

UNISA ECONOMIC RESEARCH WORKING PAPER SERIES

Public Debt and Inflation: Empirical Evidence from Ghana

Akingbade U. Aimola

Nicholas M. Odhiambo

Working Paper 1/2021

January 2021

Akingbade U. Aimola
Department of Economics
University of South Africa
P. O. Box 392, UNISA
0003, Pretoria
South Africa
Email : jafbroms@yahoo.com or
53830490@mylife.unisa.ac.za

Nicholas M. Odhiambo
Department of Economics
University of South Africa
P. O. Box 392, UNISA
0003, Pretoria
South Africa
Email: odhianm@unisa.ac.za /
nmbaya99@yahoo.com

UNISA Economic Research Working Papers constitute work in progress. They are papers under submission or forthcoming elsewhere. The views expressed in this paper, as well as any errors or omissions, are entirely those of the author(s). Comments or questions about this paper should be sent directly to the corresponding author.

Public Debt and Inflation: Empirical Evidence from Ghana

Akingbade U. Aimola¹ and Nicholas M. Odhiambo

Abstract

This paper investigates the impact of public debt on inflation in Ghana using annual data during the period 1983-2018. The study uses the Autoregressive Distributed Lag (ARDL) bounds testing approach to cointegration and an error correction model to examine this linkage. The cointegrating regression results reveal evidence of a stable long run relationship between inflation and the explanatory variables in the presence of a structural break. The findings also show a positive and significant impact of public debt on inflation. These results were found to hold, irrespective of whether the regression was conducted in the short run or the long run. The study confirms the presence of the inflationary effects of public debt in Ghana. The government should, therefore, be prudent when considering increases in public debt to minimise volatility in inflation and its associated risks to the economy.

Keywords: public debt; inflation; ARDL; Ghana.

JEL Classification: C32, E31, H63.

¹ Corresponding author: Akingbade U. Aimola, Department of Economics, University of South Africa (UNISA). Email address: jafbroms@yahoo.com or 53830490@mylife.unisa.ac.za.

1. Introduction

The control of inflation dynamics is vital to the monetary and fiscal policy objective. Given the significant role that public debt plays in fiscal deficit financing, the relationship between public debt and inflation has emerged as a topical issue in recent decades. Policymakers have started wondering whether the changing levels of public debt have an influence on inflation. Some central banks have adopted inflation-targeting policy largely on the basis that inflation is generally a monetarist's phenomenon. However, some recent studies have found that this assumption is obsolete or unfounded. According to Sims (2013, 2014, 2016), persistent and growing fiscal deficit finance through government borrowings will eventually produce inflationary pressures, regardless of the policies followed by the Central Bank. Hence, debt-financed deficits will require effective coordination with the monetary authority to avoid high and unstable inflation rates that may be harmful to macroeconomic stability. More so, according to Aimola and Odhiambo (2018), the effectiveness of monetary policy in controlling inflation critically depends on its coordination with fiscal policy, suggesting that granting Central Bank autonomy in the hope that it will insulate an economy from having to accommodate imprudent fiscal policies, may not be successful at curbing inflation. The Fiscal Theory of the Price Level (FTPL), as embedded in the non-Ricardian policy shows that fiscal authority alone can dominantly influence inflation irrespective of monetary policy.

Available data on inflation for Ghana shows that between 1983 and 2018, the country recorded high inflation rates in excess of 25% (Bank of Ghana, 2019 & World Bank, 2019). According to Masson *et al.* (1997), a country would be unable to rely on monetary policy alone to target a stable and reduced inflation rate once it experiences annual inflation rates in the range of 15%-25% for several consecutive years. Hence, the relationship between public debt and inflation becomes even more important in a country such as Ghana as changes in public debt levels tend to be linked to rising fiscal deficits.

Although a number of studies have attempted to examine the relationship between public debt and inflation, very few studies have been conducted on African countries, and where studies have been done, a significant gap still exists. Not many studies have been conducted on the relationship between public debt and inflation in Ghana where public debt has played a vital role in the funding

of fiscal deficits. In addition, time-series data were used in these studies, but no attempt has been made to address the issue of structural breaks given that Ghana's economic history has registered some structural changes over time. According to Perron (1989), unaddressed breaks may invalidate statistical test inference. It is against this argument that the relationship between public debt and inflation in Ghana is investigated in this study. Hence, the primary aim of this study is to examine the impact of public debt on inflation in Ghana using the ARDL approach. Apart from contributing to the literature on public debt and inflation by using Ghana as a case study, to our knowledge, this might well be the first study of its kind to examine the dynamic relationship between public debt and inflation in Ghana using the ARDL approach to cointegration in the presence of structural breaks.

The rest of the paper is organised as follows: Section 2 presents trends in public debt and inflation in Ghana. Section 3 discusses the theoretical and empirical literature review. Section 4 presents the estimation technique and empirical analysis. Section 5 concludes the paper.

2. Public debt and inflation in Ghana

Ghana's public debt stock has evolved in the last three decades. As a percentage of gross domestic product (GDP), this represent an increase from 26.88% in 1983 to 57.58% in 2018, with a minimum of 19.86% in 2006 and a maximum of 89.22% in 2000 (Bank of Ghana, 2019). The ratio between 1983 and 2003, before external public debt relief in 2004, average 49.92% compared to 40.84% between 2007 and 2018 after external public debt relief (Bank of Ghana, 2019). These ratios are an indication that gains from debt relief that reduced this ratio to 19.86% in 2006 were short lived. Ghana, in 2004 and 2006, secured external public debt relief under the Highly Indebted Poor Countries (HIPC) initiative and the Multilateral Debt Relief Initiative (MDRI), respectively, reducing public debt to GDP ratio from 58.35% in 2003 to 45.02% in 2004 and from 37.20% in 2005 to 19.86% in 2006 (Bank of Ghana, 2019). In spite of gains recorded in public debt ratios due to debt forgiveness, Ghana's public debt stock levels have been on the increase, with contribution from both external and domestic public debt stock (Bank of Ghana, 2019).

The structure of Ghana's public debt stock can be broadly categorised into external and domestic public debt. Prior to debt relief in 2004, public debt was characterised by huge external borrowing by government in meeting its financing needs, which resulted in public debt stock that was largely dominated by external public debt stock (Fosu, 2001). The composition of Ghana's public debt stock stood at 49.78% for external public debt stock and 50.21% for domestic public debt stock as at end 2018 (Bank of Ghana, 2019).

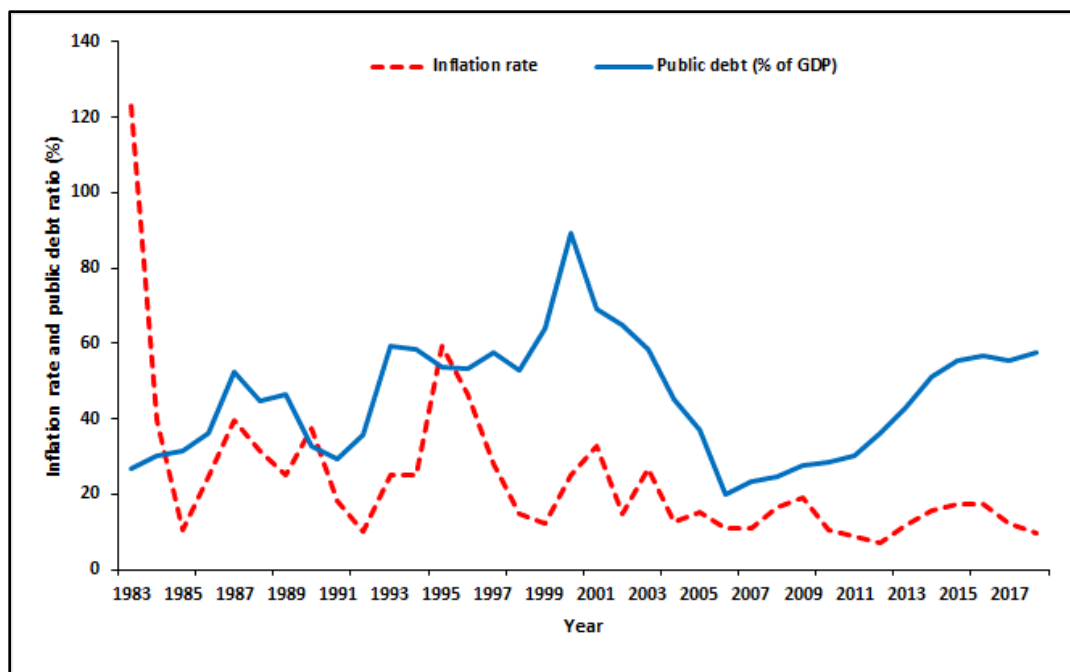
On domestic public debt stock, before the introduction of the Bank of Ghana bills in 1988 to take care of excess liquidity in the economy and to provide investment opportunities for banks, government could not borrow from the domestic market to support the budget and had to rely on the Bank of Ghana (BOG) to finance its deficit by printing money (African Forum and Network on Debt and Development (AFRODAD), 2013). This caused strong inflationary pressures in the economy and the deterioration of the financial sector (AFRODAD, 2013). The introduction of the Bank of Ghana bills saw the emergence of 30-day bills to deal with the short end of the market and longer dated bills (182-day and 2-year) and the 3-year and 5-year bonds. These developments further enhanced the development of the domestic debt market with the issuance of various short-, medium- and long-term debt instruments. Thus, the need to finance fiscal deficits, the issuance of domestic debt instruments for the purposes of domestic debt management strategy and to refinance matured securities have all contributed to increase in domestic public debt stock and public debt stock in Ghana (AFRODAD, 2013; Ghana Medium Term Debt Strategy (MTDS), 2016). Overall, growth in public debt stock for the study period was through fiscal excesses and the implementation of domestic public debt management strategy.

Inflation has been an issue of Ghana's economy during the past few decades. Inflation experience during the study period in Ghana was mixed as the inflation hovered across single, double digit and even triple digit rates. Available data indicates that between 1983 and 2018 Ghana recorded several experiences of high inflation rate in excess of 25%, suggesting that it was unable to rely on monetary policy alone for a stable and reduced inflation rate (Masson *et al.*, 1997, World Bank, 2019, and Bank of Ghana, 2019). Inflation rate reached an all-time high of 122.8% in 1983 and an all-time low of 7.13% in 2012. Inflation rate in the 1980s averaged 48.2%; and 27.61% in the 1990s, compared to an average of 15.54% in the 2000s (World Bank, 2019). For instance, in the

1980s, inflation was largely due to excessive demand pressures as a result of government's expansionary fiscal operations (Sowa, 1991). The huge fall within the same period was as a result of the implementation of the Economic Recovery Programme (ERP) that focused on reducing budget deficits and the reliance on bank financing of budget deficit (Sowa, 1991). The high investment by government in the economy to stimulate economic growth showed more in the short and medium term demand increase than output increase, and thus increased inflationary pressures in the country. The high rate of inflation reflected demand pressures driven by fiscal expansion and money growth complimented by weak economic growth (Adom *et al.*, 2015). This episode, which persisted into the 1990s, coincided with a period of expansionary fiscal deficit and money supply growth. Despite the prevalence of price controls between 1983 and 1991 for the study period, inflation rate averaged 38.79%, compared to 19.12% between 1992 and 2018. The swing in changes continued through the 2000s, although changes within this period were relatively stable for the country with single digit rates recorded in 2011, 2012 and 2018 (World Bank, 2019). Overall, major changes in inflation rate for the period under review can be attributed largely to excess domestic demand generated by expansionary fiscal and monetary policies of the government. Inflation rate stood at 9.84% as at end 2018 (World Bank, 2019).

Figure 1 illustrates trends in public debt (% of GDP) and inflation rate for Ghana using annual data for the period from 1983 to 2018.

Figure 1: Public debt and inflation in Ghana



Source: Bank of Ghana (2019) and World Bank (2019)

A closer look at the graphical representations of public debt and inflation movements in Figure 1 do appear to suggest relationship between these variables. Trends show that peaks in public debt moved quite closely with inflation over the years.

3. Literature review

Theoretical literature

Inflation as widely known is a monetary phenomenon and its control lies within the purview of monetary authorities. According to Friedman (1968), an expansionary monetary policy will increase both real output and general price level in the short-run and only the price level will increase in the long-run. In recent times, studies have shown that inflation is not only a monetary problem but also of a fiscal concern, with fiscal variables influencing price stability. According to Sargent and Wallace (1981), Leeper (1991), and Woodford (1994, 1996, 2001) fiscal and monetary policy interaction is crucial in establishing links between public debt and inflation. Hence, the control of inflationary pressures in an economy does not depend alone on the control of money supply.

The theoretical arguments on the link between public debt and inflation are centred on the Ricardian and non-Ricardian strategy on price level determination. Oscar (2007) argues that when government policy is formulated in such a way that intertemporal budget constraint is satisfied for any price level, it is a Ricardian policy and a non-Ricardian policy when it satisfies only the equilibrium price level. Erdogdu (2002) also shows that the relationship between real value of government debt and price level can be Ricardian or non-Ricardian policy depending on the fulfillment of government budget constraint. It is Ricardian policy if government budget constraint is satisfied for all price levels with an endogenous determination of monetary and fiscal policy variables. Ricardian policies assume that the Ricardian Equivalence Theorem holds, suggesting that fiscal policy does not create any wealth effects. Ricardian equivalence according to Barro (1974, 1989) is based on monetarist view on inflation that government deficit or debt does not have significant impact on the determination of price level – implying that government bonds are not net wealth.

For the non-Ricardian policy, intertemporal government budget constraint is an equilibrium condition that is not satisfied for every price level. Before the price level is determined, the level of surplus is set such that any threat to the solvency of budget constraint is met by market mechanism moving the price level (Erdogdu, 2002). The non-Ricardian policies do not follow the Ricardian Equivalence Theorem's assumption that fiscal policy does not create wealth effect. An increase in the value of government bonds affects the households' lifetime budget set. Fiscal disturbances affect price level through wealth effect on private consumption demand (Woodford, 1998). Under a non-Ricardian plan, price level is fundamentally a fiscal phenomenon, with monetary aggregates playing a marginal role (Oscar, 2007).

The validity of the Ricardian policies has been questioned in the developing economies and for most periods in the developed economies, such that anti-inflationary policies followed by apex banks in these economies may not have been sufficient to guarantee price stability and thus requiring an appropriate mix of monetary and fiscal policies (Loyo, 1999; Christiano and Fitzgerald, 2000; Attiya *et. al.*, 2008). The FTPL, as embedded in the non-Ricardian policy, seems to have particular relevance for developing economies because they issue domestic currency debt and often lack the fiscal capacity to mobilise the necessary real tax revenues, giving rise to an

‘active’ fiscal authority, while the concerns for capital flows imply that monetary policy tends to be ‘passive’ (Beck-Friis *et al.*, 2017).

More so, because these economies are characterised by large public debt, Blanchard (2004) and Favero and Giavazzi (2004) suggest that an increase in interest rate in an economy with large public debt aimed at controlling inflation within the target range may increase the cost of debt service, debt level, default probability and country premium, which may trigger capital outflows and exchange rate depreciation that would affect inflation expectations and in the end inflation itself. Hence, according to Woodford (1995, 1998), the source of change in price level can be explain by FTPL through the positive wealth effect of government debt policy on private consumption demand or increase private spending.

Kwon *et al.* (2006) argue that FTPL identifies the wealth effect of government debt as an additional channel of fiscal influence on inflation. The theory posits that increased government debt adds to household wealth and consequently to their demand for goods and services, leading to price pressures. The non-Ricardians in more recent time are of the view that under an active fiscal regime, changes in government debt will necessitate changes or fluctuations in inflation even if monetary policy is exogenous. Consequently, the determination of price level in an economy will require monetary and fiscal policy interactions (Marzieh, 2015).

Expansionary fiscal policy in the Keynesian view or increased level of debt or a reduction in tax rates, according to Branson (1989), Elmendorf and Mankiw (1999) and Wickens (2008) would, in the short run, affect aggregate demand by increasing disposable income and generating positive wealth effects that may lead to price level pressures. Sargent & Wallace (1981), Leeper (1991), and Woodford (1994, 1996, 2001) in their studies have also shown that fiscal and monetary policy interaction is crucial in establishing relationship between public debt and inflation. Hence, the control of inflationary pressures in an economy does not depend alone on the control of money supply.

The FTPL shows that fiscal authority alone can dominantly influence inflation irrespective of monetary policy. According to Sims (2013, 2014, 2016) when governments want to pay off debt without increasing taxes and printing money, they pay off the old debt by issuing new debt. The

effect of simply rolling over debt is not default, but inflation. Hence, persistent and growing borrowings by government would eventually produce inflation regardless of policies followed by the monetary authorities.

Finally, the relationship between public debt and inflation can either be direct or indirect according to Nastansky and Strohe (2015). It is direct when the central bank buys public bonds. On the other hand, it is indirect when the demand for public bonds is by the private sector. It may also be indirect through the banking sector's demand for public bonds, and through inflation expectation of the economic agents owing to high levels of public debt.

In line with all of the above, we expect government debt through wealth effect to increase inflationary pressures. This hypothesis suggests that public debt management policy may have consequences on inflation. Against this theoretical background, the study will further review empirical studies on the link between public debt and inflation that have used different country dataset.

Empirical literature review

The effect of public debt on inflation has generated empirical studies with mixed results using ordinary least square (OLS) model, vector autoregressive (VAR) model, panel data model and vector error correction (VECM) model estimation techniques using data ranging from time series to cross-sectional and panel. Even though results from these studies differ depending on study countries and estimation methods, the majority of the studies tilt more towards a positive association between public debt and inflation.

Available empirical literature surveyed for this study shows evidence supporting both positive and negative impact of public debt on inflation. Pioneering works on government debt and inflation was by Musgrave (1949) and Phelps (1973). The study by Musgrave (1949) opened up debate on the relationship between public debt and inflation. Although the study focused on the contribution of domestic public debt policy to economic stability and in particular to checking inflation, Musgrave pointed out that if, during some period, private holders of government securities endeavoured to liquidate all or a major portion of their portfolios, and if fiscal authorities were the only buyers, the volume of bank credit would expand rapidly. Such an expansion would not in all

probability have any direct connection with the legitimate needs of the economy and extremely powerful inflationary forces would be generated. Phelps (1973) argued on public finance approach to inflation that the central bank should be made the source of inflation, while treasury is left the freedom to make compensating variations in government deficit.

Sargent and Wallace (1981) one of the most referenced pioneering empirical work on government debt and inflation process adopted the framework by Phelps (1973) on public finance approach to inflation to investigate the relationship among debt management, monetary policy and inflation. Sargent and Wallace's Unpleasant Monetarist Arithmetic framework revealed that even for the Ricardian policies, it is possible for fiscal authority to affect the level of prices. They argued that with active fiscal and passive monetary policy, monetary policy would respond by setting growth rate of money to generate the money seignorage necessary to satisfy government budget constraint. This is contrary to the monetarist view that only monetary aggregates drives inflation if fiscal authority acts in a dominant fashion through expansionary fiscal policy. Sargent and Wallace (1981) and Walsh (2010) have also argued that whether government debt is ultimately paid for by taxes or printing money, it is important in the monetary policy process. After these studies, other researchers have tried to assess how monetary and fiscal policies interact in establishing the link between public debt and inflation rate.

The studies by Cardoso and Fishlow (1990), Leeper (1991), Janssen *et al.* (2004), Bildirici and Ersin (2007), Kwon *et al.* (2006), Karakaplan (2009), Reinhart and Rogoff (2010), Faraglia *et al.* (2012), Ahmad *et al.* (2012), Lopes da Veiga *et al.* (2014), Ezirim *et al.* (2014), Ngerebo (2014), Bilan and Roman (2014), Nastansky and Strohe (2015), Nguyen (2015), Ezirim *et al.* (2016), Romero and Marin (2017) and Afonso and Ibraimo (2018) revealed a positive impact of public debt on inflation. On the other hand, a few studies have shown that public debt has a negative impact on inflation. Such studies include Wheeler (1999), Taghavi (2000), Karakaplan (2009), Reinhart and Rogoff (2010), Castro *et al.* (2003), Ezirim *et al.* (2014) and Essien *et al.* (2016). Table 1 summarises methodology employed on selected studies on the impact of public debt on inflation.

Table 1: Selected studies on the nature of relationship between public debt and inflation

Author (s)	Title	Methodology	Association
Positive Association			
Bleaney (1996)	Inflation and public debt.	<ul style="list-style-type: none"> • Ordinary Least Square (OLS) 	Positive (1973-1982)
Taghavi (2000)	Debt, growth and inflation in large European economies: A vector autoregression analysis.	<ul style="list-style-type: none"> • Hybrid cointegration analysis • Vector autoregressive models 	Positive (long-term association)
Kwon <i>et al.</i> (2006)	Public debt, money supply, and inflation: A cross-country study and its application to Jamaica.	<ul style="list-style-type: none"> • Vector autoregression (VAR) • Pooled panel OLS • Dynamic fixed effects panel • Panel generalised method of moments (GMM) Arellano-Bond 	Positive
Bildirici and Ersin (2007)	Domestic debt, inflation and economic crises: A panel cointegration application to emerging and developed economies.	<ul style="list-style-type: none"> • Vector Error Correction models • Panel cointegration models 	Positive
Reinhart and Rogoff (2010)	Growth in a time of debt	<ul style="list-style-type: none"> • Analysis of relevant statistical data. 	Positive (emerging economies)
Ahmad <i>et al.</i> (2012)	Domestic debt and inflationary effects: An evidence from Pakistan.	<ul style="list-style-type: none"> • OLS estimation technique 	Positive
Ngerebo (2014)	Domestic debt burden, debt overhang and inflationary pressure in Nigeria	<ul style="list-style-type: none"> • OLS estimation technique 	Positive
Bilan and Roman (2014)	Interconnections between public indebtedness and inflation in contemporary economies	<ul style="list-style-type: none"> • Analysis of relevant statistical data 	Positive
Lopes da Veiga <i>et al.</i> (2014)	Public debt, economic growth, and inflation in African economies.	<ul style="list-style-type: none"> • Pooled analysis of relevant statistical data. 	Positive
Nastansky <i>et al.</i> (2015)	A vector error correction model for the relationship between public debt and inflation in Germany	<ul style="list-style-type: none"> • Vector Error Correction Model • Generalised Impulse Response analysis • Multivariate Beveridge-Nelson trend/cycle decomposition 	Positive
Nguyen (2015)	The effects of public debt, inflation, and their interaction on economic growth in developing countries: empirical	<ul style="list-style-type: none"> • Panel generalised method of moments (GMM) Arellano-Bond 	Positive

Author (s)	Title	Methodology	Association
	evidence based on difference panel GMM		
Romero and Marin (2017)	Inflation and public debt.	<ul style="list-style-type: none"> • Vector autoregression (VAR) • Dynamic fixed effects panel • Panel generalised method of moments (GMM) Arellano-Bond 	Positive
Afonso and Ibraimo (2018)	The macroeconomic effects of public debt: An empirical analysis of Mozambique	<ul style="list-style-type: none"> • Vector autoregression model • Impulse response functions • Variance decomposition 	Positive
Negative Association			
Bleaney (1996)	Inflation and public debt	<ul style="list-style-type: none"> • Ordinary Least Square 	Negative (1983-1989)
Wheeler (1999)	The macroeconomic impacts of government debt: An empirical analysis of the 1980s and 1990s	<ul style="list-style-type: none"> • Vector autoregressive model • Impulse response function • Variance decomposition 	Negative
Karakaplan (2009)	The conditional effects of external debt on inflation	<ul style="list-style-type: none"> • Panel generalised method of moments (GMM) Arellano-Bond 	Negative (in economies with well-developed financial markets)
Reinhart and Rogoff (2010)	Growth in a time of debt	<ul style="list-style-type: none"> • Analysis of relevant statistical data. 	Negative (advance economies)
Essien <i>et al.</i> (2016)	An empirical analysis of the macroeconomic impact of public debt in Nigeria	<ul style="list-style-type: none"> • VAR framework • Granger causality analysis • Impulse response function • Variance decomposition 	Negative

Source: (Aimola and Odhiambo, 2020)

Based on the surveyed literature in this study, relationship between public debt and inflation differs according to countries, sample period and estimation method. As a result of these findings, it will be difficult to draw a general conclusion on the relationship between public debt and inflation for this study. The study will therefore proceed to investigate the impact of public debt on inflation in Ghana.

4. Estimation techniques and empirical analysis

4.1 Estimation techniques

The study employed the autoregressive distributed lag (ARDL) bounds testing approach by Pesaran *et al.* (2001) to examine the existence of a cointegration relationship among the variables used in this study. Our rationale for adopting this technique, among others, is the robust ability of the ARDL technique in analysing short-run and long-run dynamic relationships in small sample sizes (Pesaran *et al.*, 2001; Narayan and Smyth, 2005; and Odhiambo, 2020a). Before estimating the cointegration relationship, a dummy variable (DUM95) was introduced in the model based on Zivot-Andrews (ZA) unit root test to represent a breakpoint in the series. Hence, the estimated ARDL specification is expressed as:

$$\begin{aligned} \Delta \ln INF_t = & \psi_0 + \sum_{i=1}^n \psi_{1i} \Delta \ln INF_{t-i} + \sum_{i=0}^n \psi_{2i} \Delta \ln PD_{t-i} + \sum_{i=0}^n \psi_{3i} \Delta \ln MS_{t-i} + \sum_{i=0}^n \psi_{4i} \Delta \ln INT_{t-i} \\ & + \sum_{i=0}^n \psi_{5i} \Delta \ln GDPC_{t-i} + \sum_{i=0}^n \psi_{6i} \Delta \ln GFCF_{t-i} + \psi_7 \ln INF_{t-1} + \psi_8 \ln PD_{t-1} + \psi_9 \ln MS_{t-1} \\ & + \psi_{10} \ln INT_{t-1} + \psi_{11} \ln GDPC_{t-1} + \psi_{12} \ln GFCF_{t-1} + \psi_{13} DUM95_{t-1} + \omega_t \dots (1) \end{aligned}$$

Where:

INF = Inflation;

PD = Public debt;

MS = Money supply;

INT = Interest rate;

GDPC = Economic growth;

GFCF = Private investment.

ψ_0 is the constants, $\psi_1 - \psi_6$ are the respective short-run coefficients, $\psi_7 - \psi_{12}$ are the respective long-run coefficients, ω_t is the mutually independent white-noise residuals, \ln is natural logarithm, Δ represents the difference operator, n is the lag length and t is the time period. The dummy variable (*DUM95*) was introduced in Equation 1 to represent a structural break that is endogenously determined by Zivot-Andrews test in inflation (INF). Long-run estimates from Equation 1 were subjected to the F-test to determine the existence of a long-run relationship among the variables in the equation. The computed F-statistic was compared with the appropriate asymptotic critical values generated by Pesaran *et al.* (2001). According to Pesaran *et al.* (2001), if the computed F-statistic exceeds the upper critical bound value, the null hypothesis of no cointegration is rejected (see Odhiambo, 2020b). On the other hand, if the computed F-statistic is

below the lower critical bound value, the test fails to reject the null hypothesis of no cointegration. If the F-statistic falls between the lower and upper critical bounds, the test is inconclusive.

The error correction representation of Equation 1 is specified in Equation 2.

$$\begin{aligned} \Delta \ln INF_t = & \psi_0 + \sum_{i=1}^n \psi_{1i} \Delta \ln INF_{t-i} + \sum_{i=0}^n \psi_{2i} \Delta \ln PD_{t-i} + \sum_{i=0}^n \psi_{3i} \Delta \ln MS_{t-i} + \sum_{i=0}^n \psi_{4i} \Delta \ln INT_{t-i} \\ & + \sum_{i=0}^n \psi_{5i} \Delta \ln GDPC_{t-i} + \sum_{i=0}^n \psi_{6i} \Delta \ln GFCF_{t-i} + \sum_{i=0}^n D_{95} \Delta DUM95_{t-i} + \beta_1 ECM_{t-1} \\ & + \omega_t \dots \dots \dots (2) \end{aligned}$$

Where all variables remain as defined in Equation 1. D_{95} is the short run coefficient of the dummy variable. The error-correction term is lagged once (ECM_{t-1}) and derived from the estimated cointegrated equation. The coefficient of the lagged error-correction term β_1 is expected to be negative and statistically significant, suggesting the adjustment speed to equilibrium after a shock to the system (see also Asongu *et al.*, 2013).

Data and definition of variables

The study used annual time-series data from the period 1983-2018. The choice of the period was influenced by the availability of credible and reliable data on the variables for Ghana. Data were sourced from the International Monetary Fund (IMF) and the World Bank data base. Table 2 further shows how each of the data was measured and the theoretical expectation of the coefficient for each variable.

Table 2: Data sources and measurement of variables

Variables	Description	Measurement	Expectation	Source
INF	Inflation	Consumer prices (annual %)	-	WB (2019)
PD	Public debt	Total public debt (% of GDP)	Positive	IMF (2020)
MS	Money supply	Broad money supply (% of GDP)	Positive	WB (2019)
INT	Interest rate	Monetary policy rate (annual %)	Positive	IMF (2019)
GDPC	Economic growth	Real gross domestic product (GDP) per capita, measured as gross domestic product divided by midyear population.	Positive or Negative	WB (2019)

GFCF	Private investment	Gross fixed capital formation (% of GDP)	Positive	WB (2019)
-------------	--------------------	--	----------	-----------

Source: Authors' Compilation.

4.2 Empirical analysis

4.2.1 Unit root test

Before estimating the relationship between inflation, public debt, money supply, interest rate, economic growth and private investment, it is important to test the stationarity of variables. This is to ensure that none of the variables used in this study are integrated of order two or higher. The Dickey-Fuller Generalised Least Squares (DF-GLS) and Phillips-Perron (PP) unit root tests have been employed for this purpose both at level and first difference. In addition, the study addressed the structural break issues associated with time-series data by using the Zivot-Andrews (ZA) structural break unit root test. This test endogenously corrects for one structural break to test the order of the integration among the variables. The results of the unit root tests are reported in appendix 1 and 2.

The results of the DF-GLS and PP unit root tests displayed in Appendix 1 show that none of the variables are integrated of order two (i.e. I (2)) or higher. The results of the ZA test reported in Appendix 2 also show that none of the variables is I (2) and that the structural change in inflation took place in 1995. This period coincides with the implementation of the Financial Sector Adjustment Programme (FINSAP), which took place in the 1990s. During this period, the country also moved from direct control to indirect control of monetary aggregates in achieving inflation objectives by focusing largely on the use of market-based monetary policy instruments (Brownbridge, 1995; Sowa, 2002 and World Bank, 2019).

4.2.2 ARDL bounds cointegration test

The results of the ARDL bounds cointegration test reported in Table 3 show that the calculated F-statistic exceeds the upper bound critical value, as prescribed by Pesaran *et al.* (2001). Hence, the study rejects the null hypothesis of no cointegration, suggesting the existence of a long-run

relationship between inflation, public debt, money supply, interest rate, economic growth, private investment, and DUM95.

Table 3: Results of ARDL bounds cointegration test

Dependent Variable	Function	F-test statistic	Cointegration Status			
ARDL (1, 0, 1, 1, 0, 0, 0) Selected based on Akaike Information Criteria						
Inflation	$F(InINF InPD, InMS, InINT, InGDPC, InGFCF, DUM95)$	7.04***	Cointegrated			
Asymptotic critical values						
Critical values Pesaran <i>et al.</i> (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: ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

4.2.3. Long-run and short-run estimates

Given the presence of a long run relationship between inflation and the explanatory variables, long run and short run estimates were estimated for Equation 1. These results are presented in Table 4.

Table 4: Long-run and short-run coefficients

<i>Panel A: Long-Run Coefficients (Dependent Variable is INF)</i>			
Regressor	Coefficient	T-ratio	[p-value]
Constant	6.2044***	7.7520	[0.0000]
Public debt	1.0109*	1.9294	[0.0651]
Money supply	-0.8682	-1.1763	[0.2506]
Interest rate	-0.1083	-0.1981	[0.8446]
Economic growth	-1.5827**	-2.5110	[0.0189]
Private investment	0.0608	0.1547	[0.8783]
DUM95	0.2268	0.5837	[0.5646]
<i>Panel B: Short-Run Results (Dependent variable ΔINF)</i>			
Regressor	Coefficient	T-ratio	[p-value]
Δ Public debt	0.7074**	2.3101	[0.0294]
Δ Money supply	-1.8161***	-4.1726	[0.0003]
Δ Interest rate	0.9291***	3.5413	[0.0016]
Δ Economic growth	-1.1075**	-2.7191	[0.0117]
Δ Private investment	0.0426	0.1556	[0.8776]
Δ DUM95	0.1587	0.5679	[0.5752]
ECM _{t-1}	-0.6996***	-7.8179	[0.0000]

R-Bar Squared	0.7172
F-Statistic	29.7458*** [0.0000]
Akaike Info. Criterion	0.5326
Schwarz-Bayesian Info. Criterion	0.7104

Note: ***, ** and * denote statistical significance at 1%, 5%, and 10% level, respectively.

The long-run and short-run results presented in Table 4 (Panel A and Panel B) show that the coefficient of public debt is positive and statistically significant, irrespective of the period. These results suggest that public debt plays a significant role in the process of inflation levels in Ghana, regardless of whether it is in the long run or in the short run. This finding is consistent with previous studies such as Kwon *et al.* (2006), Lopes da Veiga *et al.* (2014), Nastansky and Strohe (2015) and Romero and Marin (2017) that found a positive association between public debt and inflation. The argument for this result could also be based on a similar reason highlighted in the fiscal theory of price level determination. The theory posits that public debt through wealth effect has a positive impact on inflation (Kwon *et al.*, 2006).

The results also show that the coefficient of economic growth is negative and statistically significant in both the short run and long run. This suggests that economic growth negatively influences the rate of inflation, irrespective of the period. This finding is in line with previous studies such as Stockman (1981) that advocates a negative relationship between these variables. In the short run, money supply has a negative impact on inflation, but no impact in the long run. This result, although contrary to the expectation of the study, is not unusual (see also Bairam, 1990; West African Monetary Agency (WAMA), 2009). The coefficient of interest rate suggests a positive impact on inflation in the short run, but no impact in the long run. The findings, however, reveal that private investment and DUM95 have no impact on inflation, irrespective of the period in Ghana. This implies that an increase in private investment in Ghana is unlikely to lead to an increase in inflation. It also shows that the structural change that occurred in 1995 did not significantly affect inflation in Ghana. The estimated result of the ECM_{t-1} from Table 4 (Panel B) also shows that the sign of ECM_{t-1} is negative as expected and statistically significant. The regression results are a good fit, as indicated by the adjusted R-squared of about 72%.

The study performed stability tests for the estimated ARDL framework using the cumulative sum (CUSUM) and cumulative sum of square (CUSUMSQ) tests. Brown et al. (1975) and Pesaran and Pesaran (1997) have also used these tests for model stability. Figure 2 and 3 show that the plots of CUSUM and CUSUMSQ statistics are within the 5% critical bounds, suggesting that the model is stable over time.

Figure 2: Plot of CUSUM test

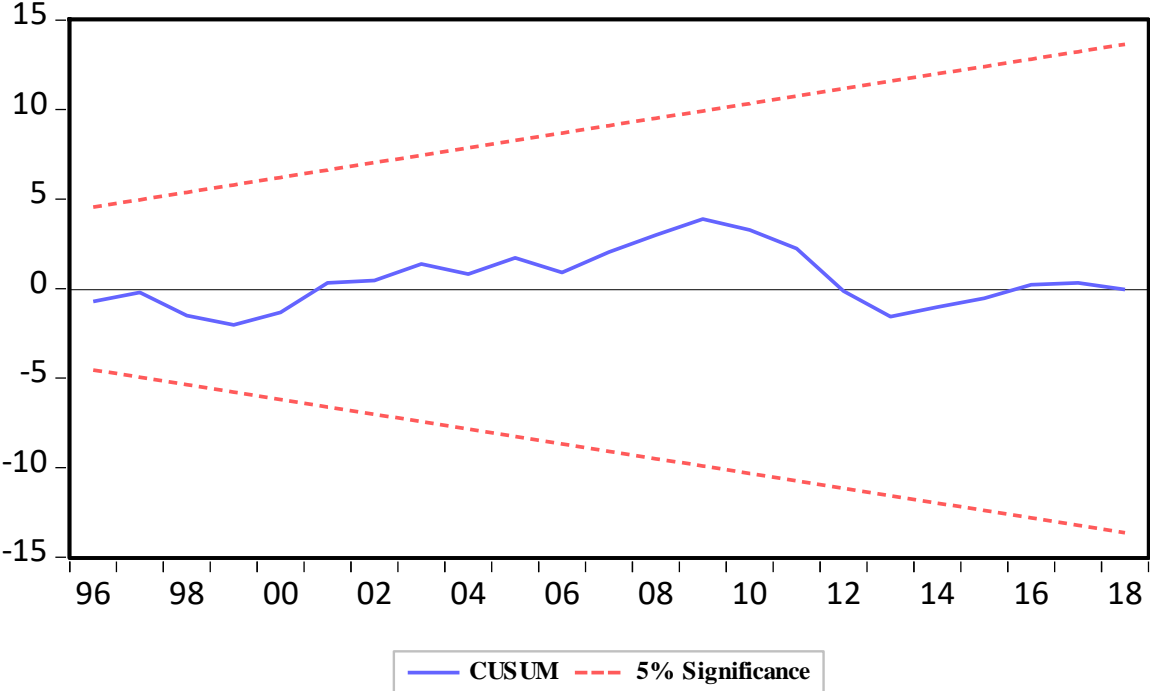
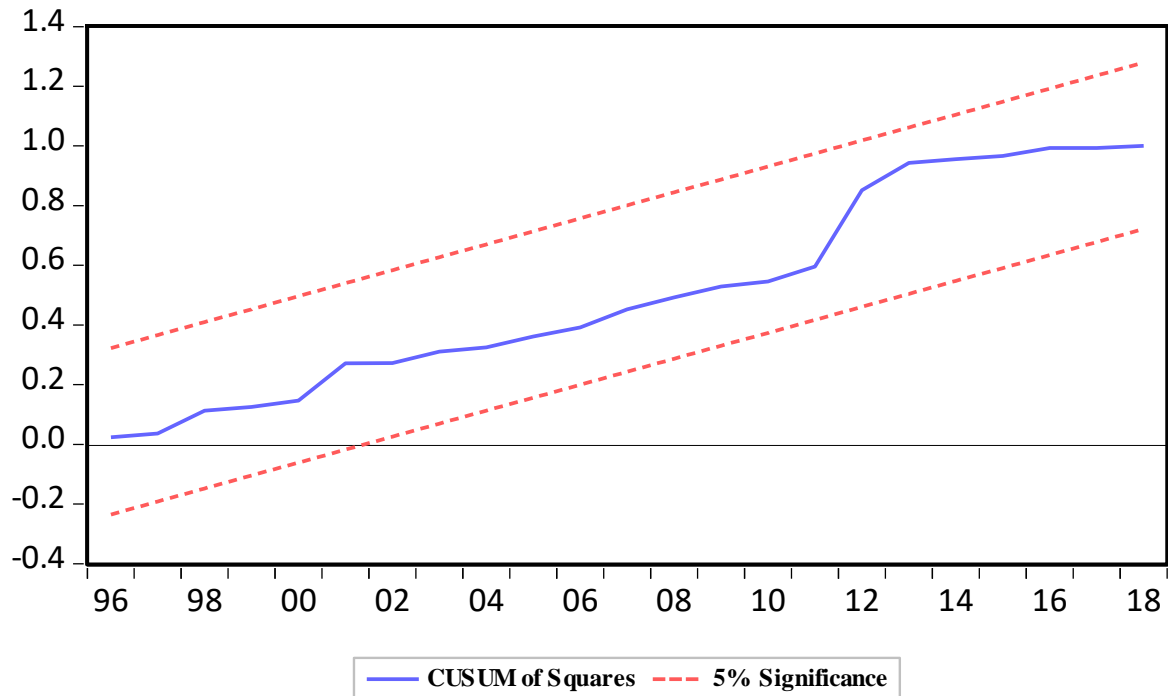


Figure 3: Plot of CUSUMSQ test



5. Conclusion

The main objective of this study was to examine the relationship between public debt and inflation in Ghana using annual data from 1983 to 2018. The study employed the ARDL approach to cointegration and the error-correction model. The study also used Zivot and Andrews (1992) model to account for the possibility of a structural break in the series. The findings revealed a stable long-run relationship between inflation, public debt, money supply, interest rate, economic growth, and private investment in the presence of structural breaks. Similarly, the long-run and short-run coefficient estimates from the ARDL framework show that public debt has a positive and significant impact on inflation in Ghana. This finding supports the Fiscal Theory of the Price Level which posits that government debt adds to household wealth. Hence, the demand for goods and services would increase exacting price pressures. Overall, the study confirms the inflationary effects of public debt management in Ghana. Hence, the government should be prudent when considering increases in public debt to minimise volatility in inflation and its associated risks on the economy. The control of inflation dynamics is vital in achieving the objectives of monetary and fiscal policy. Notwithstanding its novel contribution, this research is limited by the use of

aggregate public debt data. In future studies, researchers may, therefore, wish to use disaggregated public debt data in order to disentangle the impact of external and domestic public debt on inflation. In addition, the possibility of nonlinearity within the framework could also be investigated in order to explore the dynamic impact of public debt on inflation fully.

References

- Adom, .P. K., Zumah, F., Mubarik, A.W., Ntodi, .A.B., and Darko, .C.H. (2015). "Analysing Inflation Dynamics in Ghana." *African Development Review*, Vol. 27, Issue 1, pp. 1-13.
- Afonso, A. and Ibraimo, Y. (2018). "The Macroeconomic Effects of Public Debt: An Empirical Analysis of Mozambique." Research in Economics and Mathematics (REM) *Working Paper 029-2018*, Rua Miguel Lúpi 20, 1249-078 Lisboa, Portugal.
- African Forum and Network on Debt and Development (AFRODAD). (2013). "Loan Contraction and Debt Management in Ghana." Retrieved from <https://afrodad.files.wordpress.com/2015/03/loan-contraction-and-debt-management-in-ghana.pdf> on March 06, 2018.
- 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*, Vol. 2, No. 18, pp. 256-263.
- Aimola, A.U. and Odhiambo, N.M. (2018). "A Review of Public and Private Debt Dynamics in Nigeria." *Socioeconomica - The Scientific Journal for Theory and Practice of Socio-Economic Development*, Vol. 7, No. 14, pp.1-18.
- Aimola, A.U. and Odhiambo, N.M. (2020). "Public Debt and Inflation: A Review of International Literature." *Folia Oeconomica Stetinensia*, Vol. 20, Issue 1, pp.7-22.
- Asongu, S.A. (2013). "Fighting Consumer Price Inflation in Africa: What Do Dynamics in Money, Credit, Efficiency and Size Tell Us?" *Journal of Financial Economic Policy*, Vol. 5, Issue 1, pp. 39-60.
- Attiya, Y. J., Umaima, A. and Abdul, S. (2008). "Testing the Fiscal Theory of Price Level in Case of Pakistan." *The Pakistan Development Review*, Vol. 47, Issue 4, Part II, pp. 763-778.
- Bairam, E. (1990). "Money and Inflation: The Case of Western Developed Countries, 1960–80." *Applied Economics*, Vol. 22, Issue 7, pp. 863-869.
- Bank of Ghana. (2019). Economic data. Retrieved from <https://www.bog.gov.gh/economic-data/> on August 06, 2019.
- Barro, R. J. (1974). "Are Government Bonds Net Wealth?" *Journal of Political Economy*, Vol. 82, No. 6, pp. 1095-1117.
- Barro, R. J. (1989). "The Ricardian Approach to Budget Deficits." *Journal of Economic Perspectives*, Vol. 3, No. 2, pp. 37-54.
- Beck-Friis, P. and Willems, T. (2017). "Dissecting Fiscal Multipliers under the Fiscal Theory of the Price Level." *European Economic Review*, Vol. 95, pp. 62-83.

- Bilan, I. and Roman, A. (2014). "Interconnections between Public Indebtedness and Inflation in Contemporary Economies." *Economics and Sociology*, Vol. 7, No 4, pp. 59-70.
- Bildiric, .M. and Ersin, .O. (2007). "Domestic Debt, Inflation and Economic Crises: A Panel Co-integration Application to Emerging and Developed Economies." *Applied Econometrics and International Development*, Vol. 7, No. 1, pp. 31-47.
- Blanchard, O. (2004). Fiscal Dominance and Inflation Targeting: Lessons from Brazil, National Bureau of Economic Research (NBER) *Working Paper Series No. 10389*, Cambridge, MA, MIT Press.
- Bleaney, M. (1996). "Inflation and Public Debt." *Australian Economic Papers*, Vol. 35, Issue 66, pp. 141-155.
- Branson W. H. (1989). *Macroeconomic Theory and Policy*, 3rd ed. Haper and Row, New York.
- Brown, R. L., Durbin, J. and Evans, J. M. (1975). "Techniques for Testing the Constancy of Regression Relations Over Time." *Journal of the Royal Statistical Society, Series B (Methodological)*, Vol. 37, No. 2, pp. 149-192.
- Brownbridge, .M. (1995). "Credit Supply, Monetary Policy and Structural Adjustment in Ghana." *African Review of Money Finance and Banking*, No. 1 / 2, pp. 155-175.
- Cardoso, E. and Fishlow, A. (1990). "External Debt, Budget Deficits, and Inflation. Developing Country Debt and Economic Performance." In *NBER Macroeconomics Annual*, Vol. 2, pp. 318-334, Jeffrey D. Sachs (editor). Chicago, University of Chicago Press.
- Castro, R., Resende, C. and Ruge-Murcia, F. J. (2003). "The Backing of Government Debt and the Price Level." The Centre for Interuniversity Research in Quantitative Economics (CIREQ), *Working Paper No. 2003–2022*. Retrieved from <http://www.cireqmontreal.com/wp-content/uploads/cahiers/16-2003-cah.pdf> March 20, 2019.
- Christiano, L.J., Fitzgerald, T. (2000). "Understanding the Fiscal Theory of the Price Level." *Economic Review*, Vol. 36, No. 2, pp. 1–39.
- Elmendorf, D.W. and Mankiw, N.G. (1999). "Government Debt". In *Handbook of Macroeconomics*, edited by John B. Taylor and Michael Woodford, Chapter 25, 1615-1663. Amsterdam: Elsevier Science.
- Erdogdu, O. S. (2002). "Price Level Determination: Ricardian vs. Non-Ricardian Policies." Iowa State University Digital Repository, Ph.D. Thesis. Retrieved from <https://lib.dr.iastate.edu/cgi/viewcontent.cgi?article=1510&context=rtid> March 24, 2020.
- Essien, S. N., Agboegbulem, N. T. I., Mba, M. K. and Onumonu, O. G. (2016). "An Empirical Analysis of the Macroeconomic Impact of Public Debt in Nigeria." *CBN Journal of Applied Statistics*, Vol. 7, No. 1(a), pp. 125-145.

- Ezirim, C.B., Amuzie, A.E., Mojekwu, K. (2014). Domestic Debt Overhang and Inflationary Pressures: An Autoregressive Distributed Lag Investigation of the Nigeria Experience. Paper Accepted for Presentation at the Spring Conference of IABPAD at Double Tree Hotel, Dallas, USA.
- Faraglia, E., Marcet, A., Oikonomou, R., Scott, A. (2012). “The Impact of Debt Levels and Debt Maturity on Inflation.” *The Economic Journal*, Vol. 123, Issue 556, pp. 164–192.
- Favero, C.A. and Giavazzi, F. (2004). “Inflation Targeting and Debt: Lessons from Brazil.” National Bureau of Economic Research (NBER) *Working Paper Series No. 10390*, Cambridge, MA, MIT Press.
- Fosu, .A. K. (2001). “Emerging Africa: The Case of Ghana.” Organisation for Economic Cooperation and Development. Retrieved from <https://www.oecd.org/countries/ghana/2674859.pdf> Accessed March 06, 2018.
- Friedman, M. (1968). “*Dollars and Deficits: Inflation, Monetary Policy and the Balance of Payments*” Englewood Cliffs, New Jersey, Prentice Hall, International.
- Ghana Medium-Term Debt Management Strategy. (2016). Retrieved from <http://www.mofep.gov.gh/debtmanagementdivision>. Accessed December 15, 2017.
- International Monetary Fund (IMF). (2019). International Financial Statistics (IFS). Retrieved from <https://data.imf.org/?sk=4c514d48-b6ba-49ed-8ab9-52b0c1a0179b> May, 2020.
- International Monetary Fund (IMF). (2020). IMF Datamapper-Historical Public Debt Database. Retrieved from <https://www.imf.org/external/datamapper/datasets/GDD> May, 2020.
- Janssen, N., Nolan, C., Thomas, R. (2002). “Money, Debt and Prices in the United Kingdom, 1705–1996.” *Economica*, Vol. 69, No. 275, pp. 461–479.
- Karakaplan, M. U. (2009). “The Conditional Effects of External Debt on Inflation.” *Journal of Social and Economic Research*, Vol. 9, No.17, pp. 203-217.
- Kwon, G., McFarlane, L. and Robinson, W. (2006). “Public Debt, Money Supply, and Inflation: A Cross-Country Study and its Application to Jamaica.” International Monetary Fund *Working Paper, WP/06/121*.
- Leeper, E. M. (1991). “Equilibria Under ‘Active’ and ‘Passive’ Monetary and Fiscal Policies.” *Journal of Monetary Economics*, Vol. 27, Issue 1, pp. 129-147.
- Lopes da Veiga, J., Ferreira-Lopes A. and Sequeira, T. (2016). “Public Debt, Economic Growth, and Inflation in African Economies.” *South African Journal of Economics*, Vol. 84, Issue 2, pp. 294-322.
- Loyo, E. (1999). *Tight Money Paradox on the Loose: A Fiscalist Hyperinflation*. Harvard University. Retrieved from: <http://sims.princeton.edu/yftp/Loyo/LoyoTightLoose.pdf> Accessed February 14, 2019.

- Marzieh, A. (2015). "Monetary and Fiscal Policy Interactions: National and International Empirical Evidence." University of Glasgow Digital Repository, Ph.D. Thesis. Retrieved from <http://theses.gla.ac.uk/6796/> March 27, 2019.
- Masson, P.R., Savastano, M.A. and Sharma, S. (1997) "The Scope for Inflation Targeting in Developing Countries." International Monetary Fund (IMF) *Working Paper WP/97/130*.
- Musgrave, R. A. (1949). "Debt Management and Inflation." *The Review of Economics and Statistics*, Vol. 31, No. 1, pp. 25-29.
- 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*, Elsevier, Vol.33, Issue 4, pp. 467 – 474.
- Nastansky, A. and Strohe, H. G. (2015). "Public Debt, Money and Consumer Prices: A Vector Error Correction Model for Germany." *Statistische Diskussionsbeiträge 51*, Universität Potsdam, Wirtschafts- und Sozialwissenschaftliche Fakultät.
- Ngerebo, T.A. (2014). "Domestic Debt Burden, Debt Overhang and Inflationary Pressure in Nigeria." *Journal of Empirical Economics*, Vol. 3, Issue 3, pp. 172–183.
- Nguyen, V.B. (2015). "The Relationship between Public Debt and Inflation in Developing Countries: Empirical Evidence Based on Difference Panel GMM." *Asian Journal of Empirical Research*, Vol. 5, Issue 11, pp. 221-236.
- Odhiambo, N.M. (2020a), "Energy Consumption and Economic Growth in Botswana: Empirical Evidence from A Disaggregated Data", *International Review of Applied Economics*. Retrieved from <https://doi.org/10.1080/02692171.2020.1792851> Accessed November 2020.
- Odhiambo, N.M. (2020b), "Education and Economic Growth in South Africa: An Empirical Investigation", *International Journal of Social Economics*, Retrieved from <https://www.emerald.com/insight/content/doi/10.1108/IJSE-04-2020-0259/full/html> Accessed November 2020.
- Oscar, A. (2007). "Price Determinacy Under Non-Ricardian Fiscal Strategies." Documentos de Trabajo No. 0741, Research Department, Banco de España. Madrid. Retrieved from <https://www.bde.es/f/webbde/SES/Secciones/Publicaciones/PublicacionesSerias/DocumentosTrabajo/07/Fic/dt0741e.pdf> December 26, 2020.
- Perron, P. (1989). "The Great Crash, the Oil Price Shock, and the Unit Root Hypothesis." *Econometrica*, Vol. 57, No. 6, pp.1361–1401.
- Pesaran M.H., and Pesaran, B. (1997). *Working with Microfit 4.0: Interactive Econometric Analysis*. Oxford, Oxford University Press.
- Pesaran, M., Shin, Y., Smith, R. (2001). "Bounds Testing Approaches to the Analysis of Level Relationships." *Journal of Applied Econometrics*, Vol. 16, No. 3, pp. 289-326.

- Phelps, E. S. (1973). "Inflation in the Theory of Public Finance." *The Scandinavian Journal of Economics*, Vol. 75, No.1, pp. 67-82.
- Reinhart, C. M. and Rogoff, K. S. (2010). "Growth in a Time of Debt." *American Economic Review*, American Economic Association, Vol. 100, Issue 2, pp. 573-578.
- Romero, J. P. B. and Marin, K. L. (2017). "Inflation and Public Debt." *Monetaria*, Vol. V, No. 1, pp. 39-94.
- Romero, J. P. B. and Marin, K. L. (2017). "Inflation and Public Debt." *Monetaria*, Vol. V, No. 1, pp. 39-94.
- Sargent, T. J. and Wallace, N. (1981). "Some Unpleasant Monetarist Arithmetic." Federal Reserve Bank of Minneapolis, *Quarterly Review*, Vol. 5, No. 3, pp. 1-17.
- Sims, C.A. (2013). "Paper Money." *American Economic Review*, Vol. 103, No.2, pp.563-584.
- Sims, C.A. (2014). "Inflation, Inflation Fears, and Public Debt." Princeton University. Retrieved from <http://sims.princeton.edu/yftp/Lindau/LindauSlides.pdf> September 26, 2017.
- Sims, C.A. (2016). "Fiscal Policy, Monetary Policy and Central Bank Independence." Retrieved from [https://www.kansascityfed.org/~media/files/publicat/sympos/2016/econsymposium-sims-paper.pdf?la=en](https://www.kansascityfed.org/~/media/files/publicat/sympos/2016/econsymposium-sims-paper.pdf?la=en) September 26, 2017.
- Sowa, .N.K. (2002). "Financial Sector Reform Policies and Poverty Reduction." Centre for Policy Analysis, Accra, Ghana. Fifth AERC Senior Policy Seminar Co-sponsored with the Bank of Tanzania Poverty Reduction and Macroeconomic Management in Africa, Dar es Salaam, Tanzania. February 12-14, 2002.
- Sowa, N.K. (1991). "Monetary Control in Ghana: 1957-1988." Overseas Development Institute (ODI), *Working Paper 45*.
- Stockman, A. C. (1981). "Anticipated Inflation and the Capital Stock in a Cash-in Advance Economy." *Journal of Monetary Economics*, Vol. 8, No.3, pp. 387-393.
- Taghavi, M. (2000). "Debt, Growth and Inflation in Large European Economies: A Vector Autoregression Analysis." *Journal of Evolutionary Economics*, Vol. 10, pp. 159-173.
- Walsh, C. E. (2010). "*Monetary Theory and Policy*." Cambridge, MIT Press 3rd Edition.
- West African Monetary Agency (WAMA). (2009). Money Supply Growth and Macroeconomic Convergence in ECOWAS. Retrieved from <https://amao-wama.org/publications/money-supply-growth-and-macroeconomic-convergence-in-ecowas/> January 4, 2020.
- Wheeler, M. (1999). "The Macroeconomic Impacts of Government Debt: An Empirical Analysis of the 1980s and 1990s." *Atlantic Economic Journal*, Vol.27, Issue 3, pp. 273-284.
- Wickens, M. (2008). *Macroeconomic Theory: A Dynamic General Equilibrium Approach*. 2nd ed. Princeton, New Jersey, Princeton University Press.

- Woodford, M. (1994). "Monetary Policy and Price Level Determinacy in a Cash-in-Advance Economy." *Economic Theory*, Vol. 4, No.3, pp. 345-380.
- Woodford, M. (1995). "Price-Level Determinacy Without Control of a Monetary Aggregate." *Carnegie-Rochester Conference Series on Public Policy*, Vol. 43, Issue 1, pp. 1-46.
- Woodford, M. (1996). "Control of the Public Debt: A Requirement for Price Stability?" National Bureau of Economic Research (NBER) *Working Paper No. 5684*, Cambridge, MA, MIT Press.
- Woodford, M. (1998). "Doing Without Money: Controlling Inflation in a Post-Monetary World." *Review of Economic Dynamics*, Vol. 1, Issue 1, pp. 173-219.
- Woodford, M. (2001). "Fiscal Requirements for Price Stability." *Journal of Money, Credit and Banking*, Vol. 33, No. 3, pp. 669-728.
- World Bank (WB). (2019). *World Development Indicators 2019*. Retrieved from <http://databank.worldbank.org/data/source/world-development-indicators> May, 2020.
- Zivot, E. and Andrews, D. W. (1992). "Further Evidence on the Great Crash, the Oil-Price Shock, and the Unit-Root." *Journal of Business and Economic Statistics*, Vol. 10, No. 3, pp. 251–270.

Appendices

Appendix 1: Results of standard unit root test

Variables	Stationarity of all variables in levels				Stationarity of all variables in first difference			
	Dickey-Fuller Generalised Least Squares (DF-GLS)		Phillips-Perron (PP)		Dickey-Fuller Generalised Least Squares (DF-GLS)		Phillips-Perron (PP)	
	Without Trend	With Trend	Without Trend	With Trend	Without Trend	With Trend	Without Trend	With Trend
<i>In</i> INF	-0.0450	-1.9819	-0.1425	-5.1238***	-4.2921***	-5.6049***	-9.7520***	-16.2091***
<i>In</i> PD	-0.9562	-1.8229	-1.7845	-2.0563	-3.9662***	-4.6730***	-5.2911***	-5.2643**
<i>In</i> MS	-1.0515	-1.7646	-2.2603	-1.7543	-6.5860***	-4.7017***	-6.5099***	-9.1770***
<i>In</i> INT	-1.5322	-1.9026	-1.8685	-2.3638	-5.0477***	-5.5221***	-5.5153***	-5.5296***
<i>In</i> GDPC	1.1817	-1.4541	1.5165	-0.6578	-3.1274***	-3.7159***	-3.5497**	-4.0991**
<i>In</i> GFCF	-1.4527	-2.0286	-3.8941***	-3.0442	-3.3516***	-4.6126***	-	-5.2587***

Source: Authors' compilation.

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

Appendix 2: Results of structural break unit root test

Zivot-Andrews structural break unit root test				
Variables	ZA test at level		ZA test at first difference	
	<i>t</i> -Statistic	Break year	<i>t</i> -Statistic	Break year
<i>In</i> INF	-4.7497	1995	-5.8441***	1998
<i>In</i> PD	-3.8407	2004	-5.7083***	2007
<i>In</i> MS	-5.0849*	2006	-6.0286***	2003
<i>In</i> INT	-2.9708	1999	-6.3665***	2012
<i>In</i> GDPC	-3.4239	2002	-4.9565*	2010
<i>In</i> GFCF	-3.9519	2006	-7.1585***	2012

Source: Authors' compilation.

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