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An empirical analysis of public debt and government expenditure in South Africa

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ABSTRACT

The high rate of growth of public debt in African countries has stimulated debate among professionals, public representatives, and the general public on how government expenditure affects public debt levels. The primary focus of this paper is to study the relationship between public debt and government spending in South Africa. The methodology of this study employs the Johansen test of co-integration, the VECM, and the Granger causality test. The data period is from 1980 to 2020, and time series data was taken from the South African Reserve Bank and the International Monetary Fund. The findings of this study reveal a negative, statistically significant, and unidirectional causality coming from capital expenditure to public debt. Recurrent expenditure is positive and statistically significant, with unidirectional causality from public debt to recurrent expenditure. Inflation is positive and statistically significant; the causality result shows unidirectional causality, that is, from inflation to public debt. The study yielded positive outcomes and demonstrated statistical significance in relation to the relationship between the exchange rate and public debt. The practical implication is that the South African government should spend more borrowed money on capital expenditures. Secondly, public debt could be reduced by continuing with inflation targeting. Lastly, the government should be encouraged to borrow in local currency.

Contribution/ Originality: The study employs VECM to estimate short-run and the Johansen test of co-integration for long-run relationships for the following variables: public debt, recurring expenditure, capital expenditure, and inflation exchange rate. It further uses the Granger causality test to determine the direction of causality between and among the variables.

1. INTRODUCTION

Public debt has increased to new heights over the past decades in sub-Saharan Africa (SSA), which is blamed on governments' financial indiscipline. In just a four-year period, debt increased to 45% in 2017, from 32.2% in 2014; this is the percentage of the debt-to-GDP (gross domestic product) ratio (Van Cauwenbergh & Laleman, 2018). Economies in SSA have accumulated debt to unsustainable levels, pushing countries to debt overhang challenges, which stimulated calls for debt relief interventions (Olaoye et al., 2022). That resulted in international institutions initiating a policy that was intended to curb the situation of heavily indebted poor countries in 1996 (Ampah & Kiss, 2019).

According to Majam (2017), public debt in the context of South Africa refers to all debt that the national government owes to both internal and external creditors.The government borrows to finance different activities. The South African government has been increasing government spending over the years and borrowing more from local and international institutions, which include the African Development Bank (ADB), the World Bank, the New Development Bank (NDB), and the International Monetary Fund (IMF), among others. The constant increase in both public debt and government spending has raised concerns among South Africans about the future of the government's finances (South African Reserve Bank, 2021; Van Cauwenbergh & Laleman, 2018).

Public debt has been increasing in South Africa over the years. During the 2019 fiscal year, the public debt ratio to GDP was 52.2% (South African Reserve Bank, 2021). The coronavirus pandemic found the government in South Africa financially unprepared, so much so that they were required to borrow more money from the IMF. That took gross public debt to 83% of GDP by the end of 2020, up from 56.7% in 2018 (South African Reserve Bank, 2021). That has stimulated concern by different role players in the economy about the future of South Africa's debt path. The high levels of public debt are beyond a country's capacity to work against the growth and development of the economy (Dabrowski, 2014).

South Africa has high public debt levels, which were accumulated with the aim of improving the performance of the economy, but the country is still experiencing poor economic performance, high inequality rates, and low employment. The growth of the economy helps to repay the debt (Mothibi & Mncayi, 2019). The debt is repaid in the form of principal and interest payments; both result in the cost of servicing debt, which comes whenever the government decides to finance government spending with debt. The consequences are worse if debt is used for consumption expenditures. That creates challenges when the economy fails to produce enough to service the debt (Olaoye et al., 2022). The high cost of debt servicing has a negative impact on the national budget, making it challenging for the government to increase investment and public services (Dabrowski, 2014).

Government expenditure is defined as the resources the government spends in the economy for the needs of the nation, encompassing public goods and services. According to (Odo, Igberi, & Anoke, 2016), deficit spending increases government debt. There are two types of government expenditure: recurrent and capital expenditure. Capital or development expenditure refers to investment in infrastructure, such as building new roads and investing in land (Awoyemi, 2020). Recurrent expenditure refers to spending on consumption, which includes, among others, grants, salaries, and interest on debt (Nyarko-Asomani, Bhasin, & Aglobitse, 2019; Odo et al., 2016). The spending by the government directly contributes to the fiscal deficit, which connects it to public debt because the government deficit is financed by borrowing (Awoyemi, 2020; Uguru, 2016).

It is advisable for a government to take on debt that is within its fiscal limits to avoid long-term financial challenges (Van Cauwenbergh & Laleman, 2018). The South African government has made a number of attempts to improve and stabilise the increasing public debt levels since the dawn of democracy, starting with the Reconstruction and Development of Policy. The Growth, Employment, and Redistribution Policy came next, then the Accelerated and Shared Initiative for South Africa, and the most recent was the adoption and implementation of the National Planning Commission (2011) and Mhlaba and Phiri (2019). The plan is not bringing the much-needed outcomes, as the unemployment rate, inequality, poverty, and public debt continue to increase (Masoga, 2018).

Onyango (2019) found negative results on expenditure and public debt and positive results on development expenditure and public debt. The bidirectional relationship between public debt and development expenditure was discovered to be causal. The results show that causality emerges from public debt. Odo et al. (2016) and Mah, Mukkudem-Petersen, Miruka, and Petersen (2013) found it unidirectional, from national government expenditure to government debt. This study will contribute to the literature by studying a topic that has not been explored enough within the context of South Africa. Studies that came before usually feature government expenditure as a control variable if the study takes a closer look at public debt, like the work of Mothibi and Mncayi (2019).

There is a scarcity of studies that investigate the relationship and causality between public debt and government expenditure in the existing literature. This study employs VECM to estimate the short-run relationship and the Johansen test of co-integration for the long-run relationship, a unique combination to provide new evidence for policy-makers.

2. LITERATURE REVIEW

This section covers debt theories and adopts the Keynesian theory. A better way to describe the Ricardian Equivalence Theory is as an economic theory that contends that government spending, whether paid for by current taxes or deficits (future taxes), has an equivalent impact on the overall economy (Bal & Rath, 2014). In the long term, expenditures will be adjusted to be equal to revenue. Secondly, consumers will adjust their spending to pay future high taxes because expenditures were financed through debt (Modigliani, 1961).

The continuous increase in government debt leads to debt overhang challenges. Debt overhang is the point where a country is unable to take on new debt because of the heavy burden of its high debt (Pattillo, Poirson, & Ricci, 2004). Available resources will not allow servicing and repaying the new debt as they are directed to the already-existing debt. That has the potential to demotivate an economy to make new investments because all gains from it will be directed to service government debt (Krugman, 1988).

The Laffer curve was developed by Sachs (1989) to best explain how the government can maximise tax revenue by identifying the optimal point beyond which total tax collected begins to decline. The point is for the government to allow businesses and individuals to have an incentive to work by not taking too much out of their income. Taxes can be between zero and one hundred percent; at zero percent, the government gets no income, while at one hundred percent, no one will be willing to work. Therefore, it is important for the government to find optimal levels.

The Keynesian work states that the lower levels of government favour economic performance in the short run (Elmendorf & Gregory, 1999). Because the government's income can limit its spending, which prevents the economy from reaching its potential and is undesirable, especially for a weak economy, the Keynesian theory favored borrowing to fund government spending (Sinha, Arora, & Bansal, 2011). Equation 1 is the difference between government income and spending, which is the current balance, which can be represented as follows:

$$B_t = G_t - T_T \qquad (1)$$

Where B_t is the balance (difference between spending and income) at time t. G_t is total spending and T_T is tax revenue (Mah et al., 2013).

The public debt equation takes the following form as shown in Equation 2:

$$D_t = (1 + r)D_{t-1} + B_t \qquad (2)$$

Where the total accumulated debt is represented by D_t. Equation 3 is the total accumulated debt represented by the e pass value of total accumulated debt, total spending and tax revenue:

$$D_t = (1 + r)D_{t-1} + G_t - T_T. \qquad (3)$$

Public debt measures total accumulated debt and all other associated debt servicing costs (Mah et al., 2013). This theory of public expenditure emerged from the work done by Peacock and Wiseman (1961), who investigated expenditure behaviour in the United Kingdom. They noted that the public debt increase does not follow a straight line; instead, it increases in a stepwise manner. The public expects the government to provide all the goods and services they require, including public infrastructure.

According to Yusuf and Mohd (2021), external debt is not good for the economy, while domestic debt contributes positively to economic performance. Their work was looking at the effect of government debt on the economy using autoregressive distributed lag (ARDL) for the period between 1980 and 2018. Roth, Settele, and Wohlfart (2022) studied how people behave regarding government debt, government spending, and taxation. A sample of the population of the United States was used. His work found that people do not pay attention to the government debt impact, but when they become aware, they develop negative attitudes towards government spending. Omrane and

Omrane (2017) were interested in factors that contribute to government debt in Tunisia. The study investigated the period from 1986 to 2015. The VECM results indicated that real interest rate, trade openness, and budget deficit increase public debt. On the other hand, inflation and investment reduced public debt in Tunisia.

Ma and Qamruzzaman (2022) used the ARDL Fourier Toda-Yamamoto causality tests to find out how government spending change is not equivalent to government debt and institutional quality in Brazil, Russia, India, and China, known as the BRIC group of countries. In the work of Gomez-Puig, Sosvilla-Rivero, and Martinez-Zarzoso (2022), panel data was utilised for over 100 countries. The growth nexus and heterogeneity of the debt were used. Results show that the quality of the institution and the maturity of the debt are significant.

The work of the following researchers found these results: First, Awoyemi (2020); Uguru (2016); Odo et al. (2016); Mah et al. (2013); and Mothibi and Mncayi (2019) found a positive relationship: an increase in public debt increases government expenditure. The work of Onyango (2019) found the relationship to be negative between public debt and recurrent expenditure, whereas development expenditure is positively affecting public debt. On the direction of causality, Onyango (2019) found causality that is bidirectional between public debt and development expenditure. On recurrent spending and public debt, causality is from public debt. Odo et al. (2016) and Mah et al. (2013) found it unidirectional from national government expenditure to government debt.

Sinha et al. (2011) studied the macroeconomic variables that influence government debt in 31 high- and middle-income countries. Their study employs autoregressive multiple regression models, and its results revealed that GDP growth rate and expenditure by the government are the significant determinants of public debt, depending upon the country's economic status. In middle-income countries, the main contributors are the growth of the economy and the balance on the current account. In high-income countries, education spending has a significant influence on debt levels. The countries that were found to be struggling with higher levels of public debt, which has resulted in a debt crisis, are Spain and Greece, and the situation is not likely to improve.

The work by Aimola and Odhiambo (2020) investigated the inflation and government debt relationship in many countries. Both positive and negative relationships were found; however, positive relationships dominated the results, especially in countries with high public debt levels and poorly developed financial markets. Work by Kwon, McFarlane, and Robinson (2009) found higher debt levels in economies where development usually causes inflation. The existence of a long-run relationship was found by Yien, Abdullah, and Azam (2017). The direction of causality comes from inflation to domestic debt, and the domestic debt Granger causes the exchange rate. Bidirectional causality was found between the exchange rate and external debt.

3. DATA AND METHODOLOGY

This study uses time-series data that dates from 1980 to 2020. Some data was extracted from the South African Reserve Bank (SARB), while other data was from the International Monetary Fund (IMF). The reviewed literature serves as a guide for the model and arrangement of our variables. This study adopted the Mah et al. (2013) and modified it to fit the unique requirements of this study as shown in Equation 4.

$$In(GDEBT_t) = \beta_0 + \beta_1 In(GNEXP_t) + \beta_2 In(GNINC_t) + \beta_3 In(LINF_t) + \beta_4 In(NFDI_t) + \varepsilon_t \quad (4)$$

The model of this study is represented in Equation 5, $\beta 0$ is the constant and β1 to β4 are slope parameters of the variables that are independent.

$$LPDT_t = \beta_0 + \beta_1 LREX_t + \beta_2 LCEX_t + \beta_3 INF_t + \beta_4 LEX_t + \varepsilon_t \quad (5)$$

Public debt is our dependent variable. Independent variables are government expenditure, which is made up of recurring expenditure (REX), capital or development expenditure (CEX), inflation (INF), and exchange rate (EX). All variables that are not in percentage form are converted to logarithms for interpretation purposes.

3.1. Stationary Test

The study tests the unit root in our time series data using the following statistical tools: the augmented Dickey-Fuller test and Phillips-Perron. The Dickey-Fuller (DF) test is named after the founders, two statisticians, Dickey and Fuller, who developed the test in the early 1970s (Fah & Nasir, 2012). The augmented version used in this study is different because in the DF test, it was assumed that errors were not correlated, so to counter the problem of correlation in errors, the augmented test was developed. The augmented Dickey-Fuller test (ADF) is used to test for non-stationarity in the autoregressive model (Fah & Nasir, 2012). We use the following equation by Alam and Ahmed (2010) to conduct stationarity tests.

$$\Delta Y_t = \beta_1 + \beta_{2t} + \delta Y_{t-1} + \sum_{i=1}^{m} \alpha_i \, \Delta Y_{t-1} + \varepsilon_t \qquad (6)$$

The equation above contains ε_t, where:

$$\Delta Y_{t-1} = (Y_{t-1} - Y_{t-2}), \Delta Y_{t-2} = (Y_{t-2} - Y_{t-3}) \qquad (7)$$

The interpretation of the results for the ADF test is based on the null hypothesis that the variable has a unit root. The null hypothesis can be rejected if the ADF test statistics are greater than the test critical values. In the case where the series is not stationary when variables are at levels, all options above are applicable to first-differenced series. The null hypothesis states that the variable contains a unit root problem. The null hypothesis stated above is rejected if the ADF critical value is above the test critical value at the 0.05 percent level of confidence.

The Phillips-Perron unit root test, a non-parametric statistical method, uses a different approach from ADF to take into account the issue of the serial correlation that might be containing error terms. To resolve the serial correlation that the errors might have contained, the ADF adds the lagged values of the regression to the DF (Suk Kim, 2009). According to Fah and Nasir (2012), the following equation developed by Phillips and Perron is used to conduct a Phillips-Perron (PP) test.

$$Y_t = \emptyset + \alpha Y_{t-1} + \varepsilon_t \qquad (8)$$

Where $\emptyset$ is the intercept, α is the equilibrium, t is the trend variable, and ε is the error term.

The ADF test's explanation of the results is equivalent to the PP test's interpretation. If the PP statistics' absolute value is less than the test critical value, the null hypothesis, which says the data has a unit root, cannot be rejected.

3.2. Johansen Test of Co-Integration

When the time series data contains a unit root, it is a green light to continue with a test of co-integration, which confirms the existence of variables' relationships over longer periods (Mishra, 2011). The Johansen test of co-integration is employed to determine whether the series stationary at first order I (1) are co-integrated. The importance of co-integration analysis is when the co-integrating relationship is found to include vector residuals. It is important that the model include period-legged residuals to handle the complexity of the VECM system (Mishra, 2011). The Johansen test of co-integration reveals whether the non-stationary time series have a relationship in the long run. The Johansen test has advantages over the Engle-Granger test because it can test for more than one co-integration relationship and is not a single equation model (Suk Kim, 2009). The approach of Johansen is associated with two assessments known as the maximum Eigenvalue and trace tests.

Those are the trace test and the maximum eigenvalue test, and the formulas take these forms:

$$J_{trace} = -T \sum_{i=r-1}^{n} In(1-\lambda_i) \qquad (9)$$

$$J_{\max Eigen} = -T In(1-\lambda_{r+1}) \qquad (10)$$

The letter T represents the number of observations. In trace statistics, λ_i is the i^{th} largest value of the eigenvalue of the matrix. The null hypothesis is as follows: The number of definite co-integrating vectors is $< or =$ (less than or equal) to the number of co-integration relations (r). The maximum eigenvalue test formula contains λ_{r+1}, which represents the $(r+1)^{th}$ largest squared eigenvalue. The null hypothesis of r is equal to 0 and is tested against the alternative of $r+1$ cointegrating vectors.

3.3. Lag Order Selection Criteria

The Johansen test of co-integration is sensitive to the total number of lags employed. That requires that the number of lag lengths to be employed be predetermined. To identify the number of lags that are autoregressive (AR), we will be guided by Akaike's information criterion (AIC) and the Hannan-Quinn information criterion (HQ). If the observations are not above 60, the AIC provides more reliable results than the other information criterion (Liew, 2004). The other selection criteria are not good for small sample sizes; one example is HQ, which is good for not less than 120 observations. On the other hand, AIC and FPE are good for smaller sample sizes. Both AIC and FPE produce reliable results for small sample sizes compared to all other information criteria because of their suitable properties (Liew, 2004; Masoga, 2018).

3.4. Vector Error Correlation Model (VECM)

The VECM gives a statistical explanation of how variables in the model under investigation, in different time periods, adjust from a state of short-run to a state of long-run equilibrium. The deviation in the short run will be corrected in the long run because variables are correlated. This adjustment will bring everything back to equilibrium. The stable long-run equilibrium is permanent because co-integrated terms have independent directions from which everything is derived (Mishra, 2011).

The VECM is a system that contains the vectors of two or more variables, and all variables are endogenous; it does not contain exogenous variables. Co-integration proves that there is a long-term relationship, which means that VECM can be used. However, this model has restrictions on co-integration (Mishra, 2011). The advantage of the restricted vector error correction model is that it examines the long- and short-run dynamics of co-integrating variables. The behaviour of endogenous variables in the long run to get back to their point is restricted by VECM. The estimates of this model have more efficient coefficients. The error correction term gradually corrects the deviation from equilibrium (Stern, 2011). The error term is used to measure the speed of adjustment.

$$\Delta PDT_t = \beta_0 + \beta_1 \sum_{i=1}^{n-1} \Delta REX_{t-i} + \beta_2 \sum_{i=1}^{n-1} \Delta CEX_{t-i} + \beta_3 \sum_{i=1}^{n-1} \Delta INF_{t-i} + \beta_4 \sum_{i=1}^{n-1} \Delta EX_{t-i} \lambda EC_{t-1} + \varepsilon_t \quad (11)$$

If the coefficient of the error term found is significant and statistically significant, it represents the rate at which deviation from equilibrium is corrected in the next period. n-1 is the number of lags reduced by one. The first difference operator is denoted by delta (Δ) and the error correction term is represented by EC_{t-1} lagged one period. λ is the short-run coefficient of the error correction term, where λ is greater than -1, but less than 0. The error term is represented by ε and t represents the time period.

3.5. Diagnostic Tests and the Tests of Stability

In this section, the focus is on testing whether the model estimated above is stable and whether problems are diagnosed successfully. The results of our model would be invalid if the presence of problems such as serial correlation and heteroscedasticity were not addressed. If tests are not conducted on heteroscedasticity and serial correlation, the risk of having spurious results is not eliminated. A threat to our model is posed by covariance of errors that are not equal to zero. The diagnostic and stability tests would make sure that our model is free from autocorrelation, misspecification, and heteroscedasticity. If these errors are diagnosed, our model will have the best linearly unbiased estimates.

3.6. Serial Correlation

The correlation of errors produces the serial correlation, which implies that the covariance of errors is not zero. According to Griliches (1961), the distributive lag model is useful for addressing the issue of serial correlation. That can be achieved because the Durbin-Watson statistics increase while the serial correlation is reduced. It is more convenient to deal with serial correlation by excluding its causes from the model than to try to develop methods to live with it Griliches (1961).

3.7. Heteroscedasticity

The problem of heteroscedasticity exists if the residuals within the variance, given the independent variable, are not constant (Ouma & Muriu, 2014). When the explanatory variable increases, the variance of errors increases, which means the estimators are not the best linearly unbiased estimators (BLUE). The efficient estimator can come out of re-examining data to consider the problem of heteroscedasticity. Standard errors will make an incorrect interval in the presence of heteroscedasticity in the data utilised. However, it is only one assumption that is affected; all others are still fine, or the not-affected estimates produced will be unbiased (Williams, 2015).

3.8. Test of Normality on Residuals

The ordinary least squares (OLS) model assumes that errors are normally distributed. The coefficients of the OLS regression are said to be unbiased estimators if the residuals are normally distributed, have a zero mean, and have a constant variance. The study employs Jarque-Bera (JB) statistics to test the normality of residuals. In the JB test, the focus is more on the JB results and the probability value. If the probability value is above 5%, we conclude that errors are normally distributed (Ouma & Muriu, 2014). The problem arises if errors are not normally distributed, which has the same implications as explained under serial correlation: spurious regression is the result. That highlights the significance of solving the problem as it arises from the sampled data.

3.9. Stability Test

The restricted vector autoregressive (Molefe & Choga, 2017) are the inverse roots of the AR characteristic polynomial test that show the model is stable. The results of this test would be made with E-views on the AR root graph, which shows the circle with dotted lines; if dots are within the circle, which means the model is stable. The results of VECM specify the state and behaviour of the variables, whether they are endogenous or exogenous, and whether the impact of shocks does not last longer. That is the case if the inverse roots of the estimated model are inside the circle (Hashem & Fahmy, 2019).

3.10. Granger Causality Test

Granger causality tests whether the variables' data influences the behaviour of the other variables by identifying a causal link (Gujarati, Porter, & Gunasekar, 2012). The Granger causality test checks or measures which variable causes the other and the direction of causality. If one event happens before another, we conclude that the one event causes the other that happens after it. The direction of causality can be unidirectional, where one variable causes another, or it can be bidirectional, where the variables have an impact on each other's behaviour. The variable Granger causes another only if a past variable helps to predict another variable's current value (Stern, 2011). The null hypothesis is that the first variable (A) does not Granger cause the second variable (B). It can either be accepted or rejected, based on the probability value. If the probability is below 0.05, the null hypotheses is accepted. The following pair of equations is used to test the Granger causality (Gujarati et al., 2012):

$$Y_t = \sum_{i=1}^{n} \alpha_i Y_{t-1} + \sum_{j=1}^{n} \beta_j X_{t-j} + v_{1t} \qquad (12)$$

$$X_t = \sum_{i=1}^{n} \lambda_i Y_{t-1} + \sum_{j=1}^{n} \delta_j X_{t-j} + v_{2t} \qquad (13)$$

It is assumed that the error terms (v_{1t} *and* v_{2t}) are not correlated. Using Equations 12 and 13, the direction of causality is tested for the dependent variable and independent variable, respectively. The equations for other variables will take the same form.

4. EMPIRICAL ESTIMATION AND DISCUSSION OF RESULTS

4.1. The results of Unit Root Tests

The variables are converted to log form to test the unit root. The Phillips-Perron tests come after this section's results for unit root tests of the augmented Dickey-Fuller. The null hypothesis says each variable has a unit root.

That hypothesis is rejected if the absolute value, not considering the negative sign, of the ADF or PP test statistics is above the test critical value. We used test critical values at the 5 percent significance level. The augmented Dickey-Fuller test results are presented in Table 1.

Table 1. Augmented Dickey-Fuller test (first difference).

Variables	Model specification	ADF test statistics	Test critical values (5%)	Conclusion
Δ INF	Trend	-3.17	-2.95*	Stationary
	Trend and intercept	-5.36	-3.54**	Stationary
Δ LCEX	Trend	-4.69	-2.94**	Stationary
	Trend and intercept	-4.74	-3.53**	Stationary
Δ LREX	Trend	-3.67	-2.94**	Stationary
	Trend and intercept	-6.98	-3.53**	Stationary
Δ LEX	Trend	-6.18	-2.94**	Stationary
	Trend and intercept	-6.12	-3.53**	Stationary
Δ LPD	Trend	-2.98	-2.94*	Stationary
	Trend and intercept	-3.52	-3.52**	Stationary

Note: NB: Test critical value level of significance at 5%* and at 1%**.

The Phillips-Perron test is used to confirm the results of the ADF. Table 2 demonstrates the results of the outcomes of the PP test, which indicates the stationarity of our variables at the first difference for all our variables. We follow the same guidelines as we did for the ADF test, which was to only accept intercept and trend over trend results.

Table 2. Phillips-Perron test (First difference).

Variables	Model specification	PP test statistics	Test critical values (5%)	Conclusion
Δ INF	Trend	-10.27	-2.94**	Stationary
	Trend and intercept	-10.69	-2.94**	Stationary
Δ LCEX	Trend	-4.79	-2.94**	Stationary
	Trend and intercept	-4.79	-3.53**	Stationary
Δ LREX	Trend	-3.73	-2.94**	Stationary
	Trend and intercept	-6.94	-3.53**	Stationary
Δ LEX	Trend	-7.91	-2.94**	Stationary
	Trend and intercept	-7.89	-3.53**	Stationary
Δ LPD	Trend	-2.99	-2.94*	Stationary
	Trend and intercept	-3.55	-3.53*	Stationary

Note: NB: Test critical value level of significance at 5%* and at 1%**.

4.2. Lag order Selection Criteria

The lags are selected using the lag length selection criteria. The information presented in Table 3 summarises the results of the criteria, with the majority recommending two lags. As the star indicates, SC only advised one lag for our model.

Table 3. Lag selection criteria.

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-128.07	NA	0.00	7.00	7.21	7.08
1	94.29	374.49	2.37e-08	-3.38	-2.09*	-2.92
2	130.83	51.93*	1.38e-08*	-3.99*	-162	-3.15*

Note: The star (*) indicates the lag order selected by the criterion.
LR: sequential modified LR test statistic (each test at 5% level).
Hannan-Quinn information criterion (HQ), Akaike information criterion (AIC), Final prediction error (FPE) and Schwarz information criterion (SC).

As previously stated, the Akaike information criterion (AIC) and the Hannan-Quinn information criterion (HQ) serve as our guides. AIC and FPE are good for smaller sample sizes (Liew, 2004). Due to their suitable properties, FPE and AIC both produce reliable results for small sample sizes compared to all other information criteria, which is why these criteria recommended two lags. Other information criteria are not good for small sample sizes, such as HQ, which is recommended for large samples above 120. However, our sample size is only 40. All information criteria recommend two lags, except SC. Consequently, two lags are employed in the Johansen test and VECM.

4.3. Co-integration Test

The Johansen test of co-integration tests the variables for long-run relationships. The results from the unit root test must have results that are stationary in the same order, which will allow for a test of co-integration to determine whether variables have relationships in the long term. Max-Eigen statistics and trace statistics are our guides when determining that in comparison to the 5% level of significance.

Table 4. Summary of Johansen test of cointegration results.

Hypothesised no. of CE(s)	Eigenvalue	Trace statistic	Critical value (0.05)	Max-Eigen statistic	Critical value (0.05)
None*	0.69	110.19	88.80	44.19	38.33
At most 1	0.56	66.00	63.87	31.09	32.12
At most 2	0.35	34.91	42.92	16.53	25.82
At most 3	0.27	18.37	25.87	12.08	19.38
At most 4	0.15	6.29	12.52	6.29	12.52

Note: * denote rejection of null hypothesis at 0.05 level.

Table 4 presents the Johansen test of co-integration, represented by the Trace statistic and the Max-Eigen statistic. Trace statistics results found two integrating equations, and Max-Eigen indicates one co-integration. The null hypothesis, which says there is no co-integrating equation, should not be accepted at the 5% level of confidence by both trace and Max-Eigen statistics. The first and last sections of Table 4 demonstrate that the Max-Eigen statistic follows the same rule as the null hypothesis in cases where the trace is above the critical value at the 5% level of significance. However, the results of the trace statistic of at most one suggest there is no co-integration, but that is not accepted because the Max-Eigen statistic accepts the null hypothesis. The results of the maximum eigenvalue are chosen because they are more reliable than trace statistics. According to Lüutkepohl, Saikkonen, and Trenkler (2001), the maximum Eigen test produces good and reliable results compared to the trace test.

4.4. Results of the Long-Run Relationship

Table 5 below shows the long-run equation, which indicates that there is a statistically significant long-run relationship between variables.

Table 5. The long-run results.

Variables	LPD	LREX	LCEX	INF	LEX
Coefficients	1.00	2.97	-0.94	0.18	2.21
T-statistics		-6.65	2.12	-2.68	-2.36
Constant	24.13549				

The coefficients are statistically significant, as can be seen in Table 5, with t-statistic values above 2. The interpretation of each variable assumes that there is no change in the other variables. The relationship is positive between public debt and inflation; a one-unit increase in inflation will cause public debt to increase by 0.1786961%. There is a positive relationship between public debt and the exchange rate; about a one-unit rise in the exchange rate will lead to a 2.203542% growth in public debt. About a one-unit change in recurrent expenditure will lead to an increase in public debt of about 2.966748%. Capital expenditure is the only variable with an inverse relationship with public debt; about a one-unit change in capital expenditure will lead to a 0.941503% decrease in public debt.

The results found for the long run show that recurrent expenditure positively relates to government debt, whereas capital expenditure negatively affects public debt. These results are supported by the Keynesian theory, as it places emphasis on the type of spending that should be made from government debt. The impact of recurrent expenditure, increasing debt, is better explained by the Ricardian equivalence theory, since it says increasing debt results in higher debt. Increasing debt deprives a country of new private investment, which decreases economic growth, thereby making it difficult to repay existing debt. Debt overhang challenges also highlight challenges that cause debt, thereby resulting in even higher debt. The increasing debt negatively affects economic growth because it comes with challenges of debt repayment. As debt gets higher, the cost of servicing the debt gets higher, resulting in few benefits derived from investments made in the debt.

These results are similar to those found by Mah et al. (2013), Odo et al. (2016), Uguru (2016), Awoyemi (2020) and Mothibi and Mncayi (2019), and on the relationship that government expenditure has with public debt. The study by Onyango (2019), which is more comparable to ours, discovered that public debt has a negative relationship with recurrent expenditure but a positive relationship with debt. That makes economic sense because capital expenditure has positive economic benefits in the future, which allow the government to make debt repayments. On the other hand, recurrent expenditure is like the money that went down the drain.

4.5. Short-Run Estimates Results

This section covers the short-run results.

Table 6. Short-run coefficient and error correction.

Variables	Coefficient	Standard error	T-statistic
CointEq1	-0.04	0.01	-4.12
D(LPD(-1))	0.01	0.20	0.07
D(LPD(-2))	0.37	0.15	2.37
D(INF(-1))	-0.01	0.00	-2.43
D(INF(-2))	0.00	0.00	0.07
D(LEX(-1))	-0.05	0.06	-1.36
D(LEX(-2))	-0.08	0.06	-1.31
D(LCEX(-1))	-0.03	0.04	-0.76
D(LCEX(-2))	-0.03	0.04	-0.75
D(LREX(-1))	0.66	0.20	3.34
D(LREX(-2))	0.50	0.20	2.45
C	-0.06	0.03	-2.00
Adj. R-squared	0.59		
R-squared	0.71		
F-statistic	6.042671		

Table 6 presents the short-run results. The focus is on statistically significant variables. A negative error term means a previous period deviation from equilibrium is corrected in the current period, with -0.048866 as the speed of adjustment. The negative sign in the error correction term signifies its relevance, as the negative means it is able to drive the deviation back to equilibrium. R-square is 0.718826, which means that our variables account for almost 72% of changes in our dependent variables.

The lagged value of public debt for two previous years positively affects the public debt in the current period; lag one is statistically insignificant, lag two is significant, which means a unit change in public debt two years ago increased debt levels by 0.373919. On inflation, a unit change in the short run results in a decrease of about -0.011480 in public debt; that is, the first lag as the second lag is insignificant. The lagged values of 1 and 2 of the exchange rate are statistically significant.

4.6. Diagnostic Tests

Table 7 summarises the results of the diagnostic test. These results show that there is no serial correlation, no heteroscedasticity, and that the residuals are normally distributed.

Table 7. Summary of diagnostic results.

Test	Null hypothesis	P-value	Decision
Serial correlation	Does not have serial correlation	0.09	No serial correlation
Heteroscedasticity test	There is no heteroscedasticity	0.35	No heteroscedasticity
Test of normality on residuals	Residuals are normally distributed	0.11	Normally distributed

4.7. Serial Correlation

The LM test found no serial correlation. The p-values are above 5%, so the null hypothesis is accepted. It says there is no serial correlation, which is accepted because the LM test result has p-values of 0.0869 and 0.9009 at lag 1 and lag 2, respectively. The serial correlation is important to test in time series data. If positive results are found, that means errors in one period are associated with errors in another period.

4.8. Heteroscedasticity Test

The results reveal that our model has no heteroscedasticity; the P-value is above 5%, at 0.3525, and the Chi-square is 339.1446, and therefore the null is accepted.

4.9. Test of Normality on Residuals

The value of probability communicates that those values above 5% mean errors are normally distributed, and those below and at 5% are not normally distributed. Our results indicate that our variable has normally distributed errors as their p-values are above 5%; the null cannot be rejected because the p-value is 0.1145.

4.10. Stability Test (Inverse Roots)

The inverse root of AR is used to test its stability. The graph in Figure 1 shows the results obtained from E-Views. Results indicate that all inverse roots are found within the unit cycle, and none are above 1, which is a good sign for stability in our model. All blue dots, as they appear in Figure 1, are found within the circle, which indicates that VECM is stable.

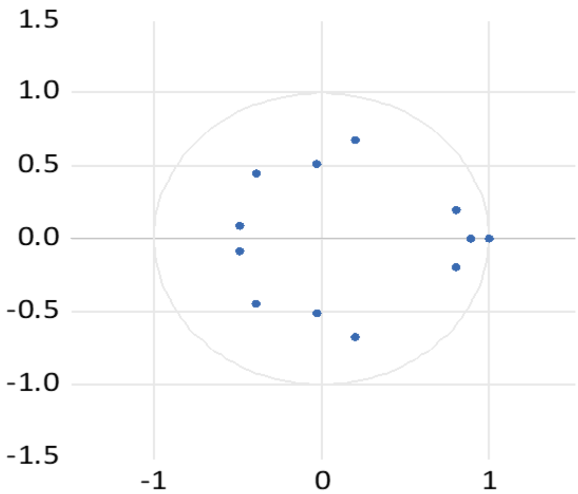

Figure 1. Inverse roots of AR characteristic polynomial.

4.11. Granger Causality Test

The table below shows the Granger causality test results that E-Views produced. The null hypothesis cannot be accepted if the probability value is less than or equal to 5%, which implies that there is causality.

Table 8. Granger causality test results

Null hypothesis	Obs.	F-statistic	Prob.	Decision
INF does not granger cause LPD	39	4.34	0.00	Causality
LPD does not granger cause INF		1.18	1.18	No causality
LCEX does not granger cause LPD	39	2.66	0.04	Causality
LDP does not granger cause LCEX		0.32	0.89	No causality
LREX does not granger cause LPD	39	1.35	0.28	No causality
LPD does not granger cause LREX		2.82	0.04	Causality
LEX does not granger cause LPD	39	0.81	0.55	No causality
LPD does not granger cause LEX		0.32	0.89	No causality

Table 8 presents results that indicate that some variables granger cause others, while others have no causal relationship. The null hypothesis, which states that public debt does not granger because recurrent expenditure, is not accepted at the 5% level (0.0375). That means public debt (LPD) influences the levels of recurrent expenditure (LREX) in South Africa. The results show that causality, which is from public debt to recurrent expenditure, is one way. The work of Onyango (2019) and Odo et al. (2016) supports these findings. The results found by Mah et al. (2013) indicate causality coming from government expenditure to government debt, the opposite of our results on recurrent expenditure. However, the results of capital expenditure agree. Since there is one-way causality coming from capital expenditure (LCEX) to government debt, the null is rejected because the p-value is 0.0462. One-way causality is found from inflation (INF), as the null is rejected since the p-value is 0.0056. These results were also found by Essien, Agboegbulem, Mba, and Onumonu (2016) and Yien et al. (2017).

5. CONCLUSION

This paper's primary objectives included testing the short-run and long-run relationships between expenditure and the debt of the South African government, which were separated into capital and recurrent expenditure in South Africa. Capital expenditure is found to inversely affect public debt, and this relationship is statistically significant. Granger causality results found a one-way causality that comes from capital expenditure to government debt. A one-unit increase in capital expenditure decreases public debt by 0.941503%, which is the negative relationship. Recurrent expenditures positively affect public debt. The causality comes from public debt to recurrent expenditure, and it is unidirectional. In the long term, a unit change in recurrent expenditure increases public debt by 2.966748%. Inflation and public debt have a positive statistically significant relationship and a one-way causality coming from inflation to government debt. Inflation also increases public debt levels, which means if inflation increases by a unit, public debt increases by 0.178696%. Public debt is positively affected by exchange rate in the long term; this relationship is statistically significant, but there is no evidence of causality. A one-unit increase in the exchange rate increases debt by 2.203542%. The study recommends that public debt must be reduced and the government must increase capital expenditure. The government should continue the fight to reduce inflation levels and should borrow more in local currency, as the fluctuations in foreign exchange markets make it expensive to borrow in foreign currency.

5.1. Limitations of the Study

Data availability was a challenge. As a result, the data used was not directly available. The capital expenditure data was derived from the existing data that represents other variables, which creates room for inaccurate data. The capital expenditure data was derived from gross capital formation, which includes investment by private corporations, which had to be subtracted.

5.2. Areas for Future Research

Future studies can look at public debt with other variables not covered in this study. Since this study focused on public debt, future studies can focus on external or internal debt as a dependent variable with the same independent variables. Future studies can also consider changing the focus period for data collection, as this might yield different results, for example, post-apartheid or post-financial crisis of 2008, which is something this study could not do.

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REFERENCES

Aimola, A. U., & Odhiambo, N. M. (2020). Public debt and inflation: A review of international literature. *Folia Oeconomica Stetinensia*, *20*(1), 9-24. https://doi.org/10.2478/foli-2020-0001

Alam, S., & Ahmed, Q. M. (2010). Exchange rate volatility and Pakistan's import demand: An application of autoregressive distributed lag model. *International Research Journal of Finance and Economics*, *48*(1), 7-23.

Ampah, I. K., & Kiss, G. D. (2019). Economic policy implications of external debt and capital flight in Sub-Saharan Africa's heavily indebted poor countries. *Society and Economy*, *41*(4), 523-542. https://doi.org/10.1556/204.2019.41.4.8

Awoyemi, B. O. (2020). The responses of public debt to changes in government expenditure in Nigeria. *African Journal of Economics and Sustainable Development*, *3*(2), 1-14.

Bal, D. P., & Rath, B. N. (2014). Public debt and economic growth in India: A reassessment. *Economic Analysis and Policy*, *44*(3), 292-300. https://doi.org/10.1016/j.eap.2014.05.007

Dabrowski, M. (2014). Factors determining a 'safe' level of public debt. *Warsaw—Moscow February-March.*

Elmendorf, D. W., & Gregory, N. M. (1999). Government debt, in J. B. Taylor and M. Woodford (eds), Handbook of Macroeconomics, volume 1 of Handbook of Macroeconomics. In (Vol. 1, pp. 1615–1669): Elsevier.

Essien, S. N., Agboegbulem, N., Mba, M. K., & Onumonu, O. G. (2016). An empirical analysis of the macroeconomic impact of public debt in Nigeria. *CBN Journal of Applied Statistics*, *7*(1), 125-145.

Fah, C. F., & Nasir, A. (2012). Dynamic relationship between bonds yields of Malaysia, Singapore, Thailand, India and Japan. *International Journal of Academic Research in Business and Social Sciences*, *2*(1), 220.

Gomez-Puig, M., Sosvilla-Rivero, S., & Martinez-Zarzoso, I. (2022). On the heterogeneous link between public debt and economic growth. *Journal of International Financial Markets, Institutions and Money*, *77*, 101528. https://doi.org/10.1016/j.intfin.2022.101528

Griliches, Z. (1961). A note on serial correlation bias in estimates of distributed lags. *Econometrica: Journal of the Econometric Society*, *29*(1), 65-73. https://doi.org/10.2307/1907688

Gujarati, D. N., Porter, D. C., & Gunasekar, S. (2012). *Basic econometrics*: Tata Mcgraw-Hill Education.

Hashem, H. Y. M., & Fahmy, H. A. (2019). Sensitivity of public debt to macroeconomic shocks: An application to the egyptian economy. *Business and Economic Horizons*, *15*(2), 219-241.

Krugman, P. (1988). Financing vs forgiving a debt overhang. *Journal of Development Economics*, *29*(3), 253-268. https://doi.org/10.1016/0304-3878(88)90044-2

Kwon, G., McFarlane, L., & Robinson, W. (2009). Public debt, money supply, and inflation: A cross-country study. *IMF Staff Papers*, *56*(3), 476-515. https://doi.org/10.1057/imfsp.2008.26

Liew, V. K.-S. (2004). Which lag length selection criteria should we employ? *Economics Bulletin*, *3*(33), 1-9.

Lüutkepohl, H., Saikkonen, P., & Trenkler, C. (2001). Maximum eigenvalue versus trace tests for the cointegrating rank of a VAR process. *The Econometrics Journal*, *4*(2), 287-310. https://doi.org/10.1111/1368-423x.00068

Ma, R., & Qamruzzaman, M. (2022). Nexus between government debt, economic policy uncertainty, government spending, and governmental effectiveness in BRIC nations: Evidence for linear and nonlinear assessments. *Frontiers in Environmental Science*, *10*, 952452. https://doi.org/10.3389/fenvs.2022.952452

Mah, G., Mukkudem-Petersen, J., Miruka, C., & Petersen, M. A. (2013). The impact of government expenditure on the Greek government debt: An econometric analysis. *Mediterranean Journal of Social Sciences*, *4*(3), 1-8. https://doi.org/10.5901/mjss.2013.v4n3p323

Majam, T. (2017). Challenges in the public debt management in South Africa: Critical considerations. *Administratio Publica*, *25*(3), 195-209.

Masoga, M. M. (2018). *The impact of public debt on economic growth in South Africa: A cointegration approach*. Doctoral Dissertation, University of Limpopo.

Mhlaba, N., & Phiri, A. (2019). Is public debt harmful towards economic growth? New evidence from South Africa. *Cogent Economics & Finance*, *7*(1), 1603653. https://doi.org/10.1080/23322039.2019.1603653

Mishra, P. (2011). Dynamics of the relationship between real consumption expenditure and economic growth in India. *Indian Journal of Economics & Business*, *10*(4), 553-563.

Modigliani, F. (1961). Long-run implications of alternative fiscal policies and the Burden of the national debt. *The Economic Journal*, *71*(284), 730-755. https://doi.org/10.2307/2228247

Molefe, K., & Choga, I. (2017). Government expenditure and economic growth in South Africa: A vector error correction modelling and Granger causality test. *Journal of Economics and Behavioral Studies*, *9*(4 (J)), 164-172.

Mothibi, L., & Mncayi, P. (2019). Investigating the key drivers of government debt in South Africa: A post-apartheid analysis. *International Journal of eBusiness and eGovernment Studies*, *11*(1), 16-33. https://doi.org/10.34111/ijebeg.20191112

National Planning Commission. (2011). *The national development plan--vision 2030. Government of South Africa, Pretoria, South Africa*. Retrieved from https://www.gov.za/issues/national-development-plan-2030

Nyarko-Asomani, A., Bhasin, V. K., & Aglobitse, P. B. (2019). Government capital expenditure, recurrent expenditure and economic growth in Ghana. *Ghanaian Journal of Economics*, *7*(1), 44-70.

Odo, S. I., Igberi, C. O., & Anoke, C. I. (2016). Public debt and public expenditure in Nigeria: A causality analysis. *Research Journal of Finance and Accounting*, *7*(10), 27-38.

Olaoye, O. O., Tabash, M. I., Omokanmi, O. J., Ogunjumo, R. A., Ojelade, M. O., & Ishola, J. A. (2022). Macroeconomic implications of escalating stock of public debt: Evidence from Sub-Saharan African economies. *African Development Review*, *34*(4), 527-540. https://doi.org/10.1111/1467-8268.12677

Omrane, S., & Omrane, H. (2017). Macroeconomic determinants of public debt growth: A case study for Tunisia. *Theoretical & Applied Economics*, *24*(4), 161–168.

Onyango, J. A. (2019). *Nexus between public sector expenditure and public debt in Kenya*. Doctoral Dissertation, University of Nairobi.

Ouma, W. N., & Muriu, P. (2014). The impact of macroeconomic variables on stock market returns in Kenya. *International Journal of Business and Commerce*, *3*(11), 1-31.

Pattillo, C. A., Poirson, H., & Ricci, L. (2004). *What are the channels through which external debt affects growth?* International Monetary Fund (IMF), Working Paper WP/04/15.

Peacock, A. T., & Wiseman, J. (1961). Front matter, the growth of public expenditure in the United Kingdom in the growth of public expenditure in the. In (pp. 32-30). United Kingdom: Princeton University Press.

Roth, C., Settele, S., & Wohlfart, J. (2022). Beliefs about public debt and the demand for government spending. *Journal of Econometrics*, *231*(1), 165-187. https://doi.org/10.1016/j.jeconom.2020.09.011

Sachs, J. D. (1989). Developing country debt and economic performance. the international financial system in developing country debt and economic: Performance the International financial system. In (Vol. 1, pp. 10-12): University of Chicago Press.

Sinha, P., Arora, V., & Bansal, V. (2011). *Determinants of public debt for middle income and high income group countries using panel data regression*. Munich Personal Repec Archive, (MPRA Paper, No. 32079).

South African Reserve Bank. (2021). *Publications*. Retrieved from https://www.resbank.co.za/en/home/publications

Stern, D. I. (2011). From correlation to granger causality. *Crawford School Research Paper*(13), 1-37. https://doi.org/10.2139/ssrn.1959624

Suk Kim, B. (2009). The impact of the global financial crisis on Asia-Pacific real estate markets: Evidence from Korea, Japan, Australia and US REITs. *Pacific Rim Property Research Journal*, *15*(4), 398-416. https://doi.org/10.1080/14445921.2009.11104288

Uguru, L. C. (2016). The link between public debt and government expenditure pattern: The Nigeria experience. *IOSR Journal of Business and Management*, *18*(1), 37-41.

Van Cauwenbergh, L., & Laleman, J. P. (2018). *Rapid public debt build-up in Sub-Saharan Africa. The Public Debt Management Network*. Retrieved from https://www.publicdebtnet.org/pdm/.content/Report/Report-00212.html

Williams, R. (2015). *Heteroskedasticity University of Notre Dame*. Retrieved from https://www3.nd.edu/~rwilliam/stats2/l25.pdf

Yien, L. C., Abdullah, H., & Azam, M. (2017). Granger causality analysis between inflation, debt and exchange rate: Evidence from Malaysia. *International Journal of Academic Research in Accounting, Finance and Management Sciences*, *7*(1), 189-196. https://doi.org/10.6007/ijarafms/v7-i1/2624

Yusuf, A., & Mohd, S. (2021). The impact of government debt on economic growth in Nigeria. *Cogent Economics & Finance*, *9*(1), 1946249. https://doi.org/10.1080/23322039.2021.1946249