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Is the effect of public debt on inflation symmetric or asymmetric? Evidence from the Gambia

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Abstract

Several studies have identified the impact of total public debt on inflation. These studies are based on the assumption of a symmetric relationship between these variables. However, because different governments react to changes in total public debt (positive or negative) differently, this study employed the nonlinear autoregressive distributed lag (NARDL) technique to investigate the nature of the link between total public debt and inflation in the Gambia for the period from 1978 to 2019. The results indicate an asymmetric relationship between total public debt and inflation, irrespective of whether the analysis was conducted in the short run or long run. The coefficient of a positive shock in total public debt is statistically significant in the short run and in the long run, suggesting the inflationary effect of positive variation in total public debt in the Gambia. On the other hand, the effect of a negative shock is not statistically significant in the short run or in the long run. These findings reinforce the need for government to approach increase in public debt with caution to minimise volatility in inflation. Overall, this study provides a fresh insight into the optimal estimation technique for testing the public debt–inflation nexus through a nonlinear approach.

Keywords: nonlinear autoregressive distributed lag (NARDL); public debt; inflation; the Gambia

JEL Classification: C32; E31; H63

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1. Introduction

The relationship between public debt and macroeconomic variables, especially inflation, has attracted considerable attention in recent years across the globe. The need to understand the relationship between these variables since the recent global financial crisis in 2008 has become more pertinent (relevant) now than before following recent increases in government borrowings for the funding of budget deficits owing to revenue shortfalls and the worldwide Coronavirus disease (COVID-19) macroeconomic fallout. According to the International Monetary Fund (IMF) (2021a), global public debt to GDP ratio averaged an unprecedented 97.3% in 2020 when compared with 83.7% in 2019 and 82.3% in 2018. The average ratio is projected to stabilise worldwide at about 98.9% in 2021 and 99% in 2022.

The central government in the Gambia has incurred large deficits and public debt owing to revenue shortfall and COVID-19 economic fallout. The rising trends in government indebtedness for the funding of fiscal deficit are raising concerns among policymakers. For the achievement of macroeconomic stability would require the harmonisation of fiscal and monetary policy in the country. Hence, going forward during and hopefully after the COVID-19 pandemic, understanding the macroeconomic effects of public debt, especially on inflation and the nature of the link between public debt and inflation in the Gambia cannot be overemphasised.

High levels of inflation rate are considered to have a negative effect on economic growth and macroeconomic stability. The macroeconomic objective of most governments including the Gambia is to maintain a low and stable inflation rate. A stable and reduced inflation rate will help to increase real return on investment enabling economic actors to respond to various investment opportunities and opening up opportunities for new and existing investors in the promotion of economic development (Aimola and Odhiambo, 2021a). However, budget deficit has been financed largely through borrowing with a view to promoting economic growth in the Gambia. Thus, establishing the relationship between public debt and inflation in the Gambia is crucial in the sense that the COVID-19 pandemic has further increased government indebtedness in the funding of budget deficit.

From a theoretical perspective, there are different views regarding the dynamics of inflation. According to the monetarist, Friedman (1968), 'inflation is always and everywhere a monetary phenomenon.' Contrary to the monetarists' view, the Fiscal Theory of the Price Level (FTPL) determination within the non-Ricardian environment suggests that price level is driven by public debt with monetary policy playing an indirect role (Woodford, 1995; 1998). According to Kwon et al. (2006) FTPL identifies the wealth effect of government debt as an additional channel of fiscal influence on inflation. The increase in government debt adds to household wealth and consequently to the demand for goods and services, leading to price pressures. In addition, Nastansky and Strohe (2015) also argue that debt-financed government expenditure would

stimulate macroeconomic demand in the short term and increase pressure on inflation in the medium- or long term.

There are several empirical studies that have examined the link between public debt and inflation for both developed and developing countries. Earlier studies (Musgrave, 1949; Phelps, 1973) recognised the relationship between government borrowings and inflation, while recent empirical studies (Karakaplan, 2009; Nguyen, 2015; Lopes da Veiga et al., 2016; Aimola and Odhiambo, 2021b) also argue that public debt influences inflation rate, particularly in developing countries where the financial market is relatively developed. Some studies support the idea that there is a positive relationship between public debt and inflation (Kwon et al., 2006; Bildirici and Ersin, 2007; Ahmad *et al.*, 2012; Sims, 2014; Nastansky and Strohe, 2015; Romero and Marin, 2017; Afonso and Ibraimo, 2018). Then again, other studies corroborate a negative relationship between these variables (Wheeler, 1999; Taghavi, 2000). A common feature of these studies is that their results are based on the assumption of a symmetric relationship between public debt and inflation. However, the relationship between these variables might be asymmetric or non-linear. Some studies seem to suggest that the relationship between public debt and inflation might be non-linear. For instance, Lopes da Veiga et al. (2016), and Reinhart and Rogoff (2010) have shown a positive relationship between high public debt to GDP ratio and high inflation, while low public debt to GDP ratio was associated with lower inflation rate. According to these studies, one can infer an asymmetric relationship in the sense that the positive impact of public debt on inflation is only evident when public debt to GDP ratio exceeds some threshold level, and below which public debt has a negative or insignificant impact on inflation. More so, Bleaney (1996), Negerebo (2014) and Ezirim et al. (2014) have revealed that inflation may either respond positively or negatively to changes in public debt depending on whether it is in the short run or long run.

Reducing public debt to GDP ratio below the accepted Economic Community of the West African States (ECOWAS) sustainable threshold of 70% is crucial for a country like the Gambia with a high level of public debt to GDP ratio that is mostly above this threshold. The Gambia presents an interesting case study particularly unlike many other countries in the ECOWAS sub-region. The inflation rate in the Gambia has remained relatively low and stable with a high level of public debt to GDP ratios generally above the 70% ECOWAS threshold. For instance, the Gambia secured external public debt relief in 2007 reducing the total public debt to GDP ratio significantly from 140.65% in 2006 to 60.9% in 2007 (Aimola and Odhiambo, 2019). Total public debt to GDP ratio has since increased consistently. Total public debt to GDP ratio stood at 80.1% in 2019 (Annual Public Debt Bulletin, 2019) and inflation rate at 7.12% in 2019 (World Bank, 2021a). Hence, the question may be posed for the economy of the Gambia whether the relationship between public debt and inflation is symmetric or asymmetric.

An important precondition for effective public debt management strategy is accurate understanding of its macroeconomic effects based on a particular country's situation analysis. The significant reduction in public debt to GDP ratio after external public debt relief and the increases

in inflation rate have made policymakers and academic researchers raise the question about the appropriateness of the assumption of a symmetric relationship between public debt and inflation, especially in developing countries. The situation in the Gambia seems to support an asymmetric relationship between public debt and inflation. Data on both public debt and inflation rate show features of asymmetric structure in their trends. The suitability of an asymmetric approach deserves further empirical investigation using a more recent econometric technique. Based on this fact, it is necessary to allow for measurement by separating positive changes from negative changes when examining the link between public debt and inflation in order to capture any evidence of asymmetric structure in the relationship should previous studies have ignored it in their analysis.

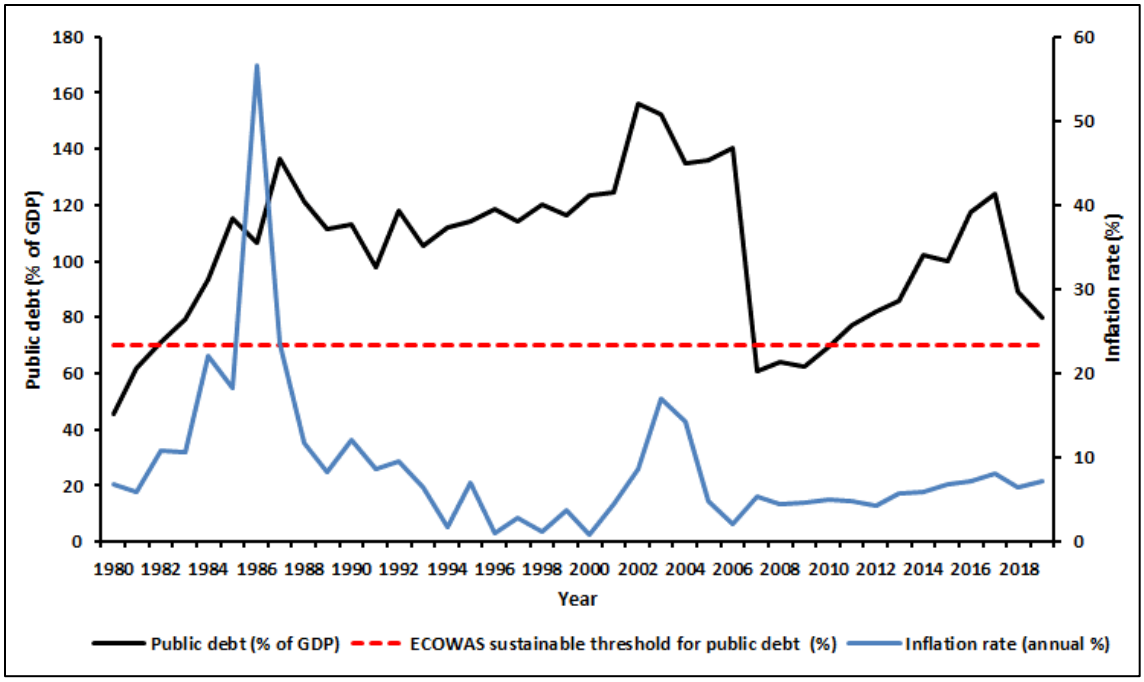
Even though available studies have focused on the symmetric effect of public debt on inflation, to the best of our knowledge, no study has investigated the asymmetric relationship between public debt and inflation in the Gambia using the nonlinear autoregressive distributed lag (NARDL) technique developed by Shin et al. (2014). This study fills this gap by examining whether the dynamic relationship between public debt and inflation in the Gambia is symmetric or asymmetric. This study, therefore, is a pioneering study in providing an answer to the question on nonlinearity in the relationship between public debt and inflation, especially in the Gambia. This study can be important for the economy of the Gambia as the potential for public debt management capacity and a stable low inflation rate is yet to be realised fully.

The rest of the paper is organised as follows: Section 2 provides a brief overview of public debt and inflation trends in the Gambia. Section 3 describes the estimation technique, model specifications of the NARDL approach, the dataset and variables used. Section 4 presents the analysis of the study results, while Section 5 concludes the study.

2. Public debt and inflation dynamics in the Gambia

Figure 1 illustrates historical trends in the Gambia's total public debt to GDP ratio and inflation rate for the period from 1980 to 2019. As shown in Figure 1, trends in total public debt ratio in the Gambia are largely above the Economic Community of the West African States' (ECOWAS) total public debt convergence threshold of 70.0% for countries within the sub-region. Although for the period 1980, 1981 and 2007 to 2010, the public debt ratio was below the ECOWAS threshold. According to World Bank (2021b), debt policy rating in the Gambia averaged 2.6 between 2005 and 2019 (when 1=low and 6=high). The ranking, which is above low but below average, is an indication that authorities are involved in debt management operations and aware of the macroeconomic effects of public debt management in the country. Nonetheless, the ranking shows that there is room for further improvement.

Figure 1: Public debt and inflation trends in the Gambia (1980-2019)



Source: International Monetary Fund (2021b); (World Bank, 2021a); Annual Public Debt Bulletin (2012-2019) – Author's compilation using Excel

As indicated in Figure 1, the total public debt to GDP ratio increased from 45.3% in 1980 to 80.1% in 2019. The annual average of public debt to GDP ratio for the period under review was 103.9%. For this period, three episodes of sharp increases are prominent in 1987, 2002 and 2017, peaking at 136.7%, 156.0% and 124.0%, respectively (International Monetary Fund, 2021b). These changes are linked to increases in both foreign and domestic borrowings. The effects of foreign exchange receipt led to increased external borrowings by government to meet its financing needs or to finance infrastructure development and to support the implementation of its Economic Recovery Programme (McPherson and Radelet, 1992; Central Bank of the Gambia, 2010; Aimola and Odhiambo, 2019). According to Aimola and Odhiambo (2019), increases in domestic borrowing can be attributed to government's development of the domestic debt market and financial instruments, and domestic debt finance of budget deficits, although total public debt ratio witnessed a sharp decline during this period from 140.65% in 2006 to 60.9% in 2007. This was due to public external debt relief that was secured by the country from its Paris Club and London Club group of creditors in 2007. The reduction was short lived as the debt ratio remain elevated above the ECOWAS' sustainable threshold of 70% starting from 2011 to 2019. The unsustainable level of public debt for this period was largely link to high fiscal deficit arising from economic mismanagement and adverse external developments (The Gambia Medium-Term Debt Strategy, 2016; Aimola and Odhiambo, 2019).

It is, however, important to note that preliminary assessment of the macroeconomic impact of COVID-19 pandemic on the Gambian economy shows a significant decline in tax revenues

(Budget Speech, 2021). This fallout from COVID-19 may have implications on the budget and government borrowing, with public debt to GDP ratio susceptible to increase changes in the near future. Attaining a ratio below the ECOWAS' sustainable threshold would therefore require credible and sustainable fiscal consolidation supported by an appropriate public debt management strategy ensuring that public debt levels are reduced to a sustainable level.

Understanding inflation dynamics is important, particularly for the Central Bank of the Gambia (CBG) and for policymakers in the conduct of monetary and fiscal policies. The Gambia has made remarkable progress in maintaining a low inflationary environment compared to other countries in the ECOWAS sub-region. Despite efforts to reduce inflation further to a stable single-digit level, challenges related to fiscal dominance still exist in its management. The inflation experience for the period under review was mixed as it hovered between single-digit- and double-digit rates.

Figure 1 illustrates trends in inflation rate for the Gambia using annual data for the period between 1980 and 2019. The inflation rate remained in single digits for most of the years and double digits in 1982–1988, 1990, 2003, and 2004. The changes were largely due to exchange rate depreciation, unsustainable macroeconomic policies, rising oil prices and excessive growth in money supply (West African Monetary Institute, 2012; Mendy and Widodo, 2018). Inflation rate reached an all-time high of 56.6% in 1986 and a low of 0.8% in 2000. The inflation rate averaged 8.9% between 1980 and 2019. In the 1980s, it average 17.5% compared to 5.4% in the 1990s and 6.4% in the 2000s (World Bank, 2021a).

Prior to the implementation of Economic Recovery Program (ERP) in 1985, The Gambia operated a fixed exchange rate system with the Dalasi pegged to the British pound sterling. Inflation rate during this period was relatively stable. Inflation rose from 5.9% in 1981 to 10.9% in 1982 and 10.6% in 1983. It then accelerated to 22.1% in 1984 and to 18.3% in 1985 before reaching its peak at 56.6% in 1986. The adoption of the ERP saw the deregulation of the financial market with a floating exchange rate regime in 1986. This resulted in an immediate and short-lived significant depreciation of the Dalasi by 53.4% in 1986 with a corresponding inflationary pressure in the economy (West African Monetary Institute, 2012).

In less than a year inflation began to decline with the stabilisation of the Dalasi as a result of the elimination of price controls and subsidies on important commodities. Inflation dropped sharply to 23.5% in 1987 and continued further downward within the double-digit mark until 1988. Inflation returned to single digits at 8.28% in 1989 before an increase to 12.2% in 1990 and, thereafter, inflation has continued to fall within the single-digit mark. The increase from 1.1% in 1996 to 2.78% in 1997 was mainly as a result of increased domestic debt and the continued sale by the CBG of Treasury Bills for deficit financing and liquidity management purposes (Mendy and Widodo, 2018). Expansionary fiscal deficit posed a significant threat to monetary policy as inflationary pressure built up. Inflationary pressure emerged between 2001 and 2003 as a result of the drought, the depreciation of the Dalasi and mainly because of monetary accommodation of

fiscal deficit. Inflation rate increased from 4.5% in 2001 to 17.0% in 2003 and 14.2% in 2004. Contractionary monetary policies by the CBG in 2004 and 2005 significantly reduced inflation to 4.8% in 2005 and 2.1% in 2006 (World Bank, 2007). Thereafter, the CBG has successfully contained inflationary pressure within the single-digit range with the inflation rate ranging between 4.0% and 8.0%, although exceeding the 3.0%–5.0% monetary policy target range (Heintz et.al, 2008; Central Bank of the Gambia, 2017). Inflation rate eased marginally to 6.52% in 2018, mainly as a result of relative stability in the foreign exchange market, and moderation in global food prices, compared to 8.03% in 2017, which also exceeded the 5.0% policy target for the year (Central Bank of the Gambia, 2017, 2018b). The inflation rate stood at 7.1% in 2019 (World Bank, 2021a).

A critical inspection of Figure 1 shows that there is no obvious conclusion to whether correlation between public debt and inflation is either positive or negative. Figure 1 shows that the variables are either moving in the same or opposite directions depending on the sub-periods of the sample being inspected. Based on this fact, it is necessary to investigate empirically using a more recent econometric technique that allows for measurement by separating positive changes from negative changes in examining the link between total public debt and inflation.

3. Research Methodology

3.1 NARDL bounds testing approach to cointegration

To investigate the existence of a dynamic relationship between public debt and inflation in the Gambia, theoretical and empirical literature has been used to identify explanatory variables in the model. The model is specified explicitly as follows:

$$INF = f(PD, MS, GDPC, GFCF, TOP) \quad (1)$$

Where: INF = inflation; PD = total public debt; GDPC = economic growth; GFCF = private investment; and TOP = trade openness.

According to Shin et al. (2014), the standard autoregressive distributed lag (ARDL) only assumes a linear or symmetric link between variables, and it is unable to capture nonlinearity or an asymmetric relationship between variables. Shin et al. (2014) extended the standard autoregressive distributed lag approach to capture both short-run- and long-run nonlinear or asymmetric dynamics between variables while retaining all the advantages of the standard autoregressive distributed lag model over other estimation techniques in the NARDL technique. To investigate the main objective of this study, whether public debt has a symmetric or asymmetric effect on inflation in the Gambia, the study employed the NARDL technique suggested by Shin et al. (2014).

The NARDL model specification is expressed as:

$$lnINF_t = \alpha_0 + \alpha_1 lnPD_t^+ + \alpha_2 lnPD_t^- + \alpha_3 lnMS_t + \alpha_4 lnGDPC_t + \alpha_5 lnGFCF_t + \alpha_6 lnTOP_t + \varepsilon_t \quad (2)$$

Where *ln* is natural logarithm, PD_t^+ and PD_t^- are the partial sum of positive and negative changes in total public debt, INF_t is inflation, MS_t is money supply, $GDPC_t$ is economic growth, $GFCF_t$ is private investment, TOP_t is trade openness. The partial sum of positive and negative changes in public debt is derived as follows:

$$lnPD_t^+ = \sum_{j=1}^{t} \Delta\, lnPD_j^+ = \sum_{j=1}^{t} max\left(\Delta lnPD_j, 0\right) \tag{3}$$

$$lnPD_t^- = \sum_{j=1}^{t} \Delta\, lnPD_j^- = \sum_{j=1}^{t} min\left(\Delta lnPD_j, 0\right) \tag{4}$$

The full representation of the NARDL model for both the short-run- and long-run asymmetric effects of total public debt, and other variables on inflation is specified as follows:

$$\begin{aligned}\Delta lnINF_t = \delta_0 &+ \sum_{i=1}^{n} \delta_{1i}\, \Delta lnINF_{t-i} + \sum_{i=0}^{n} \delta_{2i}^+\, \Delta lnPD_{t-i}^+ + \sum_{i=0}^{n} \delta_{3i}^-\, \Delta lnPD_{t-i}^- + \sum_{i=0}^{n} \delta_{4i}\, \Delta lnMS_{t-i} \\ &+ \sum_{i=0}^{n} \delta_{5i}\, \Delta lnGDPC_{t-i} + \sum_{i=0}^{n} \delta_{6i}\, \Delta lnTOP_{t-i} + \sum_{i=0}^{n} \delta_{7i}\, \Delta lnGFCF_{t-i} + \delta_8 lnINF_{t-1} \\ &+ \delta_9^+ lnPD_{t-1}^+ + \delta_{10}^- lnPD_{t-1}^- + \delta_{11} lnMS_{t-1} + \delta_{12} lnGDPC_{t-1} + \delta_{13} lnTOP_{t-1} \\ &+ \delta_{14} lnGFCF_{t-1} + \varepsilon_t \end{aligned} \tag{5}$$

Where all variables remain as defined in Equations 1and 2.

δ_0 = constant;
$\delta_1 - \delta_7$= short run coefficient;
$\delta_8 - \delta_{14}$= long run coefficient;
Δ = difference operator;
ln = natural logarithms;
n = lag lengths; and
ε_t = white-noise error term.

From Equation 5, δ_{2i}^+ and δ_{3i}^- reflect the short-run asymmetric coefficients, while δ_9^+ and δ_{10}^- capture the long-run asymmetric coefficients. Before proceeding with long-run test for a symmetric relationship, cointegration among variables is examined comparing computed *F*-statistic to the upper and lower critical bounds from Pesaran *et al.* (2001) critical values. The null hypothesis $(H_0: \delta_8 = \delta_9^+ = \delta_{10}^- = \delta_{11} = \delta_{12} = \delta_{13} = \delta_{14} = 0)$ of no cointegration is tested against the alternative hypothesis $(H_1: \delta_8 \neq \delta_9^+ \neq \delta_{10}^- \neq \delta_{11} \neq \delta_{12} \neq \delta_{13} \neq \delta_{14} \neq 0)$ of cointegration. The Wald test is used to ascertain whether there is long-run and short-run symmetry in the relationship between total public debt and inflation. The null hypothesis of long-run symmetry is tested against the alternative hypothesis of long-run asymmetry. The Wald test is also

used to test the null hypothesis of short-run symmetry against the alternative hypothesis of short run asymmetry.

The error correction model, consistent with Equation 5 explaining the short-run dynamics in the nonlinear relationship, is specified as follows:

$$\Delta lnINF_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i}\, \Delta lnINF_{t-i} + \sum_{i=0}^{n} \delta_{2i}^{+}\, \Delta lnPD_{t-i}^{+} + \sum_{i=0}^{n} \delta_{3i}^{-}\, \Delta lnPD_{t-i}^{-} + \sum_{i=0}^{n} \delta_{4i}\, \Delta lnMS_{t-i} + \sum_{i=0}^{n} \delta_{5i}\, \Delta lnGDPC_{t-i} + \sum_{i=0}^{n} \delta_{6i}\, \Delta lnTOP_{t-i} + \sum_{i=0}^{n} \delta_{7i}\, \Delta lnGFCF_{t-i} + \emptyset_1 ECM_{t-1} + \varepsilon_t \quad (6)$$

Where ECM_{t-1} is the one period lagged error correction term. The coefficient of the error correction term ($\emptyset_1$) is expected to be negative and statistically significant to conclude convergence back to long-run equilibrium after a shock or short-run disequilibrium.

Furthermore, the asymmetric cumulative dynamic multiplier is employed to evaluate the responses of inflation to increases and decreases in public debt by implementing:

$$V_h^{+} = \sum_{j=0}^{h} \frac{\varphi lnINF_{t+j}}{\varphi lnPD_t^{+}} \; and \; V_h^{-} = \sum_{j=0}^{h} \frac{\varphi lnINF_{t+j}}{\varphi lnPD_t^{-}}, h = 0, 1, 2, \quad (7)$$

By construction (see also Shin *et al.,* 2014), it is expected that, as $h \to \infty, V_h^{+} \to \gamma^{+}$

, and $V_h^{-} \to \gamma^{-}$, where γ^{+} and γ^{-} are the asymmetric long run coefficients.

Finally, to also depart from previous studies on the impact of public debt on inflation (Aimola and Odhiambo, 2021a; Bildirici and Ersin, 2007; Karakaplan, 2009; Nguyen, 2015; Nastansky and Strohe, 2015), which have explicitly assumed linearity without testing for any hidden nonlinear structure, the current study uses the BDS test developed by Brock *et al.* (1987, 1996) to investigate the possibility of nonlinear structure in the data series. This test is usually recommended before proceeding with the nonlinear estimation process.

3.2 Data source

The study used annual time series data from the period between 1978 and 2019. This paper adopts six variables for empirical analysis in the Gambia. The choice of these variables is influenced by other empirical studies highlighted in this study. The data covers the main variables of interest – total public debt (PD) and inflation (INF). The control variables' data cover money supply (MS), economic growth (GDPC), private investment (GFCF) and trade openness (TOP). The Data were sourced from the World Bank Development Indicators database, IMF database, and various issues of Annual Public Debt Bulletin published by the Directorate of Loans and Debt Management at

the Ministry of Finance and Economic Affairs (MoFEA) in the Gambia. All variables are expressed in natural logarithms. Table 1 shows how the data were measured and theoretical expectations of the coefficient for each variable.

Table 1: Data sources and measurement of variables

Variable	Description	Measurement	Expectation	Source
INF	Inflation	Consumer prices (annual %)	-	World Bank 2021a
PD	Public debt	Total public debt (% of GDP)	Positive	IMF 2021b; Annual Public Debt Bulletin (2012-2019)
MS	Money supply	Broad money supply (% of GDP)	Positive	World Bank 2021a
GDPC	Economic growth	Real gross domestic product per capita	Negative or Positive	World Bank 2021a
TOP	Trade openness	Measured as the sum of exports and imports of goods and services (% of GDP)	Negative	World Bank 2021a
GFCF	Private investment	Gross fixed capital formation (% of GDP)	Positive	World Bank 2021a

Source: Authors' Compilation

4. Empirical results and analysis

4.1 Unit root test results

This section reports the properties of annual time series data used in the study. This is important for the study to avoid any form of spurious regression. The study used the Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Zivot-Andrews tests to perform a unit root test without structural break and with structural break. The ADF and PP tests are used for unit root test without structural break, while the Zivot-Andrews test was used to investigate structural break unit root test in the series. Tables 2 and 3 present results for the unit root tests. The results reported in both Table 2 and 3 show that none of the variables is integrated of order two (i.e. I(2)). The results show a mixture of variables that are integrated of order zero and one (i.e., I (0) and I (1)). The structural breaks for the variables are corrected by Zivot-Andrews unit root test to determine the true order of integration for these variables.

Table 2: Results of standard unit root test

Variable	*Stationarity of variables in levels*		*Stationarity of variables in first difference*	
	Without trend	With trend	Without trend	With trend
Panel A: Augmented Dickey-Fuller (ADF)				
lnINF	-0.4856	-2.6865	-10.6976***	-10.4205***
lnPD	-4.4733***	-3.6919**	-	-

Variable	*Stationarity of variables in levels*		*Stationarity of variables in first difference*	
	Without trend	With trend	Without trend	With trend
lnMS	-0.7583	-1.6542	-6.5878***	-6.6709***
lnGDPC	-0.4082	-3.4000*	-5.9403***	-5.8701***
lnTOP	-0.4904	-2.3347	-3.1538***	-6.2427***
lnGFCF	2.6399	-2.4635	-6.9896***	-6.9274***
Panel B: Phillips-Perron (PP)				
lnINF	-0.5559	-3.3717*	-11.0149***	-10.7293***
lnPD	-4.2971***	-3.6983**	-	-
lnMS	-0.7595	-1.6051	-6.5940***	-6.6709***
lnGDPC	-0.5561	-3.4962*	-7.7139***	-7.5487***
lnTOP	-0.4670	-2.4054	-7.9929***	-7.9806***
lnGFCF	2.7693	-2.6759	-7.1439***	-12.9675***

Source: Author's compilation.

Note: ***, ** and * denote stationarity at 1%, 5% and 10% significance levels, respectively

Table 3: Results of structural break unit root test

Zivot and Andrews (1992) structural break unit root test				
Variables	***At levels***		***At first difference***	
	t-Statistic	*Break date*	*t-Statistic*	*Break date*
lnINF	-4.1814	1994	-11.1713***	1987
lnPD	-5.4374***	2007	-	-
lnMS	-3.9283	1991	-7.1713***	1997
lnGDPC	-4.1761	1999	-6.1437***	2011
lnTOP	-4.4735	1991	-8.2064***	1991
lnGFCF	-4.4743	2012	-7.2346***	1997

Source: Authors' compilation.

Note: *** denote stationarity at 1% significance levels

The results reported in Table 3 show that none of the variables is integrated of order 2 [i.e., I (2)], which confirms the use of NARDL estimation technique for the study. According to Pesaran *et al.* (2001) and Shin *et al.* (2014), if variables are integrated of order two (i.e. I(2)), the estimation approach is not appropriate.

4.2 Brock, Dechert and Scheinkman (BDS) test results

For the purpose of this study, it is important to test whether total public debt and inflation time series have nonlinear characteristics. If nonlinearity is detected it would mean that estimated results from a linear model may be biased for ignoring nonlinear dependences in total public debt and inflation series. This test is usually recommended before proceeding with the nonlinear estimation process. The BDS test suggested by Brock *et al.* (1996) is popularly used to detect nonlinearity in time series and it has been adopted in this study. Table 4 shows BDS test results for the variables. The null hypothesis of linearity that series are not identically and independently

distributed (IID) under different dimensions (m = 2, 3, 4, 5, 6) was rejected for total public debt and inflation series for the Gambia at the 1% level of significance, including the control variables. This result suggests that using a nonlinear model is more appropriate for examining the relationship between total public debt and inflation in the Gambia. Hence, the study proceeds by adopting the NARDL approach to investigate the relationship between these variables.

Table 4: Results of Brock, Dechert and Scheinkman (BDS) Statistics

	BDS Statistics				
Variable	*Dimension 2*	*Dimension 3*	*Dimension 4*	*Dimension 5*	*Dimension 6*
Inflation	0.0961***	0.1550***	0.1848***	0.1836***	0.1668***
Total public debt	0.1422***	0.2349***	0.2907***	0.3237***	0.3355***
Money supply	0.1075***	0.1700***	0.2051***	0.2123***	0.2196***
Economic growth	0.0924***	0.1405***	0.1551***	0.1477***	0.1303***
Trade openness	0.1319***	0.2348***	0.3140***	0.3583***	0.3823***
Private Investment	0.1342***	0.2007***	0.2253***	0.2059***	0.1462***

Note: *** denote significance at 1%.

4.3 NARDL bounds test for cointegration results

The results of the cointegration test based on the NARDL bounds testing technique are presented in Table 5. As shown in Table 5, the F-statistic of the estimated NARDL model is significant at the 1% level. Based on this finding, there is a cointegration relationship among the variables included in the model. Consequently, the study can determine whether short-run or long-run asymmetry exists in the relationship between total public debt and inflation.

Table 5: NARDL-bounds test for cointegration results

NARDL (2, 2, 0, 1, 0, 0, 2) Selected based on Akaike Information Criteria						
Dependent Variable	**Function**		**F-test statistic**		**Cointegration Status**	
Inflation	F(INF| PD^+, PD^-, MS, GFCF, TOP, GDPC)		6.17***		Cointegrated	
Asymptotic critical values						
Critical values Pesaran *et al*. (2001), p.300, Table CI(iii) Case III	**1%**		**5%**		**10%**	
	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
	3.15	4.43	2.45	3.61	2.12	3.23

Note: *** denote statistical significance at 1% level

In Table 6, the Wald test results for the existence of long-run and short-run symmetry are reported for the relationship between total public debt and inflation. The null hypothesis of long-run symmetry is tested against the alternative hypothesis of long-run asymmetry. As shown in Table

6, the null hypothesis that the variables in the long run are symmetric is rejected. The result suggests that in the long run the positive and negative partial sums of squares are significantly different from each other, and this supports an asymmetric relationship. Thus, public debt influences inflation in the long run with different levels of positive and negative effects. In the short run, the results show that the null hypothesis of short-run symmetry is also rejected. Hence, the findings suggest that there is also an asymmetric relationship between total public debt and inflation in the short run. Detailed results of the NARDL analysis are further reported in Table 7.

From these findings, the optimal model for estimating the relationship between public debt and inflation in the Gambia should include asymmetric specification in the short run and in the long run. Based on these findings, using the NARDL model, the study further investigates the impact of total public debt on inflation in the Gambia.

Table 6: Test for symmetries

Wald test	F-statistic	Decision
Long run symmetry	5.7521 [0.0243]	Long run asymmetry relationship exist
Short run symmetry	2.9610 [0.0696]	Short run asymmetry relationship exist

Note: The coefficients are tested based on null hypothesis of symmetry in the runs

4.4 Estimated long-run and short-run results

This section provides estimates for both long-run and short-run coefficients within the NARDL framework. The estimates presented in Table 7 (Panel A and Panel B) show that inflation is a positive function of positive and negative changes in total public debt, irrespective of whether the regression was conducted in the short run or the long run. The coefficients of positive variation in total public debt (PD^{+}) are statistically significant, both in the long run and in the short run. These results suggest the inflationary effect of positive variation in total public debt in the Gambia. This implies that an increase in total public debt is inflationary in the Gambia. The findings compare favourably with similar studies by Kwon et al. (2006), Nguyen (2015), and Romero and Marin (2017) that also suggests the inflationary effect of total public debt increases. On the other hand, even though the coefficients of negative variation in total public debt (PD^{-}) may suggest that if total public debt decreases, inflation also decreases, but these coefficients are not statistically significant in the long run and in the short run.

Other results presented in Table 7, Panel A and Panel B, show that the coefficients of private investment were consistent with the expectations of the study. The coefficient of money supply (MS) was positive and statistically significant in the long run, suggesting a positive impact of money supply on inflation in the Gambia. However, in the short run, results reveal a negative and statistically significant impact on inflation, as indicated by the coefficient on ΔMS. The coefficients of economic growth (GDPC and ΔGDPC) were positive and statistically significant, irrespective of whether the regression was conducted in the long run or in the short run. These

results suggest that economic growth had a positive impact on the inflationary process in the Gambia. This view is supported in similar studies by Nguyen (2015), and by Coban and Yussif (2019). The authors argue a positive relationship between economic growth and inflation. On the other hand, the coefficients of private investment (GFCF and ΔGFCF) were negative and statistically significant, irrespective of whether the regression was conducted in the long run or in the short run. This result, although contrary to the expectation of the study, was not unusual (see also Ahmad et al., 2012). Furthermore, the results show that the coefficient of trade openness (TOP) was positive and statistically significant in the long run. However, in the short run, results reveal that the coefficient on trade openness ΔTOP is statistically insignificant in the current period, but a negative and statistically significant impact on inflation in the previous period as indicated by ΔTOP(-1). The estimated result of the ECM_{t-1} from Panel B shows that the sign of ECM_{t-1} is negative, as expected, and statistically significant at the 1% significance level. This implies that the rate of adjustment to equilibrium was 97% in one period if there was a shock. The regression results were a good fit, as indicated by the adjusted R-squared of 69%.

Table 7: Long run and short run results – NARDL model

Regressor	**Nonlinear ARDL model**		
	Coefficient	***Standard error***	***p-value***
Panel A: Long run regression coefficients			
lnPD_POS	1.9499***	0.5876	0.0028
lnPD_NEG	0.2385	0.4279	0.5823
lnMS	0.9080*	0.4895	0.0754
lnGDPC	6.4418**	3.0342	0.0438
lnGFCF	-1.0582**	0.4499	0.0268
lnTOP	1.4810**	0.5377	0.0108
Panel B: Short run regression coefficients			
C	-24.5241***	3.3345	0.0000
Δ lnINF(-1)	-0.2330***	0.1186	0.0607
Δ lnPD_POS	3.8780***	1.1180	0.0019
Δ lnPD_POS(-1)	2.8595***	0.8689	0.0030
Δ lnPD_NEG	0.2322	0.4159	0.5817
Δ lnMS	-1.3343**	0.5493	0.0227
Δ lnGDPC	6.2710**	2.9431	0.0431
Δ lnGFCF	-1.0301**	0.4290	0.0241
Δ lnTOP	0.9392	0.5562	0.1037
Δ lnTOP(-1)	-1.3938**	0.5251	0.0136
ECM(-1)	-0.9735***	0.1330	0.0000
R-squared: 0.7502; Adjusted R-squared: 0.6938; F-statistic: 13.3025***; Prob.(F-statistic): 0.0000; Akaike info criterion: 1.3513; Schwarz criterion: 1.6925			

Note: *** and ** denote significance at 1%, and 5%, respectively

Table 8 shows diagnostic test results for serial correlation, heteroscedasticity, normality and functional form to ascertain the validity of the estimated model. The results show that the estimated model passed all diagnostic tests. In addition, the stability of the estimated model was confirmed by the cumulative sum of the recursive residual (CUSUM) and the cumulative sum of squares of

the recursive residual (CUSUMSQ) test. The results displayed in Figure 2 and Figure 3 suggest that the estimated model is stable. The significance of the short-run and long-run asymmetry for positive and negative shocks in total public debt is also verified in the graph of the NARDL cumulative dynamic multipliers that are shown in Figure 4. Overall, the dynamic multiplier plots show that inflation is more sensitive to positive shocks in total public debt in contrast to negative shocks displaying a significant positive asymmetry over time. Hence, the most important shocks are the ones increasing total public debt. Policies should, therefore, be targeted at sustaining appropriate total public debt to GDP ratio levels to the long run.

Table 8: Post-estimation diagnostic test results

Nonlinear ARDL model		
Null Hypothesis (F-statistic)	***F-statistic***	***p-value***
Breusch-Godfrey Test: No Serial Correlation	0.7279	0.4937
Breusch-Pagan-Godfrey: Heteroskedasticity Test	1.0879	0.4115
Ramsey RESET Test: Functional Form	0.1399	0.7117
Normality: CHSQ (2)	0.5083	0.7756

Figure 2: NARDL model CUSUM plot

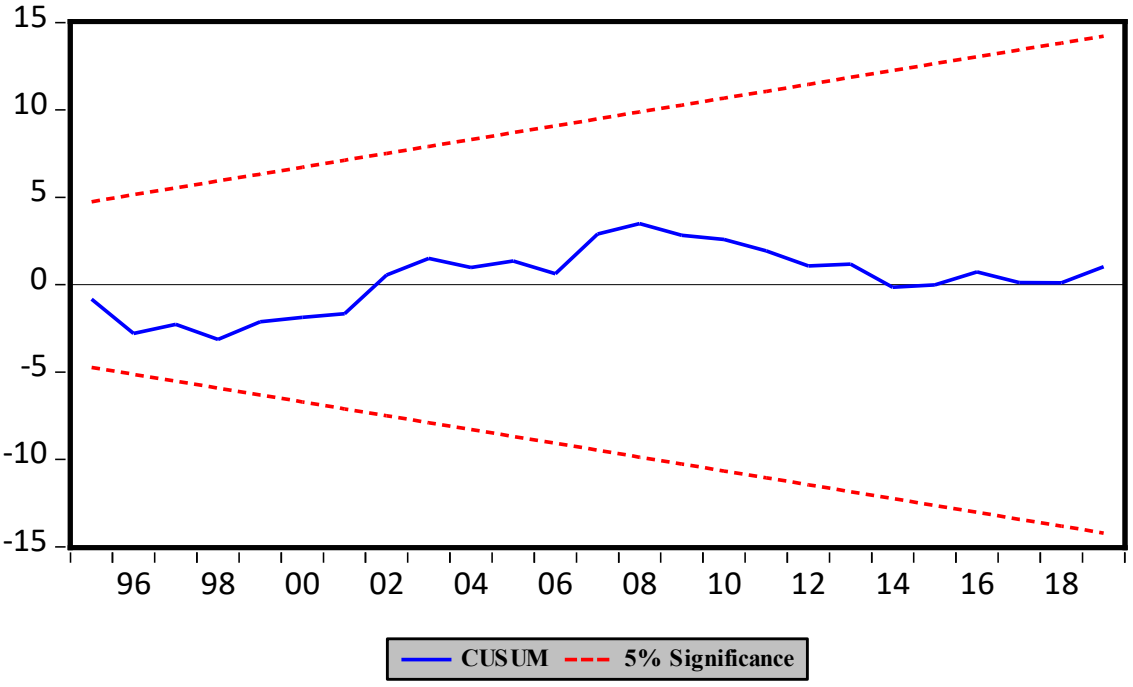


Figure 3: NARDL model CUSUM of square plot

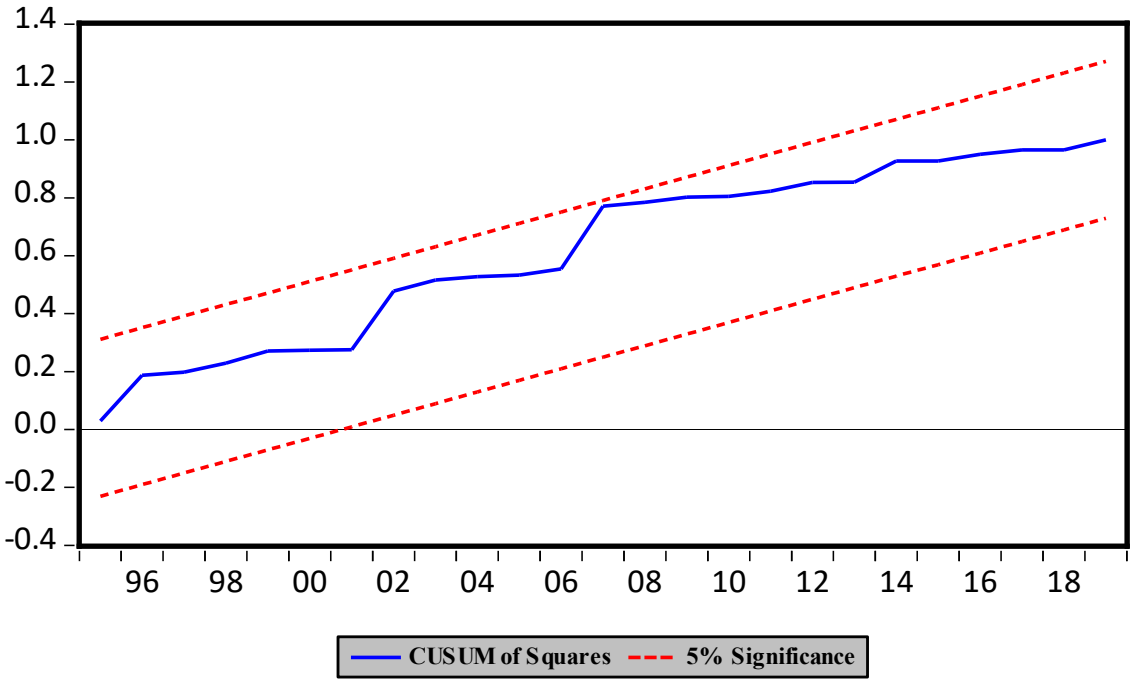
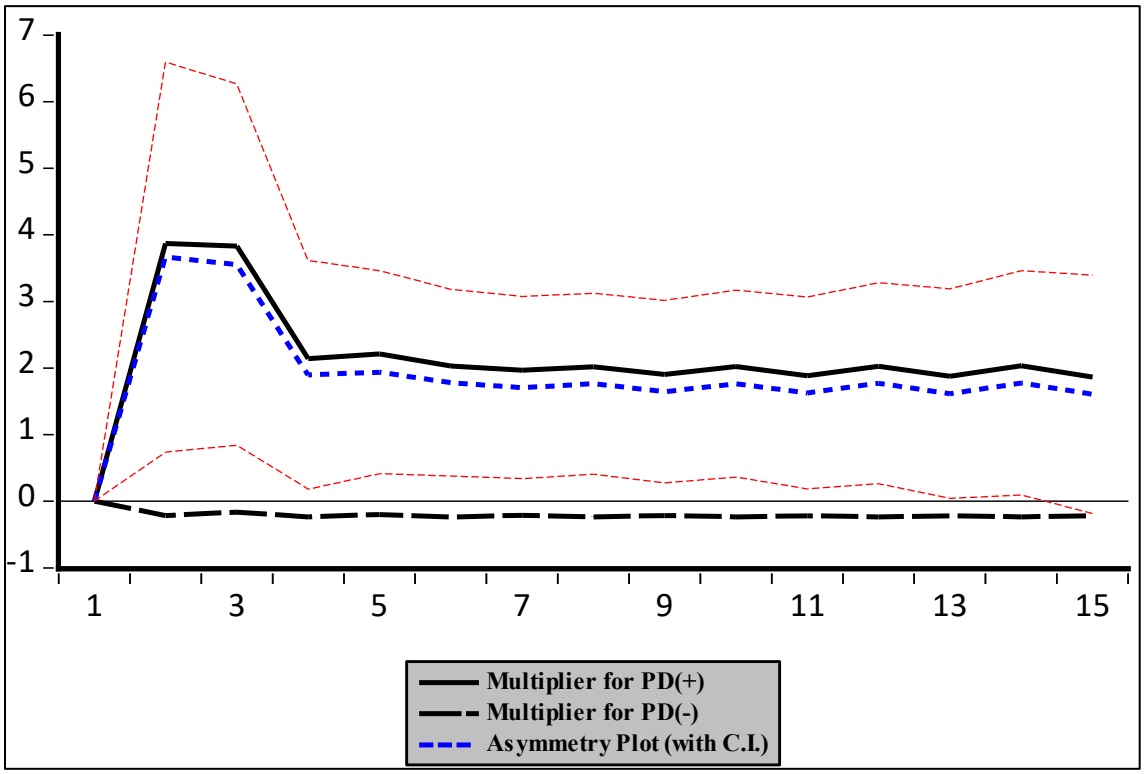


Figure 4: Total public debt dynamic multipliers



5. Conclusion

The main objective of this paper was to investigate the nature of the link between total public debt and inflation in the Gambia using annual data from the period between 1978 and 2019. This study used the NARDL approach to cointegration and error correction model to examine whether total public debt has a symmetric or asymmetric link with inflation in the Gambia. The study, in addition to the standard unit root test, also used the Zivot-Andrews structural break unit root test to ascertain the true order of integration for the study variables. The findings for the NARDL model showed a stable long run cointegration among inflation, total public debt, money supply, private investment, trade openness and economic growth for the study period. The results show an asymmetric relationship between total public debt and inflation, irrespective of whether the analysis was conducted in the short run or in the long run. The estimated results further show that inflation is a positive function of positive and negative changes in total public debt, irrespective of whether the regression was conducted in the short run or in the long run. Positive shocks in total public debt are statistically significant in the short run and in the long run, suggesting the inflationary effect of positive variation in total public debt in the Gambia. This finding is consistent with the effect of an increase in public debt on inflation in the fiscal theory of the price level determination. On the other hand, even though the coefficients of negative variation in total public debt may suggest that if total public debt decreases, inflation also decreases, the coefficients are not statistically significant in the long run and in the short run. This result remains an empirical question that would require further investigation. Overall, the study confirms the inflationary effect of total public debt and an asymmetric relationship between these variables in the Gambia. The study, therefore, suggests that an optimal estimation technique for testing the relationship between total public debt and inflation in the Gambia should incorporate the nonlinear approach. The study also recommends that the government of The Gambian should approach an increase in total public debt with caution considering its associated risk in achieving the main objective of monetary policy. Notwithstanding the significant contribution of this study to existing literature, lack of disaggregated data on total public debt (external and domestic) limits the current study's analysis to total public debt. Consequently, the study was unable to distinguish the impact of external and domestic public debt on inflation. Future research might use disaggregated data on public debt, together with other variables such as oil prices and exchange rate that have caused changes in inflation rate in the country, to further investigate the nonlinear relationship between external public debt, domestic public debt and inflation in the Gambia to see whether the results would be significantly different. This would also help to provide insight into the effects of external and domestic public debt on inflation in the Gambia. The study could also be extended to other countries, especially using a long-dated disaggregated data span.

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