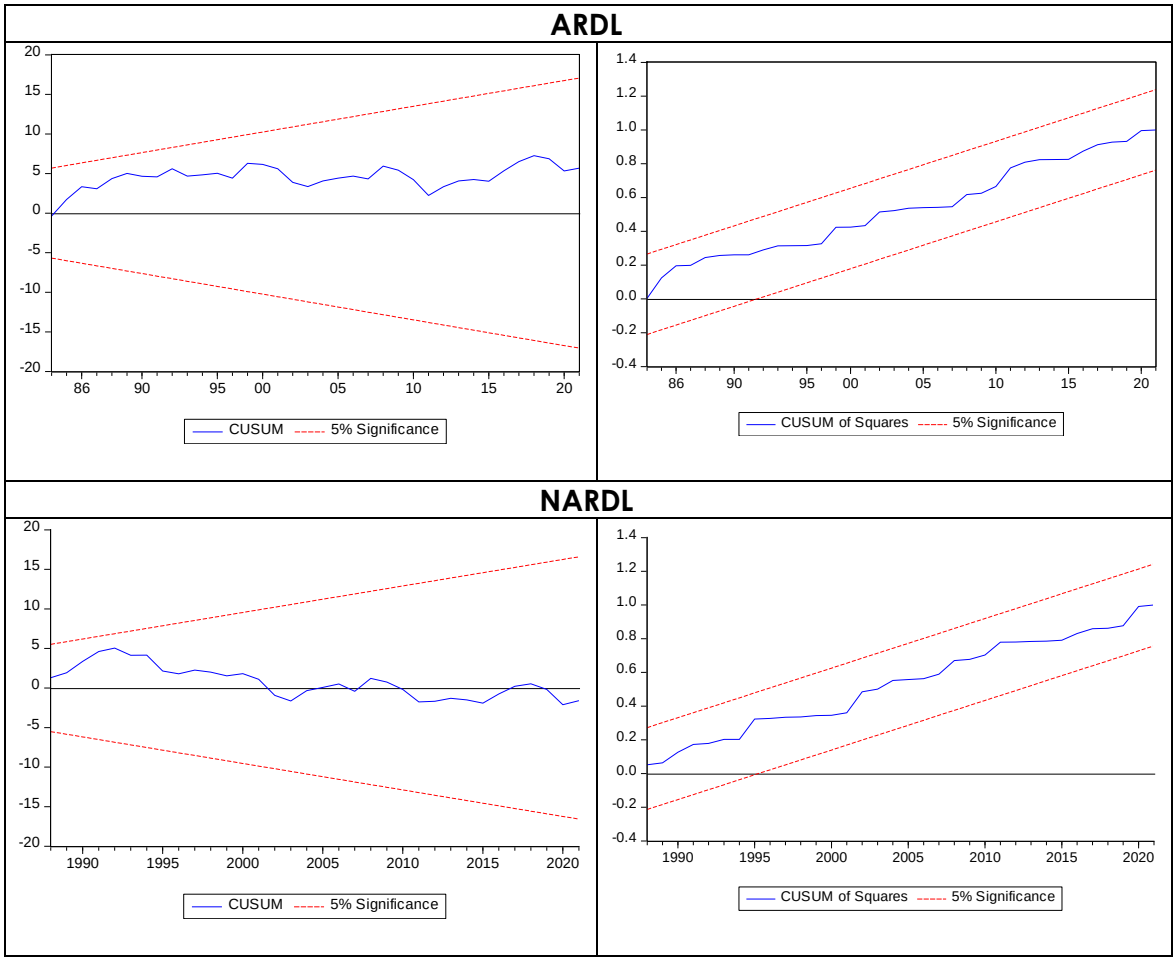

Figure 3 Plot of CUSUM and CUSUMQ

The findings of the dynamic multipliers shown in Figure 4 support the existence of an asymmetric impact of positive and negative shocks in total public debt on economic growth in Côte d'Ivoire. Figure 4 explicitly shows that economic growth responds more quickly and strongly to negative shocks to public debt in the very short run. Contrarily, economic growth responds only moderately to increases in public debt. These findings support previous NARDL findings reported in Table 6 (Panels A and B).

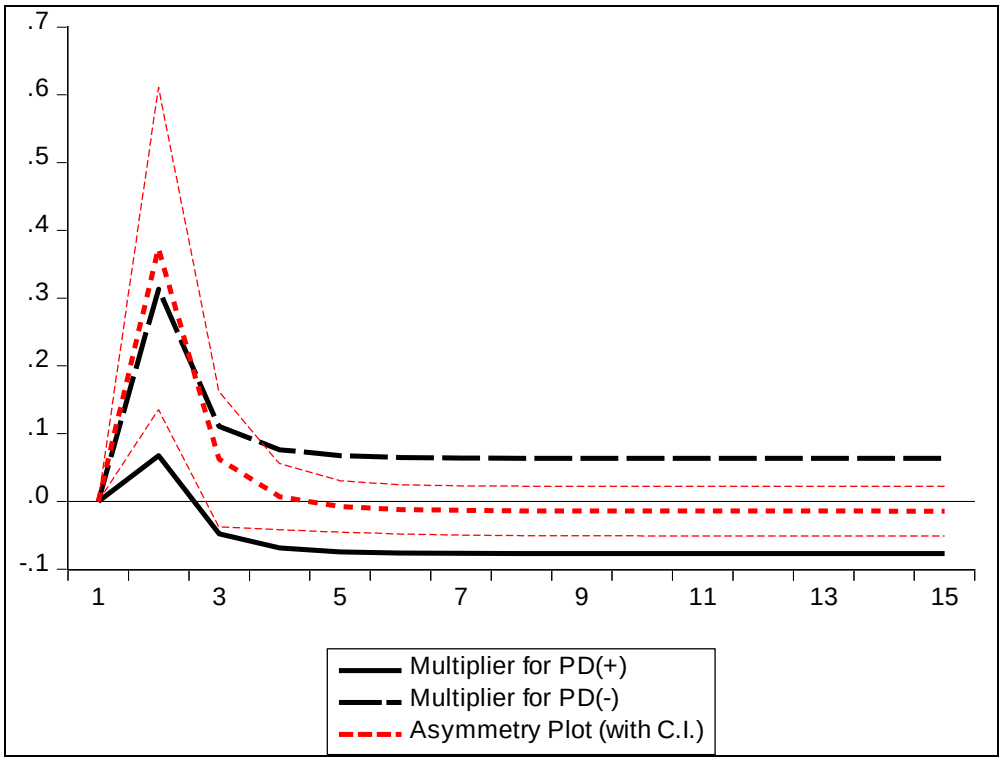

Figure 4 Plot of dynamic multiplier graph

Conclusions and policy implications

The study examined the symmetric and asymmetric impact of public debt on economic growth in Côte d'Ivoire based on a multivariate linear and nonlinear ARDL model using time series data spanning the years 1972 to 2021. The study also used the Wald test for asymmetries, the Brock-Dechert-Scheinkman nonlinearity test, and the ARDL and NARDL bounds test for cointegration. A review of country-based literature revealed that Cote d'Ivoire is a lower middle-income country that is still dependent on commodity exports. The export structure makes the economy of Cote d'Ivoire highly susceptible to global shocks, such as adverse movements in commodity and mineral prices. Three major economic phases were identified in Cote d'Ivoire: the 1960-1979 boom, the 1980-2003 crisis, and the 2004-2021 growth and recovery era. These economic trajectories, along with the recent health crises brought on by covid-19, significantly influenced the country's debt dynamics. In the 1980s and 1990s, debt stocks dramatically increased, forcing the government to take many corrective actions, including seeking debt relief and rescheduling, as well as implementing aggressive economic, trade, and financial reforms. The country started to receive partial debt relief in 1998, and major debt relief followed between the period 2002-2012. The country was categorised as being in moderate debt distress in 2021, with the public debt as a proportion of GDP rising from 33.5% in 2017 to 53.5% in December 2021.

The ARDL and NARDL bounds cointegration test results indicated that the variables in the two models had a long-run symmetric and asymmetric relationship. The Wald test results revealed the existence of an asymmetric relationship between public debt and economic growth in Cote d'Ivoire in the short run and a symmetric relationship in the long run. Estimation results for the symmetric ARDL regression model provide no evidence of a statistically significant impact of public debt on economic growth, regardless of whether the analysis was carried out in the short run

or long run. The NARDL findings indicate that, on average, positive changes to public debt lead to economic decline in the long run, while negative changes cause an economic upturn in the short run. Negative changes in the public debt stock can help to reduce the uncertainties in the business environment, which will boost private, public, and foreign direct investments. The findings also show that GDP growth responds rapidly and strongly to negative changes in public debt. In light of the fact that rising public debt has a negative impact on the real economy, the study advises the government of Côte d'Ivoire to exercise caution in this regard. The government should also continue implementing and enforcing prudent public finance and debt management measures to maintain the increase in public debt within manageable bounds and to boost domestic savings. In order to keep the country on its optimal growth path, inflationary pressures must also be kept within control.

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