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Public debt–economic growth nexus

Case of South Africa

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Abstract: Public debt is defined as the total amount owed by the government. It is calculated as the total amount of international and local debts of the nation. Since the 2008 financial crisis, public debt has been increasing worldwide. This study seeks to examine the effects of public debt on economic growth in South Africa. South Africa is chosen because it is a developing country, and there has been less representation of developing countries in the studies on public debt and economic growth. The study employs quarterly time-series data from 1990 to 2020. Results from stationarity tests show that economic growth and public debt as a percentage of gross domestic product are integrated of the first order. The impulse response results from the vector autoregressive model show that a shock on public debt will cause a decrease in economic growth in the next period.

Key words: economic growth, public debt, South Africa, stationarity, vector autoregressive

JEL classification: H6

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1 Introduction

Public debt is defined as the total amount owed by the government. It is calculated as the total amount of international and local debts of the nation (Kumar and Woo 2010). This is inclusive of the national government and their stakeholders, namely the towns, cities, districts, and other political units. With sovereign state bodies, such as the government initiatives and affiliates of which, the nations have a partnership with the private sector as one of the main investors (Kumar and Woo 2010).

Following the 2007–09 financial crisis, nearly all economies experienced an excessive increase in sovereign debts and deficits (Ayadi and Ayadi 2008). This is because, during and after the crisis, most nations increased expenditures to keep their economies (i.e. firms and households) afloat. For example, the US government debt-to-gross-domestic-product (GDP) ratio increased from 62 per cent in 2007 to 82 per cent in 2009, and in South Africa, the debt-to-GDP ratio increased from 27.06 per cent in 2007 to 30.06 per cent in 2009 (Sichula 2012).

However, the 2007–09 financial crisis is not the only culprit for excessive government debts in South Africa. Other scholars have linked the increasing government debt in the country to the lack of saving culture and limited investments (Balassone et al. 2011). In addition, unsustainable state-owned enterprises, such South African Airways and Eskom, have played a significant role in exacerbating public debt (Schularick 2012).

Moreover, countries in Europe and other industrialized economies are clearly not the only countries that were affected by the 2007 financial crisis (Reinhart and Rogoff 2010a). Because of the tight economic interrelations and integration, the crisis influenced several countries worldwide, and the emerging economies were part of those countries (Reinhart and Rogoff 2010a). Thus, in times of high public deficits and increasing public debt-to-GDP ratios, a central question concerns the relationship between public debt and economic growth and how these two interact in emerging market economies with their characteristic growth pattern.

Theoretically, there are two general views of how public deficits and debt influence the allocation of resources (Tang and Upper 2010). First, the Keynesian approach states that public deficits that increase public spending and, thus, aggregate demand have a stabilizing effect, fostering economic growth (Tang and Upper 2010). Second, the traditional neoclassical models assume that, at initial stages of development, the developing countries have limited capital stocks and investment opportunities; therefore, capital mobility (in the shape of external debt) increases economic growth (Chowdhury 2001). If the borrowed resources are used for productive investment, they do not create macroeconomic instability (Iyoha 1999).

Another school of thought is that a high level of external debt has adverse implications for investment and economic growth. A broad rationalization of these effects is referred to as 'debt overhang'. It asserts that if there is a probability that a country's future debt will be more than its repayment ability, then the anticipated costs of debt servicing can depress the investment (Kourtellos et al. 2013). Similarly, if a greater share of foreign capital is used to service the external debt, then very little will remain available to finance investment and growth. This channel is known as the 'crowding out' effect (Elbadawi et al. 1997).

The government can create domestic debt to defend the country from adverse external shocks and foreign exchange risks. This also improves the development of internal financial markets (Calvo 1988). Ayadi and Ayadi (2008) argue that government securities in developing countries are

considered an attempt by banks to guard against high private sector credit risk; therefore, domestic debt helps in 'crowding in' private investment. However, financial market liberalization and macroeconomic stability are the necessary conditions for obtaining the benefits (Amassoma 2011).

Internal financing entails problems of its own. According to Amidu (2014), in comparison with external debt, domestic debt is more expensive. Similarly, as domestic debt leads to heavy earnings for banks, government borrowing is attractive to the banks, and they prefer lending to the government over private sector. Hence, domestic debt (to some extent) can crowd out private investment (Balassone et al. 2011). Most of the studies conducted on debt-related issues so far are focused entirely on external debt, leaving out a very important part of total indebtedness—domestic debt (Minea and Parent 2012).

The concerns over the sustainability of public debt levels are grounded in both theory and empirics [see, for example, Presbitero (2012) for a comprehensive survey of the existing literature]. The theoretical literature has distinguished between the positive short-run effects of accumulating public debt in order to enact counter-cyclical policies and potential negative long-run growth effects from high levels of debt. For example, Adofu and Abula (2010) emphasize the potential crowding-out effect of higher public debt on private investment, although their back-of-the-envelope calculations suggest that the growth effects from crowding out may be modest (Barro 1974).

1.1 Objectives of the study

Public debt in South Africa, over time, has been rapidly increasing. In 2014, public debt was recorded at 46.99 per cent, increasing to 56.71 per cent in 2018, and it is projected to reach 71.6 per cent in 2022–23 (Saungwene and Odhiambo 2020). Economic growth in the country has been lacklustre in 2019—growth was reported at 0.15 per cent. In 2018, it was reported at 0.79 per cent, which shows a decrease in economic growth from 2018 to 2019 (Saungwene and Odhiambo 2020). While debt in the country has been increasing, growth has been declining. Thus, this raises a profound question: how does debt impact the country's economic growth? This literature does not provide a useful guide in this regard. Some studies argue that it has adverse effects, whereas others argue that it has a sanguine effect. Therefore, the aim of this study is to understand the nature of the relationship between government debt and economic growth in South Africa. To achieve this, the study has one objective:

- To investigate the effect of public debt on economic growth in South Africa.

2 Literature review

This section briefly examines different studies that analyse the relationship between public debt and economic growth. Although several studies have been conducted examining the effect of public debt on economic growth, they have mostly been on developed countries, and little has been done on developing countries (Checherita-Westphal and Rother 2012). Additionally, it is problematic that developing countries do not have enough empirical evidence on how public debt affects economic growth (Adofu and Abula 2010). Because these countries are not growing as they should and public debt might be the cause of this slow growth, that information should be explored to find those answers (Adofu and Abula 2010).

How important are taxes when growing an economy and as a debt-servicing mechanism? When answering this question through the Ricardian equivalence theory, which states that borrowing

does not substitute taxes, taxes can be used as a debt-servicing mechanism in the short run. However, David Ricardo views debt as deferred taxes that will be paid by the future generation (Bernheim 1987). This means the current government debt will not affect the current generation but will have a negative impact on the future generation. This can also be referred to as overlapping generations in macroeconomics.

A study by Singh (1999) used the cointegration and granger causality test, in which he examined the relationship between domestic debt and economic growth in the period 1959–95. His results show that even if the government uses taxes or debt to finance its spending, the impact on the economy will be the same for both these approaches. The debt that is being addressed can take the form of being an external or domestic debt. Moreover, if the debt continues to accumulate, this can cause the debt to be out of hand.

The sub-Saharan region is one of the regions that has several countries that are less developed. These countries are experiencing slow economic progress (Iyoha 1999). According to Fosu (1996), this slow progress is caused by an increase in the level of external debt in the region. Moreover, Elbadawi et al. (1997) conclude that external debt affects savings and investments, rather than economic growth. Ayadi and Ayadi (2008) believe this can be a problematic approach because it does not open the possibility that debt can increase economic growth.

Iyoha (1999) believes that it is possible for external debt to affect investments but influence economic growth at the same time because the growth of the economy is not only dependent on investments. There can also be other activities that lead to economic growth. For some, a country's debt can be invested into research and development, which can increase capital formation (Iyoha 1999). Conversely, some scholars believe that a lack of savings and investment can lead to a public debt increase. This is popular in most developing countries (see Missale et al. 2002; de Mendonça and Vivian 2008; de Mendonça and Machado 2013).

Furthermore, it is true that in order to be able to service debt there is some kind of investment that is needed. This shows that as much as investments are not needed to grow the economy, they can be essential in servicing debt, which shows that they are important in the functioning of the economy (Kumar and Woo 2010). Some may ask why the central bank cannot just print out more money for the country to be able to service the outstanding debts. This could cause more damage than help. It can give rise to inflation, which could decrease the value of the currency.

Zimbabwe, one of the countries in the sub-Saharan region, once implemented this policy of printing out more notes (money). Within no time the country was faced with hyperinflation (a continuous increase in prices). At some point, the Zimbabwean inflation almost reached 100 per cent (Bonga et al. 2015). The Zimbabwean dollar lost value until they adopted other currencies (e.g., the US dollar, the South African rand, and the Indian rupee) (Bonga et al. 2015).

Furthermore, scholars like Barro (1979) created theories such as the theory of optimal public finance, which looks at factors that influence the choice between taxes and the debt issue. According to Alesina and Tabellini (1990), the private sector holds the assumption that government bonds create net wealth. These assumptions are very important when it comes to analysing and showing the shifts and effects in the stock of public debt, but an expansion in fiscal policy makes it difficult for these assumptions to hold.

Nonetheless, this does not mean that the assumption does not hold; government bonds can be the reason for net wealth in the economy, especially when the government bonds exceed the fiscal policy expansion for the future (Barro 1974). This assumption made by Barro (1974) created a lot of space in the literature for scholars to analyse this relationship. Barro (1974) made another

assumption that efficient policies are important in order to have an efficient state, but it is important to accept the fact that there is an imperfect private sector, meaning an increase in public debt would increase net wealth in this context.

The major reason for most of the less-developed countries to have problems with increasing debt with no significant increase in the rate of economic growth is that many developing countries seek debt, and when that debt has been given, they use it to finance politicians and their lavish lifestyles (Amassoma 2011). This leads to using up the money that was meant for research and development, and failure to invest in research and development can lead to countries developing at a slow rate (Amassoma 2011).

Nigeria is one of the many African countries that is faced with the problem of mismanagement and misusing public debt to finance politicians rather than investing in research and development. Adofu and Abula (2010) analysed the relationship between domestic debt and economic growth in Nigeria. In their findings, they discovered that domestic debt has caused a negative effect on the Nigerian economy, and they recommended that government should implement policies that discourage domestic debt. Additionally, they advised that the Nigerian economy should concentrate on widening the tax revenue base instead (Adofu and Abula 2010).

Moreover, there are many other reasons that can lead to increased external debt. The sub-Saharan nations have experienced budget deficits because of oil shocks and the decrease in commodity prices. Some argue that this is because of the mismanagement of resources in the 1980s and 1970s (see Barro 1979; Egbetunde 2012; Baum et al. 2013). Additionally, a debt analysis was done in Kenya using the interest rate and public sector credit (PSC). It is evident that when PSC is low, then interest rates will be high, and when PSC increases, then interest rates will decrease (Iyoha 1999). Ayadi and Ayadi (2008) say this has caused domestic debt to increase.

The report from IMF (2004) shows that domestic debt contributed 23 per cent of total debt in the sub-Saharan region during the years 1995–2000, causing domestic debt to increase from 12 to 16 per cent in that same period. Several developing countries have been increasing their external debt to service the previous debt and to make sure they recover from budget deficits (Amassoma 2011). The assumption that increasing public debt can help to service previous debt goes with the direct effect of the debt hypothesis. This hypothesis states that countries borrow so they can consume in the current period and the future (Calvo 1988). Moreover, the direct effect of debt hypothesis is that debt and debt servicing do not have an impact on investments; however, it can be burdensome and can lead to slow growth (Calvo 1988). In contrast, the 'debt overhang' and the 'liquidity constraint', which are known as the traditional hypothesis, state that debt influences the fluctuations in investments and behaves as a tax of future production. This can result in a decrease in the incentive to save and invest in the economy (Kumar and Woo 2010).

Economic theory proves that, for developing countries, a monitored amount of debt could possibly lead to economic growth (Looney and Frederiksen 1986). According to Barro (1974) and Alesina and Tabellini (1990), public debt has been affected by the second world war, which ended in 1945, after the war on public debt showed an increase above a 90 per cent threshold. A study by Reinhart et al. (2012) tells us that when debt is above the 90 per cent threshold, it is likely to cause economic growth to decrease. Minea and Parent (2012) estimated that public debt that is below the threshold of 115 per cent of GDP shows that when public debt increases, growth is affected negatively. Moreover, Barro (1974) and Minea and Parent (2012) acknowledge that it is tempting to increase public debt to more than 155 per cent so that the country can benefit from public debt. This results in a 'debt intolerance ratio'.

Barro (1974) concludes that the unanticipated component of domestic debt is the one that usually affects growth. On the other hand, Kumar and Woo (2010), in their study using the cross-sectional method, concluded that debt and growth are not related. They did this using data from 34 different countries including both developed and developing countries in one sample. Among others, he analysed the United States, UK, Japan, and Australia. The developing countries were represented by Sri Lanka, Nigeria, Niger, and many others.

Poirson et al. (2004) conclude that government debt crowded out investments, which then reduces output and wages in the future. In the topic of the crowding-out effect, Amidu (2014) conducted a study in 27 different sub-Saharan countries using data from 1980–2000. He found that domestic markets in these countries are usually small and short accompanied by a very low investor base. Additionally, interest rate payments in these countries cause a burden to the budget that can initially lead to the crowding-out effect.

Bernheim (1987) agreed with the assumption made by the Ricardian equivalence that when domestic debt increases there is postponement of tax liabilities from the present to the future generation. In contrast, Barro (1979) argues that there will not be any burden transferred because of the phenomenon of operative intergenerational transfers, which can also be explained as wealth being transferred from one generation to another. On the other end, some scholars believe that when the economy registers negative trends, part of the expenditure should be financed by public loans (see Calvo 1988; Égert 2012; Sichula 2012). This would raise investment demand at a higher level of employment, resulting in an increase in GDP, and also resulting in the economy being able to finance the public debts and leading to continuous growth and a decrease in debts (see Calvo 1988; Égert 2012; Sichula 2012).

There are other ways the government can finance its debts, which are through burdening the civilians with tax, by reducing the public expenditure, and by seeking external assistance through increasing public debts. In most African countries, the government does not use one approach but chooses to use both, leading to insufficiency of the public sector (Sichula 2012), whereby the government will not be able to provide the public with essential needs, such as water and electricity. This is a reality for most African countries in the sense that only the rich have access to these resources, while the poor are being subjected to high taxes and high inflation rates.

Additionally, inflation makes it difficult for those who are living below the poverty line. The central bank could try to finance public debt by buying and selling bonds and increasing or decreasing interest rates (Barro 1979). Theory tells us that increasing interest rates would lead to credit being expensive and make it hard for the poor to repay their loans, while decreasing interest rates could help in motivating the population to save and invest more because the returns on investments would be more.

Moreover, in the case of a government that has monopoly power, an increase in public debt would increase net wealth (Barro 1979). Some scholars use the term net wealth to refer to economic growth. The assumption of uncertainty in the fluctuations of tax liabilities make an increase in public debt most likely to decrease economic growth or lead to a decrease in income (Barro 1979). In contrast, other scholars assume that government debt or an increase in public debt would result in an increase in disposable income, meaning that the amount of money that the household would take home would increase and, thus, consumption would increase (Barro 1974). Moreover, the increase in household wealth can alternatively increase individual savings, which could result in overall household savings increasing and possibly increase government savings (Barro 1974).

An increase in savings and investments of the country makes it easy for the government to settle outstanding external public debts, some theorists believe (see Bohn 1998; Cecchetti et al. 2011; de

Mendonça and Machado 2013). Cecchetti et al. (2011) assume that taxes and government debts are substitutes, meaning an increase in taxes will decrease the demand for government debt. In most cases, an increase in government debt does not mean taxes will decrease. This is a reality for most African countries (Sichula 2012). Opposing the above assumption is an increase in disposable income, leading to an increase in savings. Sulaiman and Azeez (2012) state that an increase in disposable income because of increased net wealth would result in a decrease in savings or lead to constant savings. This might lead to an increase in interest rates, which creates a decrease fraction of output and results in a decrease in accumulated capital.

Furthermore, in a non-full employment economy, the effect of public debt on household net wealth will be negative, which will decrease the aggregate demand (Reinhart and Rogoff 2010b). When a state increases public debt, the assumption is that there is more wealth in the economy, whereas in reality, trying to settle the outstanding debt will lead to an increase in taxes if the government is fixing debt issues using the fiscal policy (Reinhart and Rogoff 2010b).

Many scholars believe that the problem of public debt started to gain momentum after the 2007–08 global financial crisis (Tang and Upper 2010; Presbitero 2012; Schularick 2012). The global financial crisis has challenged most economies around the world, which is one of the reasons for substantial public debt. For both developing and developed countries, the increase in public debt has caused concerns about how this will affect fiscal sustainability and its economy and how it will impact the financial market (Schularick 2012). A study on how the financial crisis affected public debt shows that, for developed economies, public debt increased by 107 per cent of GDP after the financial crisis (Kumar and Woo 2010).

Conversely, a study by Ayadi and Ayadi (2008), which looked at the optimal domestic debt levels in low-income countries (including 40 sub-Saharan African countries) and the emerging market in 1975–2004, found that moderate levels of domestic debt to GDP has a significant positive effect on economic growth. The study provided evidence that if debt is exceeding the level of 35 per cent of total bank deposits, that will cause domestic debt to have a negative impact on economic growth. Gurley and Shaw (1957) concluded that public debt is indeed an important contributor of a strong and healthy financial structure of an economy. Some secular increase in debt should be planned by the government at some point (Gurley and Shaw 1957).

In contrast, standard growth models predict that when public debt is high, there will be a decrease in growth, unlike in the short run whereby an increase in public debt will lead net wealth and disposable income to increase, leading to a decrease in capital accumulation (Schularick 2012). Kumar and Woo (2010) say public debt does not only affect net wealth but also leads to capital accumulation, productivity, and growth, but this assumption holds in the long run. Interest rates and sovereign risk spill overs inflate borrowing costs (Kumar and Woo 2010). On the other hand, Panizza and Presbitero (2013) state that higher future distortionary taxation and lower future public infrastructure can result in higher inflation.

High public debt is likely to make the possibility for countercyclical fiscal policy that may result in higher volatility and further lower growth. Public debt also affects the currency. In most cases, it causes a banking and currency crisis (Teles and Mussolini 2014). Some findings show an inverse relationship between initial debt and growth in the next period, meaning when there is an increase in debt, subsequent growth will decrease and vice versa, holding other variables constant (see de Mendonça and Machado 2013; Kourtellos et al. 2013; Panizza and Presbitero 2013).

The debt threshold for both developed and developing economies is similar as well as the way they react to external debt. However, it is acknowledged that developing economies face a binding threshold compared to developed economies (Pattillo et al. 2002; Irons and Bivens 2010; Pescatori

et al. 2014). Additionally, looking at the developed countries as a group, it is evident that there is no systematic relationship between high debt and inflation. Nonetheless, inflation is found to be high in developing countries that are faced with high external debts (Missale et al. 2002; Sulaiman and Azeez 2012). Moreover, assessing the non-linear impact of external debt on economic growth with a panel of 93 countries over the period of 1969–98, Pattillo et al. (2002) found that an average impact of debt becomes negative at about 160–170 per cent of exports, or 35–40 per cent of GDP. The marginal impact of debt starts being negative at about half these values.

Furthermore, a study was conducted by Pescatori et al. (2014) on Organisation for Economic Co-operation and Development (OECD) countries to test the impact of public debt on the economic growth of these countries. Empirical results show that an increase in public debt decreases economic growth. After correcting for endogeneity, the data showed that there is no evidence that public debt has a causal effect on economic growth on OECD countries (Pescatori et al. 2014). Moreover, Presbitero (2012) conducted a study that showed that public debt in emerging economies has no robust effect on economic growth in the long run; however, in the short run, public debt has a negative effect on economic growth. These results were found using the autoregressive distributed lag (ARDL) model (Presbitero 2012).

In addition, a study of five of the European Union countries analysed how the public-debt-to-GDP ratio affects macroeconomic indicators (Panizza and Presbitero 2013). In the study, they used the Pearson correlation coefficient. For Greece, the public-debt-to-GDP ratio is strongly correlated to unemployment, meaning any change in public debt will influence unemployment for Greece. For Portugal, because the p-value is way below p=0.01, public debt fell to 128.5 per cent in 2016. Moreover, with an increase in the growth of public debt to GDP, Panizza and Presbitero (2013) found that growth was then 14.8 per cent in 2012 for Portugal.

It is evident that increasing public debt does not always result in economic growth falling, but it is bordered by a high public debt regime in which economic growth may increase (Égert 2012; Eberhardt and Presbitero 2013). This suggests that there should be additional evidence before advising policies that the government should implement to increase economic growth when the state is facing the problem of public debt. Economists like Barro (1974, 1979), Aghion et al. (1998), and Missale et al. (2002) suggest that to decrease public debt there must be an expansion in fiscal policy, which has a negative impact on output. Additionally, the government can adapt a decrease in their spending, which is contractionary to a fiscal policy approach. Moreover, an unplanned increase in inflation could possibly lower the cost of servicing the debt.

As Hyman (2012) says, long-term government debt tends to be affected the most by fluctuations in inflation, but the short term is usually not affected. Increasing the real value of short-term debt can also result in the government being charged a higher interest rate in the future (see Kumar and Baldacci 2010; Tang and Upper 2010). Most states end up inflating short-term debt as a coping mechanism to deal with their increasing public debt.

There are other important factors that look at how external debts are accumulated (Looney and Frederiksen 1986; Balassone et al. 2011). For example, public debt that is created during war is easier to manage than public debt accumulated during time of peace. Debt in times of war tend to have minimal effects on economic growth and inflation compared to times when there is peace (Balassone et al. 2011). Growth tends to be high after the war when the economy is reverting to being civil. When debt continues to increase in times of peace implies some problem with the policies that are implemented, and it usually takes a long time for those to be fixed or to revert to the origin (Zyuulu 2010; Lof and Malinen 2014).

3 Data and methodology

3.1 Introduction

This section will briefly outline the methodology and data used in this study to achieve the objective stated in the introduction. First, we will commence by defining the specification of the model and estimation technique and thereafter discuss the empirical strategy used in the analysis.

3.2 Data analysis

The data will be distributed into different tables and figures to show the trends of how our variables evolve over time. We will also allow for the non-linearities that exist among these variables.

3.3 Specification of the model

The specified model is shown below with real GDP as the proxy for economic growth (LGDP), which is the dependent variable, and with public debt as the percentage of GDP (DEBT), which includes both domestic and external debt. This can be expressed by the following equation:

$$X_t = f(X_{t-1}) \tag{1.1}$$

where

$$X = LGDP_t\ DEBT_t \tag{1.2}$$

LGDP is the log of GDP, and DEBT is the public debt as a percentage of GDP and is not logged because it is already in percentage form.

3.4 Estimation technique

The data are time series, and most time-series variables are usually nonstationary. So firstly, the test for stationarity is conducted using the Phillips Peron (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. This will be followed by the test of cointegration, depending on the order of integration the variables will be in and if a long-run relationship exists. Then, conducting an error correction model (ECM) or a vector error correction model (VECM) will be the next step, but if there is no cointegrating relationship, then a short-run model will be the following step. The short-run model is conducted by estimating the VAR model, but before we estimate the VAR model, there are some diagnostics tests that need to be conducted: the serial correlation test, the normality test, and the heteroscedasticity test. After estimating the VAR model, a variance decomposition model can be estimated, followed by the impulse response function, which would show how shocks in the economy will affect the variables.

3.5 Vector autoregressive model

The VAR model simply shows the presence of a lagged value off the dependent variable on the right-hand side of the equation. Vector means the system contains a vector of two or more variables. It must be known that the VAR model is constructed only if the variables are integrated of order one (i.e. stationarity after first difference). If the variables are cointegrated, then both the short-run and the long-run model can be estimated. In a VAR system, all variables are endogenous. There are no exogeneous variables because the VAR bypasses the need for structural modeling in the model as a function of the lagged values of all endogenous variables in the system. The VAR equation for this model is as follows:

$$LGDP_t = a_1 + \sum_{i=1}^{k} B_1 LGDP_{t=j} + \sum_{j=1}^{k} \varphi_1 DEBT_{M=t} + U_{1t} \quad (2.1)$$

$$DEBT_t = a_2 + \sum_{i=1}^{k} B_2 DEBT_{t=j} + \sum_{j=1}^{k} \varphi_2 LGDP_{M=t} + U_{2t} \quad (2.2)$$

In the equations above, the dependent variable is a function of its lagged values and the lagged values of the other variable in the model.

3.6 Variance decomposition

The variance decomposition of the forecast error gives the percentage of unexpected variation in each variable that is produced by shocks from other variables. It also indicates the relative impact that a variable has on another variable. Moreover, it enables assessment of economic significance of this impact as a percentage of the focused error for a variable sum to one.

4 Discussion and empirical results

4.1 Descriptive statistics

Most time-series variables are non-stationary, and to test for that, the PP test and the KPSS test are employed in this study. Both have the null hypothesis of unit root, and the alternative is that the null hypothesis is not true. These results are presented in Table 1.

Table 1: Descriptive statistics

	Debt	LGDP
Mean	37.85984	12.88164
Median	37.95000	12.91353
Maximum	63.50000	13.41114
Minimum	21.60000	12.30547
Std. dev.	9.201488	0.383364
Skewness	0.105449	-0.169625
Kurtosis	2.251973	1.485680
Jarque-Bera	3.070449	12.24196
Probability	0.215407	0.002196
Sum	4,618.900	1,571.561
Sum sq. dev.	10,244.75	17.78311
Observations	122	122

Source: author's compilation and estimates using Eviews.

Table 1 shows the descriptive statistics for both LGDP and DEBT. The skewness and the kurtosis determine how the variables are going to be distributed. When the skewness approaches 0 and the kurtosis approaches 3, the series is normally distributed. LGDP has a skewed coefficient of -0.169. This shows that the distribution is skewed to the left, while DEBT shows a positively skewed coefficient. The LGDP has a kurtosis of 1.48. The kurtosis measures the thickness of the tails.

This means the LGDP has a thin tail. The kurtosis of DEBT is 2.251, which shows that the kurtosis for DEBT is slightly less thin than the LGDP because it is closest to the kurtosis distribution of 3.

4.2 Unit root test

Table 2: PP and KPSS unit root test

		PP		**KPSS**	**Order of integration**
Variables	Exogenous	Level	1st difference	Level	
LGDP	Intercept	-1.126455	-3.562565	1.303852	I (1)
		(-2.885450)	(-2.885654)	(0.463000)	
	Trend and intercept	0.180831	-3.650740	0.213203	I (1)
		(-3.447383)	(-3.447699)	(0.146000)	
DEBT	Intercept	-0.128768	-7.293924	0.205843	I (1)
		(-2.885450)	(-2.885654)	(0.463000)	
	Trend and intercept	-0.234734	-7.430435	0.205686	I (1)
		(-3.447383)	(-3.447699)	(0.14600)	

Source: author's compilation and estimations from Eviews.

In Table 2, the stationarity test is conducted using the PP and KPSS tests. The null hypothesis for the PP states that the variables have unit root, meaning they are non-stationary, and the alternative hypothesis states that variables are stationary. The null hypothesis for the KPSS states the variables are stationary with an alternative hypothesis of non-stationarity. As shown in Table 2, the PP test reports that both LGDP and DEBT are non-stationary at a level from which is also the same for the KPSS because the null hypothesis of having a stationary series is rejected at the 5 per cent level of significance, and we accept the alternative that states the series is non-stationary. These variables are stationary when first differenced. This means these variables are integrated of the first order I (1) using the 5 per cent level of significance. Because the results show that both variables are integrated of the same order, which is I (1), a test for cointegration can be conducted using the Johansen cointegration test.

4.3 Cointegration test

Johansen test of cointegration

Table 3: Cointegration trace test

Unrestricted cointegration rank test (trace)				
Hypothesized		Trace	5%	
No. of CE(s)	Eigenvalue	Statistic	Critical value	Prob.**
None	0.044482	5.587372	15.49471	0.7437
At most 1	0.001450	0.172631	3.841466	0.6773

Source: author's compilation and estimations using Eviews.

Table 4: Cointegration max test

Unrestricted cointegration rank test (Maximum Eigenvalue)				
Hypothesized				
No. of CE(s)	Eigenvalue	Max Eigen statistic	5% critical value	Prob.**
None	0.044482	5.414740	15.49471	0.6888
At most 1	0.114341	0.172631	3.841466	0.6773

Source: author's compilation and estimates using Eviews.

The Johansen cointegration test has two tests, the trace and the Max test for cointegration, and are estimated at a 5 per cent level of significance. The null hypothesis is that there is no cointegrating relationship among the variables, while the alternative says the null hypothesis is not true. The trace test indicates that there is no cointegration between the variables (LGDP and DEBT). Next, we will examine the Max Eigenvalue test, which also has no cointegrating equations.

Because the cointegration test has been conducted and the test concluded that there is no cointegrating relationship between LGDP and DEBT, the following step will estimate the unrestricted VAR model because there is no long-run relationship. Therefore, we can only estimate the short-run model, the VAR model.

4.4 Normalized cointegration equation

Table 5: Normalized cointegration

Normalized cointegrating coefficients (standard error in parentheses)	
LGDP	DEBT
1.000000	-0.025558
	(0.00126)

Source: author's compilation and estimates using Eviews.

The LGDP is the dependent variable and can also be referred to as the endogenous variable of this regression. The Johansen normalization states that on average, in the long run, DEBT has a positive impact on LGDP ceteris paribus. The coefficients are statistically significant at the 1 per cent level of significance. In conclusion, the null hypothesis of no cointegration is rejected against the alternative of a cointegrating relationship in the model. This can be expressed in an equation form as follows:

$$LGDP - 0.025558DEBT = 0 \quad (3.1)$$

$$LGDP = 0.025558DEBT \quad (3.2)$$

4.5 Diagnostics test

Serial correlation test

Table 6: VAR residual serial correlation Lagrange multiplier (LM) test

Null hypothesis: no serial correlation at lags 1 to h						
Lag	LRE* stat	df	Prob.	Rao F-stat	df	Prob.
1	3.946878	4	0.4132	0.991001	(4, 224.0)	0.4133
2	4.873876	4	0.3005	1.226287	(4, 224.0)	0.3005

Source: author's compilation and estimates using Eviews.

Note: null hypothesis = no serial correlation; alternative hypothesis = there is serial correlation.

Examining whether the model has serial correlation or not is done through conducting the VAR residual serial correlation LM test. Table 6 shows that the null hypothesis of no serial correlation cannot be rejected because when observing the p-values they are more than 5 per cent. This means the alternative hypothesis is rejected, meaning our model does not have serial correlation.

Normality test

Table 7: Jarque-Bera test

Jarque-Bera test			
Jarque-Bera stat	2.339673	probability	0.310418

Source: author's compilation and estimates using Eviews.

In Table 7, the Jarque-Bera test for normality is conducted with 2.339673, which is the Jarque-Bera statistic, with a corresponding p-value of 0.310418, which is more than 5 per cent. It is then concluded that the residuals of the model are normally distributed, which is a good indication. This means the null hypothesis that the residuals are normally distributed is not rejected.

Heteroskedasticity test: Breusch-Pagan-Godfrey

Table 8: Heteroscedasticity

F-statistic	0.005398	Prob. F (1,113)	0.9416
Obs*R-squared	0.005493	Prob. Chi-Square (1)	0.9409
Scaled explained SS	0.003355	Prob. Chi-Square (1)	0.9538

Source: author's compilation and estimates using Eviews.

Table 8 shows the Breusch-Pagon-Godfrey test for heteroscedasticity. The test shows that the model estimated is not heteroscedastic because the p-values are above 5 per cent. It can be concluded that the residuals of this model have constant variance, and this is a good thing.

4.6 Vector autoregressive model

Variance decomposition results

Table 9: Variance decomposition

Variance decomposition of LGDP			
Period	S.E.	LGDP	DEBT
1	0.011661	100.0000	0.000000
2	0.016534	99.98017	0.019827
3	0.020306	99.93351	0.066487
4	0.023516	99.85964	0.140363
Variance decomposition of DEBT			
Period	S.E.	LGDP	DEBT
1	1.200780	17.12554	82.87446
2	1.712393	16.98000	83.02000
3	2.114891	16.83536	83.16464
4	2.462690	16.69165	83.30835
Cholesky ordering: LGDP DEBT			

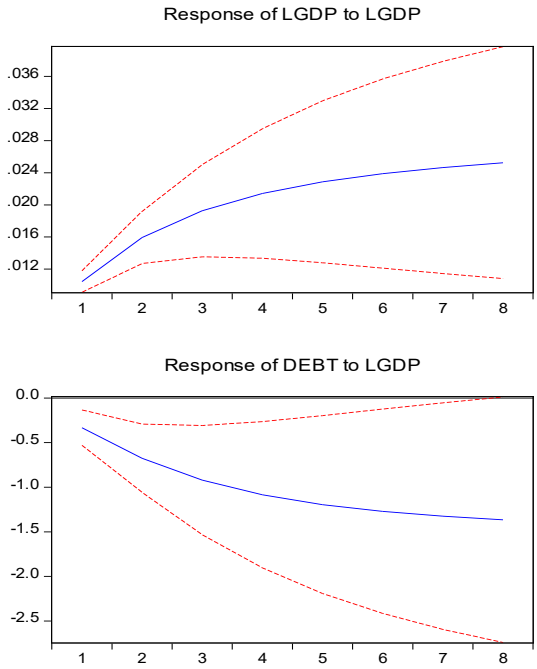
Source: author's compilation and estimates using Eviews.

In the short run, which is denoted by quarter three, the real GDP (LGDP) is 99.93 per cent. This can be interpreted as the economic growth accounting for 99.93 per cent variation of the fluctuation. A shock to public debt as a percentage of GDP can cause 6 per cent fluctuation to GDP. Moreover, a shock in LGDP can cause 16 per cent fluctuation in DEBT, while a shock in debt can cause 83 per cent fluctuation to DEBT. In conclusion, this shows that a shock in debt does not cause that much of a fluctuation in LGDP. This does make sense because real GDP does not depend on public DEBT only for it to fluctuate. Furthermore, in the long run, a shock in LGDP will cause 16.69 per cent variation of fluctuation in DEBT.

Impulse response function

Figure 1: Impulse response function for LGDP and DEBT

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.



Source: author's compilation and estimates using Eviews.

The first graph in Figure 1 shows a response of LGDP to a 1 per cent standard deviation shock to LGDP. The second graph shows the response of debt to a 1 per cent standard deviation shock to LGDP. The red lines are the 95 per cent confidence interval, while the blue line is the impulse response function. The impulse response function must lie between the 95 per cent confidence interval.

The figure shows that a shock to LGDP initially shows a gradual increase from the first period to the second period. The response continues to increase as the period continues, but when it reaches period five it starts to be steady as the increase is slightly lower compared to other periods. This can be said to be a positive response. Furthermore, one standard deviation shock to debt will inversely affect economic growth as the blue line shows a negative downward trend. This can be said to be a negative response, and as the period continues, GDP keeps falling as it is below 0. From this impulse response function, we can conclude that DEBT will affect GDP negatively, meaning economy growth decreases as DEBT increases.

5 Conclusion

This study was conducted to examine the causal relationship between economic growth and public debt in South Africa using quarterly (Q) data from 1990 (Q1) to 2020 (Q2). The objective of the study was to investigate the effect of public debt on economic growth. In making sure that the objective was unpacked properly, the study examined economic theory that exists and other past literature that was conducted. The study assessed the Ricardian equivalence theory, debt overhang, and the Keynesian theory.

Economic growth is proxied by real GDP, while public debt as a percentage of GDP contains both domestic and external debts. The study was conducted using VAR as the methodological approach, which serves as a short-run and long-run analysis between economic growth and public debt. Before the model was estimated, a stationarity test was conducted using both the PP and the KPSS test for stationarity, which revealed that the variables are integrated of the first order I (1). This then allowed for the Johansen cointegration test to be estimated, and the results showed that there is no long-run relationship between public debt and economic growth, meaning there is no cointegration.

Because there is no long-run relationship between variables, this implies that there will be no long-run error correction model conducted in this instance, but the VAR short-run model can be conducted. However, before that, some diagnostic tests were conducted, namely the serial correlation test, normality test, and heteroscedasticity test. Through the tests, the model was found not to be serially correlated and had no heteroskedasticity, and the residuals were normally distributed. The variance decomposition and the impulse response function have a similar conclusion stating that a shock in debt will decrease economic growth over time.

The rate at which public debt is increasing is unsustainable. Hence, there must be some changes in the way that the government operates in order to control the continuous increase, such as changes in government expenditure and improving the financial standing of state-owned enterprises as they are also a huge contributor of high public debt. Moreover, the government could increase tax collection through increasing economic growth. When there are more people working, there could be more revenue collected. Future researchers could look at how the pandemic has affected public debt of both developing and developed countries.

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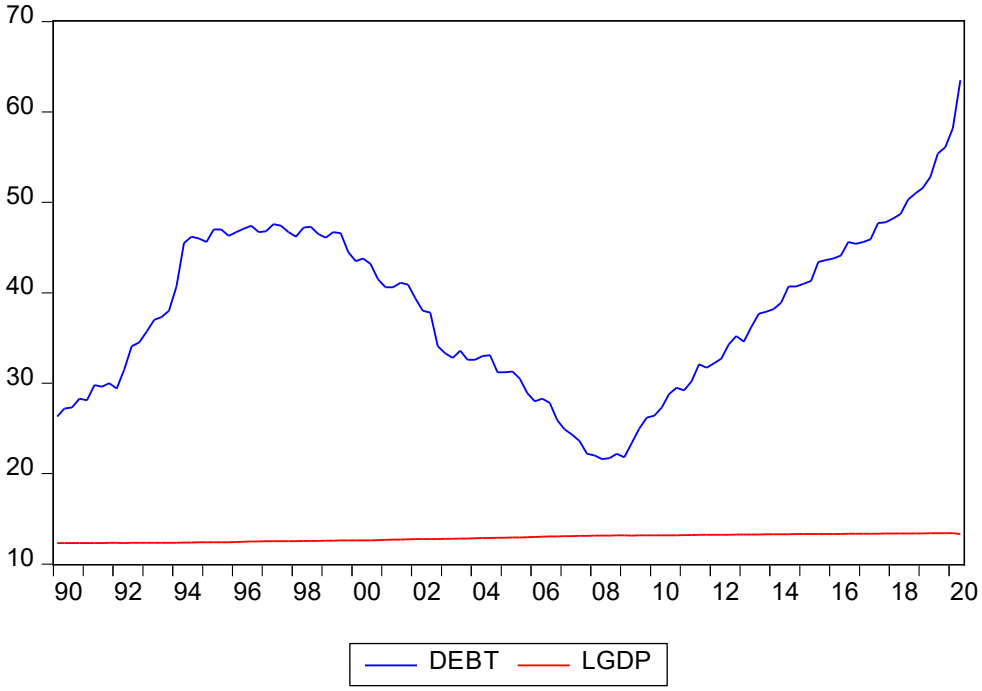
Appendices

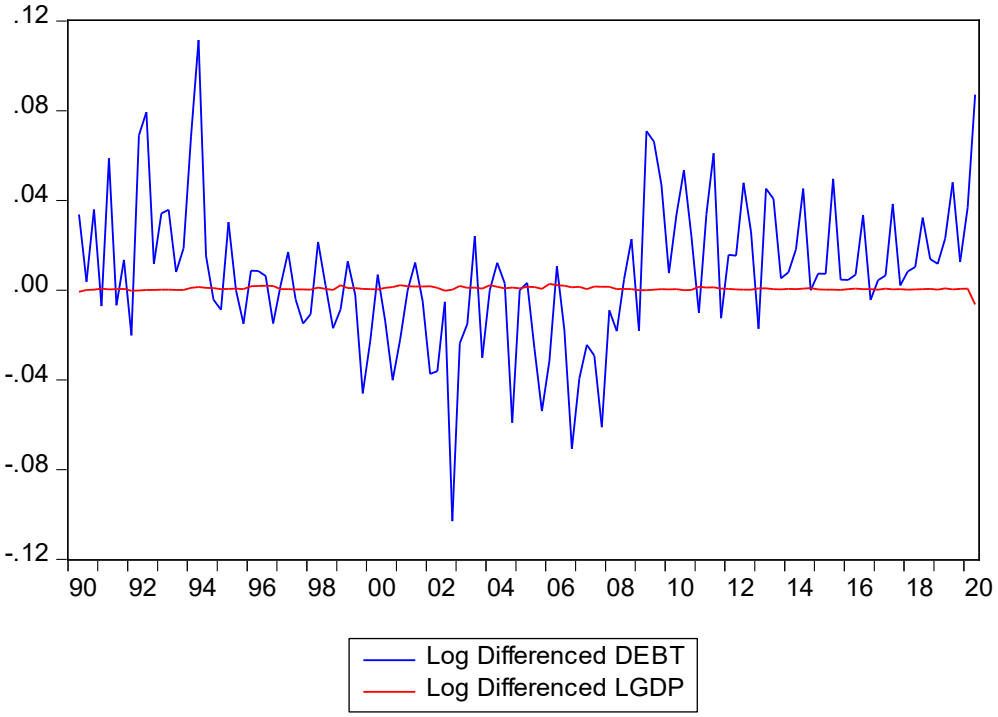
Graphs

Figure A1: Unit root



Source: author's compilation and estimations from Eviews.

Figure A2: First difference



Source: author's compilation and estimations from Eviews.

Table A1: Optimal lag selection

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-195.6335	NA	0.094971	3.321571	3.368279	3.340537
1	214.5197	799.6263	0.000103	-3.504533	-3.364409	-3.447633
2	235.6106	40.40943*	7.73e-05*	-3.791774*	-3.558235*	-3.696941*
3	238.1699	4.817625	7.92e-05	-3.767562	-3.440606	-3.634796

Source: author's compilation and estimations from Eviews.

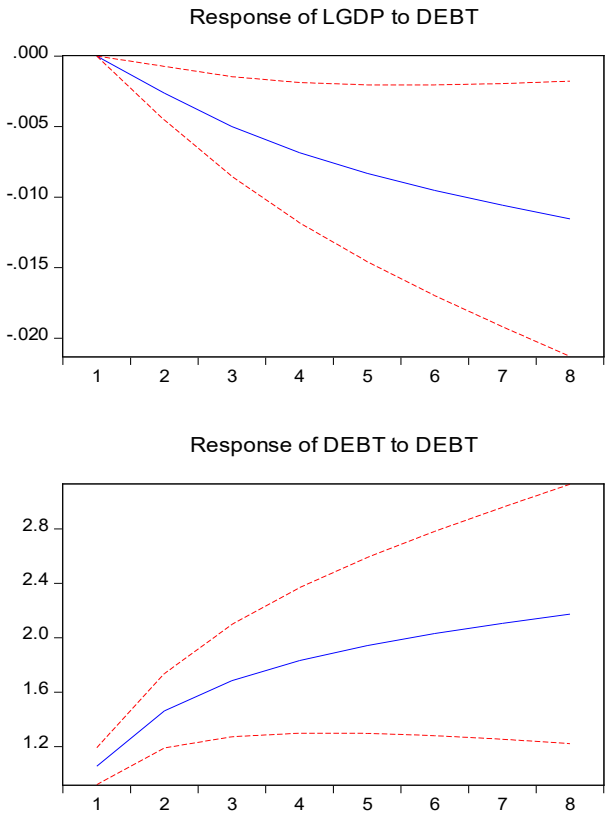
Table A2: Short-run model (VAR)

Standard errors in () and t-statistics in [ ]		
	LGDP	DEBT
LGDP (-1)	1.395968	-4.929908
	(0.39155)	*(14.4358)*
	[3.56525]	*[-0.34151]*
LGDP (-2)	-0.525938	-1.066046
	(0.41318)	*(15.2331)*
	[-1.27292]	*[-0.06998]*
DEBT (-1)	0.000229	1.561537
	(0.01110)	*(0.40907)*
	[0.02062]	*[3.81729]*
DEBT (-2)	0.003416	-0.386181
	(0.01182)	*(0.43564)*
	[0.28907]	*[-0.88646]*
C	0.335006	15.16800
	(0.24960)	*(9.20234)*
	[1.34217]	*[1.64828]*

Source: author's compilation and estimated using Eviews

Figure A3: Impulse response function

Response to Cholesky One S.D. (d.f. adjusted) Innovations ± 2 S.E.



Source: author's compilation and estimates using Eviews.