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Does Public Debt Help to Drive Uganda's Economic Growth? Insights from Application of NARDL Analysis

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Abstract

This study investigates the relationship between public debt and economic growth in Uganda for the period 1990 to 2023 using a nonlinear autoregressive distributed lag (NARDL) model. The analysis finds that public debt, measured as both total debt and debt-to-GDP ratio, has a significant and detrimental nonlinear effect on Uganda's economic growth in both the short and long run. The study concludes that Uganda should prioritize domestic revenue mobilization over further debt acquisition to foster sustainable economic growth.

Keywords

Public Debt, Economic Growth, NARDL, Uganda

1. Introduction

What drives the rates and patterns of nations' economic growth remains ongoing concern in empirical growth literature. Besides several growth theories, empirical literature presents a variety of factors responsible for country-specific growth patterns as well as factors responsible for growth differentials across nations. To contribute to the extant empirical work, this study focuses on the public debt-investment and economic growth nexus using empirical data on Uganda. Indeed, succeeding the 2007-2008 global financial crisis and subsequent 2009-2010 Eurozone debt crisis through the COVID-19 crisis, there has been a renewed interest in exploring the link between public debt and economic growth [1]. Diverse findings are reported in the literature as to the causality between public debt and investment levels and between public debt and economic growth. One strand of authors

in the empirical growth literature posit that public debt is good for economic growth (e.g. [2] [3], among others), the second strand of authors report that public debt constrains economic growth ([4]-[12], among others), the third strand of authors report that there is no causality between public debt and economic growth (e.g. [13] [14]) of which finding is supported by the Ricardian Equivalence Hypothesis, while also there is a strand of authors that have reported mixed effects (e.g. [15]-[21], among others). Amidst this disquieting debate, [22] confirms that the relationship between public debt and economic growth is indeed complex and depends on country-specific factors that are bound to change over time. [23] attribute the diverse effects of public debt on economic growth of nations to differences in development of the sampled nations, the methodologies utilized by authors, data coverage and the researchers' choice of control variables. Nevertheless, a notable pattern that emerges from empirical research is that high levels of public debt have a negative impact on economic growth [1].

Like many other developing countries, Uganda has a long history of facing budget deficits, compelling it to borrow from both multilateral and bilateral countries. At the same time, Uganda has had a volatile "growth-history". Global shocks like the global financial crisis, COVID-19 and the Russia-Ukraine war have had not only an effect on the nations' growth capabilities but also on their borrowing appetite. Notably, Uganda's economic growth rate was robust before the onset of COVID-19 in early 2020, with attainment of an average growth rate 6.2 percent in the FY2017/18 and 6.8 percent in the FY2018/2019 [24]. Around the same time, Uganda's debt to GDP ratio was estimated at 34.6 percent in 2017/2018 [25]. Uganda's economic growth rate dampened to 2.9 percent in the FY2019/2020 with a moderate recovery to 3.4 percent in the FY2020/21 and 4.7 percent in the FY2021/2022 [25] and 5.2 percent in FY2022/2023 [26]. Such post-COVID-19 period's unsound growth episodes have been observed alongside a rapidly increasing debt accumulation. For instance, in the year 2006, Uganda's total debt stood at $1.9 billion or 13.7 percent of GDP but as of June 2023, Uganda's public debt has risen to unprecedented levels, reaching shillings $25.3 billion or 52 percent of GDP [27]. The question that draws the current study to delve into an empirical investigation pertains to whether Uganda's economic growth has a relationship with levels of her public debt.

Extant literature on the related subject provides limited empirical work on Uganda. The studies done on Uganda, for instance a study by [9] employed the 3SLS to analyze the impact of public debt on investment and economic growth in Uganda by utilizing annual data for the period of 1980-2016; a study by [28] employed VECM to establish the direction of causality as well as short run and long run impact of public debt on economic growth in Uganda while utilizing quarterly time series for the period 1990Q1 to 2015Q4; and the study by [20] employed the ARDL approach to analyze the effect of public debt on Uganda's economic growth using annual data for the period 1980-2016. The main contribution of the current study to the existing body of knowledge lies in methodological approaches: First,

whereas the authors in the existing studies on Uganda used changes in GDP a measure of economic growth, the current study uses changes in real GDP per capita an as indicator of economic growth and second, whereas the existing studies done on Uganda assumed a linear relationship between the study variables and thus employed linear regression methods which assume symmetric effects. While using real GDP per capita as an indicator of economic growth and utilizing time series quarterly data for the period 1990-2023, the current study develops a nonlinear autoregressive distributed lag (NARDL) model to re-assess short and long-run causal nonlinearities in the relationship between public debt and economic growth for Uganda.

2. A Literature Survey

2.1. Theoretical Growth Literature

The Nonlinear Effect Theory

The nonlinear effect theory of debt on growth, initially proposed by [29] has been used as the main theory that underpins the current study. This theory resonates well with the nonlinear autoregressive distributed lag (NARDL) model which has been employed as the principal analytical model in this study. The nonlinear effect theory of debt on growth was proposed by [29]. According to [29], the nonlinear effect of debt on growth is suggestive of "debt intolerance" and it is associated with a nonlinear response of market interest rates as nations reach debt tolerance limits. Accordingly, rapidly rising interest rates, which also accrue from sharply accumulating debt stock, impose painful fiscal adjustment to the nation in the form of tax hikes and spending cuts, or, in some cases, outright default. Accordingly, the nonlinear effect theory implies that low levels of debt stock may have positive returns on economic growth. However, as debt reaches unsustainable levels, further debt accumulation may have counterproductive effects on long-run growth a nation's GDP. This theory becomes the most prudent theoretical underpinning for this study given that it is consistent with the main estimation tool that was implemented to estimate the empirical model.

The endogenous growth theory

The endogenous growth theory has been benchmarked as a theoretical model that underpins this study mainly from the side of the control variables introduced in the relationship being studied. The endogenous growth theory maintains that economic growth is due to factors that are internal to the nation rather than external factors. The endogenous growth theory is founded on the premise that advances in innovation, knowledge and human capital lead to increased productivity, thus positively affecting the nation's economic performance. The new wave of research based on endogenous growth was stimulated by [30] and [31]. [30] proposed that technical progress is instead endogenous but not exogenous. [30] emphasized the role of human capital as a factor of economic growth. In his argument, [30] emphasized the importance of schooling and training because by schooling one attains education, and by training one attains learning-by-doing or

skills. In a nutshell, [30] emphasized human capital accumulation through schooling and specialized human capital accumulation through learning-by-doing to be important factors influencing the nation's long-run growth rates. [30] contributions to the endogenous growth approach was extended by [31]. [31] re-emphasized that long-run growth driven by technological change which emanates from investment decisions made by profit maximizing agents. In the description of the growth model, [31] emphasized the role of four main factors that drive the nation's long-run growth: Capital, labour, human capital and an index of technology. The key takes away from the endogenous growth is the emphasis on the role of productivity factors in enhancing the nation's long-term economic growth. The weakness of this theory in regard to this study is that it is only limited to the explanation of the emergency of the control variables which have been introduced in the public debt-growth function.

The debt Overhang Theory

Debt overhang theory was first introduced by [32] and its implications on firm output performance were pragmatically laid by [33]. [32] points out that if a firm is close to bankruptcy, its creditors bear most of the return to any additional investment, the firm will not only reduce overall investment but also reduce investments in high net present value (NPV) projects, which results in investment efficiency. [33] contends that the bankruptcy of firms and households makes them make inefficient consumption/saving decisions and banks refuse to finance new investments. As firms accumulate additional debt, it becomes so large that it becomes a burden to take on additional debt to finance future projects, resulting into a debt overhang. The Debt overhang cuts on the spending power of firms and households, thus restricting the production progress resulting cuts in employment, marketing and consequently production. According to the Debt Overhang theory, therefore, debt accumulation breeds cuts in firm's investments and thus a slump in production levels.

Although this theory forms a strong groundwork to underpin the relationship being investigated in this study by way of providing the theoretical linkage between public debt and economic growth, its weakness lies not only in the inability to explain whether or not there can possibility of non-linear relationship between firm's output growth and firm's quest debt but also it is built on foundation of microeconomic units.

2.2. A Review of Related Empirical Literature

While employing the autoregressive distributed lag (ARDL) method of model estimation, [20] examined the impact of public debt, Gross debt and total debt service on Uganda's short-run and long run economic growth. The study utilized time series annual data for the period 1980-2016 for analysis. Results from the study revealed that public debt had mixed effects on Uganda's economic growth. Particularly, results revealed that public debt had a negative effect on Uganda's economic growth in the short run but the public debt exerted a positive effect on Uganda's economic growth in the long run. Mixed effects were also observed for

the debt proxies analyzed: for results showed that total debt service had a negative impact on Uganda's economic growth both in the short run and in the long run whereas Gross debt had a positive impact on Uganda's economic growth both in the short run and in the long run.

A study launched by [28] investigated the impact of public debt on economic growth in Uganda by analyzing the short-run and long-run relationships between the underlying study variables. The study utilized time series quarterly data for the period 1990Q1 to 2015Q4. The study used Vector error correction model (VECM) to estimate short-run and long-run coefficients and to analyze the Wald granger causality tests. Results from the study revealed that public debt had a significant negative effect on Uganda's economic growth in the short run and in the long run.

Using panel data for the period 1963-2019, [34] examined the influence of public debt on economic growth in three East African countries of Kenya, Uganda and Tanzania. In their analysis, the authors investigated the influence of three components of public debt as independent variables, namely external concessional public debt, external commercial public debt and domestic public debt. The empirical panel model was estimated by fixed effects estimator. Of the three components of public debt investigated, the study findings revealed that concessional debt and external commercial debt turned out to exert a significant positive effect on economic growth in the three East African countries, whereas domestic debt had a significant negative effect. Focusing on the influence of external debt, the results from the study by [34] corresponded with the results from the study by [35] who had investigated the effect of external debt financing on the economic growth of East African community countries using panel data for the period 2000-2017 and found that external debt positively influenced economic growth of the East African member states. On contrary however, findings from a more less similar study conducted earlier by [36] who investigated the effect of external public debt on economic growth in the four East African countries of Kenya, Tanzania, Uganda and Rwanda using panel data for the period 1981-2014 revealed that external debt had a negative effect on economic growth in the East African Countries.

A study by [37] examined the dynamic relationship between public debt and economic growth in Tanzania and analyzed debt threshold, while using quarterly time series data for the period from March 2005 to June 2022. Economic growth was captured by quarterly changes in GDP. The study estimated the Vector Error Correction Model to unveil the causal effects and employed the Granger causality test to discover direction of causality relationships. The findings from the study revealed a significant positive long-term effect of public debt on Tanzania's economic growth when the domestic debt-to-GDP ratio fell between 31.3 percent and 35.2 percent, beyond which findings indicated no causal connection between debt and economic growth. In addition, findings from the study disclosed that direction of causality ran from economic growth to domestic debt.

A related study was conducted by [38] Bernardin *et al.* (2017) who examined

the effect of external debt on economic growth in Sub-Saharan Africa. The study utilized panel data on 39 Sub-Saharan African countries for the study period 1990 to 2013. The authors employed the System Generalised Methods of Moments (S-GMM) estimation technique to estimate coefficients of the panel model. Findings from the study indicated that external debt negatively affected economic growth in Sub-Saharan African countries.

[39] investigated the impact of an unanticipated change in public debt on real GDP within a panel of 178 countries for the period 1995-2020. The countries studied were classified in various subsets based on certain country characteristics such as the initial level of debt, the debt trajectory over preceding years, the income level and participation in the highly indebted poor countries (HIPC) debt relief initiative. Analysis was done using the forecast errors from various vintages of the IMF World Economic Outlook publications. Results from the study revealed mixed findings on the various country subsets: on one hand, results indicated that an unanticipated increase in the public debt to GDP ratio was hurting to real GDP level for countries that had a high initial debt level and the countries with a rising debt trajectory over the five preceding years. On the other hand, results showed that an unanticipated increase in public debt boosted real GDP for countries that had a low-income level and the countries that completed the HIPC debt relief initiative.

By utilizing time series annual data spanning from 1978-2018, [40] examined the causal relationships between public debt and economic growth in Ghana. The author implemented the autoregressive distributed lag (ARDL) bounds approach to assess cointegration among the regression variables and employed the error correction model (ECM) to estimate the long-run Granger causality relationships. Results indicated absence of short-run causal relationship between public debt and Ghana's GDP. However, results indicated presence of long-run unidirectional Granger causality running from public debt to GDP. Precisely, findings showed that public debt had no effect on Ghana's GDP in the short-run but there was a positive effect of public debt on Ghana's GDP in the long run.

[41] investigated the effect of public debt on the economic growth of Nigeria for the study period spanning from 2004 to 2021. The authors employed the ordinary least squares (OLS) method to estimate empirical model for which GDP was a function public debt, interest rate, exchange rate and inflation. The authors took a log transformation of all the model variables. The estimates of the model in the study by [41] showed that all the independent variables except logarithm of exchange rate were statistically significant, with the coefficient of the public debt variable indicating a negative sign. The authors concluded that public debt had a negative effect on economic growth. While the sign on the coefficient of public debt could have been plausible, the conclusion that public debt had a negative effect on Nigeria's economic growth was far-fetched, given that the coefficient on public debt was statistically insignificant at 5 percent level.

A study by [42] investigated a nonlinear relationship between public debt and

economic growth using annual data from 20 developing countries for the period 1980-2005. Public debt to GDP ratio was investigated as the key independent variable while average GDP was used as the dependent variable. By employing a nonlinear autoregressive distributed lag model, findings from the study showed that the relationship between the debt-to-GDP ratio and average GDP growth was positive when the debt-to-GDP ratio fell below 70 percent, but beyond the 70 percent threshold, a continuous rise in the debt-to-GDP ratio had a negative impact on average GDP growth. The conclusions from the study by [42] can be compared well with the findings from a study by [43] that investigated nonlinear relationship between public debt and economic growth in seventy-one developing countries from 1984 to 2015 and revealed that public debt had a negative impact on economic growth at debt levels higher than 51.65 percent but with an insignificant effect at lower levels than the 51.65 percent threshold. Similarly, a study by [44] confirmed an inverted U-shape relationship between public debt and economic growth in Rwanda using time series data covering the period 1970-2018 in which public debt positively affected Rwanda's economic growth but beyond public debt-to-GDP ratio threshold of 50.2 percent, further increments in the public debt-to-GDP ratio was deleterious to Rwanda's economic growth.

In agreement with the theoretical stance, the survey of the empirical works on the relationship between public debt and economic growth shows mixed findings. In effect, the path of the connection between public debt and economic growth can be summarized into three descriptions: negative effect, positive effect and no effect. The surveyed literature discloses limited empirical evidence to the relationship under investigation in the context of Uganda. Consequently, this study makes a contribution by utilizing time series quarterly data on Uganda for the period 1990Q1-2023Q4 to re-examine the relationship between public debt and Uganda's economic growth.

3. Methods and Materials

The study adopted a blend of descriptive and exploratory research designs while following a quantitative approach. The study utilized time series quarterly secondary data spanning from 1990q1-2023q4, giving a time series sample data points of 136 observations (n = 136). Data on Public debt (which includes total debt and debt-to-GDP ratio) was obtained from Uganda's Ministry of Finance, Planning and Economic Development (MoFPED); Data on real GDP per capita, exchange rates and exports was obtained from Bank of Uganda while the data on the rest of the variables, that is, human capital and domestic credit was obtained from World Bank development indicators (WDI). The study conducted the conventional diagnostic tests for time series multiple linear regressions, namely: the multicollinearity test using the variance inflation factors (VIFs) [45], unit root test using the Augmented Dickey-Fuller (ADF) [46] test, cointegration test using the [47] and the [48] tests as well as appropriate robustness tests following model estimation such as serial correlation test using the Breusch-Godfrey test ([49] [50]), Hetero-

scedasticity test using the Breusch-Pagan test [51], Specification test using the RAMSEY RESET test for omitted variables [52], parameter stability test using the cumulative sum (CUSUM) test [53] and the symmetric effects assumption test using the cointegration F-test [54]. Estimation of the empirical model was achieved by implementing a nonlinear autoregressive distributed lag (NARDL) model, first proposed by [55]. Unlike the symmetric ARDL initially developed by [48] and formalized by [54], the NARDL permits for asymmetry with respect to positive and negative changes in the explanatory variable(s). Thus, the NARDL model overcomes the key weakness of the symmetric ARDL which is based on a simplistic assumption of equal and opposite effects on the dependent variables for a unit change in the independent variable (s) in either directions.

The study specifies two NARDL equations which are distinguished by the two proxy variables that have been used to measure public debt, namely total debt (*tdebt*) and debt-to-GDP ratio (*debt_gdp*), and which form the dependent variables under analysis. To begin with, two separate symmetric ARDL cointegrating models in non-error correction form are specified as follows:

$$\begin{aligned}\text{LogRGDPC}_t = {} & \delta_{01} + \sum_{i=1}^{p}\beta_{i1}\text{LogRGDPC}_{t-i} + \sum_{j=0}^{q1}\theta_{j1}\text{Logtdebt}_{t-j} + \sum_{k=0}^{q2}\vartheta_{k1}\text{Loghcap}_{t-k} \\ & + \sum_{m=0}^{q3}\pi_{m1}\text{Logdomcr}_{t-m} + \sum_{n=0}^{q4}\rho_{n1}\text{Logexp}_{t-n} + \sum_{h=0}^{q5}\sigma_{h1}\text{Logexrate}_{t-h} + \epsilon_t\end{aligned} \tag{1}$$

$$\begin{aligned}\text{LogRGDPC}_t = {} & \delta_{02} + \sum_{i=1}^{p}\beta_{i2}\text{LogRGDPC}_{t-i} + \sum_{j=0}^{q1}\theta_{j2}\text{debt\_GDP}_{t-j} + \sum_{k=0}^{q2}\vartheta_{k2}\text{Loghcap}_{t-k} \\ & + \sum_{m=0}^{q3}\pi_{m2}\text{Logdomcr}_{t-m} + \sum_{n=0}^{q4}\rho_{n2}\text{Logexp}_{t-n} + \sum_{h=0}^{q5}\sigma_{h2}\text{Logexrate}_{t-h} + \varepsilon_t\end{aligned} \tag{2}$$

In Equations (1) and (2), LogRGDPC_t is the logarithm of the current period real GDP per capita and LogRGDPC_{t-i} are lags of the logarithm of real GDP per capita variable; Logtdebt_t is the current period logarithm of total debt and Logtdebt_{t-j} are the lags of the logarithm of total debt variable; Loghcap_t is the current period logarithm of human capital and Loghcap_{t-k} are the lags of the logarithm of human capital variable; Logdomcr_t is the current period logarithm of domestic credit and Logdomcr_{t-m} are the lags of the logarithm of domestic credit variable; Logexp_t is the current period logarithm of exports and Logexp_{t-n} are the lags of the logarithm of the exports variable; Logexrate_t is the current period logarithm of exchange rate and Logexrate_{t-h} are lags of the logarithm of the exchange rate variable while ϵ and ε represent the residual elements in the respective equations.

Borrowing from the approach adopted by [56], this study transformed the symmetric ARDL models in Equations (1) and (2) into asymmetric NARDL models by splitting the effect of the key independent variable under investigation, that is, public debt, into its positive and negative partitions. By doing so, a cointegrating NARDL model in which short-run and long-run nonlinearities in economic growth are introduced via positive and negative partial sum decompositions in public debt. This gives the empirical NARDL model for estimation in non-error

correction form as follows:

$$\begin{aligned}\text{LogRGDPC}_t = {} & \delta_{01} + \sum_{i=1}^{p}\beta_{i1}\text{LogRGDPC}_{t-i} + \sum_{j=0}^{q1}\Omega_{j1}^{+}\text{Logtdebt}_{t-j}^{+} + \sum_{j=0}^{q1}\Omega_{j1}^{-}\text{Logtdebt}_{t-j}^{-} \\ & + \sum_{k=0}^{q2}\vartheta_{k1}\text{Loghcap}_{t-k} + \sum_{h=0}^{q3}\pi_{m1}\text{Logdomcr}_{t-m} + \sum_{n=0}^{q4}\rho_{n1}\text{Logexp}_{t-n} \\ & + \sum_{h=1}^{q5}\sigma_{h1}\text{Logexrate}_{t-h} + \epsilon_t \end{aligned} \tag{3}$$

$$\begin{aligned}\text{LogRGDPC}_t = {} & \delta_{02} + \sum_{i=1}^{p}\beta_{i2}\text{LogRGDPC}_{t-i} + \sum_{j=0}^{q1}\Omega_{j2}^{+}\text{debt\_GDP}_{t-j}^{+} + \sum_{j=0}^{q1}\Omega_{j2}^{-}\text{debt\_GDP}_{t-j}^{-} \\ & + \sum_{k=0}^{q2}\vartheta_{k2}\text{Loghcap}_{t-k} + \sum_{m=0}^{q3}\pi_{m2}\text{Logdomcr}_{t-m} + \sum_{n=0}^{q4}\rho_{n2}\text{Logexp}_{t-n} \\ & + \sum_{h=0}^{q5}\sigma_{h2}\text{Logexrate}_{t-h} + \varepsilon_t \end{aligned} \tag{4}$$

In Equation (3) and (4), the "+" and "−" signs on the public debt proxy variables indicate the partial sum of positive and negative decomposition of the public debt proxies such that Φ_1^+ and Φ_2^- represent the long-run impact of an increase and decrease in public debt on Uganda's economic growth while Ω_j^+ and Ω_j^- represent the short-run impact of an increase and decrease in public debt on Uganda's economic growth.

Operationalization of the Model Variables

The variable names, the variable notations, the definition of the study variables, the original units of measurement of the variables and expected signs are indicated in Table 1 as follows:

Table 1. Operationalization of the model variables.

Variable Name	Variable notation	Variable definition	Unit measure	Expected sign
Real GDP per capita	*RGDPC*	Real Gross Domestic Product divided by midyear population	Current US dollars	n/a
Total Debt	*tdebt*	Sum of domestic and External debt	Ug. Shs (Trillion)	±
Debt to DGP ratio	*debt_GDP*	Total debt as a percentage of total GDP	percentage	±
Human Capital	*hcap*	Total expenditure on Education	Current US dollars	+
Domestic Credit	*domcr*	Domestic credit to private sector	Current US dollars	+
Exports	*exp*	Exports of goods and services, the value of all goods and other market services provided to the rest of the world.	Current US dollars	+
Exchange rate	*exrate*	Relative price of one dollar in terms of Ugandan shillings.	Ug. Shs. per 1 US dollar	±

Source: Author's compilation.

4. Results

4.1. Descriptive Analysis on the Main Study Variables

The descriptive statistics of interest are the mean values, minimum values, maximum values and the coefficient of variation. The descriptive statistics are generated on model variables in their original units of measurements in order to give a real description in the interpretations. Table 2 gives the summary of the descriptive statistics of interest.

Table 2. Descriptive statistics on all model variables (variables are in their original units of measurement), study period 1990q1-2023q4.

Variable Name	N	Mean	Min	Max	CV
Real GDP per capita (current US $)	136	11.5	7.6	42.5	0.45
Total Debt (Ug. Shs, trillion)	132	18.8	1.1	89.4	1.24
Debt to GDP ratio (%)	132	0.47	0.09	1.27	0.58
Exports (current US $, billion)	136	2.7	0.21	7.5	0.82
Human capital (current US $, billion)	136	0.44	0.05	1.3	0.76
Exchange rate (Ug. Shs per one US $)	136	2202	449	3857	0.46
Domestic credit (current US $, billion)	136	2.09	0.11	6.32	0.95

Source: Author's compilation.

We focus on the interpretation of the descriptive statistics on the main study variables, namely, real GDP per capita, total debt and debt to GDP ratio. Among the reported descriptive statistics in Table 2, the study begins by interpreting the estimates of the coefficient of variation (CV). The coefficient of variation represents the percentage ratio of a variable's standard deviation to its mean. The estimates of the CV can help to identify which variables show the highest variability compared to other variables, even when the relative means of the variables are substantially different. Variables with high variability can present estimation challenges because they are associated with deviation from normal distribution. In most applied research, a CV in excess of 30 percent is considered very high and it may be a pointer (though subject to test) to departure from normal distribution a CV of less than 10 percent represents small variability in the data on a given variable (Aromhime *et al.* 2014). With reference to the descriptive statistics summarized in Table 2, it is observed that all model variables have CV estimates exceeding 30 percent, suggesting high variability in these variables. One of the strategies to reduce on the level of variable variability is taking log transformations, which was done on the variables in the final models specified for empirical estimation.

Next, the study makes efforts to interpret and discuss the rest of the descriptive statistics. According to the descriptive statistics summarized in Table 2, real GDP per capita for Uganda averaged $11.5 over the study period, with a minimum real GDP per capita of $7.6 which was recorded in the period 2016q4 and a maximum

real GDP per capita of $42.5 which was recorded in the period 1990q1 upon further cross-examination of raw data. The descriptive statistics in Table 2 also indicate that over the study period, Uganda's total debt averaged 18.8 trillion Uganda shillings, with a minimum total debt of 1.1 trillion Uganda shillings which was recorded in the period 1990q4 and a maximum total debt of 89.4 trillion Uganda shillings which was recorded in the period 2023q4 upon further cross-examination of raw data. Furthermore, the descriptive statistic summarized in Table 2 show that Uganda's debt to GDP ratio averaged 0.47 or 47 percent over the study period, with a minimum debt to GDP ratio of 0.09 or 9 percent which was recorded in the period 2007q4 and a maximum debt to GDP ratio of 1.27 or 127 percent which was recorded in the period 1992q1 upon further cross-examination of raw data.

4.2. Multicollinearity Checks among the Explanatory

The study checked for possible high linear relationships among the explanatory variables in the empirical by assessing the magnitude of the variance inflation factors (VIFs) of the explanatory variables in the final model. Table 3 gives a summary of the variance inflation factors for each independent variable in the empirical model.

Table 3. Variance inflation factors for the explanatory variables included in the final models.

		RGDPC-Total Debt Regression (Model 1)	*RGDPC-Debt to GDP Ratio Regression* (Model 2)
Explanatory variable	**Notation**	**VIF**	**VIF**
Logarithm of total debt	logtdebt	3.33	-
Debt to GDP ratio	debt_GDP	-	4.19
Logarithm of total Exports	Logexp	3.84	2.45
Logarithm of Human capital	Loghcap	1.69	1.84
Logarithm of exchange rate	Logexrate	2.22	1.99
Logarithm of domestic credit	Logdomcr	1.35	1.32
Mean VIF		**2.49**	**2.36**

Source: Author's compilation.

In consideration of the VIF estimates summarized in Table 3, it is observed that the VIF estimates of the individual explanatory variables in both model 1 and model 2 are all less than the VIF threshold of 10. Likewise, the mean VIF for all the explanatory variables jointly are less than 10 in both models (Mean VIF = 2.49 for model 1; mean VIF = 2.36 for model 2). Such results of the VIFs estimates fall within acceptable range suggesting that there is no threat of high multicollinearity in the empirical model.

4.3. Unit Root Test Results on All Model Variables and the Order of Integration of the Variables

The study employed the Augmented Dickey-Fuller (ADF) unit root testing procedure to test for presence of unit roots in all the variables in the empirical models, under the null hypothesis that the variable under investigation has a unit root, meaning that it is non-stationary. Lag selection order in the ADF tests has been established as chosen by the Schwarz's Bayesian information Criteria (SBIC). The summary of unit root tests results, lag selection order and the order of integration (OOI) of the variables is indicated in Table 4.

Table 4. Unit root test results on all model variables.

Variable	Levels			First Differences			
	Lags	ADF Z (t) Stat.	Prob. for Z (t)	Lags	ADF Z (t) Stat.	Prob. for Z (t)	OOI
Logarithm of real GDP per capita	2	−1.77	0.3764	1	−3.57***	0.0064	I (1)
Logarithm of total debt	2	−0.14	0.9451	1	−5.50***	0.0000	I (1)
Debt to GDP ratio	2	−4.69***	0.0001	--	--	--	I (0)
Logarithm of total exports	2	−1.11	0.7127	4	−3.96***	0.0017	I (1)
Logarithm of human capital	2	−0.90	0.7879	4	−4.24***	0.0006	I (1)
Logarithm of exchange rate	2	−4.15***	0.0054	--	--	--	I (0)
Logarithm of Domestic credit	2	−1.23	0.6616	4	−4.05***	0.0012	I (1)

Source: Author's compilation. ***p < 0.01; **p < 0.05; OOI = Order of Integration.

The estimated ADF Z (t) statistics, as indicated in Table 4, do not reject the null hypothesis that the variables of logarithm real GDP per capita, logarithm of total debt, logarithm of total exports, logarithm of human capital and logarithm of domestic credit have a unit root in levels but the ADF Z (t) statistics reject the null hypothesis that these variables have a unit root in their first difference respectively. Thus, ADF unit rot test results show that logarithm real GDP per capita, logarithm of total debt, logarithm of total exports, logarithm of human capital and logarithm of domestic credit variables are non-stationary in levels but become stationary in their first differences and thus they are integrated of order one, I (1).

On the other hand, the estimated ADF Z (t) statistics, as indicated in Table 4, reject the null hypothesis that debt to GDP ratio and logarithm of exchange rate have a unit root in levels, which suggests that debt to GDP ratio and logarithm of exchange rate are stationary in levels and thus they are integrated of order zero, I (0). In conclusion, the ADF unit root test results reveal that the model variables exhibit mixed orders of integration, some variables being I (0) and other variables being I (1).

4.4. Cointegration Test Results

For multivariable regression models with mixed orders of integration, the [47]

cointegration test can still be used but may not be robust if there are less than two cointegrating vectors in the model [57]. Other scholars have suggested that cointegration among variables that are a mix of I (1) and I (0) orders of integration can only exist among I (1) variables, though one can still have a long-run relationship among I (0) variables but not necessarily calling it cointegration [58]. Upon this backdrop, the study conducted the Johansen cointegration test as a pre-model estimation diagnostic test to investigate whether there are any cointegrating vectors in the empirical model as detected by the Joahansen Eigen value and Trace statistics of the Johansen cointegartion test. Table 5 shows the summary of the cointegration test results in the empirical model.

Table 5. Cointegration test results from the Johansen test.

	RGDPC-Total Debt Regression [Model 1]			RGDPC-Debt to GDP ratio Regression [Model 2]		
Max. rank (r)	**Eigen Value**	**Trace statistic**	**Critical value at 5 percent**	**Eigen Value**	**Trace statistic**	**Critical value at 5 percent**
r ≥ 0	--	260.8121	124.24	--	152.1925	124.24
r ≥ 1	0.75285	172.7536	94.15	0.51465	107.3737	94.15
r ≥ 2	0.65480	105.7443	68.52	0.45194	70.0885	68.52
r ≥ 3	0.56080	53.9074	47.21	0.36869	**41.5707***	47.21
r ≥ 4	0.35675	**26.1108***	29.68	0.27330	21.7774	29.68
r ≥ 5	0.23429	9.2927	15.41	0.17858	9.5804	15.41
r ≥ 6	0.11624	1.5080	3.76	0.11943	1.6949	3.76
r ≥ 7	0.02365	--	--	0.02697	--	--

Source: Author's compilation.

Considering the results for model 1 where total debt is used as an indicator of public debt, the Johansen cointegration test results, as summarized in Table 5, indicate that the trace statistic rejects the null hypothesis that there are no more than r = 4 (or r ≥ 4). This is because, at r ≥ 4, the critical value exceeds the trace statistic at 5 percent level of significance. Such cointegration test results suggest that there are in fact five (*i.e.* r = 5) cointegrating relations in model 1 of the RGDPC–total debt equation. Furthermore, the Johansen cointegration test results, as summarized in Table 5, indicate that the trace statistic rejects the null hypothesis that there are no more than r = 3 (or r ≥ 3). This is because, at r ≥ 3, the critical value exceeds the trace statistic at 5 percent level of significance. Such results suggest that there are in fact four (*i.e.* r = 4) cointegrating relations in model 2 of the RGDPC-debt to GDP ratio equation. In a nutshell, the Johansen contegration test results reveal presence of cointegration in the empirical models being estimated.

4.5. Analysis of the Regression Estimates

Having mixed orders of integration of the variables and presence of cointegration

in the empirical models, this study implemented an asymmetric non-linear auto-regressive lag model (NARDL) as an appropriate model to estimate the models. The regression estimates of the NARDL models are summarized in Table 6.

Table 6. NARDL regression estimates of the Growth-Public debt models: Analysis of the effect of public debt on Uganda's economic growth.

Dep. var.: (Logarithm of real GDP per capita)$_t$						
	***RGDPC–Total Debt* Regression**			***RGDPC–Debt* to GDP ratio Regression**		
	Model 1: Alternative model			**Model 2: Preferred Model**		
	NARDL (3, 0, 0, 0, 2, 0, 4) estimates			**NARDL (2, 0, 0, 0, 2, 0, 4) estimates**		
Variable	**Coef.**	**Std. Err.**	**p-value**	**Coef.**	**Std. Err.**	**p-value**
ECT (−1)	−0.3389***	0.036913	0.000	−0.3362***	0.033811	0.000
Short-run estimates						
Δ(logarithm of real GDP per capita)$_{t-1}$	0.2238***	0.069362	0.002	0.2580***	0.059981	0.000
Δ(logarithm of real GDP per capita)$_{t-2}$	0.0966*	0.051463	0.063	—	—	—
Δ(Logarithm of increasing total debt)$_t$	−0.0101***	0.003083	0.001	—	—	—
Δ(Logarithm of decreasing total debt)$_t$	−0.0099***	0.003119	0.002	—	—	—
Δ(Increasing Debt-to-GDP ratio)$_t$	—	—	—	−0.0508***	0.010845	0.000
Δ(Decreasing Debt-to-GDP ratio)$_t$	—	—	—	−0.0425***	0.009615	0.000
Δ(logarithm of human capital)$_t$	0.0163***	0.005995	0.008	0.0198***	0.005517	0.001
Δ(logarithm of domestic credit)$_t$	0.2269***	0.037715	0.000	0.2344***	0.036059	0.000
Δ(logarithm of domestic credit)$_{t-1}$	−0.1315***	0.041395	0.002	−0.1156***	0.040855	0.005
Δ(logarithm of exports)$_t$	0.0058	0.005893	0.440	0.0052	0.007692	0.499
Δ(logarithm of exchange rate)$_t$	0.0057	0.033405	0.863	0.0202	0.031504	0.523
Δ(logarithm of exchange rate)$_{t-1}$	0.2105***	0.045624	0.000	0.2261***	0.043731	0.000
Δ(logarithm of exchange rate)$_{t-2}$	0.2144***	0.041253	0.000	0.2130***	0.039951	0.000
Δ(logarithm of exchange rate)$_{t-3}$	0.1444***	0.042556	0.001	0.1507***	0.041309	0.000
Constant	2.0561***	0.258371	0.000	2.0928***	0.224279	0.000
Long run estimates						
(Logarithm of increasing total debt)$_{t-1}$	−0.0297***	0.007993	0.000	—	—	—
(Logarithm of decreasing total debt)$_{t-1}$	−0.0293***	0.008106	0.000	—	—	—
(Increasing Debt-to-GDP ratio)$_{t-1}$	—	—	—	−0.1185***	0.027380	0.000
(Decreasing Debt-to-GDP ratio)$_{t-1}$	—	—	—	−0.1065***	0.016616	0.000
(Logarithm of human capital)$_{t-1}$	0.0481***	0.016843	0.005	0.0588***	0.015859	0.000
(Logarithm of domestic credit)$_{t-1}$	0.1590***	0.026215	0.000	0.1238***	0.026995	0.000
Logarithm of exports)$_{t-1}$	0.0174	0.022431	0.440	0.0155	0.502456	0.498
Logarithm of exchange rate)$_{t-1}$	−0.8845***	0.029093	0.000	−0.8823***	0.029824	0.000
Robustness tests						

Continued

	Adj. R-square = 0.871	Adj. R-square = 0.906
• Adjusted R-square:	p > F = 0.000 & P > t = 0.000 for I (0) vars.	p > F = 0.000 & P > t = 0.000 for I (0) vars.
• [54] bounds test:	p > F = 0.000 & P > t = 0.000 for I (1) vars.	p > F = 0.000 & P > t = 0.000 for I (1) vars.
• B–G LM test for serial correlation:	p > chi.sq. = 0.153	p > chi.sq. = 0.070
• B–P test for heteroskedasticity:	p > chi.sq. = 0.0345	p > chi.sq. = 0.171
• RESET test for omitted variables:	p > F = 0.138	p > F = 0.169
• CUSUM parameter stability test:	Recursive stat. = 0.716; criticalvalue = 0.948	Recursive stat. = 0.886; critical value = 0.948
• Symmetric effects test:	LR symmetry: Prob > F = 0.3732	LR symmetry: Prob > F = 0.6244
	SR symmetry: Prob > F = 0.3664	SR symmetry: Prob > F = 0.1497

Source: Author's compilation after NARDL regression. *p < 0.1; **p < 0.05; ***p< 0.01.

4.5.1. Selection of the Preferred Model and Interpretation of Robustness Test Results

We first choose the preferred model and proceed to interpret the robustness test results and later regression results while considering the estimates of the preferred model. We base on two criteria to select the preferred model: predictive power and efficiency. On the basis on the predictive power, we compare the relative sizes of the estimated Adjusted R-square, $\overline{R}^2$. The estimate of the adjusted R-square is an indicator of the goodness of fit of the estimated regression to the observed sample data after accounting for inclusion of irrelevant explanatory variables in the relationship being estimated. On the criterion of efficiency, we base on the model whose estimated residuals are homoscedastic. In consideration of the regression estimates summarized in **Table 6**, the estimates indicate an estimated adjusted R-square of 0.871 when total debt is used as a measure of public debt in the growth model (model 1) and an estimated adjusted R-square of 0.906 when debt-to-GDP ratio is used as a measure of public debt in the growth model (model 2). This suggests that model 2 fits the observed data better compared to model 1. Additionally, a homoscedasticity test results show that the residuals in model 2 are homoscedastic while the residuals in model 1 are heteroscedastic which suggests that the estimates of model 2 are more efficient than the estimates of model 1. Therefore, on the basis of the magnitude of adjusted R-square and efficiency, model 2 becomes a preferred model over model 1.

[54] bounds test results in the preferred model: The [54] bounds test is a test of the null hypothesis of no level relationship. The [54] bounds test results indicate that the F-statistic and the t-statistic are estimated with respective p-values that are less than 5 percent for I (0) and I (1) variables. Such results imply rejection of the null hypothesis of no level relationships for I (0) variables and I (1) variables in the preferred model. The [54] bounds test results therefore indicate existence of level relationship or cointegration in the preferred model.

B-G LM test for serial correlation test results in the preferred model: Under the null hypothesis of no serial correlation, results from the Breusch-Godfrey Lagrangian Multiplier test indicate that the chi-square p-value for model 2 (p = 0.070) exceeds the significance level of 5 percent, indicating that the null hypothesis is not rejected. This result suggests the residuals for model 2 regression are not seri-

ally correlated and therefore efficient.

B-P test for heteroskedasticity in the preferred model: Results from the Breusch-Pagan (B-P) test indicate that the estimated chi-square p-value in model 2 exceeds the significance level of 5 percent ($p = 0.171$) which implies that null hypothesis of homoscedasticity is not rejected. This result suggests that the NARDL regression estimates of the preferred model (model 2) are efficient.

RESET test for omitted variables in the preferred model: As indicated in Table 6, the estimated F-statistic from the Ramsey regression specification-error test (RESET) does reject the null hypothesis of no omitted explanatory variables at 5 percent level of significance in the preferred model (model 2) ($p > F = 0.169$). This result suggests that model 2 is correctly specified and its estimated coefficients do not have omitted variable bias.

CUSUM parameter stability test results in the preferred model: Under the null hypothesis of parameter stability, the results from the Cumulative sum (CUSUM) test for parameter stability in the preferred model (model 2) indicate that the estimated Recursive statistic from the CUSUM test is less than the critical value (Recursive stat. = 0.886, critical value = 0.948). Therefore, the estimated Recursive statistics do not reject the null hypothesis of parameter stability at 5 percent level of significance, suggesting that the coefficients of the preferred model are stable.

Symmetric effects test results in the preferred model: NARDL assumes asymmetric effects of the independent variable (s) on the dependent variable. In the case of this study, the null hypothesis tested is that increasing and decreasing public debt have symmetric effects on economic growth, *i.e.* the effects of increasing and decreasing public debt on economic growth are equal but opposite. Considering the preferred mode estimates (Mode 2), the estimated F-statistic rejects the null hypothesis of long-run symmetry as well as short-run symmetry at 5 percent level of significance (prob > F = 0.6244 for long-run symmetry and $p > F = 0.1497$ for short-run symmetry). Such results suggest that changes in public debt have asymmetric effects (nonlinear effects) on Uganda's economic growth both in the short run and in the long run. Additionally, the empirical evidence of nonlinear effects justifies the implementation of nonlinear autoregressive distributed lag model for estimation of the empirical model.

4.5.2. Interpretation of Regression Estimates of the Preferred Model

***Short-run effect of increasing and decreasing public debt on economic growth*:**

The estimates of NARDL summarized in Table 6 show that the short-run coefficient on increasing debt-to-GDP ratio is negative and statistically significant at 5 percent level of significances (coef. = −0.0508, $p = 0.000$) which implies that increasing debt-GDP ratio has a significant negative effect of Uganda's economic growth in the short-run. The estimates of NARDL summarized in Table 6 also show that the short-run coefficient on decreasing debt-to-GDP ratio is negative and statistically significant at 5 percent level of significances (coef. = −0.0425, p =

0.000) which also implies that decreasing debt-GDP ratio has a significant negative effect of Uganda's economic growth in the short run. The short-run estimates of the NARDL model therefore, indicate that public debt has a non-linear detrimental effect on Uganda's economic growth in the short run, with a larger detrimental effect arising from increasing public debt.

Long-run effect of increasing and decreasing public debt on economic growth:

The NARDL estimates summarized in Table 6 indicate that the estimated long-run coefficient on increasing debt-to-GDP ratio is negative and statistically significant at 5 percent level of significances (coef. = −0.1185, p = 0.000) which implies that increasing debt-GDP ratio has a significant negative effect of Uganda's economic growth in the long run. The estimates of NARDL summarized in Table 6 also show that the long run coefficient on decreasing debt-to-GDP ratio is negative and statistically significant at 5 percent level of significances (coef. = −0.1065, p = 0.000) which also implies that decreasing debt-GDP ratio has a significant negative effect of Uganda's economic growth in the long run. The long-run regression estimates therefore show that public debt has significantly negative non-linear effects on Uganda's long-run economic growth. Like with short-run regression estimates, the long-run regression estimates indicate that public debt has a non-linear detrimental effect on Uganda's long-run economic growth, with a larger detrimental effect arising from increasing public debt.

4.5.3. Analysis of the Impact of the Control Variables Included in the Empirical Model on Uganda's Economic Growth

The variables of human capital, domestic credit, exports and exchange rate were included as control variables in the Public debt-economic growth model for Uganda. Among these control variables, estimates from the preferred model (model 2) indicate that human capital and domestic credit to the private sector have positive and significant effect on Uganda's long-run economic growth while exchange rate has a negative and significant effect. The estimates form the preferred model show that, in the short run, the variables of human capital, the current period domestic credit to the private sector and exchange rate have positive and significant effect on Uganda's economic growth. In a nutshell, estimates show that among the control variables, human capital and current period domestic credit to the private sector have a significant positive effect on Uganda's economic growth both in the short run and in the long run whereas exchange rate has a significant positive effect on Uganda's short run economic growth but yields a negative significant effect on Uganda's long run economic growth. The significant effect of exchange rate on Uganda's economic growth in the short run could be explained by the increased export volumes as a result of depreciating currency which attracts Uganda's exports. However, Uganda being a net importing country with a small export base, the export driven growth which occurs in the short run can potentially be negated in the long run, as the depreciating currency curtails imports of essential goods such as capital equipment and other intermediate inputs that

could have been be used for production of more goods in the domestic economy. The negative and significant effect of the exchange rate on Uganda's long-run economic growth could be explained by this phenomenon. Last but not least, the estimates indicate that the exports do not have any effect on Uganda's economic growth both in the short run and in the long run.

4.5.4. Conclusion

Using quarterly data on Uganda for the period 1990-2023, the objective of this study was to investigate the effects of public debt on Uganda's economic growth. In the investigation, the study assessed two proxy variables to public debt in the public debt-economic growth relationship: total debt and debt-to-GDP ratio in separate regressions, first to identify which debt indicator brings out better results, and secondly to examine the debt effects on Uganda's short-run and long economic growth. Changes in real GDP per capita have been used to capture the economic growth variable. Three theories, that is, the debt overhang theory, the endogenous growth theory and the nonlinear effect theory are used to underpin the study. The study employed an asymmetric NARDL to estimate the specified growth-public debt empirical models. The study results reveal that whether public debt is increasing or decreasing, the public debt variable has detrimental nonlinear effects on Uganda's short-run and long-run economic growth. Estimates indicate that the non-linear detrimental effects of public debt on Uganda's short-run and long-run economic growth are larger with increasing public debt levels compared to decreasing public debt levels. Additional findings indicate that human capital development and domestic credit growth have a positive and significant effect on Uganda's long-run economic growth and that human capital development and the current period growth in domestic credit growth have a positive and significant effect on Uganda's short-run economic growth. The estimates further indicate that lagged period exchange rates exert a positive and significant effect on Uganda's economic growth in the short run but the exchange rate variable has negative and significant effect on Uganda's long run economic growth. The results indicate that exports do not influence Uganda's economic growth both in the short run and in the long run.

5. Policy Recommendations

5.1. Principal Policy Recommendations

In reference to the results from the study and the study objective, this study recommends that rather than acquiring and accumulating public debt to finance lucrative programs and projects that are envisaged to foster Uganda's economic growth, the government of Uganda should put much emphasis and focus on implementing strategies that raise domestic revenues. Domestic revenue mobilization policies may entail expanding Uganda's tax base, which could be realized if more effort is devoted to formalizing businesses and other entities that are or have been operating in the informal sector. In addition, Government of Uganda may

explore other avenues of funding government projects in efforts to reduce dependence on public debt; for instance, exploring public-private partnership avenues and expansion of profit-making government projects that could make proceeds upon which government may tap resources for funding its projects.

5.2. Other Policy Recommendations

To foster Uganda's rate of growth economic growth, the results point to the following recommendations:

1) Increase investments in human capital development. Increased investment in human capital development can be a lucrative strategy to increase on stock of a skilled and healthy workforce which has higher productivity and enhances competitiveness of the economy. The government of Uganda can achieve improved human capital development through various strategic interventions, for instance prioritizing vocational training, increased budget allocation to the health sector so as to bring about improved child and maternal health, earmarking extra resources for education and training programs, including increased enrolment, retention and completion of school-going population, among others.

2) Expansion of domestic credit to the private sector. In a predominantly private sector-driven economy like Uganda, it is imperative to tap more into the potential of the private sector investments for increased production that would enhance the aggregate production levels by providing cheap and accessible credit to private sector investors. Domestic credit expansion to the private sector can also be realized through extension of affordable credit services to the wide diaspora of the population including both rural and urban locations. Further to this strategy, credit expansion to the private sector can be achieved by encouraging formal financial institutions to mobilize saving deposits and extend credit through informal and community-based financial institutions and micro finance agents in areas where formal financial institutions are limited.

3) Periodic monitoring and interventions in the exchange rate market. Uganda's exchange rate market operates under a managed exchange rate regime, and so it can employ monetary policy to stabilize the exchange rate market and bring about conducive macrocosmic condition for economic growth. Results from this study showed that raising exchange rate enhances Uganda's short-run economic growth but persistent increase in exchange rate is damaging to Uganda's long-run economic growth. This suggests that Uganda's economic growth can benefit from close monitoring of the exchange rate movements and direct interventions to stabilize the exchange rate at a sustainable level whenever it escalates to cause a misalignment.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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