“The causal and cointegration relationship between government revenue and government expenditure”

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The causal and cointegration relationship between government revenue and government expenditure

Abstract

This study determines the causal relationship that exists between government revenue and government expenditure in South Africa. The study employed annual time series data from the year 1980 to 2015 taken from the South African Reserve Bank. The Johansen multivariate method was employed to test for co-integration and for causality the Vector Error Correction/Granger causality test was employed. The empirical results suggest that there is a long-run relationship between government revenue and government expenditure. The causality result suggests that there is no causality between government revenue and government expenditure in South Africa. Thus, policy makers in the short run should determine government revenue and government expenditure of South Africa independently when reducing the budget deficit.

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Introduction

Government is an important institution in every country because it can assist in stabilizing the economy by implementing proper economic policies (Black, Calitz, & Steenekamp, 2011). One of these policies is the fiscal policy which is reflected in the government's annual budget plan. Although Carneiro, Faria, and Barry (2005) consider fiscal policy to be a short-run policy, it is an important component because it can assist in developing the economy (Gounder, Narayan, & Prasad, 2007). Fiscal policy consists of government revenue and government expenditure. Carneiro et al. (2005) believe that changes in the fiscal policy can affect the budget deficit either from the expenditure side, revenue side or from both sides. When there is more demand for government to spend and government revenue is less it will cause the government to lend or borrow to finance expenditure (Antwi, Zhao, & Mills, 2013). However, it is the causal relationship between government revenue and government expenditure that has a major impact on the budget deficit (Mehrara, Pahlavani, & Elyasi, 2011). Hence, there is a need to determine exactly the variable between government revenue and government expenditure that needs to be changed so that a reduction in the budget deficit may be realized.

From a policy point of view, there are three reasons that explain the importance of the relationship between government revenue and government expenditure (Narayan & Narayan, 2006). Firstly, if there is a unidirectional relationship from government revenue to government expenditure, then the budget deficit can be addressed by government implementing policies that will stimulate government revenue (Narayan & Narayan, 2006). Secondly, if there is a unidirectional relationship from government expenditure to government revenue, the government will have to raise taxes so that it is able to maintain the expenditure behavior. Thirdly, if there is no direction of the relationship between government revenue and government expenditure then this implies that the expenditure decisions can be made on their own without taking into consideration the government revenue (Narayan & Narayan, 2006).

Since 1994, the main purpose of the South African government was to keep the debt level sustained and reduce the debt service cost (Kearney and Odusola, 2011). Evidence from the SARB (2016) reveals that in 1993, debt-to-GDP ratio was 45.6 percent, whilst in 2001, it was 40.6 percent with the highest government debt being 46.8 percent in 1997. It was only in the year 2007 and 2008 when the South African government recorded a budget surplus of approximately 0.7 and 0.9 percent of GDP. This surplus was due to the large revenue base collected which boosted economic growth (National Treasury, 2008). The debt-to-GDP ratio grab on average from 26.3 percent to 46.5 percent in 2015.

For many years in South Africa government expenditure has been exceeding government revenue. Government expenditure as a percentage of GDP was at a minimum of 22.6 percent in 1980 to a maximum of 22.8 percent in 1993 (SARB, 2016). According to Seekings (2013), the period before 1994 government expenditure favored and privileged the

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white minority. However, when the apartheid ended, public spending incorporated the black South Africans into the system (Seekings, 2013). Furthermore, the country had to transform from the massive racial favoritism and the economy had to be developed. This resulted in government expenditure increasing to further 29.3 percent in 2015. On the other hand, the South African government revenue base is mostly reliant on taxation. In 1980, the mining tax contributed 26 percent to the revenue base compared to any other taxes. Government revenue averaged 22.9 as a percentage of GDP in 1994–1995. This is as a result of the good performance of personal income tax realized in 1994. The bulk of personal income tax contributed 40 percent to the revenue base resulting in an increase 26.4 percent in 2007-2008. There was a slight decline in the year 2009 where revenue decreased to 26 percent, however, in the period 2010–2014, revenue increased from 23 percent to 25.7 percent (SARS, 2015).

This has led the South African government to rely on borrowing to finance expenditure. Therefore, in an attempt to add to the existing debate regarding government revenue and government expenditure, the purpose of this study is to determine the causal relationship between government revenue and government expenditure in South Africa for the period 1980–2015 under the null hypothesis that the increase in government revenue and a decrease in government expenditure will influence the budget deficit positively. The rest of the study is organized as follows: section one reviews the existing literature on government revenue and government expenditure. Section two estimates and presents the model specification and data source. Section three discusses the methodology and presents the empirical results, whilst the last section concludes and provides recommendations.

1. Review of existing literature

The causal relationship between government revenue and government expenditure has been a traditional problem in public economics for many years. It is because of this that attempts have been made theoretically to deal with the causal relationship between these variables. These attempts have resulted in the development of four theoretical hypotheses that explain the behavior between revenue and expenditure. The hypotheses are as follows:

Tax and spend hypothesis

The tax-spend hypothesis was developed by Friedman (1978) together with Buchanan and Wagner (1978). This hypothesis has two views and they are as follows: Friedman (1978) argues that there the causal relationship between revenue and expenditure is positive. Friedman (1978) explains that when tax revenue increases, it will result in expenditure being increased and this will result in the budget deficit being higher than before. In other words, government will spend its revenue with the anticipation of increasing taxes. However, the revenue that will be realized with the increase in taxation will not result in government spending less but rather the government will increase spending, hence, there is a positive relationship between revenue and expenditure. Therefore, Friedman (1978) argues against the increase in taxes as a way of reducing the budget deficit but rather advises that the government reducing taxation is a better option to keep the budget deficit under control. Buchanan and Wagner (1978) share the same view of Friedman that taxation revenue will lead expenditure but not in a positive way, instead, the causal relationship is negative. Buchanan and Wagner (1978) explain that when the government cuts taxes then society will recognize that the cost of government programs has been reduced. This leads society to demand more from the government and, as a result, government expenditure will increase. This will result towards a high budget deficit, because then taxation levels will be low against an increase in government expenditure.

Spend and tax hypothesis

Peacock and Wiseman (1961) conducted an empirical study of public expenditure in the United Kingdom using Wagner's law. The study argued that the theory presented by Wagner cannot be equally applied to different societies and the upward trend of public expenditure that Wagner found can be as a result of other factors that contribute to the development of public expenditure, such as the time pattern of expenditure growth. Basically, Peacock and Wiseman (1961) believe that citizens in societies do not like to pay additional taxes while the government keeps spending the money. The government needs to take into consideration the needs of the citizens. Peacock and Wiseman (1961) further believe that citizens can also have appropriate ideas about public expenditure such as taxation should not be so high that it turns to being a burden to the society that will be viewed as an unreasonable rate of taxation by society. However, when there is a displacement in public expenditure as a result of wars in the country, then it will cause the displacement effect to take place. This will result in the shifting of expenditures and public revenues to a new level. As the new level goes through the acceptance stage, then the tolerable level of tax will emerge and in terms of government expenditure, then a new higher level will be reached. Peacock and Wiseman (1961) state that the displacement effect has two traits: people accept the new levels of taxation as a form of raising revenue when the country is in a crisis mode

and after the disturbance has disappeared, they accept the new level of taxation. This makes it possible for the government to tax and spend.

Fiscal synchronization hypothesis

Meltzer and Richard (1981) base their theory of the size of government's share on the rational choices of utility maximizing that are fully informed about the state of the economy and have knowledge about the consequences of taxation and income distribution. Meltzer and Richard (1981) in an economy believe that voters do not suffer from fiscal misconception and note that for redistribution to take place the government must extract the resources elsewhere. Their study concentrates on the demand redistribution and the size of the government that is influenced by two factors being taxes and spending. The hypothesis of the study implies that the size of government is influenced by the median voter that earns a medium income. The majority rule and the median voter are taken as the decisive voter in the economy. Taken into account is the income distribution that is skewed to the right to determine their median voter. The median voter in the study is the important voter, because nothing restricts the median voter from equalizing their income, the size of government can be increased when one includes more median voters that agree to redistribution and higher taxes and redistribution will reduce the incentive to work resulting in earning a lower income. The study developed a general equilibrium model where Meltzer and Richard (1981) believed that the combination of leisure and consumption is chosen on the individual's productivity level and earned income. The tax rate and the amount of income redistributed is as a result of the distribution of income and voting rule. This is because individual productivity cannot be observed directly therefore making taxes to be levied against earned income. The politicians in the economy are the ones who determine the share of national income taxed and redistributed. The study implements two examples being dictatorship and the right to vote in political elections with majority rule. With majority rule, the voter that has a median income and is the decisive voter, however, under dictatorship, the dictator will make the tax decision on their own. The median or decisive voter will choose the tax rate that increases their utility. In making this decision the median voter is aware that the choice made can affect everyone's decision to work and consume. When the tax rate increases, it has two effects: income received increases revenue but at the same time the income received will be reduced because people would rather spend their income on leisure and others will chose redistribution as their survival mode. Whether the tax levels are high or they are lower they have an influence when it comes to labor, leisure and the income earned. However, under universal suffrage (adults voting in political elections), the median voter is the decisive voter and the one earning a higher income will prefer the level of taxes that are lower. The study concluded that in an economy, it is mostly the decisive voter that will have the power of choosing the appropriate tax levels. Meltzer and Richard (1981) state that it does not matter whether the tax levels are low or they are high, individuals in the economy will always prefer the lower rate of taxation.

Fiscal neutrality hypothesis

Hoover and Sheffrin (1994) studied the causal relationship using historical background of taxes and spending to review the pattern of expenditure and revenue. The researches realized after making the comparison that there were some periods that were not accounted for in terms of spending and revenue. These periods are divided into two calm and they are from 1954 to 1963 and from 1974 to 1979. The results found suggest that in the periods before 1960 there was a unidirectional causal relationship between taxes and government expenditure and the period after 1960 found that there was no causal relationship between taxes and spending. This suggests that at the beginning because taxes were as a result of major wars and spending was due to foreign wars as time passed and the wars came to an end, there was no longer a need for taxes and spending to influence each other. This implies that there is an institutional separation among taxes and spending in the long run. Motivated by the question of whether the increase in the size of the federal government budget is due to the changes in expenditure accompanied by revenue or changes in revenue accompanied by expenditure or there is causality running in both directions, on the other hand, Baghesti and McNown (1994) conducted an investigation on the budgetary process in the United States by looking at three alternative hypotheses as the theories that govern the study. In their analysis Baghesti and McNown (1994) focused on the formation of budgetary policy under contemporary institutions by making use of quarterly data from January 1955 to April 1989. Criticizing the study of Hoover and Sheffrin (1994), Baghesti and McNown (1994) state that Hoover and Sheffrin (1994) failed to point the relationship of a number of diverse interests in the context of non-parliamentary U.S. institutions and they failed to identify the period of taxation or expenditure policy changes and they also segregate two fixed policy regime periods. As a result, Baghesti and McNown (1994) examined a political economy regarding the adjustment of expenditure and revenues to the budgetary disequilibria.

1.1. Empirical literature. Empirical literature on the direction of causality between government expenditure and government revenue has revealed contradictory findings. Different econometric methods, study durations and variables applied have also contributed to the reason why these contradictory results vary from country to country.

1.1.1. Literature from developed countries. Existing studies from developed countries are reviewed below.

Table 1. Empirical studies that reviewed causality of government revenue – government expenditure in developed countries (summary)

Authors and year of study	Country studied, type of data and period	Method	Causality results
Al-Qudair (2005)	Kingdom of Saudi Arabia, annual data from 1964–2001	Johansen (1988) test, ECM and Granger causality	$GREV \leftrightarrow GEXP$ causality
Khalaf (2008)	New European countries, annual data from 1957–2006 (whole sample)	Johansen (1988) test, Granger causality and VAR	$GEXP \rightarrow GREV$ causality
	Sub-periods 1957–1990		$GREV \neq GEXP$
	Sub-periods 1990–2006		$GEXP \rightarrow GEXP$ causality
Mehrara et al. (2011)	40 Asian countries, annual data from 1995–2008	Panel cointegration test by Kao (1999) and panel Granger causality	$GREV \leftrightarrow GEXP$ causality
Apergi et al. (2012)	Greece, annual data from 1957–2009	DOLS method of Enders and Granger causality (1998). Enders and Silkos (2001) method of TAR and MTAR models	$GREV \rightarrow GEXP$ causality $GREV \rightarrow GEXP$ causality revealed by asymmetric ECM
Al-Khulaifi (2012)	Qatar, annual time series from 1980–2011	Engle-Granger cointegration test, Granger causality test and ECM	$GREV \rightarrow GEXP$ causality

*Note: GREV → GEXP means unidirectional relationship from government revenue to government expenditure, GEXP → GEXP means unidirectional from government expenditure to government revenue, GREV ↔ GEXP means bi-directional causality and GREV ≠ GEXP no causality.
*Abbreviations: ECM = Error Correction Model, DOLS =Dynamic Ordinary Least Squares, VAR = Vector Autoregressive, TAR = Threshold Autoregressive model, MTAR = Momentum Threshold Autoregressive model, ADLM = Application of Autoregressive Distributive Lag Model, MWALD = Modified Wald, ARDL = Autoregressive Distributive Lag and VECM = Vector Error Correction Model.

1.1.2. Literature from developing countries. In developing countries, the relationship between government revenue and government expenditure has received much attention. This is because these countries are mostly reliant on government revenue and expenditure in order to develop. As a result, rising government deficits are always realized. Studies from developing countries are reviewed below.

Table 2. Empirical studies that reviewed causality of government revenue – government expenditure in developing countries (summary)

Authors and year of study	Country studied, type of data and period	Method	Causality results
Carneiro et al. (2005)	Guinea-Bissau, annual data for 1981–2002	Granger causality and ECM	$GEXP \rightarrow GREV$ causality
Eita and Mbazima (2008)	Namibia, annual data from 1980–2007	Johansen cointegration (1988, 1995), VAR and Granger causality test	$GREV \leftrightarrow GEXP$ causality
Al-Zeaud (2012)	Jordan, annual data from 1990–2011	Engle-Granger two steps, Johansen – Juselius tests of cointegration, Granger causality test and VECM	$GREV \leftrightarrow GEXP$ causality
Aregbeyen and Insah (2013)	Nigeria and Ghana, annual data from 1980–2010	DOLS (1993)	$GREV \leftrightarrow GEXP$ causality $GREV$ & $GEXP$ (both countries)
Nanthakumar et al. (2011)	Malaysia, annual data from 1970–2009	ADLM, Yoda-Yamamoto MWALD causality test, ADLM – ECM	$GREV \leftrightarrow GEXP$ causality
Gounder et al. (2007)	Fiji, Quarterly data from 1968/01–2003/04	Johansen's (1988) and Johansen and Juselius (1990) and Granger causality test	$GREV \leftrightarrow GEXP$ causality
Elyasi and Rahimi (2012)	Iran, annual data from 1963–2007	ARDL advocated by Pesaran et al (2001) and ECM for causality	$GREV \leftrightarrow GEXP$ causality
Dogan (2013)	Turkey, annual data from 1924–2012	Granger causality test	$GEXP \rightarrow GREV$ causality
Demirhan and Demirhan (2013)	Turkey, monthly data from January 2004–September 2010	Toda-Yamamoto (1995) method and generalized impulse response analysis to re–investigate causality	$GREV \leftrightarrow GEXP$ causality
Dada (2013)	Nigeria, annual data from 1961–2010	Engle – Granger and Johansen cointegration tests, ECM and Granger causality test	$GREV \neq GEXP$

Note: see Table 1 for the abbreviations and causality signs.

1.1.3. Literature from South Africa. South Africa is one of the developing countries and because of this, it resorts to government expenditure as an important tool in the economy for development to be realized. Hence, the country has an increasing deficit that is due to government expenditure. Studies done by Nyamonga, Sichei, and Schoeman (2007), Lusinyan and Thornton (2007) and Ziramba (2008) amongst others in South Africa have studied government revenue and government expenditure utilizing different data and econometric techniques, however, they have reached the same conclusion.

Table 3. Empirical studies that reviewed causality of government revenue – government expenditure in South Africa (summary)

Authors and year of study	Country studied, type of data and period	Method	Causality results
Nyamonga et al (2007)	South Africa, monthly data from October 1994–June 2004	Modified hylleberg for unit root testing, Johansen cointegration test and VECM for causality	$GREV \leftrightarrow GEXP$ causality (long run) $GREV \neq GEXP$ (short run)
Lusinyan and Thornton (2007)	South Africa, annual data from 1895–2005	Residual based test of Gregory and Hansen, the trace test and the Johansen cointegration test	$GREV \leftrightarrow GEXP$ causality
Ziramba (2008)	South Africa, annual data from 1960–2006	Ng-Peron unit root tests, ARDL (Pesaran et al. (2001)) of cointegration and Granger non-causality tests proposed by Toda and Yamamoto (1995) using a MWALD test	$GREV \leftrightarrow GEXP$ causality

Note: see Table 1 for the abbreviations and causality signs.

Many studies such as Al-Qudair (2005), Khalaf (2008), Mehrara et al. (2011), Al-Khulaifi (2012), Eita and Mbazima (2008), Al-Zeaud (2012), Aregbeyen and Insah (2013), Nanthakumar et al. (2011), Gounder et al. (2007), Elyasi and Rahimi (2012), Dogan (2013), amongst many others have analyzed variables such as government revenue, government expenditure and Gross Domestic Product. These studies have not analyzed the relationship between government revenue and government expenditure from the budget deficit point of view. As such, this study seeks to determine this relationship with the inclusion of government debt as a variable in the model.

2. Model specification and data source

The model adopted is taken from the theoretical framework of Friedman (1978) and the modified model including government debt is presented by equation 1:

$$GREV = \beta_0 + \beta_1 GEXP + \beta_2 GDEBT + \mu_t, \quad (1)$$

where *GREV* represents the natural logarithm of government revenue, *GEXP* is logarithm of government expenditure and *GDEBT* is logarithm of government debt. The constant is represented by β_0, while β_1 represents the coefficient of government expenditure and β_2 is the coefficient of government debt. The error disturbance is shown as μ_t. Annual time series data covering the period 1980 to 2015 taken from the South African Reserve Bank is used for empirical analyses. Government revenue (*GREV*) was obtained as national government revenue, government expenditure (*GEXP*) was obtained as national government expenditure and government debt (*GDEBT*) was obtained as total loan debt of national government. All the variables are taken in their natural logarithm form and are measured as a percentage of Gross Domestic Product.

3. Methodology and empirical results

In analyzing data the study begins by examining the variables for stationarity. Unit root tests are performed to avoid spurious regressions and to check the order of integration of the variables. To achieve this, the study employs the Augmented Dickey-Fuller test (1979) and the Phillip-Perron test (1988) for unit root testing.

3.1. Augmented Dickey-Fuller test. Dickey and Fuller developed the augmented Dickey-Fuller (ADF) test. The ADF test includes lags of differenced terms in a regression equation to make the error term (μ_t) white noise. The equation of the augmented Dickey-Fuller test is taken from Al-Khulaifi (2012) and is given as follows:

$$\Delta X_t = \varphi_0 + \varphi_1 t + \varphi_2 X_{t-1} + \sum_{i=1}^{n} p_i \Delta X_{t-1} + \mu_t, \quad (2)$$

where ΔX_t the first difference representation of the series being tested, *n* is the number of lagged difference and *t* is the trend of the series.

3.2. Phillips-Perron test. The PP test is a follow up of the ADF test. However, contrary to the ADF test the Phillips-Perron test, uses nonparametric method to solve serial correlation that often occurs among error terms with no inclusion of the lagged terms (Al-Khulaifi, 2012). Although there maybe differences, the PP test has similar characteristics with the ADF test. Therefore, these two tests often give the

same results and simultaneously share the same weakness traits (Duan & Yusupov, 2010). The PP equation is given below as:

$$\Delta Y_t = \gamma + \beta t + \delta Y_{t-1} + \mu_t, \quad (3)$$

where ΔY_t is the first difference representation of the series being tested, γ is the constant, β is the coefficient of t and δ is the lag order. The augmented Dickey Fuller and Phillips-Perron tests results are shown in Table 4.

Table 4. ADF and PP test results

Order of integration	GREV	GEXP	GDEBT	Conclusion
ADF				
Levels	-2.163681 (0.2225)	-1.115605 (0.6986)	-1.654948 (0.4444)	Non-stationary
1st difference	-5.699928*** (0.0000)	-6.122385*** (0.0000)	-3.270926*** (0.0244)	Stationary
PP				
Levels	-1.971131 (0.2976)	-1.151803 (0.6839)	-1.359025 (0.5908)	Non-stationary
1st difference	-7.702423*** (0.0000)	-6.089340*** (0.0000)	-3.272535*** (0.0243)	Stationary

Note: (***) stationarity at 10% level of significance. Values in () represent the probability value.

Table 1 indicates that the variables government revenue (GREV), government expenditure (GEXP) and government debt (GDEBT) have a unit root in levels. This confirms that the variables are non-stationary as the null hypothesis cannot be rejected. However, when first difference is employed, the series becomes stationary at 10 percent level of significance.

3.3. Lag determination. When estimating VAR the inclusion of too many lagged terms will result in not only the introduction of possible multi-collinearity, but it will also result in the consumption of the degrees of freedom. On the contrary, the inclusion of a few lagged terms will result in the specification errors. Johansen and Juselius (1990) introduced the Akaike or the Schwarz information criterions to be used when determining the appropriate lag. The AIC and SIC indicate a lag length of one as shown in Table 5. Therefore, the study adopts this lag to determine the Johansen co-integration results.

Table 5. Lag order

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-225.2007	NA	203.7252	13.83035	13.96639	13.87612
1	-144.4209	141.9767*	2.637988*	9.480054*	10.02424*	9.663156*
2	-135.9337	13.37370	2.765236	9.511136	10.46346	9.831563
3	-132.3129	5.047283	3.984643	9.837143	11.19760	10.29490

Note: * indicates lag order selected by the criterion.

3.4. Co-integration. The co-integration test is conducted using the Johansen multivariate method based on unrestricted Vector Autoregression (VAR). This is to analyze the number of co-integrating vectors in the long run and the speed of adjustment. In determining the number of co-integrating vectors the two hypothesis tests are used. These tests are the trace statistic and the max statistic. The trace statistic test as given in Masenyetse and Motelle (2012) is as follows:

$$\lambda_{trace} = -2\log(Q) = -T\sum_{i=r+1}^{p}\log\left(1-\tilde{\lambda}_i\right)$$

r = 0, 1, 2, 3……*n – 2, n -1*,

where Q represents the ratio of restricted maximum likelihood to the unrestricted maximum likelihood. The null hypothesis states that the co-integrating vectors is *(≤ r)* and the alternative states that the number of the co-integration vectors *(=r)*.

The max statistic as given in Masenyetse and Motelle (2012) can be represented as follows:

$$\lambda_{max} = -T\log(1-\lambda_{r+1}). \quad (5)$$

This represents the unrestricted maximised likelihood. The null hypothesis states that the number of the co-integration vectors *(=r)* and the alternative states *(r +1)*. Table 6 shows that there is one co-integrating vector at 5 percent level of significance. The trace statistics at none *(r=0)* reveal a trace statistic of 32.20, which exceeds its critical value of 29.79 percent. Therefore, the study rejects the null hypothesis of no co-integration vector, since the trace test shows evidence of one co-integrating vector.

Table 6. Trace and maximum Eigenvalue test results

Unrestricted cointegration rank test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace statistic	0.05 critical value	Prob.**
None *	0.450531	32.20144	29.79707	0.0259
At most 1	0.192265	11.84212	15.49471	0.1647
At most 2*	0.126089	4.582411	3.841466	0.0323
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
Unrestricted cointegration rank test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen statistic	0.05 critical value	Prob.**
None	0.450531	20.35932	21.13162	0.0638
At most 1	0.192265	7.259713	14.26460	0.4589
At most 2*	0.126089	4.582411	3.841466	0.0323
Max-Eigenvalue test indicates no cointegration eqn(s) at the 0.05 level				

The maximum Eigenvalue test in Table 6 indicates that there is no co-integration vector at 5 percent level of significance. Therefore, the study fails to reject the null hypothesis that states that there is no co-integrating vector. Since the trace test reveals evidence of at least one possible co-integration vector, while the maximum Eigenvalue indicates that there is no co-integration, the trace test is the one that is followed.

3.5. Vector Error Correction Model (VECM). The VECM is estimated as a restrictive vector error correction model, because it includes the vectors from the longrun relationship. Furthermore, the study employs the VECM, as it incorporates the information about the shortrun dynamics. The VECM equation as taken from Mukherjee and Naka (1995) is given as follows:

$$\Delta Y_t = \sum_{l=1}^{k} \Phi_l + \delta\beta\,(Y_{t-l} + Y_{\Phi t-k}) + \varepsilon_t. \qquad (6)$$

The error correction model (VECM) is given as $(Y_{t-l} + Y_{\Phi t-k})$. The Δ represents the first difference notation and Y_t is different to the order one. The lag length is represented by k and ε_t is the Gaussian white noise residual vector. The short-term adjustment between variables is indicated as Φ_l. Matrices δ and β represent the speed of adjustment to equilibrium and the cointegration vectors. The relationship between Y and Φ_l from $Y_{\Phi t-k}$ suggests that there is a long-run relationship between the variables. The error correction $(Y_{t-l} + Y_{\Phi t-k})$ shows that y is expected to change *t-1* and *t-k* is expected to change also when the independent variable Φ changes in value. The error correction corrects any disequilibrium that may have occurred in the previous year. The long-run relationship between government revenue (GREV), government expenditure (GEXP) and government debt (GDEBT) are shown in Table 7.

Table 7. Long-run relationship results

Variable	Coefficient	Standard error	*t*-statistic
GREV(-1)	1.000000	-	-
GEXP(-1)	1.384591	0.23760	-5.82735
GDEBT(-1)	-0.102698	0.06097	1.68433
C	8.988060	-	-

The results suggest that in the long run, there is a positive relationship between GREV and GEXP. However, the long-run relationship between GREV and GDEBT suggests that there is a negative relationship. The absolute *t*-statistic for the independent variable GEXP is greater than 2 indicating that the variable is significant, while the variable GDEBT is statistically insignificant. All the coefficients are significant at 1% level of significance. Thus, a 1% increase in GEXP is likely to increase GREV by 1.38%, while a 1% increase in GDEBT is likely to decrease GREV by 0.10%.

3.6. Error Correction Model. The error correction corrects any disequilibrium that may have occurred in the previous year. The results of the error correction model indicate that the variable D(GREV) is negative and statistically significant as the absolute *t*-statistic is –2.10.

Table 8. Error Correction Model (ECM) results

Variable	Coefficient	Standard error	*t*-statistic
ECM	-0.245017	0.11616	-2.10930
D(GEXP)	0.312998	0.08993	3.48065
D(GDEBT)	-0.077592	0.27213	-0.28514

Table 8 suggests that the coefficient of D(GREV) is –0.2450. This coefficient implies that the speed of adjustment is 24.5 percent. This means that if there is deviation from equilibrium, only 24 percent is corrected in one year as the variable D (GREV) moves towards restoring equilibrium.

3.7. Granger causality. This study makes use of the work of Granger (1969). The Granger causality test is based on the idea that the future cannot predict the past but it is rather the past that determines the future. The Vector Autoregressive model proposed by Granger (1969) of two variables Y_t, X_t is as follows:

$$Y_t = \alpha_{01} + \sum_{j=1}^{k} \alpha_1 Y_{t-j} + \sum_{j=1}^{k} \beta_1 X_{t-j} + \varepsilon_t. \quad (7)$$

$$X_t = \alpha_{02} + \sum_{j=1}^{k} \alpha_2 X_{t-j} + \sum_{j=1}^{k} \beta_2 Y_{t-j} + \varepsilon_{t2}. \quad (8)$$

In a regression where Y is the dependent variable and it is regressed against other explanatory variables (X), if the explanatory variable can significantly improve the prediction of Y. It can be said that X (Granger causes Y), or Y (Granger causes X), or there can be a bi-directional causality ($X \leftrightarrow Y$) or no direction of causality ($X \neq Y$). Brooks (2008, p. 298) explains that causality is a correlation of the current value of a variable to the past value of other variables. Table 9 indicates the results of causality between government revenue, government expenditure and government debt.

Table 9. Causality test (VEC Granger causality)

Dependent variable: D(GREV)			
Excluded	Chi-sq	df	Prob.
D(GEXP)	0.217887	1	0.6407
D(GDEBT)	1.935664	1	0.1641
Dependent variable: D(GEXP)			
Excluded	Chi-sq	df	Prob.
D(GREV)	0.159842	1	0.6893
D(GDEBT)	8.718036	1	0.0032

The null hypothesis of the test states that we fail to reject the null hypothesis whenever the p-value is greater than the 5 percent level of significance. The VEC Granger causality results suggest that both government expenditure and government debt do not determine government revenue. The p-value of both GEXP and GDEBT are greater than the 5 percent level of significance. Therefore, the null hypothesis cannot be rejected. The reverse equation suggests that government expenditure does not determine government revenue, whilst government debt does granger cause government expenditure. This concludes that in the short run, there is no direction of causality between government revenue and government expenditure. This finding is consistent with Dada (2013) who has provided the same evidence for Nigeria. Whilst in the short run, there is a significant relationship between government expenditure and government debt.

3.8. Diagnostics tests. When a model is not correctly specified and is not stable in a regression, it will result in the effects that are not good for estimation. Therefore, diagnostic checks are employed to ensure the adequacy of the chosen model. This study employs a range of diagnostic tests such as normality, heteroskedasticity and autocorrelation tests to detect model inadequacy and to also ensure that wrongful rejection of the null hypothesis is limited. This study employs the normality test (Jarque-Bera, 1987), white heteroskedasticty (1980) test and the Langrage Multiplier (LM) test.

Table 10. Diagnostics tests results

Test	H_0 hypothesis	Statistic	Probability
LM test	No serial correlation at lag order h	5.390905	0.7990
Normality test (Jacque-Bera)	Residuals are multivariate normal	3.255220	0.7762
Heteroskedasticity test (includes cross terms)	There is no conditional heteroskedasticity	85.22172	0.4423

The LM test, Jacque-Bera test and the test of heteroskedasticiy are conducted under their own individual hypothesis as shown in Table 10. The probability value of all the three tests are above the 5 percent level of significance indicating that the model is well specified, as these tests fail to reject their individual null hypothesis.

Conclusion

The study investigated the causal and co-integration relationship between government revenue and government expenditure using annual data covering the period 1980 to 2015 taken from the South African Reserve Bank. The ADF and PP tests of stationarity were used to detect the presence of unit root among the data series. Furthermore, the Johansen co-integration test, Vector Error Correction Model and the Granger causality test were also conducted. The ADF and PP test results in levels found that the series had unit root and to remedy the problem the series were differenced to the first order to attain stationarity. After attaining stationarity at *I*(1) the series were tested for co-integration in the long run and evidence of one co-integrating vector was confirmed by the trace test. This implies that in the long run, there is evidence of a unidirectional relationship between government revenue and government expenditure. The vector error correction model indicates that 24 percent of disequilibrium is corrected every year. The outcome of the Granger causality test indicates that there is no direction of causality between government revenue and government expenditure in the short run. However, there is evidence of unidirectional causality from government debt to government expenditure. Since a reduction in the level of government expenditure is not reasonable, the South African government can begin firstly by reducing wasteful expenditure. Secondly, the government can priorities more important government programs combined with policies that can increase the revenue base. These policies can assist policymaker to control the budget debt in South Africa.

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