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Government debt, government debt service and economic growth nexus in Zambia: a multivariate analysis

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Abstract: This paper explores the causal relationships between public debt and economic growth, and between public debt service and economic growth in Zambia for the period from 1970 to 2017. Unlike previous studies on this subject that relied on bivariate frameworks, this paper includes fiscal balance and savings as intermittent variables to minimise the problem of omission-of-variable bias. Using a dynamic multivariate autoregressive-distributed lag (ARDL)-bounds testing approach, the results indicate that there is unidirectional Granger-causality from economic growth to public debt in Zambia, irrespective of whether the analysis is done in the short run or in the long run. The study results, however, fail to find any causality between public debt service and economic growth in Zambia. These study findings support the hypothesis that the pace of economic growth matters in defining the level of public sector indebtedness. The study, therefore, recommends that the Zambian government should channel borrowed funds towards the expansion and diversification of the country's economy. This will promote its long-term

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PUBLIC INTEREST STATEMENT

This study contributes to the government debt, government debt service, and economic growth debate by examining the causal linkages between these variables in Zambia for the period from 1970 to 2017. There has been a swift accumulation of public debt in Zambia since 2012, arising largely from new non-concessionary borrowing from international capital markets and the issuance of Eurobonds. The associated bullet repayments on these Eurobonds and loan contracts, starting in 2022, may result in diversion of productive funds towards debt repayments. Therefore, this study is motivated by the need to meaningfully inform public policy in Zambia and to help the country to achieve high macroeconomic stability. In order to realise the upper-middle income category by 2030, it is critical for policymakers in Zambia to understand the direction of influence of debt variables on economic growth. Such analyses will help in economic diversification which minimises the impact of large export price swings on the domestic economy.

economic growth, broaden its revenue base, and enhance its ability to repay its financial obligations when they fall due.

Subjects: government; economics and development; finance

Keywords: causality; economic growth; public debt; public debt service; Zambia
Jel classification: H62; H63; O47

1. Introduction

The economic recession and debt crises experienced in many developed and emerging countries, beginning in 2007, led to the renewed academic and policy debate on the causal relationship between public debt and economic growth, and between public debt service and economic growth (see, among others, Donayre & Taivan, 2017; Gómez-Puig & Sosvilla-Rivero, 2018). A large proportion of existing theoretical and empirical literature supports the view that unsustainable public debt reduces a country's competitiveness and increases a country's financial market susceptibility to international shocks (see, for example, Castro, Félix, Júlio, & Maria, 2015; Cochrane, 2011; Krugman, 1988; Soydan & Bedir, 2015). Whereas there is considerable theoretical and empirical literature on the impact of public debt on economic growth (see, among others, Barro, 1979; Eberhardt & Presbitero, 2015; Ewaida, 2017; Huang, Panizza, & Varghese, 2018; Krugman, 1988), the theoretical and empirical underpinnings of the causal relationship between these macroeconomic variables is scanty, and the reported evidence has been mixed and sometimes conflicting (Donayre and Taivan, 2018; Gómez-Puig and Sosvilla-Rivero, 2018).

As the drive by most countries in sub-Saharan Africa to turn their economies into the upper-middle-income category by 2030 intensifies, it is imperative that governments understand the factors that influence economic growth, and the direction of causality between public debt and economic growth, on the one hand, and between public debt service and economic growth, on the other hand. This is because the causal relationship between sovereign debt variables and economic growth has direct policy implications, especially on tax and investment decisions—and hence on economic growth (see also Gómez-Puig & Sosvilla-Rivero, 2015).

Generally, the causal relationship between government debt and economic growth is an issue of debate between the Classical and the Keynesian schools of thought. The Classicalists are of the view that debt-financed public expenditures do not fully offset the negative impact of the crowding out of private investment, leading to economic decline (Domar, 1944). This school of thought theorises that public borrowing from the domestic market causes liquidity crises and interest rate hikes, thus discouraging private investment (Mankiw, 2000; Modigliani, 1961). Contrarily, in a typical Keynesian view, debt-financed public sector spending has a crowding in effect, which leads to a positive multiplier effect on national output (Elmendorf & Mankiw, 1999).

Diamond (1965) argues that public debt enhances economic growth in a Neoclassical growth setting, while Saint-Paul (1992) and Modigliani (1961) posit that public debt lowers growth in an endogenous growth setting. From the reviewed theoretical literature, the impact of public debt on economic growth, and public debt service on economic growth may differ, depending on the time frame considered and on the presence of threshold effects. The threshold effect states that public debt crowds out investment and reduces economic growth in the long run, while it stimulates aggregate demand and output in the short run (Ahlborn & Schweickert, 2016; Barro, 1990; Eberhardt & Presbitero, 2015; Elmendorf & Mankiw, 1999).

This debate on the causal links between public debt and economic growth is still ongoing. According to Panizza and Presbitero (2014), the existence of a correlation between public debt and economic growth may not necessarily entail causation. Further, Panizza and Presbitero (2014, p. 1) added that there is no strong evidence made yet for a causal relationship between public debt and economic growth in most studied economies.

Overall, past empirical studies on the causal link between public debt and economic growth, and between public debt service and economic growth are scarce (see, for example, Donayre & Taivan, 2018; Gómez-Puig and Sosvilla Rivero, 2015; Karagol, 2002; Kobayashi, 2015). According to Donayre and Taivan (2018) and Gómez-Puig and Sosvilla Rivero (2015), the causal relationship between public debt and economic growth is intrinsic to each country. while it stimulates aggregate demand and output in the short run, especially in African economies. Accordingly, this study extends the debate to Africa, using Zambia as a case study.

The remaining part of the paper is structured as follows: Section 2 highlights past trends in public debt, public debt service and economic growth in Zambia. Section 3 reviews the literature on the causal linkages between public debt and economic growth, and between public debt service and economic growth. Section 4 discusses the estimation techniques and empirical analysis, while Section 5 concludes the paper.

2. A highlight of the past trends in public debt, public debt service, and economic growth in Zambia

The progression of sovereign debt in Zambia since the 1960s was, on the one hand, correlated with increases in issuance of government securities, and on the other hand, associated with growing non-concessional borrowing (see Saungweme & Odhiambo, 2018a). Following the excessive foreign indebtedness and rising levels of poverty in Zambia in the 1990s, the country received massive debt relief from the international creditors through the Highly Indebted Poor Countries and Multilateral Debt Relief Initiative programs between 2000 and 2006 (Government of the Republic of Zambia (GRZ), 2006; International Monetary Fund "IMF", 2005). On the whole, the evolution of Zambia's public debt over time has been linked to domestic factors such as public policy failures, domestic political developments, and unexpected global economic shocks (Saungweme & Odhiambo, 2018a).[1]

Since the 1960s, Zambia's economy has continued to depend on the mining sector, mostly the copper industry (Central Statistics Office "CSO", 2017). This is despite the stern policy measures adopted by the country after 2000 to diversify the economy by growing the other economic sectors, especially manufacturing, agriculture, infrastructure and information and communication technology (GRZ, 2017).

The over-reliance on the mining sector continues to make the country's fiscal performance very prone to commodity price fluctuations (IMF, 2017). For instance, the fiscal deficit increased from 2.4% of gross domestic product (GDP) in 2011 to 9.4% of GDP in 2015 because of the tail-effects of the 2008 global financial crisis (CSO, 2017). The developments in the fiscal sector since 2000 were also driven by the government's initiative to address the infrastructure gap. This initiative necessitated the government to undertake an expansionary fiscal policy, which forced it to borrow excessively from both the domestic and international capital markets (Government of the Republic of Zambia, 2017). During the period 2011–2017, domestic borrowing grew by an annual average of 2.3% of GDP, while foreign public debt as a proportion of GDP increased from 22.9% in 2011 to 47.3% by the end of 2017 (World Bank, 2018).

This continual rise in public debt in Zambia after 2006 has resulted in an exponential increase in public debt servicing costs. The rising government debt service payments in Zambia have not only adversely affected poverty alleviation programmes in this country, but have also directly impacted negatively on credit creation, gross national savings, domestic interest rates, gross national investment, and on gross revenue performances of the central government (World Bank, 2017).[2] Figure 1 illustrates the trends in public debt, public debt service and economic growth in Zambia for the period from 1980 to 2017. Public debt (PD) and public debt service (PDS) are both expressed as a proportion of GDP, while economic growth is measured by the annual growth rate of real GDP per capita.

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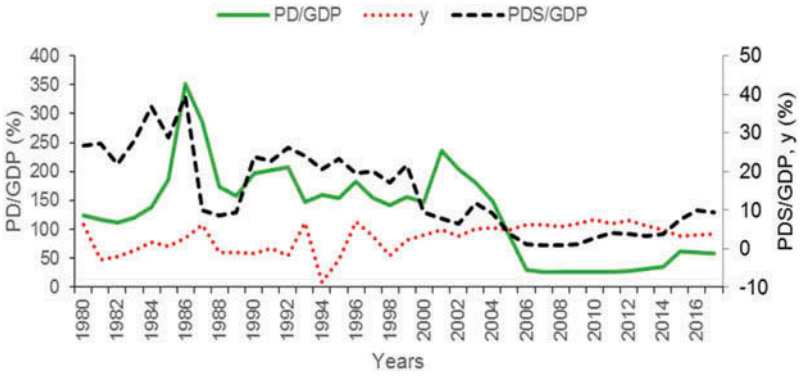

Figure 1. Public debt, public debt service and economic growth trends in Zambia (1980–2017).

Source: World Bank (2018).

The trends in public debt, public debt service and economic growth depicted in Figure 1 suggest that public debt and economic growth are negatively correlated. The build-up in public debt stocks and the accompanying high debt service costs between 1980 and 2005 are associated with low and unstable economic growth rates. During this period, the proportion of public debt to GDP and public debt service to GDP exceeded the annual economic growth rate. This means that the country was incapacitated to repay its debt, leading to the accumulation of debt arrears (IMF, 2005). From 2005, the country's public debt/GDP ratio fell considerably while debt service payments as a percentage of GDP stabilised at relatively low levels, averaging 4.0% between 2005 and 2017 (see Figure 1) (Central Statistical Office (CSO), 2017). The abrupt fall in the ratios of public debt stock and public debt service to GDP between 2005 and 2006 is a result of debt relief from international creditors, mostly the IMF, the World Bank, the African Development Bank, and the Paris Club (International Monetary Fund, 2005).

Figure 1 also shows that there was an economic rebound during the period from 2005 to 2015, growing at an annual average rate of 4.7% (World Bank, 2018). Of significance in Figure 1, however, is the period after 2015, in which both public debt stocks and government debt service costs, as a proportion of GDP, were on the rise again, relative to economic growth rate—placing the country in a high-risk debt sustainability category (see International Monetary Fund (IMF), 2017).

3. A review of literature

The theoretical arguments on the link between public debt, public debt service, and economic growth can be discussed with respect to the three schools of thought: the Keynesian, Classical, and Ricardian. First, the Keynesian school subscribes to a mono-causal theory of growth, which stipulates that debt-financed public sector spending has a fiscal multiplier on national output (Elmendorf & Mankiw, 1999). This Keynesian view is supported fundamentally by the "law of increasing state activity" hypothesis, which purports that increased government spending boosts the domestic economic activity and crowds in private investment (Ncanywa & Masoga, 2018; Wagner, 1911).

Second, the Classicalists are of the view that public debt is deleterious to the economy, particularly if public borrowing reduces both the financial discipline of the budget process and the private sector's access to credit (Broner, Aitor, Alberto, & Jaume, 2014). This preposition argues that public debt repayments, mostly foreign, crowds out economic growth by discouraging private investment and deterring potential foreign investors (Diamond, 1965; Krugman, 1988; Modigliani, 1961). Finally, the Ricardian Equivalence Hypothesis purports that fiscal stabilisation efforts have a neutral impact on economic growth (Barro, 1979, 1990). This hypothesis is based on the presumption that variations in government expenditures and revenues are matched by changes in private savings (Kourtellos, Stengos, & Tan, 2013).

The available empirical literature on the causal relationships between public debt and economic growth, and between public debt service and economic growth has shown some variations arising from both cross-country heterogeneity and time-frame considered. However, it emerged that there are four hypotheses on the causal relationships between public debt and economic growth, and between public debt service and economic growth.

First, there are studies that support the view that the pace of economic growth determines the level of public sector indebtedness. This argument is backed empirically by the work of Donayre and Taivan (2017). According to Donayre and Taivan (2017), the causal relationship between public debt and real GDP growth is intrinsic to each country. The findings of Donayre and Taivan (2017) reveal that in highly market-driven economies, the direction of causality is from low GDP growth to public debt; while in more socialist states, causality runs either from low GDP growth to public debt accumulation or is bi-directional.

Second, there are studies that support the hypothesis that high public debt causes economic growth stagnation. This view suggests that the slowdown in economic growth is largely caused by rising public debt which crowds out private investment through high cost of capital (see Mankiw, 2000; Modigliani, 1961). Studies consistent with this view include Kobayashi and Shirai (2017), Gómez-Puig and Sosvilla-Rivero (2015), Kobayashi (2015), and Reinhart, Reinhart, and Rogoff (2012). According to Kobayashi and Shirai (2017), excessive public debt depresses GDP growth rates by discouraging private sector investment and can thus cause economic recessions (see also Lamont, 1995).

The third hypothesis states that the direction of causality between public debt and economic growth and between public debt service and economic growth is bi-directional. This view is also known in the literature as the feedback hypothesis. This view is supported empirically by Owusu-Nantwi and Erickson (2016), Ferreira (2009) and Abbas and Christensen (2007).

Last is the view that no causality exists between public debt and economic growth, and between public debt service and economic growth—known in the literature as the neutral hypothesis. This debt-growth neutrality hypothesis is supported in the literature by Panizza and Presbitero (2014) and Reinhart and Rogoff (2010).

Among the few studies that tested for public debt, service-growth causality are those by Jalles (2011), Karagol (2002), Afxentiou (1993), and Amoatend and Amoako-Edu (1996). Whereas the results of Karagol (2002) and Afxentiou (1993) found the direction of flow from public debt service to economic growth, Amoateng and Amoako-Adu (1996) found a feedback causal relationship, while Jalles (2011) and Ahmed, Butt, Sabihuddin, and Shaista (2000) found no causal relationship between the variables. Table 1 presents a summary of the empirical studies on the causal link between public debt and economic growth, and between public debt service and economic growth.

4. Estimation techniques and empirical analysis

4.1. Empirical model specification

For the empirical analysis, the study employed a dynamic multivariate autoregressive-distributed lag (ARDL)-based Granger-causality framework to test the causality between public debt and economic growth, and between public debt service and economic growth in Zambia. Whereas most previous empirical studies on debt-growth causality are still based on a bivariate framework, such an approach is known to suffer from omitted-variable-bias (see, for example, Ferreira, 2009). This shortfall is addressed in this study by using fiscal balance (FB) and savings (S) as the intermittent variables in the dynamic multivariate Granger-causality models. Also, the study chose a multivariate Granger-causality approach to eliminate spurious correlations and increase the general validity of the causation test (Lutkepohl, 1982).

Table 1. Empirical research on the causality between public debt, public debt service and economic growth

Empirical researches consistent with the causality between public debt and economic growth

Author(s)	Title	Region/Country	Research methodology	Model variables	Direction of causality
Donayre & Taivan, 2017	Causality between public debt and real growth in the OECD: A country-by-country analysis	20 OECD countries	• VAR tests • Granger-causality tests	• Growth rate of real GDP • Debt-to-GDP ratio • Trade-to-GDP ratio • Capital	• Public debt ← low real GDP growth (capitalist economies)
Kobayashi, 2015	Public debt overhang and economic growth	Japan	• Simulations • Granger-causality test	• Public debt • Real GDP growth Fiscal balance	Public debt ← low real GDP growth
Gómez-Puig & Sosvilla-Rivero, 2015	On the bi-directional causal relationship between public debt and economic growth in EMU countries	European Economic and Monetary Union countries	• Granger-causality method	• Government debt-to-GDP ratio • Rate of GDP growth	High public debt → low GDP growth rate
Donayre & Taivan, 2017	Causality between public debt and real growth in the OECD: A country-by-country analysis	20 OECD countries	• VAR tests • Granger-causality tests	• Growth rate of real GDP • Debt-to-GDP ratio • Trade-to-GDP ratio • Capital	• Public debt ↔ low real GDP growth (socialist economies)
Owusu-Nantwi & Erickson, 2016	Public debt and economic growth in Ghana	Ghana	• Time-series • Johansen cointegration analysis	• GDP growth rate • Public debt • Trade openness • Inflation • Population growth • Investment spending	Public debt ↔ GDP growth rate

(*Continued*)

Table 1. (*Continued*)

Empirical researches consistent with the causality between public debt and economic growth

Author(s)	Title	Region/Country	Research methodology	Model variables	Direction of causality
Ferreira, 2009	Public debt and economic growth: A granger causality panel data approach	20 OECD countries	• Panel data approach • Granger-causality test	• Real GDP per capita • Gross government debt/ GDP ratio • Public primary surplus ratio	Public debt ↔ real GDP per capita growth
Abbas & Christensen, 2007	The role of domestic debt markets in economic growth: An empirical investigation for low income countries and emerging markets	93 developing countries	• Granger-causality test	• Real GDP growth • Domestic debt • External debt • Total government debt	Public debt ↔ real GDP growth
Panizza & Presbitero, 2014	Public debt and economic growth: Is there a causal effect?	OECD countries	• Endogenous growth model • Instrumental variable approach	• Public debt/GDP ratio • Real GDP per capita growth • National gross savings • Liquid liabilities/GDP • Inflation rate • Dependency ratio • Population growth • Trade openness • Schooling • Banking crisis	No causality
Reinhart & Rogoff, 2010	Debt and growth revisited	44 advanced and emerging countries	• Endogenous growth model • Instrumental variable approach	• Fiscal deficits • Government debt • Sovereign credit ratings • GDP • Inflation	No causality

(*Continued*)

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Table 1. (*Continued*)

Empirical researches consistent with the causality between public debt and economic growth

Author(s)	Title	Region/Country	Research methodology	Model variables	Direction of causality
Karagol, 2002	The causality analysis of external debt service and GNP: The case of Turkey	Turkey	• Time-series • Johansen and Juselious maximum likelihood cointegration technique	• GNP • Debt service	Debt service → GNP growth
Afxentiou, 1993	GNP growth and foreign indebtedness in middle-income developing countries	20 developing countries	• Johansen cointegration analysis • Granger-causality framework	• GNP growth rate • Total public debt service/exports ratio • Total public debt interest payments/exports ratio • Total public debt service/GNP ratio • Total public debt interest payments/GNP ratio	Debt service → GDP growth
Amoateng & Amoako-Adu, 1996	Economic growth, export and external debt causality: The case of African countries	35 African countries	• Time-series • Granger-causality framework	• External debt servicing • Exports • GDP growth	Debt service ↔ GDP growth
Jalles, 2011	The impact of democracy and corruption on the debt-growth relationship in developing countries	72 developing countries	• Time-series • Panel Granger-causality	• GDP growth • Debt service/exports	No causality
Ahmed et al., 2000	Economic growth, export and external debt causality: The case of Asian countries	8 Asian countries	• Granger-causality framework	• Export revenue growth • GDP growth • Foreign debt service	No causality

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The ARDL bounds testing methodology by Pesaran, Shin, and Smith (2001) and Pesaran and Shin (1999) is preferred in this study over alternative methods, such as the Engle & Granger (1987) approach and the Hansen (1990) cointegration tests. The ARDL procedure is known to give consistent and unbiased long-run parameters and valid t-statistics even in the presence of endogenous regressors (Odhiambo, 2011). The ECM-based ARDL causality estimation procedure is performed by treating in turns each variable as a dependent variable. Accordingly, a system of cointegration equations, associated with the dynamic multivariate Granger-causality models in this study is expressed as follows:

4.2. ECM-based cointegration model: public debt and economic growth (model 1)

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta y_{t-i} + \sum_{i=0}^{n} \alpha_{2i}\Delta PD_{t-i} + \sum_{i=0}^{n} \alpha_{3i}\Delta FB_{t-i} + \sum_{i=0}^{n} \alpha_{4i}\Delta S_{t-i} + \alpha_5 y_{t-1} + \alpha_6 PD_{t-1} + \alpha_7 FB_{t-1} + \alpha_8 S_{t-1} + \mu_{1t} \quad (1)$$

$$\Delta PD_t = \beta_0 + \sum_{i=0}^{n} \beta_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \beta_{2i}\Delta PD_{t-i} + \sum_{i=0}^{n} \beta_{3i}\Delta FB_{t-i} + \sum_{i=0}^{n} \beta_{4i}\Delta S_{t-i} + \beta_5 y_{t-1} + \beta_6 PD_{t-1} + \beta_7 FB_{t-1} + \beta_8 S_{t-1} + \mu_{2t} \quad (2)$$

$$\Delta FB_t = \delta_0 + \sum_{i=0}^{n} \delta_{1i}\Delta y_{t-i} + \sum_{i=0}^{n} \delta_{2i}\Delta PD_{t-i} + \sum_{i=1}^{n} \delta_{3i}\Delta FB_{t-i} + \sum_{i=0}^{n} \delta_{4i}\Delta S_{t-i} + \delta_5 y_{t-1} + \delta_6 PD_{t-1} + \delta_7 FB_{t-1} + \delta_8 S_{t-1} + \mu_{3t} \quad (3)$$

$$\Delta S_t = \rho_0 + \sum_{i=0}^{n} \rho_{1i}\Delta y_{t-i} + \sum_{i=0}^{n} \rho_{2i}\Delta PD_{t-i} + \sum_{i=0}^{n} \rho_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \rho_{4i}\Delta S_{t-i} + \rho_5 y_{t-1} + \rho_6 PD_{t-1} + \rho_7 FB_{t-1} + \rho_8 S_{t-1} + \mu_{4t} \quad (4)$$

where:

y = is the annual growth rate of real GDP per capita (a proxy for economic growth);

PD = is the stock of public debt as a share of GDP (a proxy for public debt);

FB = is the fiscal balance as a share of GDP (a proxy for fiscal balance);

S = is the share of savings in GDP (a proxy for gross domestic savings);

$\alpha_0,\ \beta_0,\ \delta_0$ and ρ_0 are respective constants; $\alpha_1 - \alpha_4$, $\beta_1 - \beta_4,\ \delta_1 - \delta_4$ and $\rho_1 - \rho_4$ are respective short-run regression coefficients; $\alpha_5 - \alpha_8,\ \beta_5 - \beta_8,\ \delta_5 - \delta_8$ and $\rho_5 - \rho_8$ are respective long-run coefficients; $\mu_1 - \mu_4$ are the mutually independent white-noise residuals; ECM_{t-1} is the error-correction term lagged once; Δ denotes change; n is the lag length; and t is the time period.

4.3. ECM-based granger-causality model: public debt and economic growth (model 1)

Following the work of Donayre and Taivan (2017), Kumar and Woo (2010) and Afonso (1993), the ECM-based multivariate Granger-causality model in this study is presented as:

$$\Delta y_t = \alpha_0 + \sum_{i=1}^{n} \alpha_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \alpha_{2i}\Delta PD_{t-i} + \sum_{i=1}^{n} \alpha_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \alpha_{4i}\Delta S_{t-i} + \alpha_9 ECM_{t-1} + \mu_{1t} \quad (5)$$

$$\Delta PD_t = \beta_0 + \sum_{i=1}^{n} \beta_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \beta_{2i}\Delta PD_{t-i} + \sum_{i=1}^{n} \beta_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \beta_{4i}\Delta S_{t-i} + \beta_9 ECM_{t-1} + \mu_{2t} \quad (6)$$

$$\Delta FB_t = \delta_0 + \sum_{i=1}^{n} \delta_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \delta_{2i}\Delta PD_{t-i} + \sum_{i=1}^{n} \delta_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \delta_{4i}\Delta S_{t-i} + \delta_9 ECM_{t-1} + \mu_{3t} \quad (7)$$

$$\Delta S_t = \rho_0 + \sum_{i=1}^{n} \rho_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \rho_{2i}\Delta PD_{t-i} + \sum_{i=1}^{n} \rho_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \rho_{4i}\Delta S_{t-i} + \rho_9 ECM_{t-1} + \mu_{4t} \quad (8)$$

where:

y = is the annual growth rate of real GDP per capita (a proxy for economic growth);

PD = is the stock of public debt as a share of GDP (a proxy for public debt);

FB = isthe fiscal balance as a share of GDP (a proxy for fiscal balance);

S = is the share of savings in GDP (a proxy for gross domestic savings);

$\alpha_0, \beta_0, \delta_0$ and ρ_0 are respective constants; $\alpha_1 - \alpha_5$ and $\beta_1 - \beta_5, \delta_1 - \delta_5$, $\rho_1 - \rho_5$ are respective regression coefficients; $\mu_1 - \mu_4$ are the mutually independent white-noise residuals; α_9, β_9, δ_9, and ρ_9 are coefficients of ECM_{t-1}; ECM_{t-1} is the error-correction term lagged once; Δ denotes change; *n* is the lag length; and *t* is the time period.

4.4. ECM-based cointegration model: public debt service and economic growth (model 2)

$$\Delta y_t = \phi_0 + \sum_{i=1}^{n} \phi_{1i}\Delta y_{t-i} + \sum_{i=0}^{n} \phi_{2i}\Delta PDS_{t-i} + \sum_{i=0}^{n} \phi_{3i}\Delta FB_{t-i} + \sum_{i=0}^{n} \phi_{4i}\Delta S_{t-i} + \phi_5 y_{t-1} + \phi_6 PDS_{t-1} + \phi_7 FB_{t-1} + \phi_8 S_{t-1} + \varepsilon_{1t} \quad (9)$$

$$\Delta PDS_t = \psi_0 + \sum_{i=0}^{n} \psi_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \psi_{2i}\Delta PDS_{t-i} + \sum_{i=0}^{n} \psi_{3i}\Delta FB_{t-i} + \sum_{i=0}^{n} \psi_{4i}\Delta S_{t-i} + \psi_5 y_{t-1} + \psi_6 PDS_{t-1} + \psi_7 FB_{t-1} + \psi_8 S_{t-1} + \varepsilon_{2t} \quad (10)$$

$$\Delta FB_t = \upsilon_0 + \sum_{i=0}^{n} \upsilon_{1i}\Delta y_{t-i} + \sum_{i=0}^{n} \upsilon_{2i}\Delta PDS_{t-i} + \sum_{i=1}^{n} \upsilon_{3i}\Delta FB_{t-i} + \sum_{i=0}^{n} \upsilon_{4i}\Delta S_{t-i} + \upsilon_5 y_{t-1} + \upsilon_6 PDS_{t-1} + \upsilon_7 FB_{t-1} + \upsilon_8 S_{t-1} + \varepsilon_{3t} \quad (11)$$

$$\Delta S_t = \eta_0 + \sum_{i=0}^{n} \eta_{1i}\Delta y_{t-i} + \sum_{i=0}^{n} \eta_{2i}\Delta PDS_{t-i} + \sum_{i=0}^{n} \eta_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \eta_{4i}\Delta S_{t-i} + \eta_5 y_{t-1} + \eta_6 PDS_{t-1} + \eta_7 FB_{t-1} + \eta_8 S_{t-1} + \varepsilon_{4t} \quad (12)$$

where:

y = is the annual growth rate of real GDP per capita (a proxy for economic growth);

PDS = is the stock of public debt service as a share of GDP (a proxy for public debt service);

FB = is the fiscal balance as a share of GDP (a proxy for fiscal balance);

S = is the share of savings in GDP (a proxy for gross domestic savings);

$\phi_0, \psi_0, \upsilon_0$ and η_0 are respective constants; $\phi_1 - \phi_4$, $\psi_1 - \psi_4$, $\upsilon_1 - \upsilon_4$ and $\eta_1 - \eta_4$ are respective short-run regression coefficients; $\phi_5 - \phi_8, \psi_5 - \psi_8, \upsilon_5 - \upsilon_8$ and $\eta_5 - \eta_8$ are respective long-run regression coefficients; $\varepsilon_1 - \varepsilon_4$ are the mutually independent white-noise residuals; Δ denotes change; *n* is the lag length; and *t* is the time period.

4.5. ECM-based granger-causality model: public debt service and economic growth (model 2)

$$\Delta y_t = \phi_0 + \sum_{i=1}^{n} \phi_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \phi_{2i}\Delta PDS_{t-i} + \sum_{i=1}^{n} \phi_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \phi_{4i}\Delta S_{t-i} + \phi_9 ECM_{t-1} + \varepsilon_{1t} \quad (13)$$

$$\Delta PDS_t = \psi_0 + \sum_{i=1}^{n} \psi_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \psi_{2i}\Delta PDS_{t-i} + \sum_{i=1}^{n} \psi_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \psi_{4i}\Delta S_{t-i} + \psi_9 ECM_{t-1} + \varepsilon_{2t} \quad (14)$$

$$\Delta FB_t = \upsilon_0 + \sum_{i=1}^{n} \upsilon_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \upsilon_{2i}\Delta PDS_{t-i} + \sum_{i=1}^{n} \upsilon_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \upsilon_{4i}\Delta S_{t-i} + \upsilon_9 ECM_{t-1} + \varepsilon_{3t} \quad (15)$$

$$\Delta S_t = \eta_0 + \sum_{i=1}^{n} \eta_{1i}\Delta y_{t-i} + \sum_{i=1}^{n} \eta_{2i}\Delta PDS_{t-i} + \sum_{i=1}^{n} \eta_{3i}\Delta FB_{t-i} + \sum_{i=1}^{n} \eta_{4i}\Delta S_{t-i} + \eta_9 ECM_{t-1} + \varepsilon_{4t} \quad (16)$$

where:

y = is annual growth rate of real GDP per-capita (a proxy for economic growth);

PDS = is stock of public debt service as a share of GDP (a proxy for public debt service);

FB = is fiscal balance as a share of GDP (a proxy for fiscal balance);

S = is share of savings in GDP (a proxy for gross domestic savings);

$\phi_0, \psi_0, \upsilon_0$ and η_0 are respective constants; $\phi_1 - \phi_5,\ \psi_1 - \psi_5,\ \upsilon_1 - \upsilon_5$ and $\eta_1 - \eta_5$ are respective regression coefficients; $\varepsilon_1 - \varepsilon_4$ are the mutually independent white-noise residuals; ϕ_9, ψ_9, υ_9, and η_9 are coefficients of ECM_{t-1}; ECM_{t-1} is the error-correction term lagged once; Δ denotes change; *n* is the lag length; and *t* is the time period.

4.6. Data description

The regression variables in this study are public debt as a share of GDP, public debt service as a share of GDP, annual growth rate of real GDP per capita, fiscal balance as a share of GDP, and gross national savings as a share of GDP. The annual time-series data for these variables are taken from the World Bank World Development Indicators database (World Bank, 2018).

Before proceeding with the analysis, the study checked for the stationarity of the variables using the Dickey–Fuller generalised least squares (DF-GLS) and the Phillips–Perron (PP) tests. The unit root results are reported in Table 2.

The results of the unit root tests presented in Table 2 indicate that all the study variables are either integrated of order zero or one, thus confirming the suitability of the ARDL-bounds estimation technique.

4.7. Cointegration tests

This section tests for the presence of long-run equilibrium relationship among regression variables in the two models using a bounds F-statistic test. The null hypothesis of no cointegration in the two models is examined by performing a joint significance test on the lagged level variables. The results of the bounds F-statistic test are presented in Table 3.

The results of cointegration tests displayed in Table 3 Panel A suggest that the cointegration between public debt, fiscal balance, savings and economic growth varies depending on the choice of the dependent variable used. The results show the presence of two cointegrating vectors in Model 1, that is, cointegration exists when economic growth and public debt are used as dependent variables. In Table 3 Panel B, cointegration exists only when economic growth is the dependent variable. The three cointegration vectors shown in Table 3 are confirmed by the F-statistics which are above the Pesaran et al.'s (2001) upper bound critical values. This evidence allows the study to proceed with the examination of the direction of causality.

Table 2. Unit root test results

	DF-GLS				PP			
	Stationarity of all Variables in Levels			Stationarity of all Variables in First Difference	Stationarity of all Variables in Levels			Stationarity of all Variables in First Difference
Variable	***With Intercept***	***With Intercept and Trend***	***With Intercept***	***With Intercept and Trend***	***With Intercept***	***With Intercept and Trend***	***With Intercept***	***With Intercept and Trend***
y	−3.295***	−6.219***	-	-	−5.592***	−6.116***	-	-
PD	−1.890*	−2.616	-	−6.131***	−1.857	−2.689	−7.378***	−7.442***
PDS	−1.757	−3.739	−8.682***	−8.744***	−1.752	−3.673**	−13.435***	-
FB	−3.267***	−5.167***	-	-	−3.302**	−5.204***	-	-
S	−1.538	−1.982	−5.953***	−7.935***	−2.714*	−2.862	-	−10.161***

Note: *, ** and *** signifies the rejection of the null hypothesis of non-stationarity at 10%, 5% and 1% significance levels, respectively.

Source: Generated using E-views 7.

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Table 3. ARDL-bounds test for cointegration results—models 1 and 2

Dependent Variable	Function		F-statistic		Cointegration Status	
Pane A: Model 1—Public debt and economic growth						
y	F(y| PD, FB, S)		4.632**		Cointegrated	
PD	F(PD| y, FB, S)		3.865*		Cointegrated	
FB	F(FB| y, PD, S)		2.926		Not cointegrated	
S	F(S| y, PD, FB)		2.781		Not cointegrated	
Panel B: Model 2—Public debt service and economic growth						
y	F(y| PDS, FB, S)		6.165***		Cointegrated	
PDS	F(PDS| y, FB, S)		1.761		Not cointegrated	
FB	F(FB| y, PDS, S)		3.101		Not cointegrated	
S	F(S| y, PDS, FB)		2.437		Not cointegrated	
Asymptotic critical values (Unrestricted intercept and no trend)						
Pesaran et al. (2001, p. 300) Table CI(iii) Case III	**10%**		**5%**		**1%**	
	I(0)	***I(1)***	***I(0)***	***I(1)***	***I(0)***	***I(1)***
	2.72	3.77	3.23	4.35	4.29	5.61

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

Source: Generated using Microfit 5.01.

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4.8. ECM-based granger-causality results

Following the establishment of cointegration between the variables in Model 1 and Model 2, the next step is to examine the direction of causality between public debt and economic growth, and between public debt service and economic growth. To determine the short-run causality, the F-statistic on the explanatory variables is used, based on the Variable Deletion Test. However, to determine the speed of adjustment towards the long-run equilibrium, the lagged error correction term is integrated in relevant regression equations—where the series are cointegrated (Equations (5), (6) and (13)). The long-run causality is established by both the significance and the negative sign of the coefficient of the error-correction term lagged once. If the sign of the coefficient of the error correction term lagged once is positive and significant, or negative but insignificant, then there is no long-run causality from the explanatory variables, meaning that the independent variables have no influence on the dependent variable in the long run. The empirical results of the Granger-causality test for Model 1 and Model 2 are presented in Table 4 Panel A and Panel B, respectively.

The empirical results presented in Table 4, for Model 1, indicate that there is unidirectional Granger-causality from economic growth to public debt in Zambia, irrespective of the time-frame considered. The short-run causality is confirmed by the corresponding F-statistic of economic growth (Δy_t) in the public debt (ΔPD_t) function, while the long-run causality is confirmed by the error-correction term (ECM_{t-1}), in the same function, which is both negative and statistically significant at 1% level. These study findings support the hypothesis that the velocity of economic growth matters most in determining the level of public sector indebtedness in Zambia. These results are consistent with the recent empirical findings by Donayre and Taivan (2017).

Further, the empirical results for Model 1 reported in Panel A indicate that there is: (i) a distinct short-run and long-run unidirectional Granger-causal flow from fiscal balance to economic growth; (ii) short-run and long-run unidirectional causality from savings to economic growth; (iii) a short-run and a long-run unidirectional Granger-causal flow from fiscal balance to public debt; (iv) a short-run unidirectional causality flow from fiscal balance to savings; and (v) no causality between savings and public debt.

The empirical results reported in Table 4, for Model 2, indicate that there is no causal relationship between public debt service and economic growth in Zambia, regardless of whether the test is done in the short run or in the long run. This finding is confirmed by the F-statistics of ΔPDS_t in the economic growth function (Δy_t) and that of Δy_t in the ΔPDS_t function, which are both statistically insignificant. The study

Table 4. Granger-causality test results—models 1 and 2

Dependent Variable	F-statistics [probability]				ECT_{t-1} [t-statistics]
	Δy_t	ΔPD_t	ΔFB_t	ΔS_t	
Panel A: Model 1—Public debt and economic growth					
Δy_t	-	0.896 [0.417]	5.551*** [0.008]	2.712* [0.080]	−0.736*** [−4.769]
ΔPD_t	5.009** [0.031]	-	5.547** [0.021]	0.125 [0.726]	−0.414*** [−3.776]
ΔFB_t	0.811 [0.373]	0.202 [0.655]	-	2.123 [0.153]	-
ΔS_t	1.995 [0.165]	0.226 [0.637]	3.310* [0.076]	-	-
Panel B: Model 2—Public debt service and economic growth					
Δy_t	-	1.263 [0.267]	8.337*** [0.006]	0.116 [0.736]	−0.218*** [−4.905]
ΔPDS_t	2.262 [0.140]	-	0.882 [0.353]	0.943 [0.337]	-
ΔFB_t	0.726 [0.399]	0.943 [0.487]	-	1.667 [0.204]	-
ΔS_t	1.847 [0.182]	0.889 [0.351]	3.011* [0.090]	-	-

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

Source: Generated using Microfit 5.01.

result is consistent with the neutral hypothesis and is supported empirically by the finding by Jalles (2011).

Other empirical results for Model 2, reported in Panel B, reveal that there is: (i) distinct short-run and long-run unidirectional Granger-causality from fiscal balance to economic growth; (ii) a short-run unidirectional Granger-causal flow from fiscal balance to savings; and (iii) no causality between savings and economic growth, fiscal balance and public debt service, and savings and public debt service.

5. Conclusion

This study has explored the causal relationship between public debt and economic growth, and between public debt service and economic growth—using the annual time series data from Zambia during the period 1970–2017. This paper differs from previous empirical studies on the subject in that it employed a dynamic multivariate framework to analyse this causal relationship, with fiscal balance and savings as intermittent variables. The study employed the ARDL bounds testing methodology to cointegration and the ECM-based Granger-causality technique to test the underlying relationship in Zambia. The empirical results of the cointegration and causality tests reveal that there is unidirectional Granger-causality from economic growth to public debt in Zambia, regardless of the time considered. The study results, however, fail to find any causality between public debt service and economic growth in Zambia. Based on the study findings, it can be concluded that the rate of economic growth influences the level of public debt in Zambia. The paper, therefore, recommends that government loans be channelled towards the expansion and diversification of the country's economy in order to promote long-term economic growth. Economic diversification will not only reduce high macroeconomic volatility arising from large export price swings, but it may also broaden the country's revenue base and therefore enhance the national ability to repay financial obligations when they fall due.

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Notes

1. See Saungweme and Odhiambo (2018a) for a comprehensive discussion of the chronological evolution, reforms and challenges of public debt in Zambia.
2. See Saungweme and Odhiambo (2018b) for a comprehensive discussion of the trends, reforms and challenges of public debt service in Zambia.

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