ASERS Publishing

DOI: https://.doi.org/10.14505/tpref.v11.2(22).08

INVESTIGATING THE GOVERNMENT REVENUE–EXPENDITURE NEXUS: EMPIRICAL EVIDENCE FOR THE FREE STATE PROVINCE IN A MULTIVARIATE MODEL

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Suggested Citation:
Omoshoro-Jones, O.S. (2020). Investigating the Overnment Revenue - Expenditure Nexus: Empirical Evidence for the Free State Province in a Multivariate Model. *Theoretical and Practical Research in Economic Field*, (Volume XI, Winter 2020), 2(22): 138 - 156. DOI:10.14505/tpref.v11.2(22).08
Article's History:
Received 1st of October 2020; *Revised* 13th of October 2020; *Accepted 12th* of November 2020; *Published* of 22nd of December 2020. Copyright © 2020 by ASERS® Publishing. All rights reserved.

Abstract: *This paper examines the government revenue–expenditure nexus for the Free State Province in a multivariate vector error correction model (VECM) using real GDP and inflation as control variables over the period 2004Q2–2018Q1.Cointegration and intertemporal (causal) links among variables were established employing Johansen (1995) and Toda-Yamamoto (1995) non-Granger causality tests. The results of the cointegration analysis confirm the existence of a long-run relationship between variables. The results of the causal analyses show a bidirectional causality between government revenues and expenditures in both the long-run and short-run supporting the fiscal synchronization hypothesis. Real GDP and inflation individually Granger-causes government revenue, in both the long-run and short-run, stressing their importance on generating revenue. Based on these findings, an isolated fiscal measure to raise tax-revenues or cut expenditure will exacerbate fiscal imbalance. On the policy front, the Free State government should adhere to a planned budget process, devise innovative revenue-generating strategies to circumvent the burden of producing inflation revenue, as well as utilize its autonomy on fiscal instruments to maintain a sustainable fiscal policy path, and stimulate economic growth.*

Keywords: government revenue; government expenditure; causality; cointegration; Free State province; South Africa.

JEL Classification: C12, C51, C54, H61.

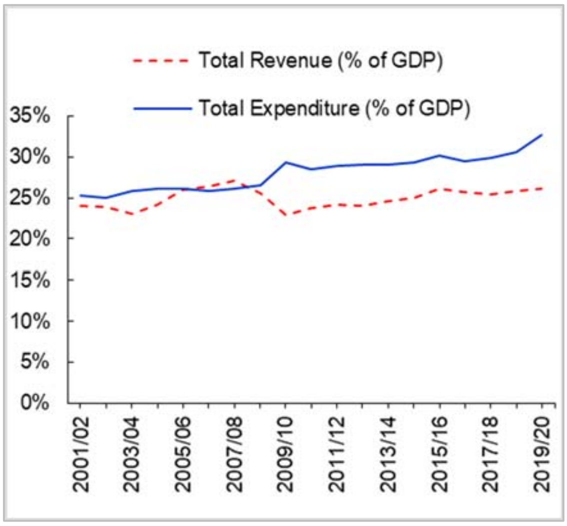
Introduction

In the aftermath of the latest global economic and financial crisis, the South African government have been grappling with an expanding fiscal debt (as a ratio of gross domestic product, GDP) due to government expenditures outpacing tax-revenues (Figures 1and 2), whereas economic growth is constrained with structural endogenous shocks such as shortage of power supply), political uncertainty, weak global demand for commodity export and gyrations in the world capital market (IMF 2009). At the same time, the labour market condition has steadily worsened in the past decade[12], and there is a growing concern over South Africa's ever-increasing fiscal debt utilized to finance the rise in government expenditures, which in turn widens the national budget deficit

[12]South Africa's fiscal debt (as % of GDP), a key measure of national government's indebtedness and financial health has nearly doubled in size from 31.8% in 1990 to 59.3% at the end of 2019 (National Treasury 2020), whereas the national economic growth drastically slowdown to about 0.7% at end of 2019 from the recorded 4.2% in 2000 (IMF 2020). The country is also experiencing a persistently high unemployment rate at 29.1% (narrowed definition) or 42.3% (expanded definition) at the end of 2019 (Stats SA 2020).

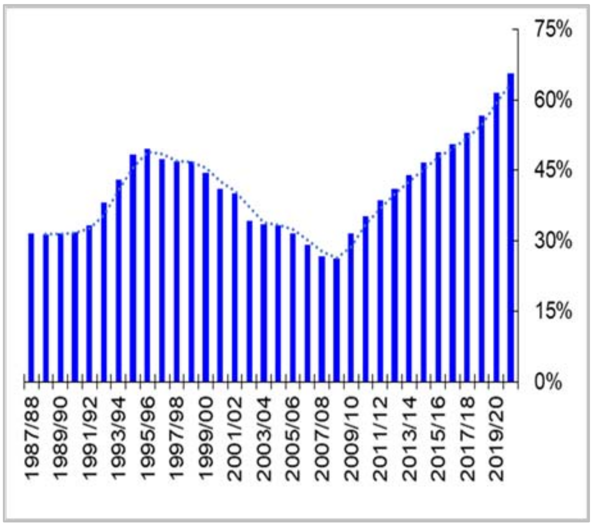
(National Treasury, 2020). The combined effects of these undesirable economic and social developments have led the national government to develop pro-growth and investment-driven macroeconomic and fiscal policies to tackle these prevailing issues (see, *e.g.,* NDP 2012; NGP 2011).

The national fiscal framework in South Africa (SA) allows the provincial governments to receive a large fraction of their revenue, in the form of a provincial equitable share (PES), from the national government. Usually, this intergovernmental transfer of revenue is mostly devoted to financing flagship programs or projects identified by the national government to show its political commitment to the voters, on tackling income inequality, unemployment and poverty rate. This process gives the assumption that provincial governments operate under a balanced budget, which becomes questionable due to off-budget activities deemed as the main priority in a particular province (Payne 1998). In the same vein, the fiscal autonomy of the provincial governments becomes crucial to generate extra revenue to fund off-budget activities (or provincial financial priorities) by either raising levies or surcharges[13]. Nonetheless, given the prevalence of narrow fiscal space, severely weak economic growth and relatively low tax-revenues in SA, the provincial government is confronted with the dilemma of either reducing public expenditure or utilize its fiscal autonomy to raise 'own' revenue to augment their provincial equitable share.



Source: National Treasury (2020), Own illustration.

Figure 1. The trend of total government revenue and expenditure (% of GDP) for South Africa.



Source: National Treasury (2020), Own illustration.

Figure 2. Fiscal debt (% of GDP) for South Africa

Against this backdrop, *a priori* decision by the policymakers either to raise tax-revenue or cut expenditure to finance current spending (or budget deficit) can lead to serious budget constraints which may indirectly dampen economic activity level or induce inflationary pressures in the domestic economy. Moreover, a better understanding of the dynamic interrelationship between government revenue and expenditures would aid policymakers to pin down the causes of, and remedies for, non-credible budget. From a policy standpoint, such knowledge could also be useful in designing and/or implementing appropriate fiscal measures to improve the budget planning process, achieve fiscal sustainability and reduce the budget deficit. Besides, it is widely accepted that sound fiscal policy can reduce output and employment fluctuations in the short-run, and also restore the economy to its potential level.

Therefore, this paper investigates the causal relationship between government revenues and expenditures at the state level, by focusing on the intertemporal interdependence between the two variables and real gross domestic product (GDP) for the Free State (FS) province, together with inflation series (control variable) over the period 2004 Q2 - 2018 Q1, employing the vector error correction modeling framework. We also apply the VAR-based Toda-Yamamoto non-Granger causality test (Toda-Yamamoto 1995) to validate the robustness of the intertemporal links (short-run causality) observed between variables, in our estimated mated vector error correction models. On this basis, one could expect, our analytical exercise to yield robust inferences and reliable conclusion on both the linear and intertemporal causative links between variables, than those reported in country-specific

[13]Levies and surcharges are other form of taxes used by the provincial (or state) government as fiscal tools to raise 'own' revenue. In this paper, provincial 'own' revenue is interchangeable referred to as government revenue.

studies focusing on South Africa (see, *e.g.,* Phiri 2019; Baharumshah *et al*. 2016; Ghartey 2010; Ndahiriwe and Gupta 2010; Lusiyan and Thorthon 2007; Nyamongo *et al*. 2007; Narayan and Narayan 2006; Chang *et al*.2002).

Our analysis is timely and important in at least on two counts. First, the economic and labour market conditions in the FS province mirrors that of the national economy given a relatively high unemployment rate of 35% (narrow definition) or 37% (expanded definition) at the end of 2019 (Stats SA, 2019)[14], and a lack lustre domestic economy that recorded negative growth of -0.3% in 2019 compared to the growth rate of 2% and 2.5% in 2000 and 2010 respectively[15]. Given these prevailing challenges, the Free State government is obliged to use its fiscal autonomy to explore innovative measures to either generate more revenue to finance the provincial needs or reduce its expenditures to achieve fiscal balance. In this context, the findings on the underlying dynamic interrelationship between government revenues and expenditure will shed more light on whether the conventional fiscal measure to raise tax-revenues (on levies and surcharges) or cut expenditures or concurrently use both measures will revive the provincial economy as well as mitigate budget constraints due to higher expenditures and low revenue (Figure 3). Second, the relationship between government revenues-expenditures empirically rests on four hypotheses in the public finance literature, that is, tax-spend (Friedman 1978; Buchanan and Wagner 1978), spend-tax (Peacock and Wiseman 1961, 1979), fiscal synchronization (Musgrave 1966; Meltzer and Richard 1981), and institutional separation (Wildavsky 1988; Baghestani and McNown 1994). These theories have different policy implications on the government decision to cut the budget, raise tax-revenue or both. From a policy perspective, it is imperative for both the fiscal authorities and policymakers in the Free State province to have in-depth knowledge of the exact theoretical relationship underlying the government revenue-expenditure nexus in the province. Such evidence could equip fiscal authorities and policymakers to design and/or implement effective fiscal measures, at the provincial level.

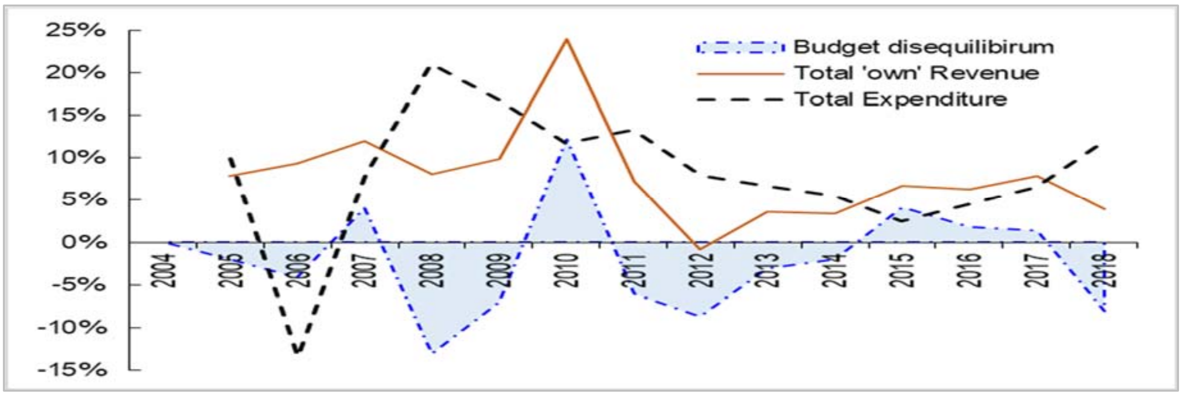
On the methodological front, the econometric method and model specification employed in this study circumvent the shortcomings of earlier studies such as using bivariate modeling approach, low frequency (annual) data and lack of testing for structural breaks in used data (see, *e.g.,* Ndahiriwe and Gupta 2010; Payne 2003; Islam 2001), which usually mask the intertemporal links between variables, and estimated model suffer from omitted variable problems. Most closely related to our work is Kavase and Phiri (2018), who investigate the fiscal sustainability across the nine South African provinces focusing on the existing asymmetric relationship between government revenue - expenditure. But, drawn inferences and conclusion of this particular study can be considered as unreliable since these authors used a bivariate model and high-frequency (annual) data that covers a short period (*i.e.,* 2000 to 2016). Also, the relatively short sample period suggests that the specified model is susceptible to misspecification bias, due to insufficient degrees of freedom required to construct the optimal number of lags for times-series in the estimated non-linear autoregressive distributed lag (NARDL) model.

We remedied the limitations in previous studies, by making use of a multivariate cointegration–based error correction model using high-frequency data (*i.e.,* quarterly series) with real GDP and inflation as control variables, to effectively deal with misspecification bias associated with omitted variable problems and spurious conclusions on the nature and direction of causality. This cointegration-based error correction model employed allows feedback between government revenue and expenditure running interactively through the real GDP and inflation variables in both the short-run and long-run (Granger and Lin 1995). Also, the error terms from the long-run regressions between government revenue, expenditure, real GDP and inflation can give more insight into how, for instance, responsive revenues and expenditures are to deviations from their long-run equilibriums with respect to GDP. Besides, the inclusion of the real GDP variable allows us to capture the intrinsic link between aggregate economic conditions, raised government 'own' revenue and expenditure growth, in the province.

The remainder of this paper is structured as follows: Section 2 provides the different theories explaining the government revenue-expenditures nexus, empirical evidence supporting these theories, and a synoptic survey of relevant studies. Section 3 outlines the econometric techniques employed. Data and stationarity properties of the time-series are presented in Section 4. Empirical results are reported and discussed in Section 5, while Section 6 concludes with some policy recommendations.

[14]Data available at http://www.statssa.gov.za/?page_id=1854&PPN=P0211&SCH=7622.

[15]Data on provincial GDP is sourced from the reliable IHS Global Markit's Rex database.



Source: In-Year-Monitoring (FS Provincial Treasury database), Estimates of Provincial Revenue and Expenditure (National Treasury's provincial financial database), Own illustration.

Figure 3. Historical trend of total revenue, total government expenditure and budget disequilibrium (ratio of GDP) for the Free State province.

1. Theories on Government Revenues - Expenditure Nexus and Empirical evidence.

In public finance, four theoretical postulations underpin the government revenue–expenditure nexus (or the tax-spend debate) and important for the formulation of fiscal policy[16].Foremost, Friedman (1978) and Buchanan and Wagner (1997) are the main proponents of the tax-spend theory. According to the Friedman (1978), changes in government revenues (taxes) leads to changes in government expenditure, hence an increase in government revenues will raise government expenditure, implying a positive relationship between the two variables. However, the widespread fiscal strategy of raising revenue through budget cuts could have an inflationary effect on goods and services, and raise government consumption expenditure, while lower taxes may reduce the budget deficit or engender fiscal sustainability (Payne 2003). But, Buchanan and Wagner (1978) posit a negative intertemporal relationship between government revenue and expenditure, implying that an increase in government revenue (or tax) can reduce the budget deficit since voters perceive tax reduction as a decline in public spending, which leads to an increase in demand for public goods and services. Empirically, a unidirectional causality running from government revenues (or taxes) to government expenditure confirms the tax-spend thesis (see, *e.g.,* Rahman and Wadud 2014; Magazzino 2013; Aregbeyen and Ibrahim 2012; Owoye and Onafowora 2010; Wolde-Rufael 2008; Kollias and Paleologou 2006; Narayan and Narayan 2006; Payne 1998).

The second thesis underscoring the government revenue-expenditure nexus is the spend-tax theory advanced Peacock and Wiseman (1961, 1979), implying that government spend first and raise revenue (taxes) later - an opposite view of the tax-spend thesis. According to the spend-tax theory, the occurrence of idiosyncratic shocks (*e.g.,* natural disaster and droughts) economic, social and political upheavals, typically leads to the imposition of higher taxes to finance the required increase in government expenditure. In the vast empirical literature, studies have shown that the spend-and-tax hypothesis holds if a unidirectional causality from government spending to government revenue (taxes) exists, indicating a 'displacement effect' (see, *e.g.,* Magazzino 2013; Keho 2010; Afonso and Rault 2009; Narayan and Narayan 2006; Chang *et al*. 2002; Ewing and Payne 1998; Von Furstenburg *et al*. 1986).

The third postulation on the government revenue-expenditure nexus is the fiscal synchronization hypothesis put forward by Musgrave (1966) and Meltzer and Richard (1981). These scholars argued that government expenditure and revenue (or tax) can be adjusted simultaneously (or concurrently) to achieve fiscal balance (or equilibrium) since policymakers have full control over these variables during budget adjustments. In other words, government expenditure and revenue are independent of each other, thus budget deficit can be reduced by raising taxes and reducing expenditure since both variables can be changed concurrently. As such, an isolated fiscal decision to raise government revenue or expenditure will lead to a serious budget deficit, since there is contemporaneous feedback between government expenditure and revenue. From a policy standpoint, the government can simultaneously choose an optimal package of public programs to be financed in its budget along with tax revenues required. Empirical evidence supporting the fiscal synchronization hypothesis shows a bidirectional causality between the government revenue and expenditure (see*, e.g.,* Al-zeaud 2015; Elyasi and

[16]See, *e.g.,* Phiri (2019) and Payne (2003) for a survey of the vast empirical literature.

Rahimi 2012; Mehrara *et al*. 2011; Owoye and Onafowora 2010; Chang and Chiang 2009; Kollias and Paleologou 2006; Wolde-Rufael 2008; Chang *et al*. 2002; Islam 2001; Ewing and Payne 1998; Manage and Marlow 1987).

Finally, Wildavsky (1988) and Baghestani and McNown (1994) propound the institutional separation hypothesis, under which decisions on government expenditure and taxation are taken independent of one another due to the conflicting views and interest of different parties or groups which causes fiscal debt to grow and makes it more challenging to implement deficit-reducing measures. From a policy perspective, if institutional separation thesis holds, fiscal consolidation implemented by raising tax revenues or cut in expenditure would have a negligible effect on the budget deficit (Lusiyan and Thorton 2007). Empirical evidence supporting the institutional separation hypothesis, indicates the absence of a causal link between government revenue and expenditure, suggesting fiscal neutrality (see, Magazzino 2013; Ali and Shah 2012; Wolde-Rufael 2008; Narayan and Narayan 2006; Kollias and Paleologou 2006; AbuAl-Foul and Baghestani 2004, among others).

1.1. Survey of Related Empirical Studies

So far, studies examining the relationship between government revenue and expenditure in South Africa is scanty, while similar research at the provincial (or state) level receives no attention. Be that as it may, reported evidence in the empirical literature is mixed, partly due to model specification bias, the different period being studied, and econometric techniques used.

Few cross-sectional studies have considered South Africa in their analysis, for instance, Ghartey (2010) utilized an ARDL model and the two-step Engle-Granger (1987) method to determine the direction of causality driving the government revenue-expenditure nexus for Nigeria, Kenya and South Africa, using annual data spanning 1960 - 2007, and reported a bi-directional causality between the two variables for South Africa, aligning with fiscal synchronization theory. In contrast, Narayan and Narayan (2006) applied the VAR-based Toda-Yamamoto (1995) causality test on the dataset of twelve developing countries for the period 1960 - 2000, and found no long-run causality between government revenue and expenditure for South Africa, keeping with the institutional separation (fiscal neutrality) hypothesis. Chang *et al*. (2002) estimate an error correction model over the period 1951 - 1996 and find a unidirectional causality running from government expenditure to revenue for South Africa in the short-run, supporting the spend-tax hypothesis.

On country-specific studies, for instance, Phiri (2019) make use of an asymmetric momentum threshold auto regression (MTAR) model (supplemented with a TEC component consisting of fiscal deficit/surplus variables (as a ratio of GDP)) to examine the government revenue-expenditure nexus for South Africa over the period 1960 Q1 to 2016 Q2, and finds a bi-directional causality between these variables, supporting fiscal synchronization hypothesis. In a different study, Baharumshah *et al*. (2016) used annual data on government expenditure and revenue, to compute an asymmetric (MTAR and TAR) and symmetric (ARDL) bivariate models for South Africa, over the period 1960 - 2013. The result of the asymmetric models indicate the absence of a long-run relationship between these variables, but evidence from the ARDL model (along with GDP as a control variable) shows that variables are cointegrated, and a bi-directional causal link between government revenue and expenditure, in the long-run and short-run.

Ndahiriwe and Gupta (2010) argued that the inconclusive result on the government revenue - expenditure for South Africa, is due to the frequency of time-series used in existing studies. Using both quarterly and annual data (with GDP and government debt as control variables), they find bi-directional causality between government revenue and expenditure in the estimated vector error correction model with quarterly data (1960 Q1 to 2006 Q2), but a similar model with annual series (1960-2005) showed no evidence on the causative links among variables. Lusiyan and Thorthon (2007) tested for structural breaks and include dummy variables in a bivariate model estimated for South Africa over the period 1895-2015 and find the existence of a long-run relationship, and bi-directional causal link between government expenditure and revenue. While, Nyamongo *et al*. (2007) used a bivariate VAR model estimated over period October 1994 to June 2004 and find a long-run bi-directional causality between government revenue and expenditure, but the absence of an intertemporal causative link between the two variables, which supports fiscal neutrality hypothesis.

Finally, Kavase and Phiri (2018) focused on South African provinces. Using an ARDL model, they examine the government revenue - expenditure nexus across nine provinces (or states), over the period 2000 -2016. They found differentiated effects of the strict fiscal stance to finance growing expenditure by raising taxes (increased revenue collection) on provincial budgets, in both the long-run and short-run. They conclude that fiscal sustainability is attainable in some provinces (such as Eastern Cape, Northern Cape and Free-State) in both the long-run and short-run, if government expenditure increases, but a reduction in government expenditure would lead to fiscal sustainability in most of the provinces (which include Western Cape, North West, Gauteng, Mpumalanga and Limpopo).

1.2. Methodology: Cointegration-Based Vector Error Correction (VEC) and Non-Granger Causality Frameworks.

To examine the government revenue–expenditure for the Free State province, we construct a functional multivariate framework to capture the linear relationship between the provincial government revenue, expenditure, and the two control variables, namely real GDP and inflation, using linear stochastic equations describe as:

$$\ln GR_t = \lambda_0 + \lambda_1 \ln GE_t + \lambda_2 Y_t + \lambda_3 \pi_t + \delta g_{1t} + \delta d_{2t} + \varepsilon_{1t} \qquad 1.1$$

$$\ln GE_t = \gamma_0 + \gamma_1 \ln GR_t + \gamma_2 Y_t + \gamma_3 \pi_t + \delta g_{3t} + \delta d_{4t} + \varepsilon_{2t} \qquad 1.2$$

where lnis the logarithm operator; $\lambda_1, \lambda_2, \lambda_3, \gamma_1, \gamma_2$, and γ_3 are coefficients to be estimated; GE_t and GR_t denotes real government expenditure and revenue respectively; Y_t and π_t are the real gross domestic product (GDP) and inflation series included as control variables to avoid the 'omitted variable' problem[17], and pin down the exact intertemporal (causal) relationship between variables; δg_{it} and δd_{it} are dummy variables to account for possible structural breaks in the series owed to important external (global) and internal (domestic) shocks; while ε_{1t} and ε_{2t} are serially uncorrelated error terms (white-noise). It is worth noting that the systems of equation presented in Eqs. 1.1 and 1.2 lend credence to the theoretical underpinnings driving the GR - GE nexus, with former denoting the spend-tax hypothesis, and the latter based on the tax-spend hypothesis. Specifically, the inclusion of the GDP variable in the system of equations allows us to account for the influence of the size of the provincial economy on the growth in both government revenue and expenditure, which in turn, are intrinsically dependent on the aggregate economic activity level (Payne 1998). Likewise, the specified system of equations also makes it possible to identify whether variables are cointegrated or not, as well as the nature (direct or indirect) and direction of causal links between variables, in the long-run and short-run (Granger and Lin 1995).

The next step is to determine whether the chosen variables are cointegrated (*i.e.,* share a common trend) in the long-run, and produce one (or more) linear combinations is stationary in levels, irrespective of varying stationarity properties. Although, variables may deviate in the short-run, in response to a shock in a system, but should revert to a steady-state in the long-run, since they share a common stochastic trend (Stock and Watson 1988). For this purpose, we apply the VAR-based Johansen's (1995) maximum likelihood reduced-rank procedure is applied. This procedure is preferred because it allows the estimation and identification of more than one cointegrating vector(s) in the multivariate system, have better small sample properties, permits feedback effect between variables, reflecting the interdependency between variables to yield robust cointegrating vectors, and the loss in terms of efficiency is minimal (see, Gonzalo 1994; Kremers *et al.* 1992).

The Johansen reduced-rank procedure (Johansen, 1995) is carried out to identify the rank of the cointegrating space, by determining the number of cointegrating vectors (r) in the parameter matrix Π. To perform the reduced rank cointegration test, consider a VAR (2, 1) with Gaussian errors, express as:

$$y_t = A_{(1)} y_{(t-1)} + A_{(2)} y_{(t-2)} + ... + A_{(n)} y_{(t-n)} + \Lambda + u_t; \quad t=1,2,...,T. \qquad 1.3$$

where y_t is a $m \times 1$ vector of endogenous variables (in our case, real government expenditure, revenue, GDP and inflation (in this case, *N*=4) in the system at time, t and u_t is $i.i.d.\ N(0,\Sigma)$. By taking first-differencing on the vector level, Eq. 1.3 becomes an error correction model estimate as:

$$\Delta y_t = \Gamma_{(1)} y_{(t-1)} + \Gamma_{(2)} y_{(t-2)} + ... + \Gamma_{(n-1)} \Delta y_{(t-n+1)} - \Pi y_{t-1} + \Lambda + u_t; \quad t=1,2,...,T. \qquad 1.4$$

where $\Gamma_i = -I + A_{(1)} + A_{(2)} + ... + A_i$ for $i = 1, 2..., n-1$, and $\Pi = 1 - A_{(1)} - A_{(2)} - ... - A_{(n)}$. Here, matrix Π conveys information about the long-run relationship between y_t variables (in our case, *GE* and *GR*

[17]Failure to account for omitted variables can give rise to misleading causal ordering among variables, leading to spurious deduction, nonetheless, this problem is typically resolved by adding control variables (most notable, real GDP) to compute a multivariate model (Payne 2003; Baghestani and McNown 1994).

specified in Eqs. 1.1 and 1.2. The cointegration rank is derived employing the trace test statistic and the maximum eigenvalue statistics based on a likelihood ratio (LR) test, with the trace test (λ_{trace}) define as:

$$\lambda_{trace}(r) = -T\sum_{i=r+1}^{n}\log(1-\hat{\lambda}_1) \qquad 1.5$$

where $\hat{\lambda}_{r+1},\ldots,\hat{\lambda}_n$ are the estimated $n-r$ with the smallest eigenvalue. The null hypothesis, H_0: numbers of cointegrating vectors $\leq r$ is tested against the alternative, H_1: numbers of cointegrating vectors equal to r. In contrast, the maximum eigenvalues test is defined as:

$$\lambda_{\max}(r, r+1) = -T\log(1-\hat{\lambda}_{r+1}) \qquad 1.6$$

The maximum eigenvalues test the null hypothesis, H_0: number of cointegrating vectors equals to r against the alternative, H_1: cointegrating vector is $r+1$. In Eq. (5) and (6), λ_i are the estimated values of the characteristic roots obtained from the estimated Π, and T is the number of observations.

In what follows, long-run relations and intertemporal links between variables are established using the vector error correction model (VECM). The presence of cointegration suggests the existence of, at least, one unidirectional causal link among variables (Granger 1988). In our application, the error correction models are computed based on the linear systems of stochastic equations in Eqs. 1.1 and 1.2 in the form:

$$\Delta\ln GR_t = \alpha_0 + \sum_{i=1}^{h_1}\alpha_{1i}\Delta\ln GR_{t-1} + \sum_{i=1}^{h_2}\alpha_{2i}\Delta\ln GE_{t-1} + \sum_{i=1}^{h_3}\alpha_{3i}\Delta\ln Y_{t-1} + \sum_{i=1}^{h_4}\alpha_{4i}\Delta\ln\pi_{t-1} + \theta\ln ECM_{1t-1} + u_{1t} \qquad 1.7$$

$$\Delta\ln GE_t = \beta_0 + \sum_{i=1}^{k_1}\beta_{1i}\Delta\ln GE_{t-1} + \sum_{i=1}^{k_2}\beta_{2i}\Delta\ln GR_{t-1} + \sum_{i=1}^{k_3}\beta_{3i}\Delta\ln Y_{t-1} + \sum_{i=1}^{k_4}\beta_{4i}\Delta\ln\pi_{t-1} + \phi\ln ECM_{2t-1} + v_{2t} \qquad 1.8$$

Here, $\Delta$is the first difference operator; α_i and β_i are the short-run dynamic coefficients of the model's convergence to long-run equilibrium; h and k are optimal lag length; θ and ϕ measures fiscal disequilibrium and the speed of adjustment to restore the model to its steady-state (or equilibrium) in the presence of a shock to the system; and the $ECM_{it-1}(i=1,2)$ is one-period lagged error correction term derived from long-run relationship capturing short-run causative process. The size and statistical significance of the lagged error correction term in the revenue and expenditure equations have important implications for policymaking, as it indicates how long it will take for each fiscal variable to return to long-run equilibrium in the aftermath of a shock to the system. u_{1t} and v_{2t} serially uncorrelated error terms, such that $E[u_{1t},u_{2s}]=0,\ E[v_{1t},v_{2s}]=0,\ E[u_{1t},v_{2s}]=0$ for all $t\neq s$. Other variables are as defined previously. Note that, short-run causality is tested in Eqs. 1.7 and 1.8 based on the standard $F-$test statistics (WALD test), which assess the joint significance of the coefficients of the first differenced (and lagged) explanatory variables. A significant negative signed *ECM* suggests that variables are cointegrated (*i.e.,* the existence of a long-run relationship), while statistically significant values of θ and ϕ confirms the presence of a long-run causality based on the significance of standard t-test. As mentioned before, we include dummy variables in Eqs. 1.7 and 1.8, to account for structural breaks due to global or domestic shocks.

Lastly, the robustness of the direction and pattern of the long-run causative processes in our models are validated by using Toda-Yamamoto (T-Y) non-Granger causality (Toda and Yamamoto 1995). Generally, the T-Y causality test requires no pre-testing for the presence of unit-root and cointegration to establish causal links between variables. The T-Y procedure uses a modified Wald test (MWALD) to test the linear restrictions of the parameters of a standard VAR(k) in levels, with k being the optimal lag length. The MWALD test based on the

T-Y procedure converges in the distribution of χ^2 random variables with m degrees of freedom whether the series is *I*(0), *I*(1) or *I*(2) stationary or not cointegrated (Wolde-Rafael 2008).

We implement the T-Y procedure by estimating a standard VAR (k) augmented with $(k+d_{\max})^{th}$ order of integration, while the $d_{\max}$ variables are treated endogenously. In the estimated model, the optimal lag length of k is selected based on Akaike information criterion (AIC), and the coefficients of the last lagged $d_{\max}$ are ignored. In the final step, the direction of causality is determined by carrying out an *F*-statistic (MWALD) test for linear or nonlinear restrictions on the first k VAR parameters. The application of the usual *F*-statistic test has asymptotic distribution for a valid inference (Clark and Mirza 2006; Zapata and Rambaldi 1997).

In our analysis, we apply the T-Y procedure by estimating seemingly unrelated regression (SUR)[18] with the system of equations, describe as:

$$\ln GR_t = \alpha_0 + \sum_{i=1}^{k+d\max} \alpha_i \ln GR_{t-i} + \sum_{i=1}^{k+d\max} \beta_i \ln GE_{t-i} + \sum_{i=1}^{k+d\max} \varphi_i \ln Y_{t-i} + \sum_{i=1}^{k+d\max} \vartheta_i \pi_{t-1} + \varepsilon_{1t} \quad 1.9$$

$$\Delta \ln GE_t = \gamma_0 + \sum_{i=1}^{k+d\max} \lambda_i \ln GE_{t-i} + \sum_{i=1}^{k+d\max} \Omega_i \ln GR_{t-i} + \sum_{i=1}^{k+d\max} \Lambda_i \ln Y_{t-i} + \sum_{i=1}^{k+d\max} \eta_i \pi_{t-1} + \varepsilon_{2t} \quad 1.10$$

$$\Delta \ln Y_t = \mu_0 + \sum_{i=1}^{k+d\max} \mu_i \ln Y_{t-i} + \sum_{i=1}^{k+d\max} \Gamma_i \ln GR_{t-i} + \sum_{i=1}^{k+d\max} \varpi_i \ln GE_{t-i} + \sum_{i=1}^{k+d\max} \Pi_i \pi_{t-1} + \varepsilon_{3t} \quad 1.11$$

$$\Delta \ln \pi_t = \psi_0 + \sum_{i=1}^{k+d\max} \psi_i \ln \pi_{t-1} + \sum_{i=1}^{k+d\max} \Theta_i \ln GR_{t-i} + \sum_{i=1}^{k+d\max} \Phi_i \ln GE_{t-i} + \sum_{i=1}^{k+d\max} \theta_i \pi_{t-1} + \varepsilon_{4t} \quad 1.12$$

where $\varepsilon_{i,t} (i = 1,2,3,4)$ are serially independent random error terms with a mean of zero and finite covariance matrix. All other variables and symbols remain the same as previously described. For example, the existence of long-run causality can be assessed in Eqs. (9) and (10), given the null hypothesis that *GR* does not Granger-cause *GE (denoted as* $H_0 : \Omega_i = 0, \ \forall i \le k$), or *GE* does not Granger-cause *GR,* represented as $H_0 : \lambda_i = 0, \ \forall i \le k.$

1.3. Data and Stationarity Properties.

The estimated models consist of the natural logarithms of quarterly series on total government revenue, total expenditure and GDP for the Free State (FS) province, including consumer price index (CPI) series, over the period 2004 Q2 – 2018 Q1[19]. Our choice of data frequency is justifiable since high-frequency data have been shown to produce more reliable evidence on the government revenue-expenditure nexus for South Africa, compared to annual data (Ndahriwe and Gupta 2010). Data on fiscal variables are primarily sourced from the South Africa Department of National Treasury[20] and Free State Provincial Treasury's In-Year-Monitoring databases. Historical CPI series is obtained from Statistics South Africa (Stats SA)[21]. Series on the provincial gross domestic product is sourced from the Global Markit ReX database. Where necessary, nominal series are rebased to index (2010=100). All nominal variables are transformed to real using the CPI, and seasonally adjusted applying ARIMA X–13 procedure. The real government revenue and expenditure series were rescaled as a ratio of real GDP, to capture the effects of growth in the domestic provincial economy (Zapf and Payne 2009), since the growth rates of these fiscal variables are reliant on economic activity levels (Narayan and Narayan 2006).

[18]The SUR procedure remains valid in the absence of a long-run relationship between variables, as long as the order of integration does not exceed the true lag length of the model (Toda and Yamamoto 1995:225).

[19]Annual data were converted to quarterly series using the linear transformation (first-to-match last) method provided in Eviews 10 software.

[20]Audited financial data sourced from various annual Budget Statements, Medium Term Budget (MTBPS) and Provincial Intergovernmental Fiscal Review (IGFR) publications, available at http://www.treasury.gov.za.

[21]Headline CPI series used to compute the inflation series is obtained from Stats SA, available at: http://www.statssa.gov.za/?s=consumer+price+index&sitem=publications.

Before testing whether selected variables in the estimated models are cointegrated, we check for structural breaks and establish the stationarity properties of each variables utilizing the Zivot and Andrews (1992, hereafter Z-A) and Phillips-Perron (1988) unit root tests, which identify inherent break dates congruent to existing endogenous breaks in each series. Given the exposure of South Africa as a small open economy to global shocks, it is plausible that our chosen variables may have structural breaks associated with important global and domestic events, which rendered the use of conventional unit root test such as the Augmented Dickey-Fuller inappropriate(see*, e.g.,* Vogelsang and Perron 1998;Barnejee *et al.* 1992)[22]. Failure to account for existing endogenous break in a time-series can lead to rejection of the presence of a unit root, which may otherwise be false (Islam 2001). To establish stationarity, the unit root tests are carried out on both levels and the first differences of the chosen variables.

More specifically, the Z-A unit root test can confirm the presence of structural breaks in the deterministic trend and also endogenously determine break dates from time-series, instead of *a prior* fixed date. In our application, we apply the Z-A unit root test (based on ADF) suitable for time-series with intercept and trend breaks, in the form:

$$\Delta y_t = \mu + \beta_t + \theta DU_t + \gamma D + \phi_1 DT_t + \alpha y_{t-1} \Sigma_{t=1}^{k} \vartheta_t \Delta y_{t-1} + \varepsilon_t \quad 1.13$$

where y_t is a time series, Δindicates the first difference of series, t is a time-trend, k is the optimal leg length to stationarity of y_t, ε_t is the error term. DU_t and DT_t are dummy variables to capture trend shift and mean shift respectively, occurring at each possible break date, *TB* defined as:

$$DU_t = \begin{cases} 1 & if\ t > TB \\ 0 & otherwise \end{cases} \text{ and } DT_t = \begin{cases} t - TB & if\ t > TB \\ 0 & otherwise \end{cases} \quad 1.14$$

Conversely, the Phillips-Peron (PP) unit root test used can be represented as:

$$\Delta y_t = \alpha + \lambda_t + \rho y_t + \varepsilon_t \quad 1.15$$

where t value is associated with the estimated coefficient of ρ . The series is stationary if ρ is negative and significant.

To refrain from testing for structural breaks based on *a priori* fixed dates, we rely on the break dates identified by Z-A and PP unit root tests, which are provided in Table 1. For robustness, we also perform a multiple breakpoint unit root tests based on sequential breaks, recursive partitions and global crisis induced breaks proposed by Bai and Perron (2003)[23]. In general, structural breaks determined by all the unit-root test, are quite similar[24], suggesting break dates for the period 2009 Q1 and 2011 Q2 (for government revenue variable); 2006 Q1 and 2006 Q2 (for government expenditure variable); 2009 Q2 and 2017 Q2 (for the real GDP variable); and 2010 Q3, 2016 Q1 and 2015 Q2 (for the inflation series). On the basis, the estimated dummy variables included in the error correction models consist of: (i) 2008 Q1–2012 Q2, capturing the full impact of the latest global economic recession and financial contagion; (ii) 2009 Q1–2011 Q4, which accounts for the period of a synchronized economic downturn in Africa; (iii) 2009 Q1–2010 Q4, accounting for the sharp fall in economic activity level in South Africa, during the latest global economic crisis period, prior a rebound at the beginning of 2011; and (iv) 2013 Q1–2018 Q4 to capture the implemented s*trict fiscal consolidation period* to enforce prudent financial management and good governance across the three spheres of government (*i.e.,* national, provincial, and municipal levels), since 2013.

[22]See, *e.g.,* Perron (2017, 2006) for useful literature on dealing with structural break issue in time-series.

[23]The multiple breaking point unit root test is developed based on theoretical contributions of, for example, Zivot and Andrew (1992), Banerjee *et al.* (1992), and Vogelsang and Perron (1998). This test is carried out using Eviews 10, and the results are available upon request from the author.

[24]The three unit root tests employed produce break dates, which mostly coincide with, for example (i) the latest 2007/8 global economic recession; (ii) prevailing weak economic condition in the country, since 2014; (iii) the adoption of strict fiscal consolidation process by the national government since 2014, to reduce wasteful public expenditure and the rapidly expanding fiscal debt (% of GDP) which is above 58%; and (iv) the gradual decline in generated revenue, since 2017 (see, Figure 3).

1.4. Empirical Results and Discussion

We begin our analysis by considering the stationarity properties of the variables. The results of the Z-A and PP unit root tests presented in Table 1, unequivocally shows that the null hypothesis of unit root with a structural break for most of the time-series variables cannot be rejected at levels, but stationarity is achieved after first differencing[25]. As expected, only the inflation series is stationary in levels, and others are *I*(1) stationary variables with endogenous structural breaks.

Having confirmed that variables are *I*(1) stationary, the next step is to examine whether variables are cointegrated, that is, if a long-run relationship exists among variables before assessing the direction of causal links between variables using the vector error correction modeling approach. The Johansen's (1992, 1995) reduced-rank procedure is used to determine whether variables are linearly cointegrated. To carry out the VAR-based reduced-rank cointegration test, the next step is to select the optimal lag length. The set of information criteria used are provided in Table 2[26], mostly favored a maximum lag length of 2. Further, the number of cointegrating ranks based on both the trace and maximum eigenvalue test statistics provided in Table 3, confirm the existence of at least one cointegrated vector between variables, at a 5% significance level.

[25]The results of the Bai and Perron (2003) multiple breakpoints unit root tests carried out, align with those reported here, and available upon request.

[26]The selection criteria are log-likelihood ratio, sequential modified LR test statistic (at 5% significance level), Final prediction error (FPE), Akaike information criterion (AIC), and Schwarz information criterion (SIC) and Hannan-Quinn (HQ) information.

Table 1. Results of structural breaks unit root test.

Variables	$\ln GR$	$\Delta \ln GR$	$\ln GE$	$\Delta \ln GE$	$\Delta^2 \ln GE$	$\ln Y$	$\Delta \ln Y$	$\Delta^2 \ln Y$	π	$\Delta\pi$
Z-A structural unit root test (*t*-statistic)										
Intercept	-4.699***	-5.128**	-4.275	-5.484*		-4.83***	-3.371		-8.181*	-3.242
break dates	2009Q2	2010Q2	2007Q2	2007Q2		2011Q2	2009Q2		2007Q4	2006Q2
Trend	-3.971	-2.641	-4.112	-4.473**		-3.586			-7.631*	-3.185
break dates	2009Q4	2013Q1	2011Q1	2007Q3		2008Q2			2008Q3	2006Q3
Intercept and trend	-6.211	-5.548**				-4.677	-3.687		-8.188*	-4.788
break dates	2009Q2	2010Q2				2011q2	2009Q2		2007Q4	2008Q2
Phillips-Perron unit root (*t*-statistic)										
Intercept	-1.006	-2.608***	-0.028	-2.438	-7.275*	0.837	-2.560	-7.281*	-2.283	7.284**
Intercept and trend	-1.499	-2.647	-2.347	-2.485	-7.207*	-2.908	-2.493	-7.249*	-2.362	7.426**
Bai-Perron multiple breakpoint test.										
Intercept										
F-statistic				-4.571**				-8.056*	-4.955*	
break dates				2006Q1				2009 2	2010Q3	
t-statistic				-4.571**				-8.056*	-4.672*	
break dates				2006Q1				2009Q2	2016Q1	
Intercept and trend										
F-statistics	-9.579*	-5.678*		-6.119*				-7.940*	-5.856*	
break dates	2009Q1	2011Q1		2006Q1				2017Q2	2015Q1	
t-stat	-9.579*	-5.678*		-6.119*				-7.940*	-5.856*	
break dates	2009Q1	2011Q1		2006Q1				2017Q2	2015Q1	

Notes: *, **, *** denote 1%, 5% and 10% statistically significance level respectively.

Table 2. Optimal lag selection for the cointegration test based on information criteria.

Lag length	LogL	LR	FPE	AIC	SC	HQ
0	462.811	NA	0.000	-17.993	-17.841	-17.935
1	841.789	683.647	0.000	-32.227	-31.469	-31.938
2	903.672	101.925*	1.99e-20*	-34.026*	-32.662*	-33.505*
3	909.313	8.405	3.08e-20	-33.620	-31.650	-32.867
4	916.589	9.703	4.61e-20	-33.278	-30.702	-32.294
5	928.623	14.157	5.96e-20	-33.122	-29.941	-31.907

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

Table 3. Results of Johansen (unrestricted) cointegration rank tests.

H_0	H_1	Test statistics	Critical Values (95%)	p-value
		Trace Statistics		
$r = 0$	$r = 1$	48.555	47.856	0.042
$r < 1$	$r = 2$	19.543	29.797	0.454**
$r \leq 2$	$r = 3$	7.305	15.494	0.542
		Maximum Eigenvalue Statistics		
$r = 0$	$r = 1$	29.0114	27.584	0.032
$r < 1$	$r = 2$	12.239	21.131	0.524**
$r \leq 2$	$r = 3$	7.216	14.264	0.463

Notes: p-values based on MacKinnon-Haug-Michelis (1999).

*, **, *** denote 1%, 5% and 10% statistically significance levels, respectively.

Next, before drawing inference from the estimated VEC models, we applied the stability test proposed by Brown *et al.* (1975) based on the cumulative sum (CUSUM) and CUSUM of the square tests for dynamic stability. Figures 4 and 5 (in the Appendix) shows that the parameters and variance of the estimated models are dynamically stable at 5% significance level, implying that deductions and conclusion on the nature and direction of causality between variables, in the long-run and short-run, are reliable.

Turning to the results of the VEC models summarized in Table 4. As expected, the one-period lagged error correction terms in both the government revenue equation $[F(GR|GE)]$, and government expenditure equation $[F(GE|GR)]$, are negative and statistically significant at 5% level respectively, confirming the existence of a stable and long-run relationship between variables. These results also suggest a bi-directional long-run causality from government revenue (expenditure) to expenditure (revenue), running interactively through real GDP and inflation. This evidence indicates that fiscal synchronicity hypothesis underpins the government revenue–expenditure nexus for the Free State province, consistent with the findings reported by Phiri 2019; Baharumshah *et al.* 2016; Ghartey 2010; Lusiyan and Thornton 2007; and Nyamongo *et al.* 2007, for South Africa, but at odds with those documented in earlier cross-sectional studies, supporting the institutional separation (Narayan and Narayan 2008) and spend-tax (Chang *et al.* 2002) hypotheses.

Furthermore, in both models, the coefficient of the lagged error correction terms is significantly negative in both dynamic models, but with a varying speed of adjustment to restore fiscal disequilibrium after a shock to the systems. Although, the rate of adjustment to restore equilibrium may appear to be relatively slow in both models, nonetheless, fiscal disequilibrium (or imbalance) is corrected by 26% in the $F(GR|GE)$ model compared to a much slower adjustment of about 11% in the $F(GE|GR)$ model, in each quarter. Additionally, real government expenditure, real GDP and inflation individually Granger causes government revenue in the long-run, only in the $F(GR|GE)$ model, given their statistical significance at 5% level, and corresponding significant t-statistics at 1% levels.

Table 4. Long-run Granger causality based on the estimated VEC models with dummy variables.

VECM 1: $F(GR\|GE)$			VECM 2: $F(GE\|GR)$		
	$\Delta \ln GR$	*p*-values		$\Delta \ln GE$	*p*-values
α_0	0.0001 [0.508]	0.000*	β_0	-0.003 [-4.238]	0.000*
$\phi \ln ECM_{2t-1}$	-0.256 [-4.125]	0.000*	$\theta \ln ECM_{1t-1}$	-0.107 [-2.991]	0.005*
$\Delta \ln GR_{t-4}$	-0.2556 [-1.839]	0.039**	$\Delta \ln GR_{t-1}$	-0.331 [-1.870]	0.071***
$\Delta \ln GE_{t-1}$	0.271 [1.995]	0.054**	$\Delta \ln GE_{t-1}$	0.464 [3.229]	0.003*
$\Delta \ln Y_{t-4}$	-0.056 [-2.387]	0.023**	$\Delta \ln GE_{t-4}$	-0.641 [-5.037]	0.000*
$\Delta \ln \pi_{t-3}$	0.001 [2.192]	0.036**	δ_{1t} (xdum01)	0.005 [4.716]	0.000*
δ_{5t} (xdum02)	0.001*	0.000*	δ_{2t} (dd4)	0.005 [6.651]	0.000*
δ_{6t} (dd4)	0.000*	0.044**	δ_{3t} (dfcon)	0.005 [4.142]	0.000*

Post-estimation diagnostic tests	VECM 1	VECM 2
F-statistic	9.331(0.000)*	14.829 (0.000)**
Adjusted $\overline{R}^2$	0.759	0.846
Jarque-Bera	3.975 (0.136)	4.978 (0.082)
BG Serial Correlation LM	2.603 (0.272)	2.062 (0.363)
ARCH	2.355 (0.124)	0.088 (0.765)
Breusch-Pagan-Godfrey	27.695 (0.186)	9.137 (0.995)

Notes: *, **, *** denotes 1%, 5% and 10% significance level respectively. α_0 and β_0 are constant parameters, *t*-statistics in [ ] parenthesis, and *p*-values in ( ) parenthesis with asymptotic values $Obs * R^2 \sim \chi^2$.

To validate the presence of long-run causality in the estimated error correction models, the standard $F-$statistic test (at a 5% significance level) is applied, and the results are reported in Table 4. On block causality, the significant $F-$statistic value (lower panel) shows that the independent variables (which include real government expenditure, real GDP and inflation rate) jointly Granger cause government revenue, in the long-run, in the $F(GR|GE)$ model. On the contrary, there is no evidence of long-run causality either individually or jointly from the independent variables to government expenditure in the $F(GE|GR)$ model.

As can be seen in Table 5, the reported $F-$statistic test results for the $F(GE|GR)$ model indicates that government revenue Granger cause government expenditure, and government expenditure Granger cause government revenue in the $F(GR|GE)$ model, with these result being statistically significant 1% and 5% significant level respectively. This evidence suggests the existence of a bi-directional causality in the short run, consistent with the fiscal synchronization hypothesis, supporting the evidence reported by Phiri 2019; Baharumshah *et al*. 2016; Ghartey 2010; and Nyamongo *et al*. 2007, for South Africa. We also find a statistically significant unidirectional short-run causality running individually from real GDP and inflation to government revenue in the $F(GR|GE)$ model. This finding confirms the important roles of economic growth and inflation rate, on raising revenue, at the provincial level, especially the Free State province. Interpretively, an economic boom that raises aggregate consumption expenditure would lead to an increase in revenue collected, while inflation rate determines the growth rate of revenue collected over a period.

Table 5. $F-$statistic test results for Granger causality in the estimated vector error correction models.

Estimated VECM Variables	$F(GR\|GE)$ $\Delta \ln GR$	$F(GE\|GR)$ $\Delta \ln GE$	Direction of causality
$\Delta \ln GR_{t-1}$	–	3.498 (0.071)*	$GR \rightarrow GE$
$\Delta \ln GE_{t-1}$	3.998 (0.054)**	–	$GE \rightarrow GR$
$\Delta \ln Y_{t-2}$	5.699 (0.023)**	–	$Y \rightarrow GR$
$\Delta \ln \pi_{t-4}$	4.805 (0.036)**	–	$\pi \rightarrow GR$

Notes: *, **, *** denote 1%, 5% and 10% statistically significance level respectively. *p*-values in ( ) parenthesis.

In our final analysis, the causality analysis carried out in the VEC model is complemented with the Toda and Yamamoto non-Granger (modified WALD) test, and the results are provided in Table 6. In general, the T-Y non-Granger causality corroborates the long-run causality observed in the estimated error correction models. The result of the VAR-based T-Y causality test shows that the real government expenditure, real GDP and inflation, individually Granger cause government revenue, in the long-run, with these causal links are unidirectional and statistically significant (at 5% level). This finding further reinforces the important role of economic growth and inflation rate on government revenue and expenditure growth rates, as previously noted in the causality results based on the error correction modeling approach.

Similarly, the result of the T-Y causality analysis also suggests the existence of a long-run (unidirectional causality) running from government revenue to government expenditure, for the Free State province. On the other hand, we observed a significant unidirectional causality running from real GDP to both government revenue and expenditure, which aligns with the widely accepted notion that these fiscal variables are dependent on the level of economic activity (Narayan and Narayan 2006). Overall, the results of causality analysis provide concrete support for fiscal synchronization hypothesis, underscoring the dynamics of government revenue–expenditure nexus in long-run and short-run, for the Free State province. This finding is consistent with those reported in the extant empirical literature for developed and developing countries, for example, see Al-zeaud (2015) for Jordan; Elyasi and Rahimi (2012) for Iran; and Chang *et al.* (2002) for Canada.

Table 6. Results of the T-Y non-Granger (MWALD) causality test.

	$F-$statistic value	*p*-value	Long-run causality
$GR \rightarrow GE$	10.728	0.2181	No
$GE \rightarrow GR$	14.681	0.065*	Yes
$GR \rightarrow Y$	3.986	0.858	No
$Y \rightarrow GR$	14.648	0.066*	Yes
$GE \rightarrow Y$	12.907	0.115	No
$Y \rightarrow GE$	5.942	0.354	No
$\pi \rightarrow GE$	30.500	0.000*	Yes
$GR \rightarrow \pi$	7.344	0.049	No
$\pi \rightarrow GR$	15.765	0.045**	Yes
$\pi \rightarrow Y$	17.121	0.028*	Yes
$GE \rightarrow \pi$	14.005	0.081*	Yes
$Y \rightarrow \pi$	8.834	0.356	No

Notes: *, **, *** denote 1%, 5% and 10% statistically significance levels, respectively. *p*-values in ( ) parenthesis. Optimal lag (of 9) is selected using log-likelihood ratio, LR, AIC, FPR, SC and HQ information criteria. All residuals were checked for white noise using several misspecification tests.

Conclusion

This paper set out to examine the dynamics of causal relationships underlying the government revenue-expenditure nexus for Free State province, over the period 2004 Q2–2018 Q1, including real GDP and inflation rate as control variables, in a multivariate vector error correction model. To this end, we employ the Johansen's reduced-rank cointegration to establish the existence of a long relationship between variables being studies, while both the nature and the direction of the long-run and intertemporal (short-run) causal links were uncovered, using appropriate tests in estimated error correction models, complemented with the VAR-based Toda-Yamamoto non-Granger causality test.

Our main findings are summarized as follows: First, the cointegration analysis confirms the existence of a stable long-run relationship between the selected variables. This evidence is further reinforced by the statistically significant, and negative coefficients of the one-period lagged error correction terms, in the error correction models. We also find slow adjustment rates, ranging from 11% to 26% every quarter, to restore fiscal disequilibrium (after a shock) in the provincial economy. Second, the causality analysis shows a bi-directional causality running from government revenue to government expenditure, and vice-versa in both the long-run and short-run, supporting the fiscal synchronization hypothesis. Interpretively, government revenue and expenditure are independent of one another, and the provincial government have control over generated revenue (via tax imposition) and expenditure as fiscal tools to restore budgetary equilibrium. Third, real GDP and inflation individually Granger-causes government revenue, in the long run. In the short run, there is a unidirectional causality running from real GDP to government revenue, whereas inflation Granger causes government revenue and expenditure, without any feedback effect. These causal flows are statistically significant, stressing the importance of economic growth and inflation rate on the level of provincial 'own' revenue.

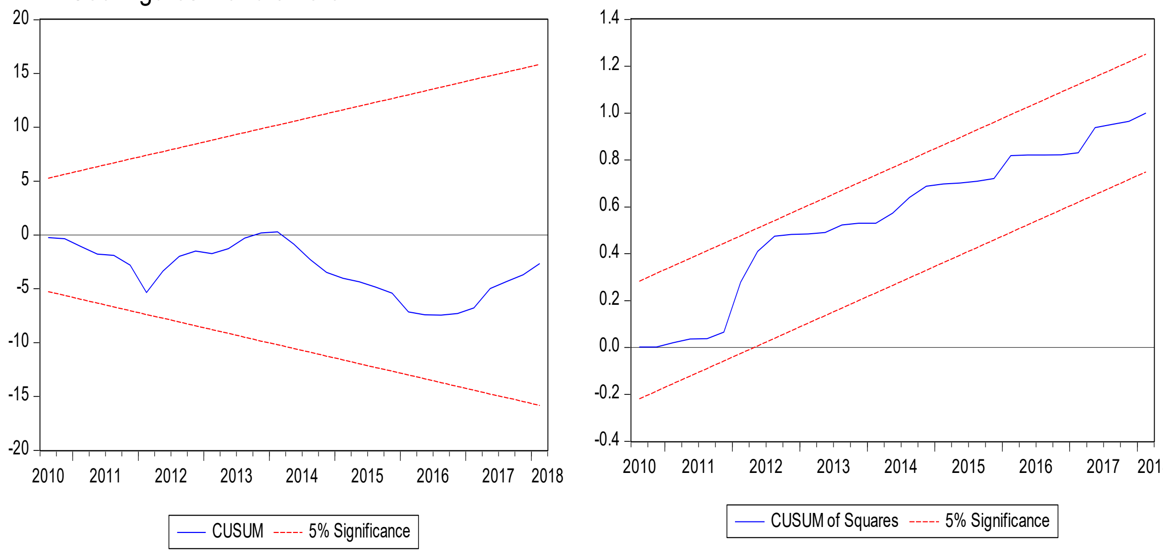
These findings have some important policy implications. Firstly, the evidence for fiscal synchronicity underlying the government revenue–expenditure nexus suggests that fiscal pressures or budget constraints linked to budget deficit could be alleviated by raising revenue via taxes (*i.e.,* surcharges and levies) and cut in government expenditure. Albeit, rapid growth in government expenditure relative to government revenue would not only limit fiscal space, cause fiscal imbalance and heightened (adverse) budgetary pressures at the provincial level, but can exacerbate fiscal debt at the national level. In the context, the Provincial Treasury should adopt stringent measures to improve the current budgetary stance of the province to facilitate fiscal prudence, sound financial management, adequate budget planning process, implementation of a credible budget and eradicate fruitless expenditure. Secondly, since empirical evidence shows that provincial government revenue and expenditure are dependent on the growth rate of economic activity level and inflation, policymakers and fiscal authorities should consider the implications of raising government revenue (via tax imposition) or expenditure, especially on economic activity level in the province. In this context, an accommodative fiscal stance that stimulates provincial economic growth has the potential to increase government revenue, whereas high government expenditure which heightens inflationary pressure would crowd out economic growth (or economic gains). Same policy prescription applies to a conservative fiscal stance to reduce government expenditure and revenue (by lowering taxes or phasing out certain surcharges and levies).

Finally, our findings stressed the need for implementation of effective policy to drive turn-around strategies in the short-term and medium-term, at the provincial level. In this regard, the Free State provincial government can consider, for example, intensifying its revenue-raising effort by prioritizing the implementation of fiscal measures to stimulate revenue collection, harness its revenue-generating autonomy by broadening revenue collection base to prevent revenue slippage, and improve the value of money spent on competing public projects, by undertaking thorough feasibility studies, as well as cost-benefit analysis model to determine the profitability of projects to be financed.

In future research, we intend to examine whether our results based on the cointegration and causality analysescarried out here are valid in a multivariate asymmetric (non-linear) model, as evidenced in recent studies investigating the same line of inquiry (see*, e.g.,* Raza *et al*. 2019; Tiwari and Mutascu 2016; Saunoris 2015).

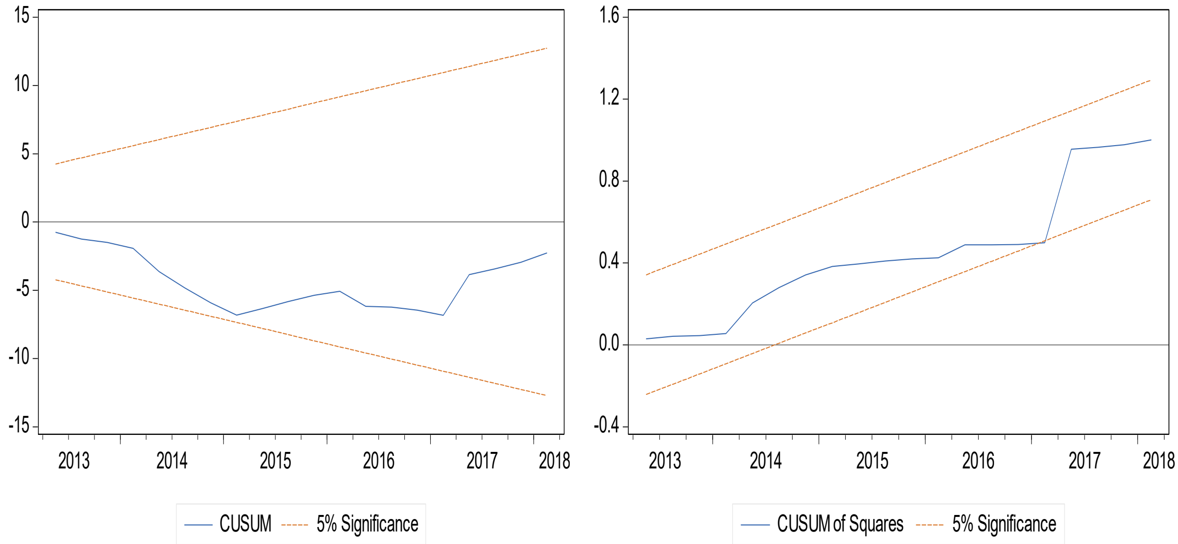
Appendix

See Figures 4 and 5 here.



Notes: The CUSUM parameter (and variance) stability test assess the robustness of the specified model. This graph shows that both parameters and variance of the model are stable under both cumulative sum (CUSUM) and CUSUM of the square tests, at a 5% significance level.

Figure 4. Graphical display of the dynamic stability test for $F(GR|GE)$ model



Notes: See Figure 4.

Figure 5. Graphical display of the dynamic stability test for $F(GE|GR)$ model

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