External Debt, Domestic Debt and Inflation in Nigeria: A Multivariate Granger-Causality Test

Akingbade U. Aimola[*♣] and **Nicholas M. Odhiambo**[♣]

[♣]University of South Africa, South Africa

Submitted: June 1, 2022 • Accepted: October 5, 2022

ABSTRACT: Most recent studies have established a significant link between public debt and inflation. However, limited studies dealt with the direction of causality between these variables. Since external public debt relief in 2005, the Nigerian government has pursued public debt management strategy aimed at restoring macroeconomic stability. Yet, inflation rates remain high compared to the Central Bank's single digit policy target range of 6% to 9%. It is unclear whether the high inflation rate is related to the renewed contributions of external and domestic public debt in the funding of the budget deficit, and if it is, what could be the direction of the causality? Therefore, this study examines the dynamic Granger-causality between public external and domestic debt and inflation in Nigeria using annual data for the period between 1986 and 2019. The study introduces interest rate and economic growth as intermittent variables alongside key variables to create a multivariate Granger-causality model to account for omission-of-variable bias. Using the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration and the error correction model (ECM)-based Granger-causality test, the results show a distinct unidirectional causal flow from inflation to external debt. The findings further show a feedback relationship between domestic debt and inflation in the short run, but causality runs from domestic debt to inflation in the long run. The findings of this study have important policy implications.

JEL classification: C32, E31, H63.

Keywords: Domestic Debt, External Debt, Inflation, Nigeria, Granger-Causality.

[*]Corresponding Author. E-mail: jafbroms@yahoo.com

DOI: 10.2478/erfin-2022-0005

1 Introduction

The current economic environment amid Coronavirus disease (COVID-19) has seen a decline in government revenue accumulation in Nigeria. Some policymakers attribute these to dwindling oil prices further exacerbated by the COVID-19 pandemic and shortfall in tax revenue. Nigeria has also witnessed large deficits and increases in public debt to GDP ratios in recent decades. Despite these challenges, the government has relied on public borrowings to finance its deficits. According to Blanchard and Johnson (2013), budget deficit may increase public debt. Therefore, the government must pay attention to the macroeconomic consequences of public debt dynamics, especially inflation, since public debt can result from a budget deficit.

Most studies on the public debt-inflation nexus in developed and developing countries focus on impact analysis. Only a few studies have explored causality between these variables. Even though these studies show a significant impact of public debt on inflation, establishing the direction of causality is crucial. The knowledge of the direction of causality between public debt and inflation would, for instance, provide policymakers with the appropriate information as to targeted public debt management strategy and monetary policy interventions to be devised in areas needed.

In Nigeria, the choice of increasing interest rates in the management of inflation needs to be approached with caution. According to Blanchard (2004) and Favero and Giavazzi (2004), economies with large public debt that increase interest rates aimed at controlling inflation rate may increase the cost of debt service, debt level, default probability and country premium, which may trigger capital outflows and exchange rate depreciation that may affect inflation expectations and in the end inflation itself. Hence, the issues of the direction of causality between public external debt and inflation and public domestic and inflation are vital to macroeconomic stability in Nigeria.

There is a dearth of literature in general and for Nigeria on causality between public external debt and inflation and public domestic debt and inflation. To our knowledge, studies have explicitly addressed this issue with the pairwise Granger-causality test. According to Lütkepohl (1982), Granger-causality in a bivariate framework may suffer from omitted-variable-bias. This study addresses the problem of omitted variable bias in the bivariate Granger-causality framework by introducing interest rate and economic growth as intermittent variables alongside inflation, public external debt and public domestic debt to create a multivariate Granger-causality model.

To this end, this study empirically investigates the causal relationship between public external debt and inflation and public domestic debt and inflation using annual time-series data in Nigeria. The study uses Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration and the error correction model (ECM)-based Granger-causality test because of its robustness in the presence of a small sample size to investigate the causal relationship between these variables. To our knowledge, few studies have attempted to study the causal relationship between public external debt and inflation and public

domestic debt and inflation. This study aims to provide the answer to the question on the direction of causality between these variables in Nigeria to check whether the results differ fundamentally from other studies. The study would therefore fill an important gap in the empirical literature, especially for developing countries such as Nigeria.

The remaining part of the paper is organised as follows. Section 2 analyses the dynamics of public external debt, public domestic debt and inflation in Nigeria. Section 3 reviews relevant literature on the relationship between public debt and inflation. Section 4 describes the estimation techniques used in the study. Section 5 presents the results of the study. This paper ends with conclusions and final remarks.

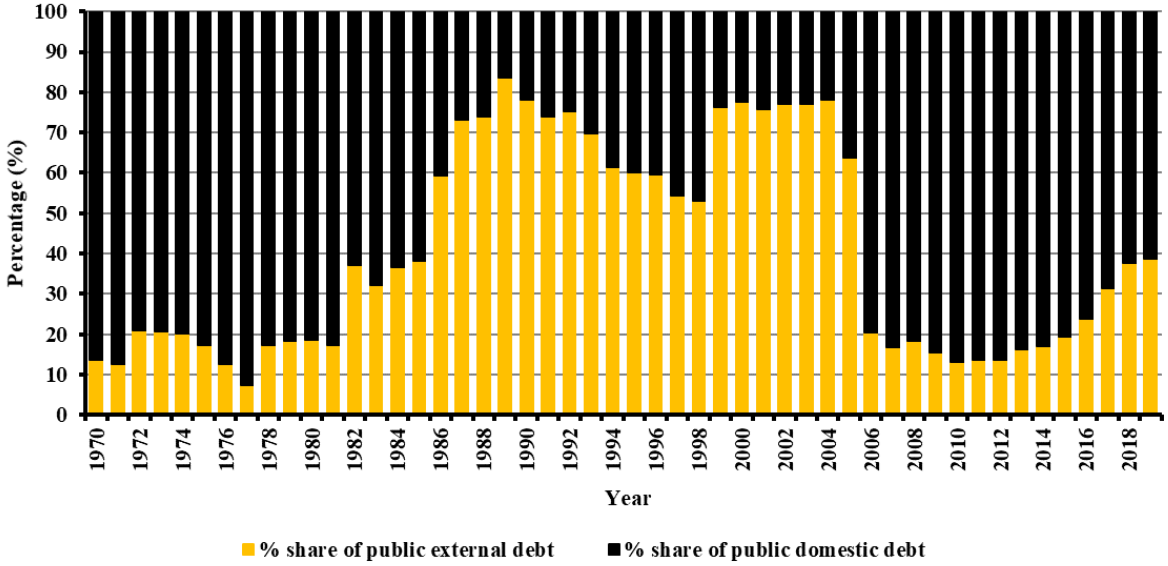
2 External debt, domestic debt and inflation dynamics in Nigeria

Similarly to many other developing economies, public debt in Nigeria has played a significant role in deficit financing because of dwindling oil revenue and tax revenue shortfalls. Since establishing the Debt Management Office in 2000, public debt management has significantly improved. As a result, the country has recorded debt burden indicators well below the identified debt limit thresholds (Aimola and Odhiambo, 2018). For instance, the total public debt to GDP ratio stood at 16.00% at the end of 2019 when compared to the Economic Community of the West African States (ECOWAS) total public debt convergence threshold of 70.00% for countries within the sub-region (Central Bank of Nigeria, 2019; Debt Management Office Nigeria, 2017). According to the World Bank's debt management performance assessment evaluations, the debt policy rating in Nigeria was an average of 4.23 between 2005 and 2019 (out of 1 = low to 6 = high) (World Bank, 2019). The ranking indicates that the government is actively engaged in debt management operations.

Figure 1 shows trends in the composition of Nigeria's total public debt stock from 1970 to 2019. As shown in Figure 1, Federal Government's domestic debt stock largely dominated total public debt stock from 1970 to 1985 averaging 78.72% share of total public debt stock (Central Bank of Nigeria, 2003). On the other hand, between 1986 and 2005, external public debt stock dominated the largest share of total public debt stock, averaging 70.07% (Central Bank of Nigeria, 2019). According to Titus (2013), the capitalisation of defaulted interest payments and accumulation of payment arrears were responsible for the surge in external public debt stock for this period, even when no new loans were contracted. Figure 1 also shows that from 2006 to 2019, Federal Government's domestic debt stock dominated the total public debt stock portfolio averaging 78.84%. This trend highlights the renewed contribution of public domestic debt to fill funding gaps and the implementation of domestic debt management strategies (Debt Management Office Nigeria, 2017, 2018). The recent shift from public external debt to public domestic

debt in the total public debt portfolio reflects policy response to the debt crisis and the recent global financial crisis towards a debt portfolio composition target of 60:40 ratios for domestic public debt and external public debt, respectively, and government deepening of the financial market (Debt Management Office Nigeria, 2016). As a result, the public domestic debt ratio exceeded the target ratio for this period, while public external debt was below the target ratio. For instance, it was 73:27 in 2017, 68:32 in 2018, and 67:33 in 2019, respectively (Debt Management Office Nigeria, 2020). Overall, fiscal excess, the bottleneck in accessing funding and the implementation of debt management strategies are primarily linked to changes in these ratios.

Figure 1: Trends in the composition of total public debt stock (1970–2019)

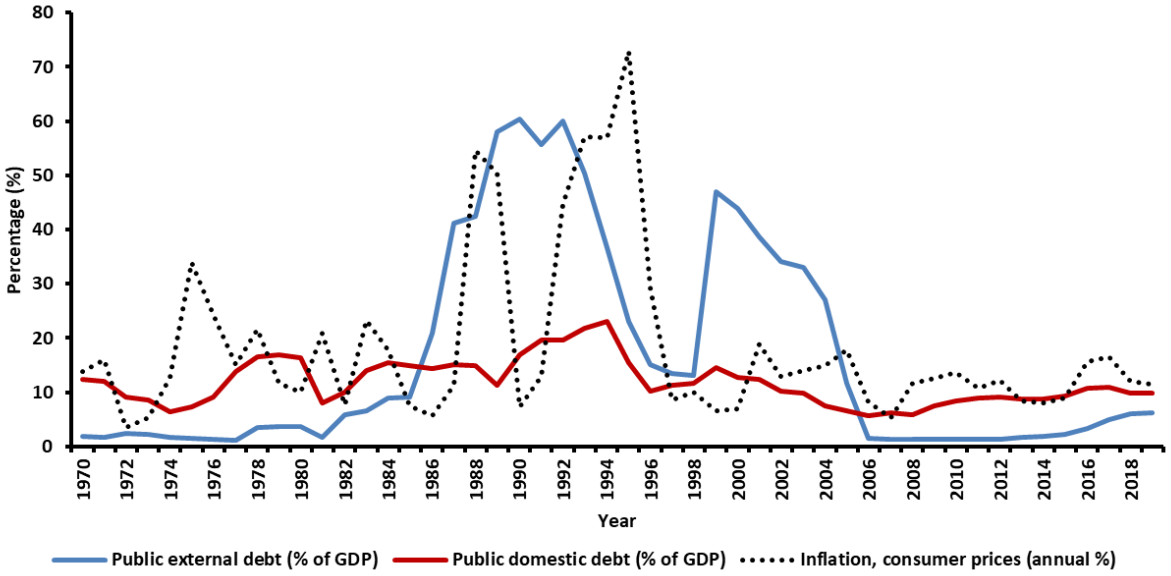


Source: Authors' compilation using Excel.

Figure 2 is an overview of the dynamics of public external debt, domestic debt and inflation rate from 1970 to 2019. Since the 1970s, Nigeria has accumulated large amounts of public external debt. The public external debt to GDP ratio increased from 1.95% in 1970 to 6.20% in 2019. Three prominent episodes produced sharp increases in public external debt in 1986, 1990 and 1999, peaking at 20.92%, 60.37% and 47.01%, respectively (Central Bank of Nigeria, 2019). The spikes in public external debt ratio, in the 1980s, were linked mainly to the effects of foreign exchange receipt in supporting the finance of infrastructural projects and the fall in the international crude oil price (Essien et al., 2016). The surges in public external debt ratio, in the 1990s, were linked to the capitalisation of defaulted interest payments and accumulation of payment arrears even when no new loans were contracted (Titus, 2013). In the 1990s, the increasing debt levels became unsustainable, causing repayment problems and a debt crisis. Nigeria 2005 secured public external debt relief, reducing the public external debt to GDP ratio from 26.98% in 2004 to 11.66% in 2005 and further in 2006 to 1.49%. The reduction in 2005 was due to the

implementation of the first and second phases of the Paris Club debt relief deal, while the reduction in 2006 was a result of the implementation of the third phase of the Paris Club debt deal and the exit from London Club debt obligations (Central Bank of Nigeria, 2019; Debt Management Office Nigeria, 2007). After that, increases in public external debt are linked mainly to the net negative effect of cross-exchange rate movements within loan portfolio currencies and the additional disbursements of multilateral and bilateral loans (Debt Management Office Nigeria, 2017).

Figure 2: Trends in external debt, domestic debt and inflation in Nigeria (1970–2019)



Source: Authors' compilation using Excel.

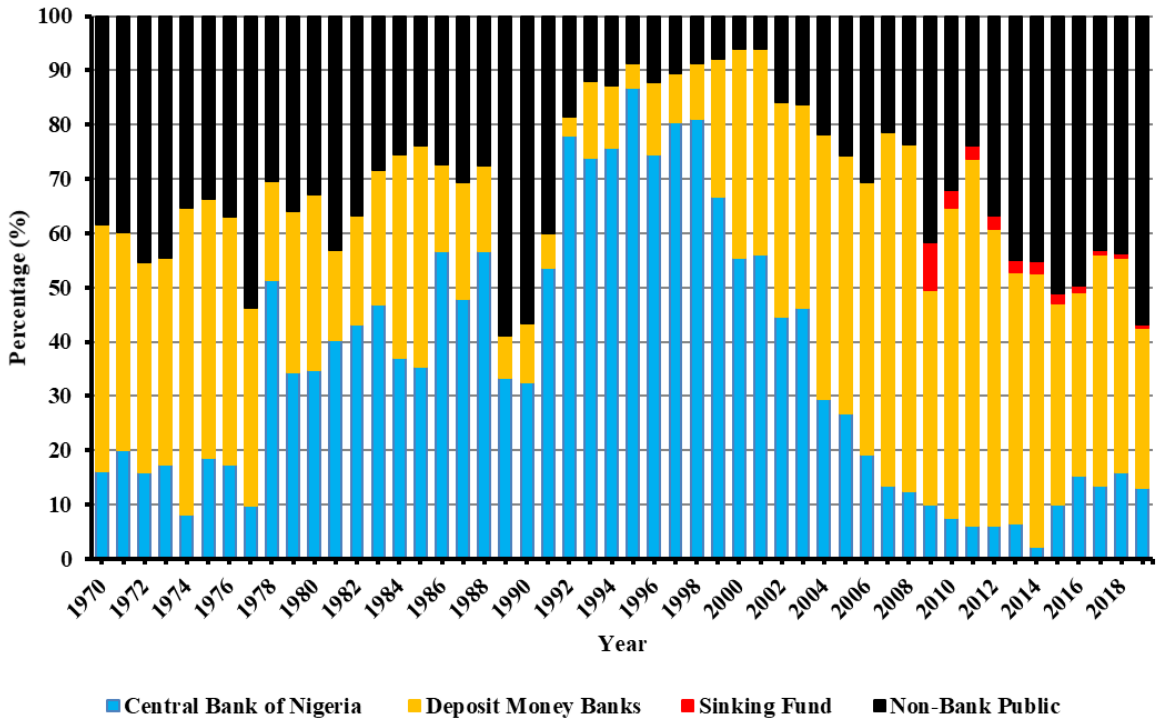
The federal government's domestic debt to GDP ratio, as shown in Figure 2, decreased from 12.41% in 1970 to 9.80% in 2019. The public domestic debt to GDP ratio increased from 12.41% in 1970 to 16.85% in 1979 and 21.78% in 1993 before reaching its peak in 1994 at 23.04%. After this period, there was a gradual decline to its minimum of 5.77% in 2006, shortly after public external debt relief in 2005 and 2006 (Central Bank of Nigeria, 2019). Onwards, the public domestic debt to GDP ratio gradually increased to 10.96% in 2017 before dropping to 9.80% in 2019. The changes after public external debt relief, according to Titus (2013), can be attributed to the government's deepening of the financial market through the development of financial instruments and domestic debt finance of budget deficits.

One of the main objectives of monetary policy in Nigeria is price stability. This policy is implemented together with fiscal policy to achieve this goal. For the period under review, fiscal imbalance in the country has impaired the outcome of this goal. A low and stable inflation rate is an indication of macroeconomic stability. The inflation rate hovered between single-digit and double-digit rates. As shown in Figure 2, the inflation rate decreased from 13.76% in 1970 to 11.40% in 2019. Three prominent episodes produced

sharp increases in the inflation rate in 1975, 1988 and 1995, peaking at 33.96%, 54.51% and 72.84%, respectively (World Bank, 2019). In the 1970s, 1980s and 1990s, spikes in inflation rate were primarily linked to the effect of government expansionary fiscal and monetary operations, monetisation of oil revenue and public external debt repurchased with new local currency obligation (Bawa et al., 2016; Moser, 1994). The government in the 1980s reduced the inflation rate through price control measures. The inflation rate fell to a single-digit rate in 1985 at 7.44% and in 1986 at 5.72%. In the 1990s, there was a sharp decline in the inflation rate from 72.84% in 1995 to 8.53% in 1997 and 6.62% in 1999, owing to government implementation of effective monetary and fiscal policies as well as stabilisation of the exchange rate (Udoh and Isaiah, 2018). During the 2000s, prudent macroeconomic policies also helped reduce and stabilise the inflation rate (Udoh and Isaiah, 2018). The inflation outcome remained single-digit in 2006, 2007, 2013, 2014 and 2015, and became double-digit from 2008 to 2012 and from 2016 to 2019. For instance, the double-digit rate in 2008 was linked mainly to global food shortages and financial crises. After that, other changes to double-digit rates are primarily linked to expansionary fiscal and monetary policy operations (Central Bank of Nigeria, 2010). The current double-digit rates do not compare favourably with the West African Monetary Zone (WAMZ) single-digit rate convergence criteria. The inflation rate stood at 11.40% at the end of 2019 (Central Bank of Nigeria, 2019).

According to Hanson (2007), since the recent banking crisis, governments in both crisis and non-crisis countries have continued to rely increasingly on domestic debt in the funding of their expenditure because of the fallen cost of borrowing compared to the past and relative to foreign debt. For the period under review, the domestic debt to GDP ratio witnessed moderate increases compared to notable increases in nominal terms. For instance, the public domestic debt to GDP ratio moderately increased from 6.60% in 2005 to 9.80% in 2019, compared to an increase in nominal terms from ₦ 1,525.91 billion in 2005 to ₦ 14,272.64 billion in 2019 (Central Bank of Nigeria, 2019). On average, for the study period, the central bank of Nigeria dominated the holding of public domestic debt. Borrowing costs were kept artificially low due to the central bank's purchase of most securities below the market-clearing rate. Hence, considering the critical role interest rate plays in the inflationary process and concerns among policymakers on the actual macroeconomic effects of public domestic debt in Nigeria, the study analyses the breakdown of public domestic debt by holders' category for the period between 1970 and 2019 briefly. The analysis of public domestic debt based on a composition by holders is essential because of the effects that unsustainable debt management policies, debt crises and economic distress may have on borrowing costs (Bua et al., 2014). In addition, a diverse investor base of public domestic debt holding reduces interest rates and rollover risks by weakening the monopoly power of a particular group of financial institutions (Bua et al., 2014; Christensen, 2004). Figure 3 shows the breakdown of public domestic debt by holders' category from 1970 to 2019.

Figure 3: Domestic debt composition by holders (1970–2019)



Source: Authors' compilation using Excel.

For the period under review, public domestic debt was held primarily by the central bank of Nigeria, deposit money banks, non-bank public and sinking funds. Sinking fund holdings of public domestic debt only cover the period from 2009 to 2019 in Nigeria. As shown in Figure 3, investors holding public domestic debt alternated primarily among the central bank of Nigeria, deposit money banks and non-bank public. On average, for the period between 1970 and 2019, holdings by the central bank of Nigeria, deposit money banks and non-bank public averaged 35.09%, 33.32%, and 31.05%, respectively. For the period before public external debt relief (1970–2004), the average holding by the central bank of Nigeria was 45.03%, deposit money banks were 26.90%, and the non-bank public was 28.07%. On the other hand, for the period after external public debt relief (2007–2019), held by the central bank of Nigeria, deposit money banks, non-bank public and sinking funds averaged 10.18%, 48.22%, 39.52%, 2.08%, respectively (Central Bank of Nigeria, 2003, 2019). The central bank of Nigeria's holdings of public domestic debt was dominant for the reviewed period, mainly between 1970 and 2003. This holding indicates monetary financing of budget deficits or the holdings utilised for monetary policy purposes (Christensen, 2004; United Nations Conference on Trade and Development, 2016). However, a noticeable decline in its share was observed starting in 2004, reflecting diversification in the holdings of government securities. This decline also coincided with a rise in non-bank public and a decline in deposit money banks' holdings of public domestic debt. The recent increases in non-bank public holdings reflect

policy response to broaden the investor base, reduce the risk of crowding out private investment and government deepening the financial market through the development of financial instruments, debt markets and domestic debt finance of budget deficits (Debt Management Office Nigeria, 2016; Titus, 2013).

Keeping in mind the discussion in this section, the management of public debt and inflation has created a significant challenge in the macroeconomic stabilisation process in Nigeria. Therefore, this study was carried out to empirically analyse the direction of causality between public debt and inflation in Nigeria. Based on the findings of this study, government should be able to implement target monetary policy and public debt management strategy aimed at further supporting/improving macroeconomic stabilisation in Nigeria.

3 Review of relevant literature

The causality between public debt and inflation has not been extensively explored. To date, to the researchers' knowledge, only a few studies were conducted on the causal relationship between public external debt and inflation and public domestic debt and inflation. Studies between these variables in developed and developing countries traditionally focused on impact analysis. However, few recent studies have explored causality between these variables, especially in developing countries. On the other hand, more studies focus on causality between the key determinants of government borrowing (budget surplus or deficit) and inflation. If the government runs a surplus public debt decreases, and when it runs a deficit, public debt increases (Blanchard and Johnson, 2013). How a budget deficit is financed can significantly impact inflation (Catão and Terrones, 2005; Olaniyi, 2020). Fiscal imbalance is one of the major factors responsible for changes in public debt stock in most countries. For instance, Aimola and Odhiambo (2021) reported that Islam and Wetzel (1991) argue that less developed countries' fiscal deficit has been blamed for much of their debt crises, high inflation and poor economic growth. Also, Budina and Van Wijnbergen (2000) argue that since 1989, persistent fiscal deficit problems have been the key factor behind inflation volatility in Eastern European countries. In addition, Kwon et al. (2006) suggested that within the Fiscal Theory of Price Level framework, the wealth effect of public debt is an additional channel of fiscal influence on inflation. Sims (2013), on the other hand, argue that regardless of policies followed by the monetary authorities, persistent and growing fiscal deficit finance through government borrowings eventually produces inflation.

Few studies have contributed to the literature on the causality between public debt and inflation in Nigeria. For example, Essien et al. (2016) examined the impact of public sector borrowings on prices, interest rates and output in Nigeria from 1970 to 2014. The study within the autoregressive vector framework established that the public external and domestic debt level did not significantly impact the general price level. The findings using

a pairwise Granger-causality test also show that neither public external debt nor public domestic debt Granger-cause inflation in Nigeria. Similarly, Odior and Arinze (2017), in their study for the period between 1980 and 2016, using a pairwise Granger-causality test, found that neither external debt nor domestic debt Granger-caused inflation, but in the short run, unidirectional Granger-causality ran from inflation to external debt, and from inflation to domestic debt in Nigeria. On the other hand, when Ezirim et al. (2016) used domestic debt burden (measured by Treasury Bills rate) for the period between 1970 and 2010 in a pairwise Granger-causality test, results showed that debt burden represented by debt-service payment (the interest payments on debts) made by the government to its domestic creditors exerted significant inflationary pressures on the economy, but not vice versa. These studies might have suffered from problems associated with omitted variable bias in a bivariate Granger-causality test framework. Similarly, Feridun and Adebiyi (2006), using the Mean Absolute Percentage Errors (MAPEs) method to forecast inflation, confirmed that given monetary variables and information about inflation, domestic debt might have been more helpful in predicting inflation in Nigeria. This finding further suggests the inflationary tendencies of domestic debt in the country.

Yien et al. (2017) examined the dynamic relationship between external debt, domestic debt, exchange rate and inflation in Malaysia between 1960 and 2014 using exploratory data analysis, the Johansen cointegration test and the Granger-causality test. The analysis showed that domestic and external debt had a strong positive association with inflation. In the short run, external debt impacted inflation significantly. Their findings further revealed that domestic debt did not Granger-cause inflation, but inflation was found to Granger-cause domestic debt. On the other hand, in a similar study by Devapriya and Ichihashi (2012) for Sri Lanka within the autoregressive vector framework, the Granger-causality test revealed evidence of bidirectional causality between domestic financing and inflation, while unidirectional causality ran from inflation to foreign financing.

In the case of causality between total public debt and inflation, Taghavi (2000) assessed the potential adverse effects of large debts on price inflation, real GDP growth, real debt ratio and real gross fixed capital formation in four large European economies (France, Germany, Italy and United Kingdom) for the period between 1970 and 1997. The pairwise Granger-causality test results suggested that all countries had a debt ratio (gross public debt as % of GDP) Granger-cause inflation under three- and five-year lags. The findings further showed bidirectional causality at five-year lags between debt ratio and inflation in Germany, Italy and United Kingdom. Similarly, Lai et al. (2015) examined the causal relationship between government debt, gross domestic product and inflation in France using annual data for the period between 1980 and 2010. The study used Vector Autoregression (VAR) model and the Granger causality test to analyse the causal relationship among these variables. The study found a strong bidirectional causal relationship between government debt and inflation in France.

Examining the relationship between domestic debt, inflation and economic crises,

Bildirici and Ersin (2007) revealed that increasing the public debt to GDP ratio increased the costs of public domestic debt, and the government eventually secured debt at a higher cost and low maturity, further contributing to inflationary pressure. This result was confirmed in a similar study done by Ahmad et al. (2012) for Pakistan on the relationship between public domestic debt and inflation between 1972 and 2009. The study suggested that the stock of public domestic debt and its related debt service cost contributed to fluctuations in the general price level in Pakistan.

Karakaplan (2009) used the generalised panel method of moments (GMM) Arellano-Bond estimation method for 121 countries, including developed, emerging market and developing countries, between 1960 and 2004, and found that external debt was less inflationary in economies with well-developed financial markets. The study further suggested that the effect of external debt on inflation varied across countries. Similarly, Cardoso and Fishlow (1990) examined the relationship between external public debt and inflation in Brazil using a seignorage model for an open economy with a standard financial market. The research outcomes showed that switching from external to domestic budget deficit finance pushed both real interest rates and inflation rates upward. The study concluded that inflation acceleration between 1979 and 1985 in Brazil was linked to the switch from external to domestic finance of budget deficit in the country. In yet another study, Koluri and Giannaros (1987) confirmed the direct and indirect effects of external debt on the inflation rate in Brazil and Mexico; only the indirect effect was established through money growth.

In Nigeria, increases in public debt stock were mainly driven by large fiscal deficits because of dwindling oil revenue and tax revenue shortfalls. Recent data shows that public debt stock is primarily made up of public debt stock due to domestic budget deficit finance (Central Bank of Nigeria, 2019; Debt Management Office Nigeria, 2020). Folorunso (2013) disaggregated public debt into domestic and external debt to examine the causal relationship and the relative effect of both categories of debt on fiscal deficit using time series data for the period between 1970 and 2011 in the country. The pairwise Granger-causality test results supported a bidirectional relationship between fiscal balance and public debt as well as its domestic component, while causality ran only from external debt to fiscal deficit. This study's results further showed that domestic and external debt had positive impacts on the fiscal deficit in Nigeria. Domestic debt had a more significant impact on the fiscal deficit than external debt. Inflation negatively and significantly impacted the fiscal deficit in the short run. Income growth was the key factor influencing fiscal deficit in the short and the long run. The paper concluded that Nigeria's high public debt levels could have been attributed to persistently high fiscal deficits, while the fiscal deficit was also not insulated from the level of public debt. These findings further justify the literature review on the causal relationship between the primary cause of government borrowings (fiscal deficits) and inflation for the current study because, for the study period, fiscal deficits were financed mainly through government borrowings.

Government borrowings play a significant role in deficit financing in Nigeria. From 1986 to 2019, excluding 1995 and 1996, the government ran a budget deficit with increases in public debt stock (Central Bank of Nigeria, 2019). According to Koluri and Giannaros (1987), expansionary fiscal policy actions financed through borrowing were bound to increase inflationary pressures. Therefore, this study briefly highlights studies on the causal relationship between fiscal deficit and inflation. Available studies on this issue can be broadly classified into three groups. The first group argue that there is a unidirectional causal flow from deficit to inflation. The second group posits bidirectional causality between deficit and inflation. The third group suggests no causality between deficit and inflation. The studies by Ssebulime and Edward (2019) for the case of Uganda; Murshed et al. (2018) for Bangladesh; Dissanayake (2016) for Sri Lanka; Inam (2014); Awe and Olalere (2012); Anayochukwu (2012); Onwioduokit (1999); Oladipo and Akinbobola (2011) for the case of Nigeria; and Parida et al. (2002) for India revealed unidirectional causality running from budget deficit to inflation. On the other hand, Devapriya and Ichihashi (2012) for Sri Lanka, Oseni and Sanni (2016); Chimobi and Igwe (2010) for the case of Nigeria; and Ahking and Miller (1985) for the United States support bidirectional causality between budget deficit and inflation. The third group, which supports no causality between deficit and inflation, includes studies done by Bwire and Nampewo (2014) for Uganda, and more recently, by Olaniyi (2020) for Nigeria. The findings of the highlighted studies tentatively show possible outcomes for the causality test between public debt and inflation, given the contribution of public debt to budget deficit financing in Nigeria. According to Blanchard and Johnson (2013), if the government runs a surplus public debt decreases and when it runs a deficit, public debt increases. Hence, empirically investigating the causal relationship between public debt (domestic and external) and inflation in Nigeria cannot be overemphasised.

The literature reviewed in this section provided an understanding of the relationship between public debt and inflation from a country-specific and mixed-countries perspective. The outcomes vary from country to country, and it could be concluded that the direction of causality between public debt and inflation is not clear-cut. Therefore, it would be difficult to draw a general conclusion about the direction of causality between public debt and inflation for this study. Existing evidence also indicates that literature has not yet established any conclusive and consistent evidence on the direction of causality between public debt and inflation.

Given the inconclusive evidence from the existing literature, the need to continuously assess the current development in causality between public debt and inflation is justified. Hence, this study is expected to fill the existing literature gap on causality between public debt and inflation in Nigeria, especially as it concerns the short- and the long-run horizon using contemporary econometric techniques. The study, therefore, aims to re-examine the direction of causality between public external debt and inflation and public domestic debt and inflation, taking advantage of recent annual time series data in Nigeria.

4 Estimation techniques

4.1 The ARDL bounds testing approach to cointegration

In this study, to empirically analyse the existence of a cointegration relationship among variables, the ARDL bounds testing approach is used. This approach by Pesaran et al. (2001) is based on the ordinary least squares (OLS) estimation technique. The rationale for adopting this modelling approach to cointegration over other bounds testing approaches such as Engle and Granger (1987) and Johansen and Juselius's (1990) cointegration method is the robust ability of the ARDL test in capturing short-run and long-run relationships in small sample size. Moreover, the procedure can also be used to examine cointegration regardless of whether the underlying regressors are integrated of order zero [I(0)] or order one [I(1)] or a mixture of both (Narayan and Smyth, 2005; Pesaran et al., 2001). In addition, given that the ARDL approach can use Akaike Information Criterion (AIC) and Schwartz-Bayesian Criterion (SIC), among others, to guide our choice of optimal lag length to avoid incorrect model specification and problems of degrees of freedom due to short-lag lengths and long-lags, respectively, the general-to-specific modelling approach can also be adopted within the ARDL framework to obtain optimal lag length per variable. Lastly, even when some of the regressors are endogenous, the ARDL approach can obtain unbiased long-run estimates and valid t-statistics (see also Odhiambo, 2008).

The current study consists of two models – Model 1 and Model 2. Model 1 tests the causality between public external debt and inflation. Model 2 examines the causality between public domestic debt and inflation. In these models, two variables are added apart from key variables of interest to address the variable-omission bias associated with the bivariate Granger-causality model. These models, which allow for dynamics involving other variables than the key variables under consideration, incorporated interest rate and economic growth as the intermittent variables to create a multivariate Granger-causality model. The choice of these variables was based on theoretical and empirical literature. The models are explicitly specified as follows:

Model 1 – Public external debt and inflation

$$\mathrm{INF} = f(\mathrm{ED}, \mathrm{LR}, \mathrm{GDP}) \tag{1}$$

Model 2 – Public domestic debt and inflation

$$\mathrm{INF} = f(\mathrm{DD}, \mathrm{LR}, \mathrm{GDP}) \tag{2}$$

where:
INF = Inflation;

ED = Public external debt;
DD = Public domestic debt;
LR = interest rate;
GDP = economic growth.

Following Pesaran et al. (2001) and Narayan and Smyth (2005), cointegration equations for Model 1 can be specified as follows, taking each variable in turn as a dependent variable:

Model 1 – ARDL specification

$$\begin{aligned}\Delta \ln \mathrm{INF}_t = \varphi_0 &+ \sum_{i=1}^{n} \varphi_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=0}^{n} \varphi_{2i} \Delta \ln \mathrm{ED}_{t-i} \\ &+ \sum_{i=0}^{n} \varphi_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=0}^{n} \varphi_{4i} \Delta \ln \mathrm{GDP}_{t-i} \\ &+ \varphi_5 \ln \mathrm{INF}_{t-1} + \varphi_6 \ln \mathrm{ED}_{t-1} + \varphi_7 \ln \mathrm{LR}_{t-1} + \varphi_8 \ln \mathrm{GDP}_{t-1} + \mu_{1t} \end{aligned} \tag{3}$$

$$\begin{aligned}\Delta \ln \mathrm{ED}_t = \gamma_0 &+ \sum_{i=1}^{n} \gamma_{1i} \Delta \ln \mathrm{ED}_{t-i} + \sum_{i=0}^{n} \gamma_{2i} \Delta \ln \mathrm{INF}_{t-i} \\ &+ \sum_{i=0}^{n} \gamma_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=0}^{n} \gamma_{4i} \Delta \ln \mathrm{GDP}_{t-i} \\ &+ \gamma_5 \ln \mathrm{ED}_{t-1} + \gamma_6 \ln \mathrm{INF}_{t-1} + \gamma_7 \ln \mathrm{LR}_{t-1} + \gamma_8 \ln \mathrm{GDP}_{t-1} + \mu_{2t} \end{aligned} \tag{4}$$

$$\begin{aligned}\Delta \ln \mathrm{LR}_t = \delta_0 &+ \sum_{i=1}^{n} \delta_{1i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=0}^{n} \delta_{2i} \Delta \ln \mathrm{INF}_{t-i} \\ &+ \sum_{i=0}^{n} \delta_{3i} \Delta \ln \mathrm{ED}_{t-i} + \sum_{i=0}^{n} \delta_{4i} \Delta \ln \mathrm{GDP}_{t-i} \\ &+ \delta_5 \ln \mathrm{LR}_{t-1} + \delta_6 \ln \mathrm{INF}_{t-1} + \delta_7 \ln \mathrm{ED}_{t-1} + \delta_8 \ln \mathrm{GDP}_{t-1} + \mu_{3t} \end{aligned} \tag{5}$$

$$\begin{aligned}\Delta \ln \mathrm{GDP}_t = \beta_0 &+ \sum_{i=1}^{n} \beta_{1i} \Delta \ln \mathrm{GDP}_{t-i} + \sum_{i=0}^{n} \beta_{2i} \Delta \ln \mathrm{INF}_{t-i} \\ &+ \sum_{i=0}^{n} \beta_{3i} \Delta \ln \mathrm{ED}_{t-i} + \sum_{i=0}^{n} \beta_{4i} \Delta \ln \mathrm{LR}_{t-i} \\ &+ \beta_5 \ln \mathrm{GDP}_{t-1} + \beta_6 \ln \mathrm{INF}_{t-1} + \beta_7 \ln \mathrm{ED}_{t-1} + \beta_8 \ln \mathrm{LR}_{t-1} + \mu_{4t} \end{aligned} \tag{6}$$

where:
INF = Inflation;
ED = Public external debt;

LR = Interest rate;
GDP = Economic growth;
φ_0, γ_0, δ_0, and β_0 = respective constant;
$\varphi_1 - \varphi_4$, $\gamma_1 - \gamma_4$, $\delta_1 - \delta_4$ and $\beta_1 - \beta_4$ = respective short-run coefficients;
$\varphi_5 - \varphi_8$, $\gamma_5 - \gamma_8$, $\delta_5 - \delta_8$ and $\beta_5 - \beta_8$ = respective long-run coefficients;
Δ = difference operator;
ln = natural logarithm;
n = lag lengths;
and $\mu_{1t} - \mu_{4t}$ = white-noise error terms.

Model 1 – ECM-based Granger-causality specification

The generic ECM-based Granger-causality function for Model 1 can be specified as follows:

$$\Delta \ln \mathrm{INF}_t = \varphi_0 + \sum_{i=1}^{n} \varphi_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \varphi_{2i} \Delta \ln \mathrm{ED}_{t-i} + \sum_{i=1}^{n} \varphi_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=1}^{n} \varphi_{4i} \Delta \ln \mathrm{GDP}_{t-i} + \varphi_9 \, \mathrm{ECM}_{t-1} + \mu_{1t} \tag{7}$$

$$\Delta \ln \mathrm{ED}_t = \gamma_0 + \sum_{i=1}^{n} \gamma_{1i} \Delta \ln \mathrm{ED}_{t-i} + \sum_{i=1}^{n} \gamma_{2i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \gamma_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=1}^{n} \gamma_{4i} \Delta \ln \mathrm{GDP}_{t-i} + \gamma_9 \, \mathrm{ECM}_{t-1} + \mu_{2t} \tag{8}$$

$$\Delta \ln \mathrm{LR}_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=1}^{n} \delta_{2i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \delta_{3i} \Delta \ln \mathrm{ED}_{t-i} + \sum_{i=1}^{n} \delta_{4i} \Delta \ln \mathrm{GDP}_{t-i} + \delta_9 \, \mathrm{ECM}_{t-1} + \mu_{3t} \tag{9}$$

$$\Delta \ln \mathrm{GDP}_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i} \Delta \ln \mathrm{GDP}_{t-i} + \sum_{i=1}^{n} \beta_{2i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \beta_{3i} \Delta \ln \mathrm{ED}_{t-i} + \sum_{i=1}^{n} \beta_{4i} \Delta \ln \mathrm{LR}_{t-i} + \beta_9 \, \mathrm{ECM}_{t-1} + \mu_{4t} \tag{10}$$

All variables, parameters and notations remain as defined in Equations (3)–(6). φ_9, γ_9, δ_9, and β_9 are the coefficients of one period lagged error-correction term (ECM_{t-1}).

Model 2 – ARDL specification

$$\begin{aligned}\Delta \ln \mathrm{INF}_t = \psi_0 &+ \sum_{i=1}^{n} \psi_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=0}^{n} \psi_{2i} \Delta \ln \mathrm{DD}_{t-i} \\ &+ \sum_{i=0}^{n} \psi_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=0}^{n} \psi_{4i} \Delta \ln \mathrm{GDP}_{t-i} \\ &+ \psi_5 \ln \mathrm{INF}_{t-1} + \psi_6 \ln \mathrm{DD}_{t-1} + \psi_7 \ln \mathrm{LR}_{t-1} + \psi_8 \ln \mathrm{GDP}_{t-1} + \omega_{1t} \end{aligned} \tag{11}$$

$$\begin{aligned}\Delta \ln \mathrm{DD}_t = \theta_0 &+ \sum_{i=0}^{n} \theta_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \theta_{2i} \Delta \ln \mathrm{DD}_{t-i} \\ &+ \sum_{i=0}^{n} \theta_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=0}^{n} \theta_{4i} \Delta \ln \mathrm{GDP}_{t-i} \\ &+ \theta_5 \ln \mathrm{INF}_{t-1} + \theta_6 \ln \mathrm{DD}_{t-1} + \theta_7 \ln \mathrm{LR}_{t-1} + \theta_8 \ln \mathrm{GDP}_{t-1} + \omega_{2t} \end{aligned} \tag{12}$$

$$\begin{aligned}\Delta \ln \mathrm{LR}_t = \alpha_0 &+ \sum_{i=0}^{n} \alpha_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=0}^{n} \alpha_{2i} \Delta \ln \mathrm{DD}_{t-i} \\ &+ \sum_{i=1}^{n} \alpha_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=0}^{n} \alpha_{4i} \Delta \ln \mathrm{GDP}_{t-i} \\ &+ \alpha_5 \ln \mathrm{INF}_{t-1} + \alpha_6 \ln \mathrm{DD}_{t-1} + \alpha_7 \ln \mathrm{LR}_{t-1} + \alpha_8 \ln \mathrm{GDP}_{t-1} + \omega_{3t} \end{aligned} \tag{13}$$

$$\begin{aligned}\Delta \ln \mathrm{GDP}_t = \lambda_0 &+ \sum_{i=0}^{n} \lambda_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=0}^{n} \lambda_{2i} \Delta \ln \mathrm{DD}_{t-i} \\ &+ \sum_{i=0}^{n} \lambda_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=1}^{n} \lambda_{4i} \Delta \ln \mathrm{GDP}_{t-i} \\ &+ \lambda_5 \ln \mathrm{INF}_{t-1} + \lambda_6 \ln \mathrm{DD}_{t-1} + \lambda_7 \ln \mathrm{LR}_{t-1} + \lambda_8 \ln \mathrm{GDP}_{t-1} + \omega_{4t} \end{aligned} \tag{14}$$

where:
INF = Inflation;
DD = Public domestic debt;
LR = Interest rate;
GDP = Economic growth;
ψ_0, θ_0, α_0, and λ_0 = respective constant;
$\psi_1 - \psi_4$, $\theta_1 - \theta_4$, $\alpha_1 - \alpha_4$ and $\lambda_1 - \lambda_4$ = respective short-run coefficients;
$\psi_5 - \psi_8$, $\theta_5 - \theta_8$, $\alpha_5 - \alpha_8$ and $\lambda_5 - \lambda_8$ = respective long-run coefficients;
Δ = difference operator;
ln = natural logarithm;

n = lag lengths;
and $\omega_{1t} - \omega_{4t}$ = white-noise error terms.

Model 2 – ECM-based Granger-causality specification

$$\Delta \ln \mathrm{INF}_t = \psi_0 + \sum_{i=1}^{n} \psi_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \psi_{2i} \Delta \ln \mathrm{DD}_{t-i} + \sum_{i=1}^{n} \psi_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=1}^{n} \psi_{4i} \Delta \ln \mathrm{GDP}_{t-i} + \psi_9 \, \mathrm{ECM}_{t-1} + \omega_{1t} \tag{15}$$

$$\Delta \ln \mathrm{DD}_t = \theta_0 + \sum_{i=1}^{n} \theta_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \theta_{2i} \Delta \ln \mathrm{DD}_{t-i} + \sum_{i=1}^{n} \theta_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=1}^{n} \theta_{4i} \Delta \ln \mathrm{GDP}_{t-i} + \theta_9 \, \mathrm{ECM}_{t-1} + \omega_{2t} \tag{16}$$

$$\Delta \ln \mathrm{LR}_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \alpha_{2i} \Delta \ln \mathrm{DD}_{t-i} + \sum_{i=1}^{n} \alpha_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=1}^{n} \alpha_{4i} \Delta \ln \mathrm{GDP}_{t-i} + \alpha_9 \, \mathrm{ECM}_{t-1} + \omega_{3t} \tag{17}$$

$$\Delta \ln \mathrm{GDP}_t = \lambda_0 + \sum_{i=1}^{n} \lambda_{1i} \Delta \ln \mathrm{INF}_{t-i} + \sum_{i=1}^{n} \lambda_{2i} \Delta \ln \mathrm{DD}_{t-i} + \sum_{i=1}^{n} \lambda_{3i} \Delta \ln \mathrm{LR}_{t-i} + \sum_{i=1}^{n} \lambda_{4i} \Delta \ln \mathrm{GDP}_{t-i} + \lambda_9 \, \mathrm{ECM}_{t-1} + \omega_{4t} \tag{18}$$

All variables, parameters and notations remain as defined in Equations (11)–(14). ψ_9, θ_9, α_9, and λ_9 are the coefficients of one period lagged error-correction term (ECM_{t-1}).

4.2 Data source

For empirical analysis, this study uses annual time series data covering the period between 1986 and 2019 for Nigeria. The researcher's choice of data for this period was influenced by the availability of reliable data on some variables. The source of data on inflation, interest rate and economic growth is the World Bank Development Indicators (WDI) database. In addition, public external and domestic debt data were sourced from the Central Bank of Nigeria Statistical Bulletin. Further detail on the data source and how they are measured is provided in Table 1. In addition, natural logarithms of all variables are used in empirical analysis.

Table 1: Data sources and measurement of variables

Variables	Description	Measurement		Source
INF	Inflation	Consumer prices	(annual %)	World Bank (2019)
ED	Public external debt	Public external debt	(% of GDP)	Central Bank of Nigeria (2019)
DD	Public domestic debt	Public domestic debt	(% of GDP)	Central Bank of Nigeria (2019)
LR	Interest rate	Lending rate	(annual %)	World Bank (2019)
GDP	Economic growth	Real gross domestic product per capita, measured as gross domestic product divided by midyear population.		World Bank (2019)

Source: Authors' compilation.

5 Empirical results

5.1 Unit root test for stationarity

Before proceeding with the ARDL cointegration test, pre-testing variables for unit roots is essential. It is important to ensure that the dependent variable is integrated of order one [I(1)] and the independent variables are integrated of either order one [I(1)] or order zero [I(0)] or a mixture of both (Pesaran et al., 2001). It is also essential to confirm that none of the variables is integrated of order two [I(2)] or higher. The presence of I(2) variables would lead to a spurious F-test. The critical values of the F-statistics computed by Pesaran et al. (2001) are based on the assumption that variables are integrated of order zero [I(0)] or integrated of order one [I(1)] (Pesaran et al., 2001). Hence, for this study, the Augmented Dickey-Fuller (ADF), Dickey-Fuller generalised least squares (DF-GLS), Phillips-Perron (PP) and Zivot-Andrews structural break unit root tests are employed. The summarised results of ADF, DF-GLS and PP tests on the integration properties of inflation (INF), public external debt (ED), interest rate (LR), public domestic debt (DD) and economic growth (GDP) for Nigeria are reported in Table 2. Zivot-Andrews structural break test results are reported in Table 3.

Table 2 and Table 3 show unanimously for all the tests that none of the variables is integrated of order two and higher. All the variables are integrated of order one, justifying the validity and suitability of this study's ARDL bounds testing approach.

5.2 Cointegration test: ARDL bounds testing

In line with the above, the presence of cointegration was examined for Model 1 and Model 2. The cointegration F-statistic test results for the models are presented in Table 4.

The results reported in Table 4 show that cointegration was confirmed in some of the

Table 2: Unit root tests of all variables

	Stationarity of variables In levels		Stationarity of variables In first differences	
Variable	Without trend	With trend	Without trend	With trend
Panel A: Augmented Dickey-Fuller (ADF)				
ln INF	−1.5013	−2.0851	−3.9523***	−3.8736***
ln ED	−1.6092	−2.0243	−3.9470***	−3.9077**
ln DD	−1.6372	−0.7066	−3.6549**	−3.9004**
ln GDP	−0.5122	−2.0564	−4.0049***	−3.9669**
ln LR	−2.4416	−3.2651*	−4.4721***	−4.4536***
Panel B: Dickey-Fuller generalized least squares (DF-GLS)				
ln INF	1.8111*	−1.7976	−4.7199***	−6.1955***
ln ED	−1.5410	−2.1551	−3.3332***	−3.7412**
ln DD	−1.5146	−2.0300	−2.8145***	−4.8736***
ln GDP	−0.7346	−2.0918	−3.9003***	−4.0620***
ln LR	−1.8904*	−2.5514	−5.8341***	−6.1687***
Panel C: Phillips-Perron (PP)				
ln INF	−1.0409	−3.7165**	−7.9377***	−7.1436***
ln ED	−1.2246	−1.9575	−3.9575***	−3.8716**
ln DD	−1.3930	−1.6033	−4.7682***	−4.7026***
ln GDP	−0.3848	−2.0212	−4.0347***	−4.0091**
ln LR	−2.5639	−3.2651*	−5.7671***	−5.9912***

Source: Authors' 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				
	In levels		In first differences	
Variables	*t*-statistic	Break date	*t*-statistic	Break date
ln INF	−3.9116	1999	−7.5596***	1996
ln ED	−3.9900	2005	−8.3074***	2010
ln DD	−2.7976	2000	−5.4142***	2007
ln GDP	−3.3953	2004	−5.2410**	1995
ln LR	−3.7008	2003	−5.1309**	2003

Source: Authors' compilation.
Note: ** and *** denote stationarity at 5% and 1% significance levels, respectively.

functions supporting the suitability of the ECM-based Granger-causality testing. For the Granger-causality test, the study includes one period lagged ECM term only in equations found to be cointegrated (see also Narayan and Smyth, 2006). In Model 1, variables were cointegrated only when inflation, public external debt and interest rate were taken as dependent variables. In Model 2, variables were cointegrated only when inflation, economic growth and interest rate were taken as dependent variables. These findings were confirmed by their corresponding F-statistics, suggesting that cointegration varies according to the dependent variable.

Table 4: Bounds F-statistic results for cointegration

Dependent Variable	*Function*	F-test statistic	Cointegration Status
Model 1 – Public external debt and inflation			
Inflation	$F(\ln \text{INF} \mid \ln \text{ED}, \ln \text{GDP}, \ln \text{LR})$	8.4535***	Cointegrated
Public external debt	$F(\ln \text{ED} \mid \ln \text{INF}, \ln \text{GDP}, \ln \text{LR})$	10.0508***	Cointegrated
Economic growth	$F(\ln \text{GDP} \mid \ln \text{INF}, \ln \text{ED}, \ln \text{LR})$	2.4564	Not cointegrated
Interest rate	$F(\ln \text{LR} \mid \ln \text{INF}, \ln \text{ED}, \ln \text{GDP})$	8.2117***	Cointegrated
Model 2 – Public domestic debt and inflation			
Inflation	$F(\ln \text{INF} \mid \ln \text{DD}, \ln \text{GDP}, \ln \text{LR})$	8.6657***	Cointegrated
Public domestic debt	$F(\ln \text{DD} \mid \ln \text{INF}, \ln \text{GDP}, \ln \text{LR})$	1.5037	Not cointegrated
Economic growth	$F(\ln \text{GDP} \mid \ln \text{INF}, \ln \text{DD}, \ln \text{LR})$	9.2855***	Cointegrated
Interest rate	$F(\ln \text{LR} \mid \ln \text{INF}, \ln \text{DD}, \ln \text{GDP})$	9.7168***	Cointegrated

Asymptotic critical values						
	1%		5%		10%	
Pesaran et al. (2001, p. 300)	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
Table CI (iii) Case III	4.29	5.61	3.23	4.35	2.72	3.77

Source: Authors' compilation.
Note: *** denotes 1% significance level.

5.3 ECM-based Granger-causality test

Following the cointegration among variables, the study uses the ECM-based Granger-causality test to determine the variables' short-run and long-run causal relationships. The F-statistics and lagged error correction terms are used to determine the direction of causality. While the t-statistic on the lagged error-correction term suggests the long-run causal relationship, the F-statistic on the short-run explanatory variable suggests the short-run causal effect. Table 5 presents ECM-based Granger-causality test results for Models 1 and 2.

As illustrated in Table 5, Panel A – Model 1, the results show that short- and long-run unidirectional causality runs from inflation (INF) to public external debt (ED). The short-run result is supported by the F-statistics of inflation which is statistically significant. The long-run result is supported by the coefficients of the one-period lagged error-correction term (ECM_{t-1}) that is negative and statistically significant in the corresponding public external debt function. The results further show that public external debt does not Granger-cause inflation in Nigeria. The F-statistics of public external debt support this result in the corresponding inflation function that is statistically insignificant. This is in line with similar studies done by Essien et al. (2016) and Odior and Arinze (2017).

Other results presented in Table 5, Panel A – Model 1 reveal that there is: (i) short-run and long-run unidirectional Granger-causality running from economic growth (GDP) to inflation; (ii) short-run and long-run bidirectional causality between the interest rate (LR)

Table 5: Granger-causality tests results

Panel A: Model 1 – Public external debt and inflation

Dependent	F-statistics [probability]				ECM_{t-1}
variable	$\Delta \ln \mathrm{INF}_t$	$\Delta \ln \mathrm{ED}_t$	$\Delta \ln \mathrm{GDP}_t$	$\Delta \ln \mathrm{LR}_t$	[t-statistics]
$\Delta \ln \mathrm{INF}_t$	—	0.6890	6.5006***	6.0600***	−0.8422***
	—	[0.4150]	[0.0058]	[0.0077]	[−5.3320]
$\Delta \ln \mathrm{ED}_t$	7.3650***	—	12.4797***	1.7955	−0.8993***
	[0.0023]	—	[0.0002]	[0.1946]	[−4.8902]
$\Delta \ln \mathrm{GDP}_t$	0.5596	4.3721***	—	4.2385***	—
	[0.4636]	[0.0081]	—	[0.0301]	—
$\Delta \ln \mathrm{LR}_t$	19.2960***	0.2357	2.3392	—	−0.6108***
	[0.0000]	[0.6316]	[0.1387]	—	[−5.4744]

Panel B: Model 2 – Public domestic debt and inflation

Dependent	F-statistics [probability]				ECM_{t-1}
variable	$\Delta \ln \mathrm{INF}_t$	$\Delta \ln \mathrm{DD}_t$	$\Delta \ln \mathrm{GDP}_t$	$\Delta \ln \mathrm{LR}_t$	[t-statistics]
$\Delta \ln \mathrm{INF}_t$	—	6.5510***	10.3014***	3.7888**	−0.6066***
	—	[0.0035]	[0.0010]	[0.0210]	[−5.4298]
$\Delta \ln \mathrm{DD}_t$	7.1746***	—	7.3214***	2.6467*	—
	[0.0051]	—	[0.0011]	[0.0803]	—
$\Delta \ln \mathrm{GDP}_t$	0.8292	28.0084***	—	0.6444	−0.1321***
	[0.3728]	[0.0000]	—	[0.4311]	[−3.3971]
$\Delta \ln \mathrm{LR}_t$	26.1700***	3.6659*	0.0318	—	−0.5876***
	[0.0000]	[0.0670]	[0.8600]	—	[−6.0207]

Source: Authors' compilation.
Note: ***, ** and * denote stationarity at 1%, 5% and 10% significance levels, respectively.

and inflation; (iii) short-run bidirectional causality between economic growth and public external debt, and long-run unidirectional Granger-causality running from economic growth to public external debt; (iv) short-run unidirectional Granger-causality running from interest rate to economic growth; and (v) no causality between interest rate and public external debt.

The results reported in Table 5, Panel B – Model 2 reveal a bidirectional Granger-causality between public domestic debt (DD) and inflation (INF) in Nigeria in the short-run. The statistically-significant F-statistics supports this finding in the corresponding inflation and public domestic debt equations. However, in the long run, Granger causality was found to be unidirectional, from public domestic debt to inflation. This outcome was confirmed by the coefficients of the one period lagged error-correction term (ECM_{t-1}) that is negative and statistically significant in the corresponding inflation function.

Other results presented in Table 5, Panel B – Model 2 reveal that in Nigeria there

is: (i) unidirectional Granger-causality running from economic growth (GDP) to inflation was found to exist both in the short-run and long-run; (ii) bidirectional causality between the interest rate (LR) and inflation was found to exist both in the short-run and long-run; (iii) short-run bidirectional causality between economic growth and public domestic debt, and long-run unidirectional Granger-causality running from public domestic debt to economic growth; (iv) short-run bidirectional causality between public domestic debt and interest rate, and long-run unidirectional Granger-causality running from public domestic debt to interest rate; and (v) no causality between interest rate and economic growth.

6 Conclusion and policy recommendations

This study examined the dynamic causal relationship between public debt and inflation in Nigeria using annual data for the period between 1986 and 2019. Most literature on inflation dynamics in Nigeria largely ignores the effect of public debt, and there are numerous concerns among policymakers on the true macroeconomic effect of public debt. The renewed contributions of public external debt and public domestic debt to the total public debt portfolio after the recent external debt relief have raised concerns among researchers and policymakers. From a policy viewpoint, considering the critical role of public borrowing in funding government developmental expenditure in Nigeria, knowledge of the direction of causality provides insight into the formulation and steering of appropriate debt management strategy and monetary policy toward attaining sustainable macroeconomic stability in the country. The current study decomposed total public debt into public external debt and public domestic debt. It employed the autoregressive distributed lag bounds testing approach to cointegration and the error correction model based Granger-causality test to investigate the causal relationship between public external debt and inflation and public domestic debt and inflation in Nigeria using annual data. The study introduced interest rate and economic growth as intermittent variables alongside key variables to create a multivariate Granger-causality model to account for omission-of-variable bias. The findings show that public external debt does not Granger-cause inflation but provides support in the short- and in the long-run for unidirectional Granger-causality running from inflation to public external debt in Nigeria. On the other hand, the results suggest the short-run bidirectional Granger causality between public domestic debt and inflation. In the long run, a unidirectional Granger causality was found to be running from public domestic debt to inflation. These findings suggest the critical challenges inflation management might have on public external debt in Nigeria. It also shows the dependence of government expenditure on domestic public borrowing. Therefore, reducing public domestic debt may significantly reduce inflationary pressure in the country. Hence, the study recommends that the Nigerian government implements public domestic debt and inflation rate management strategies aimed at supporting/improving macroeconomic stabilisation in the country. For instance, the government may cut down

spending or raise taxes to help reduce the inflation rate since inflation Granger-causes public external debt. Similarly, the government should exercise caution in accumulating public domestic debt-financed expenditure since public domestic debt Granger-causes inflation. It would be beneficial for future research to consider other estimation techniques, such as the nonlinear/asymmetry Granger-causality approach to check whether their results differed fundamentally from those reported in this paper for the study countries.

References

Ahking, F. W. and Miller, S. M. (1985). The Relationship Between Government Deficits, Money Growth and Inflation. *Journal of Macroeconomics*, 7(4):447–467.

Ahmad, M. J., Sheikh, M. R., and Tariq, K. (2012). Domestic Debt and Inflationary Effects: An Evidence From Pakistan. *International Journal of Humanities and Social Science*, 2(18):256–263.

Aimola, A. U. and Odhiambo, N. M. (2018). A Review of Public and Private Debt Dynamics in Nigeria. *Socioeconomica*, 7(14):1–18.

Aimola, A. U. and Odhiambo, N. M. (2021). Public Debt and Inflation Nexus in Nigeria: An ARDL Bounds Test Approach. *Cogent Economics & Finance*, 9(1):1–20.

Anayochukwu, O. B. (2012). Fiscal Deficits and Inflation in Nigeria: The Causality Approach. *International Journal of Scientific & Technology Research*, 1(8):6–12.

Awe, A. A. and Olalere, S. (2012). The Nexus Between Budget Deficit and Inflation in the Nigerian Economy (1980–2009). *Research Journal of Finance and Accounting*, 3(10):78–92.

Bawa, S., Abdullahi, I. S., and Ibrahim, A. (2016). Analysis of Inflation Dynamics in Nigeria (1981–2015). *Central Bank of Nigeria Journal of Applied Statistics*, 7(1b):255–276.

Bildirici, M. and Ersin, O. O. (2007). Domestic Debt, Inflation and Economic Crises: A Panel Cointegration Application to Emerging and Developed Economies. *Applied Econometrics and International Development*, 7(1):31–47.

Blanchard, O. (2004). Fiscal Dominance and Inflation Targeting: Lessons from Brazil. Working Paper 10389, National Bureau of Economic Research.

Blanchard, O. and Johnson, D. (2013). *Macroeconomics*. Pearson Education Limited England, UK, 6 edition.

Bua, G., Pradelli, J., and Presbitero, A. F. (2014). Domestic Public Debt in Low-Income Countries and Structure: Trends and Structure. *Review of Development Finance*, 4(1):1–19.

Budina, N. and Van Wijnbergen, S. (2000). Fiscal Deficits, Monetary Reform, and Inflation Stabilization in Romania. Policy Research Working Paper 2298, The World Bank Development Research Group, Macroeconomics and Growth.

Bwire, T. and Nampewo, D. (2014). Fiscal Deficits Financing: Implications for Monetary Policy Formulation in Uganda. *Journal of Applied Finance and Banking*, 4(2):125–138.

Cardoso, E. and Fishlow, A. (1990). External Debt, Budget Deficits, and Inflation. In *Developing Country Debt and Economic Performance, Volume 2: Country Studies–Argentina, Bolivia, Brazil, Mexico*, pages 318–334. University of Chicago Press.

Catão, L. A. and Terrones, M. E. (2005). Fiscal Deficits and Inflation. *Journal of Monetary Economics*, 52(3):529–554.

Central Bank of Nigeria (2003). Annual Statistical Bulletin 2003. Annual statistical bulletin, Central Bank of Nigeria. https://www.cbn.gov.ng/documents/Statbulletin.asp.

Central Bank of Nigeria (2010). Monetary Policy Review (MPR), Maiden Edition. https://www.cbn.gov.ng/OUT/2011/PUBLICATIONS/MFR/MPD/MONETARYPOLICYREVIEW.PDF.

Central Bank of Nigeria (2019). Annual Statistical Bulletin 2019. Annual statistical bulletin, Central Bank of Nigeria. https://www.cbn.gov.ng/documents/Statbulletin.asp.

Chimobi, O. P. and Igwe, O. L. (2010). Budget Deficit, Money Supply and Inflation in Nigeria. *European Journal of Economics, Finance and Administrative Sciences*, 19(5):52–60.

Christensen, J. E. (2004). Domestic Debt Markets in Sub-Saharan Africa. IMF Working Papers 46, International Monetary Fund.

Debt Management Office Nigeria (2007). Annual Report and Statement of Accounts 2007. Annual report, Debt Management Office Nigeria. https://www.dmo.gov.ng/publications/reports/dmo-annual-report-statement-of-accounts/1057-dmo-2007-annual-report/file.

Debt Management Office Nigeria (2016). Debt Management Strategy (DMS) 2016–2019. Strategy report, Debt Management Office Nigeria. https://www.dmo.gov.ng/publications/other-publications/debt-management-strategy/1288-nigeria-s-debt-management-strategy-2016-2019/file.

Debt Management Office Nigeria (2017). Annual Report and Statement of Accounts 2017. Annual report, Debt Management Office Nigeria. https://www.dmo.gov.ng/publications/reports/dmo-annual-report-statement-of-accounts/2503-2017-annual-report/file.

Debt Management Office Nigeria (2018). Annual Report and Statement of Accounts 2018. Annual report, Debt Management Office Nigeria. Accounts.https://www.dmo.gov.ng/publications/reports/dmo-annual-report-statement-of-accounts/3060-2018-annual-report/file.

Debt Management Office Nigeria (2020). Debt Management Strategy (DMS) 2020–2023. Strategy report, Debt Management Office Nigeria. https://www.dmo.gov.ng/publications/other-publications/debt-management-strategy/3469-nigeria-s-medium-term-debt-management-strategy-2020-2023/file.

Devapriya, T. N. and Ichihashi, M. (2012). How Does the Budget Deficit Affect Inflation in Sri Lanka. Idec discussion paper 2012, Hiroshima University.

Dissanayake, D. M. S. B. (2016). Identifying the Relationships Between Budget Deficit and Selected Macroeconomic Variables: A Study of Sri Lanka During the Postliberalization Era. In *University of Sri Jayewardenepura, Sri Lanka, 13th International Conference on Business Management (ICBM)*.

Engle, R. F. and Granger, C. W. J. (1987). Co-Integration and Error Correction: Representation, Estimation, and Testing. *Econometrica*, 55(2):251–276.

Essien, S. N., Agboegbulem, N., Mba, M. K., Onumonu, O. G., et al. (2016). An Empirical Analysis of the Macroeconomic Impact of Public Debt in Nigeria. *Central Bank of Nigeria Journal of Applied Statistics*, 7(1a):125–145.

Ezirim, C. B., Mojekwu, K., Amuzie, A. E., and Muoghalu, M. I. (2016). The Relationship Between Domestic Public Debt Burden and Inflationary Pressures in Nigeria: Is There a Causal Relationship? *International Journal of Business & Public Administration*, 13(2):80–99.

Favero, C. A. and Giavazzi, F. (2004). Inflation Targeting and Debt: Lessons from Brazil. Working Paper 10390, National Bureau of Economic Research.

Feridun, M. and Adebiyi, M. A. (2006). Forecasting Inflation in Developing Economies: The Case of Nigeria. *International Journal of Applied Econometrics and Quantitative Studies*, 3(1):55–84.

Folorunso, B. A. (2013). Relationship Between Fiscal Deficit and Public Debt in Nigeria: An Error Correction Approach. *Journal of Economics and Behavioral Studies*, 5(6):346–355.

Hanson, J. A. (2007). The Growth in Government Domestic Debt: Changing Burdens and Risks. Policy Research Working Paper 4348, The World Bank Economic Policy and Debt Department.

Inam, U. (2014). Budget Deficit and Inflation in Nigeria: An Empirical Analysis (1970–2010). *Journal of Economics and Sustainable Development*, 5(2):26–32.

Islam, R. and Wetzel, D. L. (1991). The Macroeconomics of Public Sector Deficits. Working Papers 672, The World Bank Policy Research Department.

Johansen, S. and Juselius, K. (1990). Maximum Likelihood Estimation and Inference on Cointegration–with Applications to the Demand for Money. *Oxford Bulletin of Economics and Statistics*, 52(2):169–210.

Karakaplan, M. U. (2009). The Conditional Effects of External Debt on Inflation. *Journal of Social and Economic Research*, 9(17):203–217.

Koluri, B. R. and Giannaros, D. S. (1987). Deficit and External Debt Effects on Money and Inflation in Brazil and Mexico: Some Evidence. *Eastern Economic Journal*, 13(3):243–248.

Kwon, G., McFarlane, L., and Robinson, W. (2006). Public Debt, Money Supply, and Inflation: A Cross-Country Study and Its Application to Jamaica. IMF Working Papers 121, International Monetary Fund.

Lai, S.-L., Trang, L.-H., and Kuo, K.-C. (2015). Causal Relationship among Debt, GDP and Inflation in France. *International Journal of Intelligent Technologies and Applied Statistics*, 8(3):205–224.

Lütkepohl, H. (1982). Non-Causality Due to Omitted Variables. *Journal of Econometrics*, 19(2–3):367–378.

Moser, G. G. (1994). The Main Determinants of Inflation in Nigeria. IMF Working Papers 76, International Monetary Fund.

Murshed, M., Amin, S., and Chadni, M. H. (2018). Causality Analysis Between Inflation, Budget Deficit and Money Supply: Empirical Evidence From Bangladesh. *World Journal of Social Sciences*, 8(3):94–109.

Narayan, P. K. and Smyth, R. (2005). The Residential Demand for Electricity in Australia: An Application of the Bounds Testing Approach to Cointegration. *Energy Policy*, 33(4):467–474.

Narayan, P. K. and Smyth, R. (2006). Higher Education, Real Income and Real Investment in China: Evidence from Granger Causality Tests. *Education Economics*, 14(1):107–125.

Odhiambo, N. M. (2008). Financial Depth, Savings and Economic Growth in Kenya: A Dynamic Causal Linkage. *Economic Modelling*, 25(4):704–713.

Odior, E. S. and Arinze, S. (2017). The Dynamics of Inflation, Public Debt and Exchange Rate in Nigeria. *Business and Economic (BizEcons) Quarterly*, 1:19–34.

Oladipo, S. and Akinbobola, T. O. (2011). Budget Deficit and Inflation in Nigeria: A Causal Relationship. *Journal of Emerging Trends in Economics and Management Sciences*, 2(1):1–8.

Olaniyi, C. O. (2020). Application of Bootstrap Simulation and Asymmetric Causal Approach to Fiscal Deficit-Inflation Nexus. *Global Journal of Emerging Market Economies*, 12(2):123–140.

Onwioduokit, E. A. (1999). Fiscal Deficits and Inflation Dynamics in Nigeria: An Empirical Investigation of Causal Relationships. *Central Bank of Nigeria Economic and Financial Review*, 37(2):1–16.

Oseni, I. O. and Sanni, H. Y. (2016). Does Fiscal Deficit Granger Cause Impulsiveness in Inflation Rate in Nigeria? *Acta Universitatis Danubius. Œconomica*, 12(4):208–216.

Parida, P., Mallick, H., and Mathiyazhagan, M. K. (2002). Nexus between Fiscal Deficits, Money Supply and Price Level in India: A VAR Approach. Working Papers 104, The Institute for Social and Economic Change, Bangalore.

Pesaran, M. H., Shin, Y., and Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Econometrics*, 16(3):289–326.

Sims, C. A. (2013). Paper Money. *American Economic Review*, 103(2):563–584.

Ssebulime, K. and Edward, B. (2019). Budget Deficit and Inflation Nexus in Uganda 1980–2016: A Cointegration and Error Correction Modeling Approach. *Journal of Economic Structures*, 8(1):1–14.

Taghavi, M. (2000). Debt, Growth and Inflation in Large European Economies: A Vector Auto-regression Analysis. *Journal of Evolutionary Economics*, 10:159–173.

Titus, G. S. (2013). Public Debt and Economic Growth: Evidence from Nigeria's Data. *West African Financial and Economic Review*, 10(1):55–92.

Udoh, N. S. and Isaiah, A. S. (2018). A Predictive Model for Inflation in Nigeria. *Central Bank of Nigeria Journal of Applied Statistics*, 9(2):103–129.

United Nations Conference on Trade and Development (2016). Economic Development in Africa Report 2016: Debt Dynamics and Development Finance in Africa. Report, United Nations. `https://unctad.org/webflyer/economic-development-africa-report-2016`.

World Bank (2019). World Development Indicators 2019. `http://databank.worldbank.org/data/source/world-development-indicators`.

Yien, L. C., Abdullah, H., and Azam, M. (2017). Granger Causality Analysis Between Inflation, Debt and Exchange Rate: Evidence from Malaysia. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, 7(1):189–196.

Zivot, E. and Andrews, D. W. K. (1992). Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root Hypothesis. *Journal of Business & Economic Statistics*, 10(3):251–270.