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Public Debt and Economic Growth: A Threshold Determination in Ghana

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Abstract: This study examines the existence of a debt Laffer-curve effect on economic growth in Ghana by investigating the non-linear relationship between public debt and economic growth. Specifically, the study seeks to determine the threshold level beyond which increases in public debt begin to exert a negative effect on economic growth. Using annual time series data spanning the period 1965 – 2018, the study employs the Autoregressive Distributed Lag (ARDL) modelling approach with a quadratic debt term to capture the potential non-linear dynamics between public debt and growth. The empirical findings reveal the presence of an inverted U-shaped relationship between public debt and economic growth, confirming the existence of a non-monotonic effect of debt on growth in Ghana. The results further indicate that the optimal public debt threshold is approximately 52.4 percent of GDP. Beyond this threshold, additional increases in public debt adversely affect economic growth, raising concerns about debt sustainability and long-term macroeconomic stability in Ghana. The findings suggest that Ghana's current public debt levels may not support sustained long-term economic growth. Consequently, the study recommends that policymakers maintain the public debt-to-GDP ratio below the estimated threshold to promote macroeconomic stability and achieve sustainable economic growth.

Keywords: Public Debt, Economic Growth, Debt Laffer-curve, Threshold analysis, Non-linear ARDL, Ghana.

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1. Introduction. Public debt is a financial obligation of a country's central government, used to finance economic growth and development in developing economies (Ouedraogo, 2015). Neoclassical growth models justify government borrowing for capital-scarce countries to boost capital accumulation and output per capita. In the 1970s and 1980s, a global debt crisis occurred due to subpar debt management practices in low- and middle-income economies (IMF, 2022). Oil shocks in 1973 and 1979 led to oil exporters depositing dollar reserves in western commercial banks, which became 'petrodollars'. These banks loaned these reserves to developing countries at low interest rates, making borrowing costs low. However, the Federal Reserve Bank increased interest rates to combat inflation, leading to higher borrowing costs for developing countries. From 1978 to 1981, developing countries faced rising unemployment and higher borrowing costs due to interest rate hikes, costing them around $22 billion (IMF, 2022). Commodity prices also slumped due to the recession caused by the Fed's contractionary monetary policy. To address these issues, many adopted expansionary fiscal policies and revalued their currencies, resulting in colossal loans. In 1982, Mexico's failure to service debt obligations led to a debt crisis (IMF, 2022).

The debt crisis in developing countries was primarily due to the use of short-term loans to finance long-term projects, which led to unmet obligations and large balance of payment deficits (Marquez, 2000). As GDP fell, developing nations sought sustainable growth alternatives. To address this, they took out more loans to increase expenditure and prevent low capital inflows. African countries, for the first time, engaged with the Euromarket to borrow more and finance expenditure (Krumm, 1985). Keynesian economics suggests that governments can run deficits to execute necessary projects and policies. While national tax revenues are the optimal choice, borrowing from the public is common to bridge the gap between tax revenues and expenditures (African Development Bank, 2018). Developing countries with poor tax systems and low incomes can consider borrowing as a budget financing method, making public debt crucial.

Several African nations, including Ghana, became heavily indebted during the debt crises of the 1970s and 1980s. This made it challenging to pay back loans. Then, a further debt crisis for most African countries emerged in the 1960s. High African debt throughout the 1970s and early 1980s, according to Yagc et al., (1985), caused debt to rise from $140 billion at the start of the crisis in 1982 to at least $270 billion in 1990. Historically, Ghana's economy has mostly experienced increasing public debt, eventually causing some economic challenges. These challenges included high inflation levels and a rapid depreciation of the exchange rate (Adi, 2019). This has lurched Ghana into further unsustainable debt levels since the dependence on foreign financial support was necessary for economic revamping. The highest debt-to-GDP ratio in Ghana stood at 112 percent of GDP in 2000 (Adi, 2019; IMF, 2022). That was an increase of 94 percentage points from the 1970s' average debt-to-GDP ratio of 18 percent (IMF, 2022).

Nevertheless, Ghana's debt stock started to decline with its participation in the World Bank's HIPC Initiative in 2001. Following the conclusion of this initiative in 2006, the nation's debt stock was $780 million, reaching the lowest debt-to-GDP ratio of 25% in the previous 20 years (Adi, 2019; IMF, 2022). Recently, concerns about a potential debt crisis in Africa, including Ghana, have been raised. The World Bank reports that since the implementation of the HIPC initiative, the rate of debt growth in sub-Saharan Africa (SSA) has accelerated. SSA's average sovereign debt-to-GDP ratio climbed from 37 percent in 2012 to 57 percent in 2017 (World Bank, 2019), an increase of 20 percentage points. While other emerging nations in Africa had an average debt-to-GDP ratio of 60 percent, Ghana's debt stock increased once again, reaching the present level of nearly 84 percent of GDP (IMF, 2022).

With the debt problems re-emerging in developing countries after HIPC, concerns about whether public debt might be hitting threshold levels detrimental to economic growth began to surface. Studies on the topic of the non-linear or threshold impacts of debt on economic growth were subsequently conducted as a result. Kaminsky et al., (1996), Elbadawi et al., (1997), and Deshpande (1997) are a few examples of these early investigations. The global financial crisis of 2008 stretched the threshold campaign to wealthy nations as well. Examples of these studies include those by Reinhart and Rogoff (2010), Cecchetti et al., (2011), Pescatori et al., (2014), Aschauer (2000), and Checherita-Westphal et al., (2012). More discussion about the public debt ceiling and its effects on economic growth was sparked as a result. Instead of using the conventional linear methods of the impact of public debt on growth regression analysis, many have chosen to further explore the relationship between debt and growth using non-linear threshold estimate methodologies (Cai, 2017). In general, the body of literature provides a jumble of information about public debt ceilings and their effects on economic growth in emerging nations.

According to the literature, it is still unclear how exactly public debt affects short-, medium-, and long-term growth (Panizza & Presbitero, 2013; Arabi et al., 2018). The growth effects of public debt buildup in the context of the linear and threshold forms previously mentioned have been a topic of long-standing discussion among economists. A section of the literature that used the threshold form shows that once debt-to-GDP ratios reach a certain point, growth is negatively impacted. Salmon (2021) did a thorough review of the literature from 2010 to 2020 on the relationship between public debt levels and economic development in order to better understand the argument between the linear and threshold methods. The study also looked at the claim that there is a nonlinear debt threshold above which public debt negatively affects economic growth and states that while such thresholds might exist, there may not be a common threshold level for all

countries, but it may largely depend on other factors, such as a country's level of development and the quality of its institutions.

Additionally, other studies have also examined the impact of threshold debt on growth and found the existence of non-linear causal relationship between public debt and economic growth (see Kumar & Woo (2010), Mercinger et al., (2014), Baglan & Yoldas (2016), Brida et al., (2017), Ahlborn & Schweickert (2018), Koffi (2019), Mensah et al. (2019), Bhimjee & Leão (2020), and Ndoricimpa (2020). However, other studies also identified that there is no sustained threshold non-linear causal relationship between public debt and economic growth (see Baglan & Yoldas (2013), Eberhardt & Presbitero (2013), and Pescatori et al., (2014).

In relation to the above, majority of empirical studies on Ghana's public debt's effect on economic growth have focused more on linear function specifications. Studies on the threshold analysis in Ghana are hard to come by. Nevertheless, a few studies on threshold analysis of public debt and economic growth exist in Africa such as Sanusi et al., (2019), Koffi et al., (2019), Mensah et al., (2019), and Ndoricimpa (2020). They all employed panel data estimation techniques, and their findings support the position that the public debt threshold is sensitive to country specific characteristics. This study finds it necessary to specifically evaluate and estimate the threshold level of public debt in Ghana similar to studies by Mupunga et al., (2015) and Omotosho et al., (2016) for Zimbabwe and Nigeria, respectively.

Therefore, the main objective of this study is to determine the existence of a non-linear relationship between public debt and economic growth in Ghana by using the NARDL model with a quadratic estimation technique to establish the debt-to-GDP threshold ratio above which economic growth may be inhibited.

The rest of the study is organized into four sections as follows: section one covers introduction, section two reviews the literature, section three deals with the methodology, while section four reports the empirical estimates with its interpretations, and the last section concludes the study with policy suggestions.

2. Literature Review.

2.1. Theoretical Literature

According to Keynesian theory, the market may not always achieve full employment in the short run, and government interventions are needed to counteract market failures and promote balanced growth. Keynesian spending and investment multipliers argue that debt encourages economic recovery, especially in emerging countries. The classical approach, however, suggests avoiding debt to avoid overspending, as it allows the government to achieve its goals.

Endogenous growth theory suggests that government debt can positively impact growth if used to fund productive sectors of the economy. However, the crowding-out effect caused by public debt can have a detrimental long-term effect on economic growth. Recent literature suggests an inverted U-shaped relationship between growth and debt variables, suggesting an ideal public debt-to-GDP ratio that maximizes growth. The threshold strand of literature suggests that when the ratio is below a threshold, the crowding-in effect outweighs the crowding-out effect, promoting economic expansion. Conversely, beyond this threshold, the crowding-out effect outweighs the crowding-in effect, negatively affecting economic growth.

The debt Laffer curve by Sachs (1989), when examined in the context of the debt overhang hypothesis, supports the notion of a public debt ceiling that maximizes growth. It suggests that rising debt levels lead to decreased chances of debt repayment. The curve predicts that large public debt stocks slow economic growth due to crowded private investment. Krugman's debt overhang concept suggests that financing a nation's debt becomes more challenging as cumulative payment commitments behave like investment taxes. Although Krugman did not directly address the effect of debt on growth, his hypothesis suggests that high debt levels may lead to low growth due to low investments.

By extension of these theoretical foundations, there is another theory that supports the existence of a nonlinear link between the magnitude of public debt and economic growth. The threshold or nonlinear effect theory is used to describe this. According to this theory, when public debt levels are below a specific ideal threshold, they tend to have positive benefits on economic growth, but when they exceed that threshold, they have negative effects (Reinhart & Rogoff, 2010).

2.2 Empirical Literature

Using panel data covering the years 1969–1998, Pattillo et al., (2002) investigate the relationship between the debt ceiling and growth in 93 developing nations. They use the system generalized method of moments (sGMM) and fixed effects estimates to analyse their data and included a quadratic debt factor in their OLS model. Their research reveals that the debt-to-GDP ratio should not exceed 35 to 40 percent. The non-linear impact of external debt on economic growth in 93 developing countries was subsequently investigated by Patillo et al. (2011) using spline and quadratic econometric models. The data spanned the years 1969 to 1998. They discovered a non-linear, bell-shaped association between the ratio of public external debt to GDP and economic growth. Similar to the findings of Patillo et al. (2002), their study also show that foreign debt becomes harmful to growth if it exceeds a debt-to-GDP ratio of 35 to 40 percent.

Reinhart and Rogoff (2010) examine the relationship between total public debt, inflation, and economic growth. Between 1790 and 2009, they study 44 developing and advanced nations. Their research shows that lower economic growth outcomes were related to debt-to-GDP ratios greater than 90 percent in all economies tested, including advanced and developing market economies. Additionally, they find that a percentage point

rise in foreign debt exceeding 60 percent of GDP lowers yearly economic growth by over one percentage point. Following these findings, Herndon et al., (2013) criticized the methodological accuracy of Reinhart and Rogoff (2010), which led to a similar study that corrected for the errors. Some of the criticisms included the deliberate removal of available data, coding errors, and unfitting eights placed on summary data that led to wrong calculations. In an effort to correct such errors, Herndon et al., (2013) examined 20 advanced economies between 1946 and 2009 and discovered that while a debt-to-GDP ratio above 90% does occasionally slow economic growth, the relationship between public debt and economic growth depends on the study's time frame and the nation under consideration. The same sample was examined by Minea and Parent (2012) using a panel smooth transmission regression (PSTR) model, discovered a new turning point of 115 percent debt-to-GDP, above which debt is detrimental to growth.

In order to determine whether there is a nonlinear threshold or several thresholds, Topal (2014) examined the relationship between public debt and economic growth in 12 countries within the Eurozone. He used a two-stage least squares regression and a threshold technique similar to Padoan et al., (2013) to account for population growth, gross capital formation, and old-age dependency. The findings show that public debt levels below 71.66 percent of GDP often have beneficial effects on economic growth, while debt levels over this threshold have no appreciable positive effects. The study continues by saying that economic growth turns negative over a second benchmark of roughly 80.2 percent debt-to-GDP.

Additionally, by employing ordinary least squares (OLS) and threshold dynamics techniques, Wright and Grenade (2014) discovered a non-linear link between public debt and economic development in thirteen Caribbean nations. They also discovered that growth is possible with a debt-to-GDP ratio of 61 percent or less, but that public debt above 61 percent likely to have negative consequences on investment and economic growth. Their findings also demonstrated a clear discrepancy between the calibrated optimal debt-to-GDP ratios and the actual country-level debt-to-GDP ratios. After discovering the inverse relationship between debt and growth, they recommend that by allowing government borrowing under certain conditions would produce long-term growth dividends.

Mupunga et al., (2015) estimated an ideal growth-maximizing public debt threshold for Zimbabwe utilizing data from 1980 to 2012 using a bivariate quadratic growth model while adjusting for other growth-affecting factors. Their goal was to determine the relationship between public debt and growth. Their findings supported Zimbabwe's inverted U-shaped relationship between governmental debt and economic development. Additionally, they calculated the optimal public debt level for maximizing economic growth to be between 45% and 50%, indicating that exceeding this level is likely to have detrimental consequences on economic growth.

For the period of 2004 to 2012, Omotosho et al., (2016) investigate whether there were threshold effects in Nigeria's relationship between public debt and economic development. They discovered evidence of an inverted U-shape link between three categories of public debt (domestic, external, and total) and economic growth by applying the threshold analysis model from Khan and Senhadji (2001) to the quarterly data. Total public debt types were determined to have an appropriate growth threshold of 73.1 percent, while foreign and domestic debts had optimal growth thresholds of 49.4 percent and 30.9 percent, respectively.

While Koffi (2019) studied the effect of public debt on economic growth in sub-Sahara African (SSA) nations, Sanusi et al. (2019) also determine the non-linear effects of public debt on economic growth of Southern Africa Development Community (SADC) countries. Both studies support the presence of a non-linear link between public debt and economic growth. According to Sanusi et al., (2019), the debt threshold for the SADC countries is 57 percent of GDP. Koffi (2019) however, finds debt threshold of 36.18 percent after which growth begins to fall.

According to Ndoricimpa (2020), Africa's debt ceiling should be between 62 and 66 percent of GDP. Similarly, Mensah et al., (2019) find debt threshold of 20-50 percent of GDP for Africa. The differences in results of the two studies may be attributed to differences in estimation techniques. While Mensah et al., (2019) employ a panel threshold-ARDL regression model, Ndoricimpa (2020) applies a panel smooth transition model. This indicates that there is no unique threshold value for all African countries as it may differ from one country to another depending on prevailing economic conditions of each country. In view of this, country-specific studies become necessary to understand the exact debt threshold relation with economic growth, hence the focus of this study on Ghana using the Autoregressive Distributed Lagged model.

Recent studies have continued to support the existence of nonlinear and threshold effects in the public debt-growth relationship. Okwoche and Makanza (2023), using data from 24 sub-Saharan African countries from 1980 to 2018, found evidence of a nonlinear relationship between public debt and economic growth, with threshold estimates ranging from 78 to 85 percent of GDP in most cases. Similarly, Kitutila (2024), using data from 22 sub-Saharan African countries from 1990 to 2021, found strong evidence that public debt nonlinearly affects economic growth, with a threshold close to 53 percent of GDP, above which public debt negatively affects growth. Shah et al. (2025), using a dynamic panel threshold model for developing countries from 1990 to 2020, also found that public debt negatively affects economic growth above a threshold of 50.988 percent of GDP. These recent findings reinforce the view that public debt thresholds vary across countries, regions, and estimation techniques, thereby strengthening the need for country-specific studies such as the present study on Ghana.

3. Methodology and research methods.

3.1 Model Specification

This study uses an optimal threshold approach to examine the relationship between public debt and economic development. The threshold analysis employs available data using Autoregressive Distributed Lag (ARDL) in a quadratic model specification to establish the non-linear relationship between public debt and economic growth. The ARDL technique by Pesaran et al., (2001) with a squared variable for the public debt ratio to determine the threshold beyond which economic growth begins to decline is able to accommodate a mixture of integrated variables of order 0 and 1 from the stationarity test. The ARDL model offers several advantages over other models such as its ability to estimate both long-run and short-run parameters concurrently with variables integrated at I(0) and I(1); and also suitable for small data sample sizes (Sanusi et al., 2019). The general ARDL equation with the squared debt term is expressed as:

$$\Delta GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + \alpha_2 PDR_{t-1} + \alpha_3 PDR^2{}_{t-1} + \alpha_4 TRADE_{t-1} + \alpha_5 GOVE_{t-1} + \alpha_6 GOVI_{t-1} + \alpha_7 POPG_{t-1} + \alpha_8 INF_{t-1} + \sum_{i=1}^{\omega} \rho_{1i} \Delta GDP_{t-i} + \sum_{i=1}^{\omega} \rho_{2i} \Delta PDR_{t-i} + \sum_{i=1}^{\omega} \rho_{3i} \Delta TROPE_{t-i} + \sum_{i=1}^{\omega} \rho_{4i} \Delta GOVE_{t-i} + \sum_{i=1}^{\omega} \rho_{5i} \Delta GOVI_{t-i} + \sum_{i=1}^{\omega} \rho_{6i} \Delta POPG_{t-i} + \sum_{i=1}^{\omega} \rho_{7i} \Delta INF_{t-i} + \epsilon_t \quad (14)$$

where Δ stands for the first difference operator, ω is the maximum lag order determined by the Akaike Information Criterion (AIC) or Schwarz Information Criterion (SIC) Information Criterion, α_0 is the constant term,and ϵt is the normally distributed error term with a constant variance and a zero mean. The long-run parameters are α_1 to α_8 are the long-run parameters while the short-run parameters are ρ_1i to ρ_7i. GDP represents economic growth, PDR represents public-debt-ratio, TROPE represents trade openness, GOVE represents government expenditure, GOVI represents government investment, POPG represent population growth, and INF represents inflation.

3.2 Data Sources

The data for this study ranges from 1965 to 2018 on annual bases and the variables are described in table 1 below.

Table 1: Variable Description and Data Sources

Variable	Description	Sources of Data
GDP	Real GDP growth rate	World Bank
PDR	Public Debt Ratio	Historical Public Debt Database (of the IMF)
TROPE	Sum of Exports and Imports as a percentage of GDP	World Bank
GOVE	Government Expenditure as a percentage of GDP	International Fiscal Statistics (of the IMF)
GOVI	Government Investment as a percentage of GDP	International Fiscal Statistics (of the IMF)
POPG	Population Growth rate	World Bank
INF	Inflation rate	World Bank

Source: Compiled by the author from World Bank, IMF Historical Public Debt Database, and IMF International Financial Statistics.

4. Results and Discussions

4.1 Descriptive Statistics

Table 2: Summary Statistics (1965-2018)

	GDP	PDR	GOVE	GOVI	INF	POPG	TROPE
Mean	3.675486	41.23981	10.79970	16.09640	27.98513	2.546747	54.77594
Median	4.551230	33.85500	10.87726	14.30478	18.03709	2.521037	45.92086

Maximum	14.04712	111.9500	16.76471	29.00214	122.8745	3.045341	116.0484
Minimum	-12.43163	5.040000	5.861290	3.749769	-8.422486	1.856668	6.320343
Std. Dev.	4.520759	25.19618	2.514224	6.895384	27.38030	0.282826	27.35155
Observations	54	54	54	54	54	54	54

Source: Author's computation based on World Bank and IMF data.

From Table 2, the average annual percentage of economic growth in Ghana over the study period was 3.68 percent, with a standard deviation of 4.52 percentage points. The minimum and maximum growth rates recorded in Ghana during this period were -12.43 percent and 14.05 percent, respectively. During this time, Ghana's national debt as a percentage of GDP averaged 41.23 percent. A debt-to-GDP ratio deviates from the average by 25.20 percentage points. The minimum debt-to-GDP ratio for this period was 5.04 percent, while the highest debt-to-GDP ratio recorded was 111.95 percent.

4.2 Results of Stationarity Tests

Two unit root tests are conducted to confirm stationarity of the variables, and these are the Augmented Dickey Fuller (ADF) test, and the Phillips-Perron (P-P). The results are presented in Table 3 below:

Table 3: Results for Augmented-Dickey Fuller (ADF) Unit Root Test

	Augmented-Dickey Fuller (ADF)			**Phillips-Perron (P-P)**		
	Levels	1st Difference		Levels	1st Difference	
VARIABLE	T- Statistic	T-Statistic	Order of Integration	T-Statistic	T-Statistic	Order of Integration
GDP	-5.573***		I(0)	-2.772**		I(0)
PDR	-2.446	-5.674***	I(1)	-1.576	-4.809***	I(1)
PDR^2	-1.260	-6.714***	I(1)	-2.943	-5.867***	I(1)
TRADE	-1.976	-6.533***	I(1)	-2.490	-4.334**	I(1)
GOVE	-3.391	-7.529***	I(1)	-1.245**		I(0)
GOVI	-2.973	-7.136***	I(1)	-2.951	-6.905***	I(1)
POPG	-1.694	-3.602***	I(1)	-2.948	-4.542***	I(1)
INF	-2.638	-5.561***	I(1)	-2.957	-5.205**	I(1)

Note: *** (1%), **(5), *(10%)

Source: Author's estimation.

According to the ADF unit root test, the series for economic growth (GDP) is stationary at levels. This means that the variable is integrated of order zero, I(0). Conversely, public debt ratio (PDR), trade openness (TROPE), government spending (GOVE), and government investment (GOVI), population growth (POPG) and inflation (INF) are all stationary at first difference. Thus, these variables are integrated of order one, I(1). In terms of the Phillips-Perron (P-P) unit root test, economic growth (GDP) and government spending (GOVE) are stationary at levels while the rest, public debt (PDR), trade openness (TRADE), government investment (GOVI), population growth (POPG) and inflation (INF).

Overall, the unit root test indicates that the variables are a mixture of I(0) and I(1) variables, hence the ARDL model is the suitable cointegration technique as it disregards the order of Integration. Also, since none of the variables are I(2), the ARDL model can be applied to examine the long-run relationships. Accordingly, the ARDL model requires a bounds test of cointegration between the dependent variable (GDP) and the explanatory variables. Before the bounds test, we determine the optimal lag length using different information criteria.

4.3 Optimal Lag Choice

The optimal lag length is needed to determine structure of the ARDL model specification for the parameter estimation. It is important for our small sample size not to have many lags since degrees of freedom can be compromised. The result of the optimal lag length based on different information criteria is reported in Table 4. The different information criteria used include likelihood ratio (LR), final prediction error (FPE), akaike information criterion (AIC), schwarz information criterion (SIC), and hannan-quinn information criterion (HQ). From Table 4, the optimal lag length is one (1) based on most of the criteria used.

Table 4: Results for Lag Structure Criteria

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-135.0763	NA	17.95644	5.723052	6.028976*	5.839550
1	-134.9509	0.205686*	18.61791*	5.758036	6.102200	5.889095*
2	-131.6821	5.230053	17.02823	5.667284	6.049689	5.812906
3	-131.6451	0.057672	17.72969	5.705806	6.126451	5.865990
4	-131.6236	0.032705	18.47865	5.744945	6.203830	5.919691

Source: Author's estimation.

4.4 Results of the Bounds Test

The ARDL bounds test identifies long-run cointegrating relationships among the variables. The results are presented in Table 5.

Table 5: Results for the Bounds Test

F-Bounds Test		**Null Hypothesis: No levels relationship**		
Test Statistic	Value	Significance	I(0)	I(1)
F-statistic	5.146394	10%	1.92	2.89
K	7	5%	2.17	3.21
		2.5%	2.43	3.51
		1%	2.73	3.9

Note: k is the number of regressors in the model.

I(0) is the lower bound I(1) is the upper bound

Source: Author's estimation.

The null hypothesis for the bounds test is that there is absence of cointegration among the variables. Therefore, to establish the existence of long-run cointegration among the variables, the F-statistic in the bounds test results from Table 5 must be greater than the upper bound I(1) value of 3.21, at 5-percent level of significance. Hence, Table 5 indicates that the F-statistic of 5.1464, is greater than the upper bounds at all the levels of significance. This indicates the existence of long-run cointegration among the model's variables.

4.5 Long-Run Results of the ARDL Model

Having established the existence of long-run cointegration through the bounds test, the ARDL-model in equation (1) is estimated as reported in Table 6.

Table 6: Long-Run Results of the ARDL Model

Dependent Variable: GDP

Selected Model: ARDL (1, 0, 0, 0, 0, 1, 1, 0) selected based on AIC

Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.**
PDR	0.288237**	0.132291	2.178807	0.0350
PDR^2	-0.002750**	0.001070	-2.569591	0.0138
GOVE	-0.156978	0.252778	-0.621011	0.5379
GOVI	-0.315847*	0.185265	-1.704840	0.0956
TROPE	0.110042**	0.048371	2.274965	0.0281
INF	0.015696	0.036153	0.434148	0.6664
POPG	-1.727425	2.380522	-0.725650	0.4721
C	2.845105	8.337241	0.341253	0.7346

Note: **, * represents significance level of 5 % and 10% percent respectively.

Source: Author's estimation.

From Table 6 above, public debt ratio (PDR and PDR2) and trade openness (TROPE) are statistically significant at 5 percent level of significance in the long run while the other variables are not. An increase in trade openness by 1 percentage point increases GDP by 0.11 percentage points in the long run. In addition, the coefficient on the squared term of public debt ratio (PDR2) is statistically significant and negative as expected. This further confirms the non-linear effect of public debt on economic growth. Thus, in the long run, the significance of the coefficients for PDR and PDR2 imply that in Ghana, the marginal effect of public debt on economic growth is an increasing function of the debt but to a certain level after which economic growth tend to decline. This finding is consistent with earlier studies by Iyoha (1999), Drine and Nabi (2010), Cordella et al. (2010), Mupunga et al. (2015), Reinhart and Rogoff (2010), Omotosho et al. (2016), and Sanusi et al. (2019), all of which indicate that a public debt stock that is too high is detrimental to economic growth, particularly in developing nations.

Due to the non-linear relationship between debt and growth, it is possible to calculate the equation algebraically or plot the results to examine the inverted U-shaped graph of public debt versus economic growth to determine the debt threshold. This threshold is derived algebraically as follows:

$$\frac{\partial GDP}{\partial PDR} = 0.288237 - (2 \times 0.002750)\,\mathrm{PDR} = 0$$

$$\mathrm{PDR}^* = \frac{0.288237}{0.0055} = 52.40672 \approx 52.4\%$$

The result suggests that the debt threshold in Ghana is approximately 52 percent.

4.6 Short-Run Results of the ARDL Model

From the long-run cointegration test between the variables, the error correction model is estimated to obtain short-run estimates. The short-run results are provided in Table 7 below:

Table 7: Short-Run Results of the ARDL Model

Dependent Variable: D(GDP)
Selected Model: ARDL (1, 0, 0, 0, 0, 1, 1, 0) selected based on AIC

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	2.631541	7.727547	0.340540	0.7351
D(PDR)	0.266600**	0.122024	2.184814	0.0345
D(PDR^2)	-0.002544**	0.000987	-2.577066	0.0136
D(GOVE)	-0.145194	0.235092	-0.617607	0.5402
D(TROPE)	0.101782**	0.044670	2.278541	0.0278
D(POPG)	-1.597758	2.194168	-0.728184	0.4705
D(GOVI)	0.046100	0.201878	0.228357	0.8205
D(INF)	-0.015074	0.025550	-0.589969	0.5584
ECT(-1)	- 0.724936***	0.146065	-4.963105	0.0000

R-squared	0.530447	F-statistic	18.45151
Adjusted R-squared	0.501699	Prob(F-statistic)	0.000000
Durbin-Watson stat	1.983064		

Note: ***, ** represents significance level of 1 % and 5 % respectively.
Source: Author's estimation.

The short-run results in Table 7 above show that public debt and trade openness are statistically significant at a 5 percent level of significance in the short run. The coefficients for public debt (PDR and PDR2), which are statistically significant at the 5 percent level of significance, reinforce the non-linear effect on economic growth seen in the long run. This means in the short run, the marginal effect of public debt tends to have a positive impact on economic growth until a certain threshold, where the impact becomes negative.

Irrespective of whether it's in the short run or long run, public debt raises economic growth in the country up to a certain point and then declines thereafter. This threshold level in the short run can also be computed manually as:

$$\frac{\partial GDP}{\partial PDR} = 0.266600 - (2 \times 0.002544)\ \text{PDR} = 0$$

$$\text{PDR}^* = \frac{0.266600}{0.005088} = 52.397798 \approx 52.4\%$$

This result indicates a threshold level of approximately 52 percent after which economic growth begins to falls in Ghana.

Coincidentally, the short-run public debt threshold is not different from the long-run optimal threshold. This means even though the marginal coefficients on PDR and PDR 2 may differ in the short and long runs, a debt trajectory is created such that a threshold of 52.4 percent debt-to-GDP or a lower debt-to-GDP ratio is plausible for faster economic growth. In terms of trade openness, an increase in trade openness by 1 percentage point increases economic growth by 0.10 percentage points in the short run. Although this effect is less than the long-run impact, the statistical significance in both the short and long runs implies Ghana's growth is partially rooted in international trade (exports and imports).

Another vital result is the error correction term (ECT). Theoretically, this term must be statistically significant, less than unity in absolute value, and bear a negative sign. From Table 7. the ECT is statistically significant at 1percent level, less than one in absolute value, and has a negative sign as expected. The ECT value of 72.4 percent of disequilibrium in economic growth for the past years is corrected within a year.

4.7 Diagnostic Tests

Table 8: Test for Serial Correlation

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	2.308674	Prob. F(2,40)	0.1125
Obs*R-squared	5.484849	Prob. Chi-Square(2)	0.0644

Source: Author's estimation.

The null hypothesis for the Breusch-Godfrey Serial Correlation LM Test is the absence of or no serial correlation in our model. The decision rule of this test lies in the p-value (Prob. F(2,40) and the level of significance. Given a p-value of 0.1125 for the F-statistic, which is greater than 1 percent and 5 percent level of significance, we fail to reject the null hypothesis. Thus, the ARDL model is devoid of serial correlation.

Table 9: Test for Functionality

	Value	df	Probability
t-statistic	1.259599	41	0.2149
F-statistic	1.586590	(1, 41)	0.2149

Source: Author's estimation.

The null hypothesis for the RAMSEY test is the robustness of our specified ARDL model. Given a p-value of 0.2149 for the F-statistic, which is greater than 1 percent and 5 percent level of significance, we fail to reject the null hypothesis. Thus, the ARDL model is devoid of misspecification.

Table 10: Test for Heteroskedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	1.462680	Prob. F(10,42)	0.1876
Obs*R-squared	13.68999	Prob. Chi-Square(10)	0.1876
Scaled explained SS	22.57472	Prob. Chi-Square(10)	0.0124

Source: Author's estimation.

The null hypothesis for the Breusch-Pagan-Godfrey test is the absence of heteroskedastic error term in our specified ARDL model. Given a p-value of 0.1876 for the F-statistic, which is greater than 1 percent and

5 percent level of significance, we fail to reject the null hypothesis. Thus, the ARDL model has homoskedastic error term.

5. Conclusions and Policy Recommendations.

5.1 Conclusion

In light of recent literature talking of a potential non-linear relationship, the primary goal of this study was to determine the precise link between public debt and economic growth in Ghana. Ho and Njindan (2020) discovered a negative impact of debt on economic growth in Ghana, contrary to the findings of Adi (2019), which show a beneficial influence of public debt on growth both in the short and long terms. There is no doubt that Ghana's economic growth is significantly impacted by governmental debt. The non-linear term (quadratic) form is the most effective way to represent the dual-sign impacts of public debt on growth that are included in this study. The results in this study confirm the existence of a non-linear relationship between public debt and economic growth in Ghana. This means every percentage point increase in the debt-to-GDP ratio in Ghana leads to an effect that could be positive or negative, contingent on whether the optimal threshold level of 52.4 percent has been reached. A positive impact implies that whatever public debt was incurred was engaged in real-sector developmental projects. However, a negative effect due to a departure beyond the threshold could be attributed to less credit given to the private sector, low private investment, capital flight, and the inception of the debt overhang hypothesis. The statistical significance of trade openness means intensifying Ghana's international trade with foreigners would propel economic growth.

5.2 Policy Recommendations

The study finds Ghana's public debt ratio to be 52.4 percent which bodes well for long-term growth. Therefore, government needs to bring down the current ratio which is about 100 percent if it is minded to achieve continues and sustained economic growth. Specifically, the following policy recommendations are made to be considered in order to keep a healthy economy for an accelerated growth:

If possible, this optimal ratio of 52.4 percent should be legislated and be made a law to guide the Finance ministry in their borrowing programmes. Hence this threshold should be binding on government in order to achieve economic growth and the Parliament should have an oversight responsibility to ensure the strict adherence to this policy by the government. If this is implemented, it would prevent government from defaulting in its loan repayments.

In addition, this study suggests that the borrowed amounts should be invested in productive ventures in order to yield positive economic growth. Borrowing comes at a cost; therefore, whatever the borrowed amount is invested in should yield high returns, both in nominal terms and in real terms to enable a smooth pay back. It is also recommended by this study that government should avoid using short-term loans to finance long-term projects as it tends to increase the debt-to-GDP ratio in the short run.

Improved revenue mobilization measures are required to generate adequate domestic revenue in order to minimize government borrowing to finance development projects. Ghana's tax-to-GDP ratio has been quite low compared to her expenditure; hence budget deficits are inevitable thereby leading the proclivity to borrow excessively. The Ghana Revenue Authority (GRA) should therefore widen its tax base to capture all potential taxpayers for an enhanced domestic revenue mobilization.

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