Investigating the Government Revenue–Expenditure Nexus: Empirical Evidence for the Free State Province in a Multivariate Model.

Omoshoro-Jones, Oyeyinka Sunday

Free State Provincial Treasury, Bloemfontein, South Africa

27 March 2020

Investigating the Government Revenue–Expenditure Nexus: Empirical Evidence for the Free State Province in a Multivariate Model.

Oyeyinka S. Omoshoro-Jones

Ecoonomic Analysis Directorate, Department of Free State Provincial Treasury, Bloemfontein, South Africa, 9301.

Abstract: This paper examines the government revenue–expenditure nexus for the Free State Province in a multivariate modelling framework using real GDP and inflation as control variables over the period 2004Q2–2018Q1. Cointegration and intertemporal (causal) links among variables were established employing Johansen-Juselius (1990) within a vector error correction model (VECM) and Toda-Yamamoto (1995) non-Granger causality test. Cointegration analysis affirms 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 revenues 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. The Free State government through its provincial treasury should adhere to a planned budget process, devise innovative revenue-generating strategies to circumvent the burden of producing inflation revenue, and effectively use its autonomy on fiscal instruments to maintain a sustainable fiscal policy path and stimulate economic activity level.

Keywords: VECM, Expenditure, Revenue, Causality, Cointegration, Free State province.

JEL Classification: C12, C51,C54, H61.

1. 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 GDP) due to government expenditures outpacing tax-revenues (Figs. 1 and 2 *in the Appendix*), while economic growth is constrained with structural endogenous shocks (e.g., shortage of power supply), political uncertainty, weak global demand for commodity export and gyrations in the world capital market. At the same time, the labour market condition has steadily worsened in the past decade[1]. The combined effects of these developments require the national government to design/ implement effective economic and fiscal policies to tackle these socioeconomic issues and stimulate economic growth (see, e.g., NDP, 2012; NGP, 2011). While, in political and academic discussions, there is a growing concern over South Africa's ever-increasing fiscal debt utilized to finance the rise in government expenditures, which in turn widen budget deficit (National Treasury, 2020).

Intuitively, the narrowing fiscal space, severely weak economic growth and relatively low tax-revenues may affect the national government's allocations (i.e., equitable shares[2]) to provinces directly or indirectly. Hence, provincial governments are often confronted with the dilemma of either reducing public spending or utilize their fiscal autonomy to raise "own revenue" to augment their provincial

---

[1]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), even as its 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 (StatsSA, 2020).

[2]South African uses an intergovernmental fiscal framework, in which, collected tax-revenue by the national government are allocated as equitable shares (to fund both earmarked and conditional grants) across the nine provinces based on set of criterion.

equitable share (PES). Nevertheless, a key question is which of these budgetary components will actually foster fiscal sustainability or restore fiscal balance?. The answer to this question cannot be based on *a priori* judgement but it remains an empirical issue.

In South Africa, the provincial governments receive a large fraction of their revenue (i.e., PES) from the national government in the form of intergovernmental transfers which are mostly devoted to financing flagship programmes or projects identified by the national government to show its political commitment to the voters, on tackling income inequality, unemployment and poverty rate. This 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 this context, 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 and surcharges[3]. Albeit, *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.

However, 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 budget deficit. Besides, it is widely accepted that sound fiscal policy can promote price stability and sustain growth in output and employment. As a policy tool, it can reduce output and employment fluctuations in the short-run, and also restore the economy to its potential level.

This present study contributes to the extant literature investigating the causal relationship between government revenues and expenditures at the state level, by focusing on the temporal interdependence between the two variables in the domestic economy of the Free State (FS) province over the period over the period 2004Q2–2018Q1 employing the vector error correction modelling approach and VAR-based non-Granger causality test developed by Toda-Yamamoto (1995), together with real gross domestic product (GDP)[4] and inflation as control variables within a multivariate framework.

This empirical analysis is timely and important in at least on two counts. Firstly, 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[5], and a lacklustre 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[6]. Premised on this reality, the provincial government is faced with the daunting task of resuscitating the provincial economy and concurrently reduce the prevailing high rate of unemployment and poverty rates with the limited available financial resources which constitute the bulk of the equitable shares allocated by the national government.

On the other hand, the enforcement of stringent fiscal consolidation measures by the South African government, to reduce the increasing fiscal debt, budget deficit, wasteful expenditures and public wage bill, has an unintended indirect effect on the Free State's equitable share, while the increasing off-the budget activities to ameliorate the impact of the emergent dire socioeconomic conditions makes the provincial budget fiscally unsustainable. Given the current socio-economic and fiscal 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. Hence, 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 (Fig.3 in *the Appendix*).

---

[3]Levies and surcharges are other form of taxes used by the provincial (or state) government as fiscal tools to raise 'own' revenue. Note, the provincial 'own' revenue is referred to as government revenue from Sections 3 to 6.
[4]Note, GDP variable that is used in our analysis refers to the GDP-R that measures the provincial economic growth, calculated and published by the Statistics South Africa (StatsSA).
[5]See, StatSA's published Quarterly Labour Market Survey for 2019:Q4.
[6]Provincial macroeconomic data is sourced from the reliable IHS Global Markit's Rex database.

Secondly, the relationship between government revenues-expenditures empirically rests on four hypotheses in the public finance literature[7], which includes (i) tax-spend, (ii) spend-tax, (iii) fiscal synchronization, and (iv) institutional separation. While the first three hypotheses imply interconnection between government revenue and expenditures (see, e.g. Friedman, 1978; Buchanan and Wagner, 1979; Musgrave, 1966; Meltzer and Richard, 1981), the institutional separation hypothesis suggests an independent relationship between these budgetary components (Wildavsky, 1988; Baghestani and McNown, 1994). These theories have different policy implications. This, 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. This rationale lends credence to the relevance of the empirical investigation in this paper. Concrete evidence on the theory underpinning the revenues-expenditures nexus in the Free State will be useful to the fiscal authorities and policymakers in designing (or implementing) effective fiscal measures to finance other provincial priorities.

This paper also contributes to the extant literature in several dimensions. So far, only a few studies have examined the causal relationship between government revenue and expenditures in South Africa from the national government perspective (see, e.g., Chang et al.2002; Narayan and Narayan, 2006; Lusiyan and Thorthon, 2007; Nyamongo et al.2007; Ghartey, 2010; Ndahiriwe and Gupta, 2010; Baharumshah et al.2016; Phiri, 2019), however the same empirical research on the provincial economy[8] remain scarce. To the best of our knowledge, our study is the first attempt to explore this line of empirical inquiry at the sub-national sphere of government in South Africa.

Furthermore, the findings in the existing literature for South Africa is inconclusive, as authors report contradictory evidence supporting a unidirectional causality running from government expenditures to revenue (see, Chang et al.2002); no temporal causal link between variables, indicative of fiscal neutrality (Narayan and Narayan, 2006) and bidirectional causality between variables (see, e.g., Phiri, 2019; Baharumshah et al.2016; Ghartey, 2010; Lusiyan and Thorthon, 2007). Thus, it is difficult for policymakers to design and/or implement effective fiscal measures to reduce the budget deficit or achieve fiscal sustainability in South Africa. Aside from, the different econometric techniques used in earlier studies and time-periods examined; the mixed results reported in most of the earlier studies can be attributed to cointegration and causality analyses were carried out in a bivariate framework which suffers from the omitted variable problem (see, e.g., Payne, 2003; Baghestani and McNown, 1994; Ashan et al. 1992; Signh and Sani, 1984, Lutkepohl, 1982); widespread use of low frequency (annual) data, as opposed to high-frequency data, has been proven to obscure the existing causative links between revenue and expenditures (Ndahriwe and Gupta, 2010); and structural breaks are often unaccounted for in the annual data used (save for Phiri, 2019; Lusiyan and Thorton), despite the increasing exposure of South Africa to globally transmitted shocks due to the country's well documented increasing integration into the world economy and financial markets since 1994. Likewise, several fiscal measures have been adopted to encourage fiscal discipline and financial management at the national, provincial and municipal levels[9].

Broadly speaking, the shortcomings in these earlier studies can lead to erroneous conclusions and fiscal policy formulation, given that the relationship between government revenue and expenditure may have changed because of the close link between business cycles and the budget working via automatic fiscal stabilizers and discretionary fiscal measures (Ewing, 2006:191), thus the failure to determine possible endogenous breaks (and deterministic trend) in the revenue and expenditure series can produce spurious results and conclusion on causal links (Islam, 2001).

---

[7]The different tax-debate theories, empirical evidence and policy implications are discussed in subsequent section of this paper.

[8]Note, South African provinces are analogous to states in other countries/regions. See, e.g., Saunoris (2015), Payne (1998), Marlow and Manage (1987) and Von Furstenburg et al.(1986) for studies investigating the government revenues-expenditures nexus at the state levels. See, also Payne (2003) for few studies that focused on the temporal relationship between government revenues and expenditures at the state and local government (municipality) levels.

[9] Enacted financial regulations, most notably Public Finance Management Amendment Act (PFMA), No. 29 of 1999 and Municipal Finance Management Act (MFMA) No. 56 of 2003, enforced by the National Treasury.

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. Even so, the drawn inferences and conclusion of this particular study can be considered as unreliable since the analytical exercise is performed in a bivariate model using high-frequency data that covers the period 2000 to 2016. Also, the short time-period covered in this study makes it susceptible to misspecification bias due to insufficient degrees of freedom, required to construct the optimal number of lags for times-series included in the non-linear autoregressive model (NARDL) used.

The methodology and model specification employed in this study circumvent the limitations of earlier studies. Specifically, our causality analysis is carried out in 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. Foremost, the 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; Johansen and Juselieus, 1990). Second, 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. It is worth noting that the inclusion of the provincial real GDP in our model is due to the fact that the provincial government 'own' revenue and expenditure growth are intrinsically linked to the aggregate economic conditions in the province. Finally, the novel Toda-Yamamoto non-Granger causality test used in our analysis provides a reliable robustness check for the results of the estimated vector error correction models on the long-run relationship among variables. All in all, our drawn inferences and conclusion on both the linear and temporal causative links among variables are expected to be more robust than those reported in earlier studies.

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.

2.   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, these include: (i) the tax-spend, (ii) spend-tax, (iii) fiscal synchronization and (iv) institutional separation. A bird's eye view of the burgeoning empirical literature validating these theories is provided in this sub-section, and relevant empirical studies are presented in Table A1 in the Appendix. See, for example, Payne (2003) and Phiri (2019) for a much broader survey of the empirical literature.

Friedman (1978) and Buchanan and Wagner (1997) are the main proponents of the *tax-spend theory*, arguing that changes in government revenues (taxes) leads to changes in government expenditure, from an opposing viewpoint. According to Friedman (1978), an increase in government revenues will directly raise government expenditures, implying a positive relationship between the variables. For example, the conventional fiscal measure to reduce budget deficits by increasing tax-revenue will exert an inflationary effect on goods and services, which raises government consumption expenditure. On this basis, lower taxes would reduce the budget deficit or engender fiscal sustainability (Darrat, 2002; Payne, 2003). On the contrary, Buchanan and Wagner (1997) posit a negative intertemporal relationship between government revenue and expenditure. Here, an increase in government revenue (or tax) will reduce the budget deficit, since voters will perceive a reduction in tax revenue as a decline in public spending, leading to increasing demand for public goods and services. Thus, increases in tax revenues combined with spending cuts will lower budget deficits. Empirically, a unidirectional causality from government revenues (or taxes) to government expenditure confirms the tax-spend thesis. The tax-spend hypothesis has been supported by the following empirical studies, to mention a few: Manage and Marlow (1986), Ram (1988), Bohn (1991), Owoye (1995), Ross and Payne

(1995), Payne (1998), Park (1998), Ewing and Payne (1998), Daratt (1998), Narayan and Narayan (2006), Kollias and Paleologou (2006), Wolde-Rufael (2008), AbuAl-Foul and Baghestani (2004), Eita and Mbazima (2008), Aregbeyen and Ibrahim (2012), Sennoga (2012), Magazzino (2013), Rahman and Wadud (2014), and Obeng (2015).

Tuning to the *spend-tax theory*, government spend first and raise revenue (taxes) later, which is the opposite of the tax-spend thesis. Peacock and Wiseman (1961, 1979) advanced spend-tax theory, arguing that the occurrence of idiosyncratic shocks (e.g., natural disaster, droughts) economic, social and political upheavals typically leads to higher taxes initially used to finance the required increase in government expenditure. This postulation is akin to Ricardian equivalence proposition by Barro (1974, 1978) suggesting that the present borrowing by government results in an increased tax liability in the future, hence government expenditure is fully capitalised by the public in recognition of these increased future tax liabilities. Empirically, the spend-and-tax hypothesis holds if a unidirectional causality from government spending to government revenue (taxes) exists and is known as the 'displacement effect'. The spend-tax theory has been supported by the work of, for example, Blackley (1986), Von Furstenburg et al. (1986), Jones and Joulifain (1991), Payne (1998), Afonso and Rault (2009), Magazzino (2013), Chang et al. (2002), Narayan and Narayan (2006), Saunoris and Payne (2010), Keho (2011), Paleologou (2013), Kaya and Şen (2013), Ritcher and Dimitrios (2013), Nwosu and Okafor (2014), and Tiwari and Mutascu (2016).

Whereas, Musgrave (1966) and Meltzer and Richard (1981) put forward the *fiscal synchronization hypothesis*, maintaining that government expenditures and taxes can be adjusted simultaneously (or concurrently) to achieve fiscal balance (or equilibrium) given that policymakers have full control on both variables during budget adjustments. In theory, concurrent decisions on the appropriate government expenditure and tax revenues are imperative to optimize a community's intertemporal social welfare function in a democratic society, as decisive voter also compares the marginal benefits and costs of initiated government programmes (Musgrave, 1966:19). Conversely, preferences of a community would determine the quantity and quality of public goods that government expenditure caters for, implying that the welfare-maximising choice of a decisive voter influence government expenditure level (or size), while the decisive voter chooses the tax share (Meltzer and Richard, 1981:924).

Therefore, the government can simultaneously choose an optimal package of public programmes to be financed in its budget along with tax revenues required. Since government expenditure and revenue are independent of each other, budget deficit can be reduced by raising taxes and reducing expenditure since both variables can be changed concurrently. Empirically, a bidirectional (or contemporaneous feedback) causality between government revenues and government expenditures validates the fiscal synchronization theory. Hence, an isolated fiscal decision to raise government revenue or expenditure will lead to a serious budget deficit, if contemporaneous feedback exists between the two variables. Empirical evidence on fiscal synchronisation theory have been reported by, for example, Manage and Marlow (1987), Miller and Rusek (1990), Owoye (1995), Payne (1998), Ewing and Payne (1998), Islam (2001), Chang et al. (2002), Kollias and Paleologou (2006), Lusiyan and Thorthon (2007), Nyamogo et al. (2007), Wolde-Rufael (2008), Chang and Chiang (2009), Ndahiriwe and Gupta (2010), Ghartey (2010), Mehrara et al. (2011), Elyasi and Rahimi (2012), Al-zeaud (2015), Takumah (2014), Baharumshah et al. (2016), Phiri (2019) and Raza et al. (2019).

Lastly, Wildavsky (1988) and Baghestani and McNown (1994) suggested 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 (Drazen, 2001; Persson et al. 2000). From a policy perspective, if institutional separation thesis holds, then fiscal consolidation out by raising tax revenues or cut in expenditure will not affect budget deficit (Lusiyan and Thorton, 2007:497). Empirically, no intertemporal causality between government revenue and expenditure is existing, and also referred to as fiscal neutrality. To mention a few, studies with findings on fiscal neutrality consists of the empirical work of AbuAl-Foul and Baghestani (2004), Narayan and Narayan (2006), Ewing (2006), Kollias and Paleologou (2006), Wolde-Rufael (2008), Zapf and Payne (2009), Magazzino (2013), Ali and Shah (2012), Masere and Kaja (2014), and Baharumshah et al. (2016).

2.1. Survey of related empirical studies

In the vast empirical literature, empirical studies examining the relationship between government revenue and expenditure in South Africa is scanty, while similar research at the provincial level receives no attention so far. Be that as it may, the findings of these studies remain mixed, partly due to model specification bias, different time period being studied, and econometric techniques used.

Some cross-sectional studies have considered South Africa in their analysis in a multivariate model by incorporating GDP as a control variable to deal with misspecification bias due to omitted variable problem (Payne, 2003). Most notably, Chang et al. (2002) employed the error correction modelling approach to assess the government revenue-expenditure nexus across ten developing economies using annual series, over the period 1951–1996 and finds a unidirectional causality running from government expenditure to revenue for South Africa in the short-run, supporting the spend-tax hypothesis. On the contrary, using the Toda-Yamamoto (1995) non-Granger causality test for twelve developing countries during the 1960–2000, Narayan and Narayan (2006) found no long-run causality between government revenue and expenditure in South Africa, keeping with the institutional separation (or fiscal neutrality) hypothesis. In a subsequent study, Ghartey (2010) utilised an ARDL model and the two-step Engle-Granger method to determine the direction of causality driving the government revenue-expenditure nexus in Nigeria, Kenya and South Africa using annual data spanning 1960–2007 and found a bi-directional causality among these variables for South Africa suggesting the existence of fiscal synchronisation hypothesis.

Similarly, few country-specific studies have considered the government revenue-expenditures nexus in South Africa. Among these, Lusiyan and Thorthon (2007) accounted for structural breaks by including dummy variables in bivariate model estimated for the period over the period 1895-2015 and established long-run relationship with the help of a VAR-based Johansen cointegration test. Their Granger-type causality tests suggest the existence of a bidirectional relation between revenue and expenditure, thus keeping with fiscal synchronisation hypothesis. Nyamongo et al. (2007) estimated a bivariate VAR model over the period October 1994 to June 2004 and reported a long-run bi-directional causality between government revenue to expenditure but without any evidence of temporal causal link which supports fiscal neutrality hypothesis. Ndahiriwe and Gupta (2010) argued that the mix results in the direction and nature of the causal relationship between government revenue and expenditure in South Africa can be attributed to the frequency of time-series used. Using both quarterly and annual together with GDP and government debt as control variables, the authors find bi-directional causality between revenue and expenditure only in the vector error correction model with quarterly data (1960Q1 to 2006Q2) but the result of a similar model with annual series (1960-2005) showed no evidence on the causative links among variables being studied.

More recent studies have utilized the asymmetric model to capture the non-linear features underlying government revenue and expenditure. In this strand of studies, Baharumshah et al. (2016) used annual data to estimate both asymmetric (i.e., threshold autoregression (TAR) and momentum threshold autoregression (MTAR)) and symmetric (error correction based-ARDL) bivariate cointegration models over the period 1960–2013 for South Africa and found no evidence of asymmetric cointegration among variables in both the TAR and MTAR, however, the results of the multivariate ARDL that make use of the GDP as control variable confirm that variables are linearly cointegrated in the long-run with bi-directional causality running from government revenue to expenditure, and vice versa in both the long-run and short-run.

Focusing on fiscal sustainability of South African provinces given the adopted strict fiscal consolidation stance by National Treasury, Kavase and Phiri (2018) employ the non-linear ARDL model to examine the asymmetry relationship behind government revenue–expenditure nexus across nine provinces over the period 2000–2016, and finds that the widespread strict fiscal stance to finance growing expenditure by raising taxes (increased revenue collection) has a differentiated long-run and short-run effects on provincial budgets, and widens the national fiscal debt given varying financial priorities in each province. These authors conclude that fiscal sustainability is attainable in both the long-run and short-run if government expenditures increased in Eastern Cape, Northern Cape and Free-State provinces but reduced in Western Cape, North West, Gauteng, Mpumalanga and Limpopo.

Finally, in a recent empirical work, Phiri (2019) make use of an asymmetric MTAR cointegration model supplemented with a TEC component with fiscal deficit/surplus (as a ratio of GDP) as a control

variable to examine the government revenue-expenditure nexus for South Africa over the period 1960Q1 to 2016Q2, and finds a bi-directional causality, in support of fiscal synchronization hypothesis.

3. Econometric Methodology: Cointegration-based Vector Error Correction Modelling

This sub-section outlines the econometric approaches employed to examine the relationship between government revenue and expenditures in the Free State province. We begin with the construction of a hypothetical (functional) multivariate framework needed to study the existing linear and temporal relationships between provincial government 'own' revenue, expenditure and the two control variables. Next, we outline the cointegration based-vector error correction model and Toda-Yamamoto's MWALD tests based on the developed functional model to carried out the causal analysis between variables.

3.1. Modelling Framework.

In the empirical literature, the assessment of the government revenue–expenditure nexus in a multivariate framework has been proven to produce more robust results and conclusion, compared to a bivariate modelling approach, which may obfuscate the direction and pattern of temporal links among variables, and misspecification bias associated with omitted variable problem (see, e.g., Payne, 2003; Lutkepohl, 1982)[10]. To this end, the underlying dynamically complex government revenue (GR)–government expenditure (GE) nexus is investigated at the sub-national level using provincial data by considering long-run linear stochastic equations within a multivariate framework as follows:

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

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

where, ln is 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; Y_t and π_t are the real gross domestic product (GDP) and inflation series included as control variables to pin down the exact intertemporal (causal) relationship among 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).

The motivation behind the specified models are as follows: First, the specified models lend credence to the theoretical underpinnings driving the GR–GE nexus, given that Eq.1 modelled *the spend-tax hypothesis* (Peacock and Wiseman, 1961), while Eq.(2) represent the *tax-spend hypothesis* (Friedman, 1978). Second, this multivariate set-up allows feedback interaction between the independent and endogenous variables to accurately uncover the direction and the nature of causality underscoring the government revenue-expenditure nexus which cannot be determined purely a priori judgement. Third, the inclusion of important macro-variables, that is, the GDP and inflation as two control variables in the system help to obviate model misspecification bias[11] since the failure to account for omitted variables can give rise to misleading causal ordering among variables, leading to spurious results (see,

---

[10]In the public finance literature, same evidence on dealing with misspecification bias due to omitted variable problems have been proven in related strand of empirical studies exploring the government expenditure–economic growth nexus, see, e.g., Signh and Sani (1984) and Ashan et al. (1992).

[11]See, Payne (2003) for detailed survey on for cross-country and country-specific studies which have used GDP and inflation as control variables in a multivariate set-up. For instance, few studies focusing on the relationship between government revenue and expenditure in South Africa, most notably Chang et al.(2002), Narayan and Narayan (2006), Wolde-Rafael (2008), Ghartey (2010), and Baharumshah et al. (2016) used GDP as control variable in their estimated models.

Ahsan, Kwan and Sahni, 1992). Following the empirical work of Baghestani and McNown (1994), it has become a common practice to add a third variable, usually the GDP in a multivariate model. The inclusion of the GDP variable in the specified model 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. This modelling strategy also helps to distinguish between the direct causality relation between revenues and expenditures and the indirect causality effects via GDP and inflation. While, the error terms from the long-run regressions between government revenue and GDP (Eq.1) and government expenditure and GDP (Eq.2) could provide meaningful insight on the responsiveness and deviation of government revenues and expenditures from their long-run equilibriums with respect to GDP (Payne, 1998).

Finally, the specified models permit clear identification of possible cointegrated vectors (long-run relationships) in the system of equations, required for the inclusion of error-correction terms that could provide another source of causality in the long-run in the estimation of multivariate vector autoregressive models. Overall, estimated models in Eqs.1 and 2 allows us to correctly determine whether variables are cointegrated or not (Johansen, 1988; Johansen and Juselius, 1990), direct and indirect causative processes in both the long-run and short-run (Granger and Lin, 1995; Engle and Granger, 1987).

3.2. Testing for Long-run Relationship: Cointegration Approach.

Before testing for the direction and pattern of the causative process driving the GR–GE nexus via the control variables within multivariate error correction modelling framework, the next step is to determine whether the chosen variables are cointegrated in the long-run by sharing a common trend, yielding one or more linear combinations variables that are stationary in levels irrespective of varying stationarity properties. However, variables may deviate in the short-run in response to a shock in a system but expected to revert to a steady-state (i.e., long-run equilibrium) since they share a common stochastic trend (Stock and Watson, 1988). Engle and Granger (1987) showed that if two nonstationary variables are cointegrated, then a vector autoregression in the first difference is misspecified.

For our application, the VAR-based Johansen's (1992, 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, and also have better small sample properties, and also permits feedback effect among variables, reflecting the interdependency among variables to yield robust cointegrating vectors compared to the traditional E-G two-step procedure that is limited to bivariate relationships. Lastly, the loss in terms of efficiency is minimal[12].

The Johansen procedure is carried out to identify the rank of the cointegrating space, by determining the number of cointegrating vectors (r) in the parameter matrix Π. Following Johansen (1995) and Johansen and Juselius (1990) on the reduced rank cointegration test, consider a VAR (2,1) with Gaussian errors expressed as:

$$y_t = A_{(1)}y_{(t-1)} + A_{(2)}y_{(t-2)} + ... + A_{(n)}y_{(t-n)} + \Lambda + u_t; \quad t=1,2,...,T. \quad (3)$$

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.(3) becomes an error correction model estimated as:

$$\Delta y_t = \Gamma_{(1)}y_{(t-1)} + \Gamma_{(2)}y_{(t-2)} + ... + \Gamma_{(n-1)}\Delta y_{(t-n+1)} - \Pi y_{t-1} + \Lambda + u_t; \quad t=1,2,...,T. \quad (4)$$

where, $\Gamma_i = -I + A_{(1)} + A_{(2)} + ... + A_i$ for $i=1,2...,n-1$, and $\Pi = 1 - A_{(1)} - A_{(2)} - ... - A_{(n)}$

---

[12]See, e.g., Gonzalo (1994) and Kremers et al. (1992) on the superiority of Johansen reduced rank procedure in comparison to conventional Granger causality test.

Note, the main focus of the Johansen reduced rank cointegration test is on matrix Π, conveying the information about the long-run relationship between y_t variables (e.g., GE and GR). 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}) defined as:

$$\lambda_{trace}(r) = -T \sum_{i=r+1}^{n} \log(1 - \hat{\lambda}_1) \qquad (5)$$

where, $\hat{\lambda}_{r+1}, ..., \hat{\lambda}_n$ are the estimated $n - r$ 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

$$\lambda_{max}(r, r+1) = -T \log(1 - \hat{\lambda}_{r+1}) \qquad (6)$$

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.

3.3. Granger Causality Test: Error Correction Modelling Approach

In what follows, temporal links between variables is established using the vector error correction model (VECM). Generally, the presence of cointegration suggests the existence of, at least, one unidirectional causal link among variables (Granger, 1988). Based on this hypothesis and multivariate framework specified in Eqs. (1) and (2); the cointegrated error correction models investigating the long-run and temporal dynamics behind the GR–GE nexus, in which government revenue and expenditure are each treated as the independent variable are estimated as:

$$\Delta \ln GR_t = \alpha_0 + \sum_{i=1}^{h_1} \alpha_{1i} \Delta \ln GR_{t-1} + \sum_{i=1}^{h_2} \alpha_{2i} \Delta \ln GE_{t-1} + \sum_{i=1}^{h_3} \alpha_{3i} \Delta \ln Y_{t-1} + \sum_{i=1}^{h_4} \alpha_{4i} \Delta \ln \pi_{t-1} \qquad (7)$$
$$+ \theta \ln ECM_{1t-1} + u_{1t}$$

$$\Delta \ln GE_t = \beta_0 + \sum_{i=1}^{k_1} \beta_{1i} \Delta \ln GE_{t-1} + \sum_{i=1}^{k_2} \beta_{2i} \Delta \ln GR_{t-1} + \sum_{i=1}^{k_3} \beta_{3i} \Delta \ln Y_{t-1} + \sum_{i=1}^{k_4} \beta_{4i} \Delta \ln \pi_{t-1} \qquad (8)$$
$$+ \phi \ln ECM_{2t-1} + v_{2t}$$

Here, Δ 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. More importantly, 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. In Eqs. (7) and (8), short-run causality is based on the standard F – test statistics (WALD test), which assess the joint significance of the coefficients of the

9

first differenced (and lagged) explanatory variables. A significant negative signed ECM affirms that variables are cointegrated, and statistically significant values of θ and ϕ confirms the presence of a long-run causality based on the significance of standard t-test, respectively. Note, in our application, estimated dummy variables accounting for structural breaks due to global or domestic shocks, are treated endogenously in the computed models in Eqs. (7) and (8).

3.4. Toda-Yamamoto Non-Granger causality Approach.

To ensure the robustness of the direction and pattern of long-run causative process, we employed a more powerful Toda-Yamamoto (hereafter, T-Y) non-Granger causality introduced by Toda and Yamamoto (1995). Unlike the traditional Engle-Granger causality test, the T-Y non-Granger causality test requires no pre-testing for the presence of unit-root and cointegration to establish causal links among variables. The T-Y procedure uses a modified Wald test (MWALD) to test the linear restrictions of the parameters of a standard $\text{VAR}(k)$ 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, 2008:276).

To implement the T-Y procedure, a standard $\text{VAR}(k)$ augmented with a $(k+d_{max})^{th}$ order of integration is estimated, in the first step. The optimal lag length of k is selected with the help of information criteria (e.g., Schwartz Bayesian Criterion, SBC or Akaike information criterion, AIC) to determine the maximal order of integration, d_{max} of variables treated endogenously, producing a standard VAR with $(k+d_{max})^{th}$ order of integration, with the coefficients of the last lagged d_{max} being ignored (see, e.g., Caporale and Pittis,1999; Zapata and Rambaldi, 1997; Clark and Mizzra, 2006). In the final step, the direction of causality is determined by performing the MWALD test for linear or nonlinear restrictions on the first k VAR parameters. The application of the usual F-statistic test has asymptotic distribution where valid inference can be made.

In our application, the T-Y procedure is performed by computing a seemingly unrelated regression (SUR)[13] with the system of equations described as:

$$\ln GR_t = \alpha_0 + \sum_{i=1}^{k+d\max} \alpha_i \ln GR_{t-i} + \sum_{i=1}^{k+d\max} \beta_i \ln GE_{t-i} + \sum_{i=1}^{k+d\max} \varphi_i \ln Y_{t-i} + \sum_{i=1}^{k+d\max} \vartheta_i \pi_{t-1} + \varepsilon_{1t} \quad (9)$$

$$\Delta \ln GE_t = \gamma_0 + \sum_{i=1}^{k+d\max} \lambda_i \ln GE_{t-i} + \sum_{i=1}^{k+d\max} \Omega_i \ln GR_{t-i} + \sum_{i=1}^{k+d\max} \Lambda_i \ln Y_{t-i} + \sum_{i=1}^{k+d\max} \eta_i \pi_{t-1} + \varepsilon_{2t} \quad (10)$$

$$\Delta \ln Y_t = \mu_0 + \sum_{i=1}^{k+d\max} \mu_i \ln Y_{t-i} + \sum_{i=1}^{k+d\max} \Gamma_i \ln GR_{t-i} + \sum_{i=1}^{k+d\max} \varpi_i \ln GE_{t-i} + \sum_{i=1}^{k+d\max} \Pi_i \pi_{t-1} + \varepsilon_{3t} \quad (11)$$

$$\Delta \ln \pi_t = \psi_0 + \sum_{i=1}^{k+d\max} \psi_i \ln \pi_{t-1} + \sum_{i=1}^{k+d\max} \Theta_i \ln GR_{t-i} + \sum_{i=1}^{k+d\max} \Phi_i \ln GE_{t-i} + \sum_{i=1}^{k+d\max} \theta_i \pi_{t-1} + \varepsilon_{4t} \quad (12)$$

where, $\varepsilon_{i,t}(i=1,2,3,4)$ are serially independent random error terms with a mean of zero and a finite covariance matrix. All other variables and symbols remain the same as previously described in

---

[13]The SUR procedure remains valid in the absence of a long-run relationship among variables, as long as the order of integration does not exceed the true lag length of the model (see, T–Y, 1995:225).

the models estimated earlier. Given the systems of equations in Eqs. (9) and (10), the null hypothesis that GR does not Granger-cause GE can be denoted as: $H_0 : \Omega_i = 0, \ \forall i \leq k$, and GE does not Granger-cause GR as $H_0 : \lambda_i = 0, \ \forall i \leq k$. As explained earlier, note that the inclusion of Y_t and π_t as control variables to minimize the spurious relationship due associated with omitted variables which often renders inferences from bivariate tests on the revenue and expenditure nexus to become inconclusive, inconsistent and invalid. Also, these control variables allow us to ascertain the exact direction of causality underlying the government revenue-expenditure nexus, consistent with the competing theories discussed previously.

4. Data and Stationarity properties of series.

Our estimated model consists of the natural logarithms of quarterly series on generated "own" revenue, total expenditure and gross domestic product for the Free State (FS) province, and consumer price index (CPI) for the period 2004Q2–2018Q1 ($N = 56$ observations)[14]. The fiscal data are primarily sourced from the South Africa Department of National Treasury[15] and Free State Provincial Treasury's In-Year-Monitoring (IYM) databases. Historical CPI series is obtained from Statistics South Africa (StatsSA)[16], while the provincial gross domestic product (GDP-R) data is sourced from the IHS Global Markit's REX database. Where necessary, nominal series are rebased to index (2010=100), transformed to real using the CPI, and seasonally adjusted applying ARIMA X–13 procedure. The real government revenue and expenditure series are rescaled as a ratio of real GDP[17] to capture the effects of growth in the domestic provincial economy (Zapf and Payne, 2009), as their growth rates are reliant on economic activity levels (Narayan and Narayan, 2006).

The chosen data frequency and sample period can be justified in two folds: First, high-frequency data have been shown to produce a more reliable inference on the temporal relations behind the revenue-expenditure nexus in South Africa, in contrast to the inaccurate inference from annual data (Ndahriwe and Gupta, 2010). Second, the chosen sample period allows us to account for the influence of developments in both the global and national levels on the pattern of fiscal balance from both the supply and demand side, which may cause structural breaks in the selected economic and financial variables. Failure to account for possible structural breaks due to significant political and social changes could bias the results of our multivariate model.

Before testing whether the variables are cointegrated, stationarity properties of the series should be established to avoid spurious regression. Owed to the increasing integration of South Africa into the world economy and capital markets, expose the national economy to exogenous economic shocks and financial contagion, which in turn, can filter into the provincial economy. Moreover, a close relationship exists between unit-roots and structural changes in the economy, which a traditional unit root test, such as the augmented Dickey-Fuller (ADF) cannot account for, especially when time-series are trend stationary with structural breaks (Hansen, 2001; Perron, 1989). Thus, it is plausible that our chosen variables may have structural breaks associated with important global and domestic events[18], which

---

[14]Linear interpolation technique is used to convert the available annual data to quarterly series solely to avoid misspecification due to small sample size, insufficient degrees of freedom and short time period.

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

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

[17] The extant empirical literature is inconclusive on the use of real or nominal variables, but our modelling strategy follows the those studies using multivariate models, for example, Baghestani and McNown (1994), Payne (1997), Narayan and Narayan (2005), Zapf and Payne (2009), Chang and Chiang (2009), and Owoye et al.(2010). To the best of our knowledge, no studies have considered inflation as a control variable in a multi-variate set-up.

[18]In this study, we suspect co-breaking in the chosen time-series due to, among others: (i) the latest 2007/8 global economic recession, which evolved into financial crisis in the Euro area that creates tight economic condition in the capital market, (ii) severely weak South African economic growth since 2014, (iii) the adopted ongoing fiscal consolidation strategy in South Africa since 2014 aimed at reducing wasteful public expenditure and the rapidly

rendered the use of conventional unit root tests inappropriate (see, e.g., Zivot and Andrews, 1992; Barnejee et al.1992 and Perron and Vogelsang, 1998)[19]. As stated earlier, 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 (see, Perron, 1989; Islam, 2001).

It is, therefore, appropriate to test of unit root against the alternative that data is stationary with breaks in the deterministic trend. For this purpose, we applied the Zivot and Andrews (1992, hereafter ZA) and Phillips-Perron (1997) unit root tests that allow for structural breaks to establish the stationarity properties of each variable as well as identify inherent break dates congruent to existing endogenous breaks in each series. In particular, the ZA-unit root test can confirm the presence of structural breaks in the deterministic trend and also endogenously determine break dates from data, instead of *a prior* fixed date (Perron, 1989). We proceed to apply the ZA Model C (same as, Perron and Vogelsang IO Model 2) based on ADF suitable for data with trending data with both intercept and trend breaks. The ZA test is described as:

$$\Delta y_t = \mu + \beta_t + \theta DU_t + \gamma D + \phi_1 DT_t + \alpha y_{t-1} \Sigma_{t=1}^{k} \vartheta_t \Delta y_{t-1} + \varepsilon_t \tag{13}$$

where y_t is a time series, Δ indicates 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 men shift respectively, occurring at each possible break date, *TB* defined as:

$$DU_t = \begin{cases} 1 & if \ t > TB \\ 0 & otherwise \end{cases} \quad and \quad DT_t = \begin{cases} t - TB & if \ t > TB \\ 0 & otherwise \end{cases} \tag{14}$$

Whereas, the Phillips-Peron (PP) unit root test is estimated as follows:

$$\Delta y_t = \alpha + \lambda_t + \rho y_t + \varepsilon_t \tag{15}$$

Here, *t* value is associated with the estimated coefficient of ρ. The series is stationary if ρ is negative and significant. The test is performed both in levels and the first difference of the series to establish stationarity. To abstain from *a priori* fixed dates, we rely on the break dates identified by three different unit root tests, that is the ZA, PP and Bai-Perron's multiple breakpoint unit-roots were carried out on each variable, and the results are reported in Table 1. For robustness check, we also perform a multiple breakpoint unit root test on the estimated OLS regression in Eqs. (1) and (2)[20], and the results are provided in Tables B1 to B5 in the Appendix.

Possible break dates identified using all the unit root tests for each series are summarised as follows: 2009Q1 and 20011Q2 for government revenues; 2006Q1 and 2006Q2 for government expenditures; 2009Q2 and 2017Q2 for real GDP; and 2010Q3, 2016Q1 and 2015Q2 for inflation. Whereas, the results of the multiple breakpoint tests carried out on the OLS regression in Eqs. (1) and (2) based on sequential breaks, recursive partitions and global crisis induced breaks to show more co-breaking in data, which typically coincide with shocks associated with the global economic and financial crisis, as well as structural endogenous shocks that occurred in the South African economy due to, for example, political uncertainty, fiscal and economic policies. Thus, for parsimony and robustness, dummy variables are constructed to capture the existing breaks in the data.

Because our sample period covers notable structural changes in the South African economy, for example, the inception of the intergovernmental fiscal framework (IGFR) in the post-apartheid era (i.e., 2002) by the National Treasury to effectively manage the distribution of fiscal resources (national

---

expanding fiscal debt (% of GDP) that is currently above 58% (quote), and (iv) decline in revenue generated since 2017 (Fig.3).

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

[20]The OLS equations are estimated in levels (excluding dummies). The multiple breaking point unit root test is developed based on theoretical contributions of ZA (1992), Baneerjee et al.(1992), Volgesang and Perron (1998) and Perron (1998), among others. This test is carried out in Eviews 10.

revenue collected) to sub-national spheres of government; the latest global economic and financial crisis (2007-2012); and the implementation of strict fiscal consolidation strategy since 2013 to curb wasteful spending, rising government expenditure and stimulate economic growth. These significant events and evolution in the South African economy were accounted for by estimating four dummy variables: (i) *full impact* of the global economic recession and financial contagion over the period: 2008Q1–2012Q2, (ii) *period of a synchronised economic downturn in Africa*, from 2009Q1–2011Q4[21], (iii) *sharp fall in South African economic activity* during the period 2009Q1–2010Q4 before recovery at the beginning of 2011, and (iv) the *ongoing strict fiscal consolidation period* to enforce prudent financial management and good governance for the period 2013Q1–2018Q4. It is worth noting that the constructed dummy variables also capture the identified different break dates by the novel unit root tests applied.

5. Empirical Results and Discussion

We begin our analysis by considering the stationarity properties of the variables. The results of the unit root test unequivocally show 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. Note, only the inflation series is expected to be stationary in levels, while other variables are $I(1)$ stationary with endogenous structural breaks.

Table 1. Results of structural breaks unit root test (2004Q2–2018Q1)

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	$\Delta\pi$
ZA 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	

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

---

[21] The recessionary effect of the global crisis on many African countries including South Africa that begun in 2007 lasted up to 2010, followed by economic recovery in 2011 due to strong demand for commodity export (main component of Africa countries export) from emerging market economies, particularly the BRICs (Brazil, Russia, India, China) group led by China, as well as the adopted counter-fiscal strategy by investing in large infrastructure projects financed with concessional loans from China (IMF, 2009, Arief et al.2010).

5.1. Cointegration and Direction of Causality.

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 among variables using the vector error correction modelling approach. The Johansen's (1992,1995) reduced-rank procedure is applied to establish whether variables are linearly cointegrated. The set of information criteria used unanimously to select an optimal lag length of 2, as reported in Table 2[22], and Table 3 presents the numbers of cointegrating ranks based on the trace and maximum eigenvalue test statistics at 95% significance level. Both test statistics suggest the existence of at least one cointegrated vector (or cointegration equation) between variables at a 5% significance level.

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

Note: (*) 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 VAR-based 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

Note: *p*-values based on MacKinnon-Haug-Michelis (1999). *,**,*** denote 1%, 5% and 10% statistically significance levels, respectively.

Since the cointegration test suggests the existence of one linear relationship between the variables in the long run; the error correction models specified Eqs. (9) and (10) were estimated to determine the long-run and temporal causative processes driving the government revenue–expenditure nexus for the Free State province. Before deducing inferences from the models, the dynamic stability estimated error correction models were assessed using the stability test introduced by Brown et al. (1975), and the results are displayed in Figs. B1 and B2 (in the Appendix) which shows that both parameters and variance of the model are dynamically stable under both cumulative sum (CUSUM) and CUSUM of the square tests at a 5% significance level. By implication, obtain results of the estimated error correction models has economic meaning and can be used to draw a robust conclusion on the direction of causal links between variables.

The evidence of long-run relationship existing among variables from the cointegration analysis is validated in the estimated VECMs, and the cointegration equations are represented as:

---

[22]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.

$$\ln GR_{t-1} = 0.551 + 0.419 \ln GE_{t-1} - 0.019 \ln Y_{t-1} - 0.004 \ln \pi_{t-1}$$
$$[-4.976] \qquad [2.222] \qquad [2.612]$$
$$(16)$$

$$\ln GE_{t-1} = 3.02 - 0.94 \ln GR_{t-1} - 0.11 \ln Y_{t-1} - 0.02 \ln \pi_{t-1}$$
$$[3.472] \qquad [7.058] \quad [7.015]$$
$$(17)$$

where, *t*-stats are in [ ] parenthesis. Note, Eq.(16) shows a positive relationship between government revenue and expenditure, consistent with the tax-spend thesis of Friedman (1978). According to Eq.(16), a one percent increase in the provincial government revenue will raise government expenditure by nearly 0.42% in the long-run and leads to marginal fall in economic activity and inflation by 0.01% and 0.004% respectively. On the contrary, the relationship between government revenue and expenditure in Eq.(17) exhibits an inverse relationship, aligning with Buchanan and Wagner (1977) postulation on the same tax-spend hypothesis. By interpretation, Eq.(17) suggests that a one percent increase in government expenditure exert negative effects on government revenue (-0.94%), economic activity (-0.11%) and inflation (-0.02%). Conclusively, these inferences are economically relevant and robust given the statistically significant *t*-statistics values at 5% level.

Strikingly, the inferred asymmetric (non-linear) relationship driving the government revenue-expenditure nexus in the Free State province is rather unsurprising. In reference to Ewing et al. (2006), typical asymmetric cointegration between government revenues and expenditures can be attributed to: (i) the differentiated response of the provincial government to either positive or negative changes in fiscal disequilibrium that arises from disproportionate revenue or expenditure levels, (ii) changes in taxpayers behaviour to higher tax rate or tax base, and (iii) the existence of a close link between the business cycle and budget due to the presence of automatic stabilizers, which can cause cyclical fluctuation in budgetary components such as government revenues and expenditures in response to cyclical changes in the business cycle (Ewing et al. 2006:191). The asymmetric relationship between government revenues and expenditures for South Africa has been confirmed in recent studies (see, e.g., Phiri, 2019 and Baharumshah et al. 2016). Elsewhere, see, Saunoris and Payne (2010) and Zapf and Payne (2009) for similar studies.

Next, we turn to the results of the error correction models reported in Table 4. As expected, the error correction terms of both the government revenue equation $\left[F(GR|GE) \right]$ and $\left[F(GE|GR) \right]$ are negative and statistically significant at 5% level, affirming the existence of a stable and long-run relationship among variables in both models. Also, these results suggest a bi-directional long-run causality from government revenue to expenditure and vice-versa, running interactively through real GDP and inflation. This finding suggests the dominance of fiscal synchronicity hypothesis underpins the relationship between government revenue and expenditure in the Free State province, keeping in line with the reported findings 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 mixed results documented in earlier cross-sectional studies which support institutional separation or neutrality hypothesis (Narayan and Narayan, 2008) and Spend-Tax hypothesis (Chang, et al.2002) underpinning the causal relationship between revenue and expenditure for South Africa.

Additionally, the coefficients of the one-period lagged error correction terms are significantly negative in both dynamic models, but with a varying speed of adjustment to restore fiscal disequilibrium following a shock to the system. Although, the ate 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. The empirical results reveal that the real government expenditure, real GDP and inflation individually Granger causes government revenue in the long-run in the $F(GR|GE)$ model given their statistical significance at 5% level with corresponding significant t-statistics at 1% levels.

The result on block causality based on the significant F – statistic value (at 5% level) suggests that the independent variables (i.e., real government expenditure, real GDP and inflation rate) jointly

Granger causes government revenue in the long-run. In contrast, there is no evidence supporting long-run causality individually or jointly, from the independent variables to government expenditure in the $F(GE|GR)$ model.

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

	VEC Model 1: $GR|GE$			VEC Model 2: $GE|GR$	
	$\Delta \ln GR$	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	VEC Model 1	VEC Model 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)

Note: *,**,*** denotes 1%, 5% and 10% significance levels. α_0 and β_0 denotes constant parameters, p-values for BG LM test, ARCH and BPG test are in ( ) parenthesis with asymptotic values $Obs * R^2 \sim \chi^2$.

Whereas, the temporal causal link among variables is established in the VECM by applying the standard $F-statistic$ (or WALD) test, and the results are reported in Table 5. Empirical results show that government revenue Granger causes government expenditure, and vice-versa, suggesting a bi-directional causality in the short run consistent with the fiscal synchronization hypothesis. This result supports the findings of earlier studies that employ advanced econometric techniques such as vector error correction (Nyamongo et al.2007), autoregressive distributed lag (Baharumshah et al.2016, Ghartey, 2010) and momentum threshold autoregressive (Phiri, 2019) models for South Africa. Elsewhere, Owoye et al. (2010) also found short-run fiscal synchronization hypothesis driving the government revenue-expenditure nexus in five European countries, using the ARDL approach during the period 1970 to 2008.

There is also evidence for unidirectional short-run causality from control variables to government revenue in the $F(GR|GE)$ model only, where the real GDP and inflation individually Granger-causes government revenue in the short run, without any feedback effect. This inference corroborates the result of the block causality ($F-statistic$) test performed on the cointegrated variables in the $F(GR|GE)$

model (Table 4), which confirm the important roles of the control variables, that is, real economic growth and inflation on revenue generation in the FS province. Intuitively, 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 of time. Meanwhile, government revenue Granger cause expenditure in the $F(GE|GR)$ model.

Table 5. F – test result on temporal Granger causality from the estimated VEC models.

Models	$F(GR|GE)$	$F(GE|GR)$	
Variables	$\Delta \ln GR$	$\Delta \ln GE$	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)**	–	π $\rightarrow$ GR

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

Finally, for robustness, the VECM-based causality analysis is complemented with the MWALD (i.e., non-Granger causality) test procedure developed by Toda and Yamamoto (1995). As explained earlier, the T-Y non-Granger causality approach focuses on the long-run causal relationship among the variables estimated in levels in a VAR $(k + d_{\max})^{th}$ model, hence, no short-run causality exists. The results of the Toda and Yamamoto (1995) causality tests are reported in Table 6.

Broadly speaking, the non-Granger causality corroborates the long-run causality results obtained from the computed VECM-based model, which shows that real government expenditure, real GDP and inflation Granger causes government revenue in the long-run. Equally, the results also confirm results suggest long-run unidirectional causality from government revenue to government expenditures in the Free State province. Interestingly, the result of the T-Y non-Granger causality reinforces previous findings on the important role of both economic growth and inflation on government revenue and expenditure.

Table 6. Granger non-causality test using the T-Y approach.

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

Note: *,**,*** 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.

In particular, further empirical evidence shows that inflation Granger causes government expenditure, revenue and economic growth in the long-run without any feedback effect, while a unidirectional long-run causality runs from economic growth to government revenue. This finding is consistent with the widely accepted notion that government's revenue and expenditure are both

dependent on the level of economic activity (Narayan and Narayan, 2006), and the Buchanan-Wagner hypothesis which stressed indirect taxation through inflation, direct taxation and debt issuance as key sources of financing government expenditure. On this premise, the optimal level of revenue sources to finance a given expenditure level depends on their relative costs from a political perspective, however, an increase in revenue collection (via direct taxation) may lead to a reduction in government expenditures, if there is a reduction in the forms of indirect taxation, that is, a reduction in debt issuance and bracket creep (see, Payne, 2003:304).

Taken together, our findings from both causality analysis provide concrete support for the fiscal synchronization hypothesis in the Free State province in both the short-and long-run dynamics, consistent with the findings of, for example, Phiri (2019), Baharumshah et al. (2016), Ghartey 2010 and Lusinyan and Thornton (2007) for South Africa; Takumah (2014) for Ghana; Al-zeaud (2015) for Jordan; Chang et al. (2002) for Canada; Elyasi and Rahimi (2012) for Iran.

6. Conclusion and some policy recommendation.

This study contributes to the empirical literature by examining the long-run and short-run causal relationships between government revenue and government expenditure in the Free State province over the period 2004Q2–2018Q1, using real GDP and inflation as control variables in a multivariate model. Specifically, we employ the VAR-based Johansen reduced-rank cointegration and vector error correction model to establish the nature and the direction of the long-run and temporal between government revenue and government expenditure. For robustness, we also utilize the robust Toda-Yamamoto (1995) non-Granger causality test to confirm the direction of long-run causality underpinning the government revenue–expenditure nexus.

Our main findings are summarized as follows: Firstly, the performed cointegration test suggest the existence of a stable long-run relationship between government revenue, government expenditure, real GDP and inflation in the Free State province. We also find the coefficient of the error correction term to be statistically significant and negative in both the revenue and expenditure equations, providing concrete support for the existing long-run relationship among variables. The results of the error correction model show a slow adjustment process, ranging from 11% to 26% every quarter to restore fiscal disequilibrium in the aftermath of a shock to the provincial economy. Secondly, concerning the long-run and temporal causal patterns, we find evidence of bi-directional causality running, interactively through the control variables, from government revenue to government expenditure, and vice-versa in both the long-run and short-run, supporting the fiscal synchronisation hypothesis. This empirical evidence implies that 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.

Finally, we find that economic growth and inflation rate plays an important role in 'own' revenue raised in the province. Taken together, the causal analysis shows that 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, and inflation Granger causes government revenue and expenditure, without any feedback effect.

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, given the empirical evidence that provincial government revenue and expenditure are dependent on the growth rate of economic activity level and inflation, hence 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. Intuitively, an accommodative fiscal stance that stimulates provincial economic growth has the potential to increase government revenue, in contrast, high government expenditure that heightens inflationary pressure will 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, the empirical findings in this study 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 (FSPG) can consider the following strategies: First, the provincial government should intensify its revenue-raising effort by prioritizing the implementation of fiscal strategies aimed at stimulating government revenues through its Provincial Treasury.

Second, FSPG needs to harness the revenue-generating autonomy of the provincial government, through the Provincial Treasury, to broaden its revenue collection (or tax) base to prevent revenue slippage, for example, by extending revenue collection to untaxed informal sector activities. In the same vein, policymakers should consider new revenue-generating measures to raise revenue via: (a) imposition of surcharges and levies on property development and constructed weighbridges, (b) leasing of municipal (and communal) lands to property developers and potential large-scale farmers, (c) conduct asset audit to identify unused provincial government buildings which can be renovated and leased to companies for office spaces.

Third, it is also important for the provincial government to increase public investment in tourism given the unique geographical location of the Free State province, as an in-land transit route to major economic hubs in the country, notably Gauteng and Western Cape provinces) in the country. Lastly, FSPG should prioritize fiscal prudence by improving value-for-money on each rand spent on implemented infrastructure projects by carrying out a thorough feasibility study, and the use of cost-benefit analysis (CBA) models to determine the profitability (i.e., return on investment, ROI) of executed projects. These remedial actions can significantly reduce fruitless expenditure and high-cost overruns on projects, at the same time, improve the expected ROI on executed projects, the quality and service delivery of publicly demanded goods.

In future research, it would be interesting to build on the empirical work in this paper by investigating whether the evidence of fiscal synchronization underlying the government revenue–expenditure nexus for the Free State province holds by employing an asymmetric (non-linear) econometric model. This is crucial since macroeconomic variables are non-linear as well as the plausibility of the differentiated responses of fiscal disequilibrium that arises from a disproportionate government revenue or expenditure levels to either positive or negative innovations, as shown in the surveyed recent studies in the previous sections. In the same vein, government revenue and expenditure might have been sensitive to cyclical movements in the provincial economy.
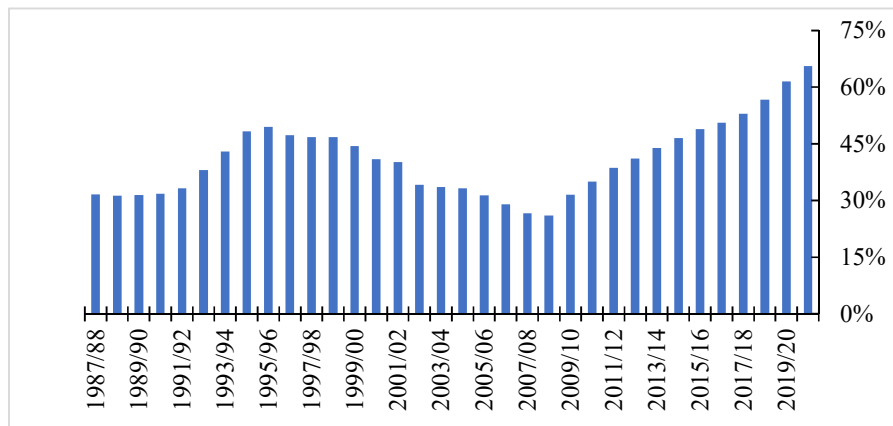
Appendix. See, Fig. 1, 2 and 3.

Fig.1: Trends of total government revenue, total government expenditure and budget imbalance (ratio of GDP) for South Africa, 2001-2019.
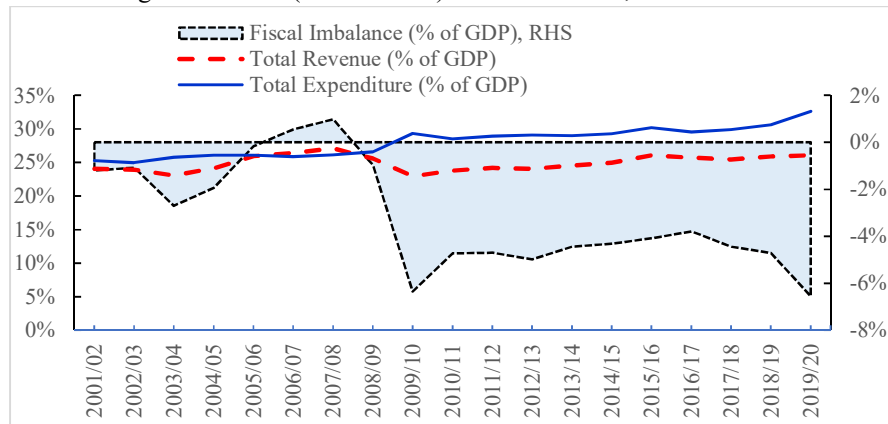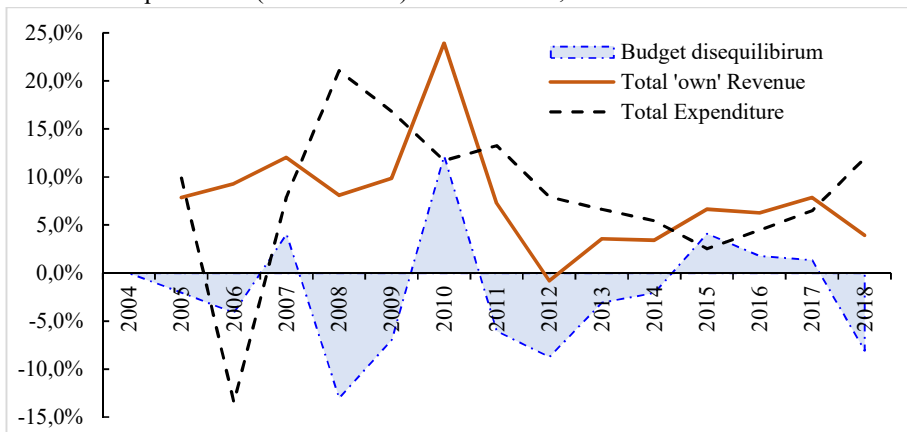

Data Source: National Treasury, Budget Speech 2020. Author's illustration.

Fig. 2: Gross fiscal debt (or government loan) for South Africa (% of GDP), 1987-2020.

Data Source: National Treasury, Budget Speech 2020. Author's illustration.

Fig.3: Trends of total 'own' revenue, total government expenditure and budget disequilibrium (ratio of GDP) for Free State, 2004-2019.

Data Source: In-Year-Monitoring database (Free State Provincial Treasury) supplemented with data from the 2019/20 Estimates of Provincial Revenue and Expenditure Trend (Free State Provincial Treasury). Author's illustration.
Note: Budget disequilibrium is the estimated from the financial data by the author.

Appendix A: Empirical evidence on government revenues-expenditure theories.

Table A1. A brief survey of previous and recent empirical studies.

Author(s)	Country/ countries	Econometric technique	Period	Conclusion on direction of causality.
AbuAl-Foul and Baghestani (2004)	Egypt and Jordan	VAR and ECM	Egypt (1977-1998), Jordan (1975-2001)	Egypt: GR → GE; Jordan: GE ↔ GR
Afonso and Rault (2009)	25 EU countries	Panel Granger causality tests	1998–2006	Italy, France, Spain, Greece, Portugal: GE → GR; Belgium, Germany, Austria, Finland, UK: GR → GE
Ali and Shah (2012)	Pakistan	VECM	1976–2009	GE ≠ GR
Al-zeaud (2015)	Jordan	VECM	1990–2011	GE → GR
Aregbeyen and Ibrahim (2012)	Nigeria	ARDL	1970–2008	GR → GE
Blackley (1986)	US	Granger causality	1929-1982	GE → GR
Bohn (1991)	US	ECM	1792–1988	GR → GE
Chang and Chiang (2009)	15 OECD	Panel VAR	1992–2006	GE = GE
Chang et al. (2002)	10 developed and developing countries	ECM	1951–1996	Japan, Lebanon, South Korea, Taiwan, Tunisia, UK, USA: GR → GE; Australia and South Africa: GE → GR; Canada: GR ↔ GE; New Zealand and Thailand: GE ≠ GR
Daratt (1998)	Turkey	VECM	1967–1994	GR → GE
Eita and Mbazima (2008)	Namibia	VAR	1977–2007	GR → GE
Elyasi and Rahimi (2012)	Iran	ARDL	1963-2007	GE ↔ GR
Ewing (2006)	US	TAR and MTAR	1958–2003	Asymmetric cointegration: Revenues and expenditures respond to worsening budgets but not to improving ones. GE = GE in the short-run GE ↔ GR in the long-run
Ewing and Payne (1998)	5 Latin American countries	ECM	1950–1994	Columbia, Ecuador, Guatemala: GR → GE; Chile and Paraguay: GE ↔ GR

Source: Authors Compilation.

Notes: GE represents government expenditures and GR represents government revenue. ***Directions of causality***: GE → GR: government expenditure Granger causes revenue (spend-tax hypothesis); GR → GE: government revenues Granger causes expenditure (tax-spend hypothesis); GE ↔ GR: the existence of bidirectional causality between government expenditure and revenues: GE ≠ GR: inexistence of causality between the variables. ***Methodologies:*** TAR, MTAR, TVECM, VAR, ECM, UDL, NARDL, ARDL, and JJ denote threshold autoregressive and momentum threshold autoregressive models, threshold vector autoregressive, correction model, error correction model, unrestricted distributive lag model, nonlinear autoregressive distributive lag model, autoregressive distributive lag model, vector autoregressive model and Johansen-Juselieus cointegration test.

21

Table A1. (Continue).

Islam (2001)	US	Granger causality tests	1929-1997,	GE → GR
Jones and Joulifain (1991)	US	ECM	1972–1860	GE → GR
Kaya and Şen (2013)	Turkey	VAR and Granger causality	1975-2011	GE → GR
Keho (2011)	Ivory Coast	TVECM	1960–2007	Asymmetric cointegration.GR → GE in periods of budget deficit; GE → GR in periods of budget surplus
Kollias and Paleologou (2006)	15 EU countries	VECM	1960–2002	Portugal: GE = GE; Denmark, Greece, Ireland: GE ↔ GR; Netherlands, Portugal Sweden: GE ≠ GR; Finland, France, Italy, Spain, UK: GR → GE
Magazzino (2013)	15 ECOWAS countries	Granger causality	1980-2011	GE ↔ GR; Benin; Mali; Niger; Senegal, Togo, Gambia, Ghana, Guinea, Liberia and Nigeria; GE → GR: Burkina Faso, Cote d'Ivoire, Guinea-Bissau, Cape Verde and Sierra-Leone
Manage and Marlow (1986)	US	Granger causality test	1929–1982	GE ↔ GR
Manage and Marlow (1987)	US' state and local government levels.	Granger causality test	1952–1982	GR → GE for aggregate state government level; GE ≠ GR for aggregated local government level.
Masere and Kaja (2014)	Zimbabwe	JJ Cointegration and Granger causality tests	2010:1 to 2012:12 (monthly data)	GE ≠ GR
Mehrara et al. (2011)	40 Asian countries	Panel cointegration and panel causality tests	1995–2008	GE ↔ GR
Miller and Rusek (1990)	US	VAR and ECM	Post-World War II	GE ↔ GR
Mohanty and Mishra (2017)	India	VECM	1980/81- 2013/14	GE → GR
Nwosu and Okafor (2014)	Nigeria	VAR and VECM	1970–2011	GE → GR
Obeng (2015)	Ghana	VAR	1980–2013	GR → GE
Owoye (1995)	7 European countries	ECM	1961–1990	Ireland: GE ↔ GR; Italy and Japan: GR → GE; Canada, France, Germany, UK, USA: GE ↔ GR
Paleologou (2013)	Sweden, Greece and Germany	TAR and MTAR cointegration model	1965–2009	No asymmetric cointegration in Sweden and Germany, GE ↔ GR in both countries; Asymmetric cointegration in Greece with GE → GR
Park (1998)	Korea	VAR	1964-1962	GR → GE
Payne (1998)	48 contiguous states in the US	ECM	1942-1992	GR → GE in 24 states; GE → GR in 8 states; GE ↔ GR in 11 states

22

Payne (2008)	Turkey	TAR and MTAR cointegration model	1968–2004	No asymmetric cointegration, GR → GE
Rahman and Wadud (2014)	Bangladesh	JJ Cointegration and ECM	1973-2013	GR → GE
Ram (1988)	US	Granger causality	1929–1983	GR → GE
Raza et al.(2019)	Pakistan	NARDL	1972–2014.	Asymmetric relationship. Negative shocks in the revenues cause a larger increase in the expenditures. GE ↔ GR
Ritcher and Dimitrios (2013)	Greece	JJ Cointegration and Granger causality tests	1833-2009	GE → GR
Ross and Payne (1998)	US	Johansen-Juselius (1990) cointegration test, ECM and ARCH models	1955:1-1994:2, (quarterly)	GE → GR
Saunoris, J.W (2015).	48 contiguous US states	Pedroni cointegration test and ARDL-based ECM	1951 to 2008	GR → GE
Saunoris and Payne (2010),	US	TAR and MTAR cointegration model	1955–2009	Asymmetric cointegration. Revenues and expenditures respond to worsening budgets quicker than to improving ones. GE → GR over long-run
Sennoga (2012)	56 districts in Uganda	Granger causality tests	2001-2003	GR → GE
Takumah (2014)	Ghana	VECM	1986–2012	GE ↔ GR
Tiwari and Mutascu (2016)	Romania	TAR and MTAR cointegration model	1999–201	Asymmetric cointegration. Revenues and expenditures respond to worsening budgets quicker than to improving ones
Von Furstenburg et al. (1986)	US' state and local government levels.	VAR	1954:Q1–1982:Q4	GE → GR for aggregate state and local government Levels.
Wolde-Rufael (2008)	13 African countries	VAR	1964–2003	GE → GR: Burkina Faso; GR → GE: Ethiopia, Ghana, Kenya, Nigeria, Mali, Zambia; GR ↔ GE: Mauritius, Swaziland, Zimbabwe; GE ≠ GR: Botswana, Burundi, Rwanda:
Zapf and Payne (2009)	US	TAR and MTAR cointegration model	1959–2005	No asymmetric cointegration

Source: Authors Compilation. *Notes*: GE represents government expenditures and GR represents government revenue. ***Directions of causality***: GE → GR: government expenditure Granger causes revenue (spend-tax hypothesis); GR → GE: government revenues Granger causes expenditure (tax-spend hypothesis); GE ↔ GR: the existence of bidirectional causality between government expenditure and revenues: GE ≠ GR: inexistence of causality between the variables. ***Methodologies:*** TAR, MTAR, TVECM, VAR, ECM, UDL, NARDL, ARDL, and JJ denote threshold autoregressive and momentum threshold autoregressive models, threshold vector autoregressive, correction model, error correction model, unrestricted distributive lag model, nonlinear autoregressive distributive lag model, autoregressive distributive lag model, vector autoregressive model and Johansen-Juselieus cointegration test.

Appendix B: Tables B1, B2 and Figures 1, 2

Table B1. Multiple breakpoint tests: Bai-Perron tests of L+1 vs. L sequentially determined breaks.

Break Test	F-statistic	Scaled F-statistic	Critical Value	Break dates:	
				Sequential	Repartition
0 vs. 1 *	35.29097	141.1639	16.19		
1 vs. 2 *	35.41123	141.6449	18.11	2009Q2	2006Q2
2 vs. 3 *	18.49455	73.97822	18.93	2012Q1	2009Q1
3 vs. 4 *	25.72346	102.8938	19.64	2006Q2	2012Q1
4 vs. 5	0.429369	1.717478	20.19	2016Q1	2016Q1
Sequential F-statistic determined breaks = 4					

Note: (*)Significant at the 0.05 level. Break test options: Trimming 0.15; Critical values from Bai-Perron (2003).

Table B2. Multiple breakpoint tests: Bai tests of breaks in all recursively determined partitions.

Break Test	Breaks	F-statistic	Scaled F-statistic	Break dates	
				Sequential	Repartition
0 vs. 1 *	2009Q1	35.29097	141.1639	2009Q2	2006Q3
1 vs. 2	2003Q4	1.999809	7.999237	2012Q1	2012Q1
1 vs. 2 *	2011Q4	35.41123	141.6449		
2 vs. 3	---	---	---		
2 vs. 3	2003Q4	3.513198	14.05279		
Sequential F-statistic determined breaks = 2					

Note: (*)Significant at the 0.05 level. Break test options: Trimming 0.15; Critical values from Bai-Perron (2003), CV=16.19.

Table B3. Multiple breakpoint tests: Bai-Perron tests of L+1 vs. L globally determined breaks.

Break Test	F-statistic	Scaled F-statistic	Critical Value	Estimated break dates.					
0 vs. 1 *	35.29097	141.1639	16.19	1	2009Q2				
1 vs. 2 *	35.41123	141.6449	18.11	2	2006Q3	2011Q4			
2 vs. 3 *	7.592057	30.36823	18.93	3	2006Q2	2009Q1	2012Q1		
3 vs. 4 *	40.05362	160.2145	19.64	4	2006Q2	2009Q1	2012Q1	2016Q1	
4 vs. 5	0.689171	2.756683	20.19	5	2006Q2	2009Q1	2010Q2	2012Q2	2016Q1
Sequential F-statistic determined breaks = 4									
Significant F-statistic largest breaks = 4									

Note: (*)Significant at the 0.05 level. Break test options: Trimming 0.15; Critical values from Bai-Perron (2003).

Table B4. Multiple breakpoint tests: Bai-Perron tests of L+1 vs. L globally determined breaks.

Break Test	F-statistic	Scaled F-statistic	Critical Value	Estimated break dates.					
0 vs. 1 *	35.29097	141.1639	16.19	1	2009Q2				
1 vs. 2 *	35.41123	141.6449	18.11	2	2006Q3	2011Q4			
2 vs. 3 *	7.592057	30.36823	18.93	3	2006Q2	2009Q1	2012Q1		
3 vs. 4 *	40.05362	160.2145	19.64	4	2006Q2	2009Q1	2012Q1	2016Q1	
4 vs. 5	0.689171	2.756683	20.19	5	2006Q2	2008Q2	2010Q2	2012Q2	2016Q1
Sequential F-statistic determined breaks = 4									
Significant F-statistic largest breaks = 4									

Note: (*)Significant at the 0.05 level. Break test options: Trimming 0.15; Critical values from Bai-Perron (2003).

Table B4. Multiple breakpoint tests: Bai-Perron tests of 1 to M globally determined breaks.

Break Test	F-statistic	Scaled F-statistic	Weighted F-statistic	Critical Value		Estimated break dates.				
1 *	35.29097	141.1639	141.1639	16.19	1	2009Q2				
2 *	131.1537	524.6147	616.8127	13.77	2	2006Q3	2011Q4			
3 *	170.7400	682.9600	908.5557	12.17	3	2006Q2	2009Q1	2012Q1		
4 *	638.1696	2552.678	3830.200	10.79	4	2006Q2	2009Q1	2012Q1	2016Q1	
5*	4770.570	**19082.28**	**33987.03**	9.09	5	2006Q2	2008Q2	2010Q2	2012Q2	2016Q1

UDMax statistic* = 19082.28   UDMax critical value** = 16.37
WDMax statistic*= 33987.03   WDMax critical value** = 17.83
Sequential F-statistic determined breaks = 5
Significant F-statistic largest breaks = 5
UDmax determined breaks = 5
WDmax determined breaks = 5

Note: (*)Significant at the 0.05 level. Break test options: Trimming 0.15; Critical values from Bai-Perron (2003).


Table B5. Multiple breakpoint tests: Bai-Perron tests of 1 to M globally determined breaks.

Breaks	No. of coefficient	Sum of Sq. Residual	Log-L	Schwarz* Criterion	LWZ* Criterion		Estimated break dates.				
0	4	0.000881	230.210	-10.772	-10.588	1	2009Q2				
1	9	0.000224	268.609	-11.784	-11.361	2	2006Q3	2011Q4			
2	14	3.55E-05	320.165	-13.266	-12.592	3	2006Q2	2009Q1	2012Q1		
3	19	1.69E-05	340.964	-13.649	-12.711	4	2006Q2	2009Q1	2012Q1	2016Q1	
4	24	3.10E-06	388.443	-14.986	-13.765	5	2006Q2	2008Q2	2010Q2	2012Q2	2016Q1
5	29	2.95E-07	454.225	**-16.976**	**-15.447**						

Schwarz criterion selected breaks = 5
LWZ criterion selected breaks = 5

Note: (*)Significant at the 0.05 level. Break test options: Trimming 0.15; Critical values from Bai-Perron (2003).
*Minimum information criterion values displayed with shading

Figure B1. Results of the dynamic stability for $\left[F(GR|GE) \right]$ model
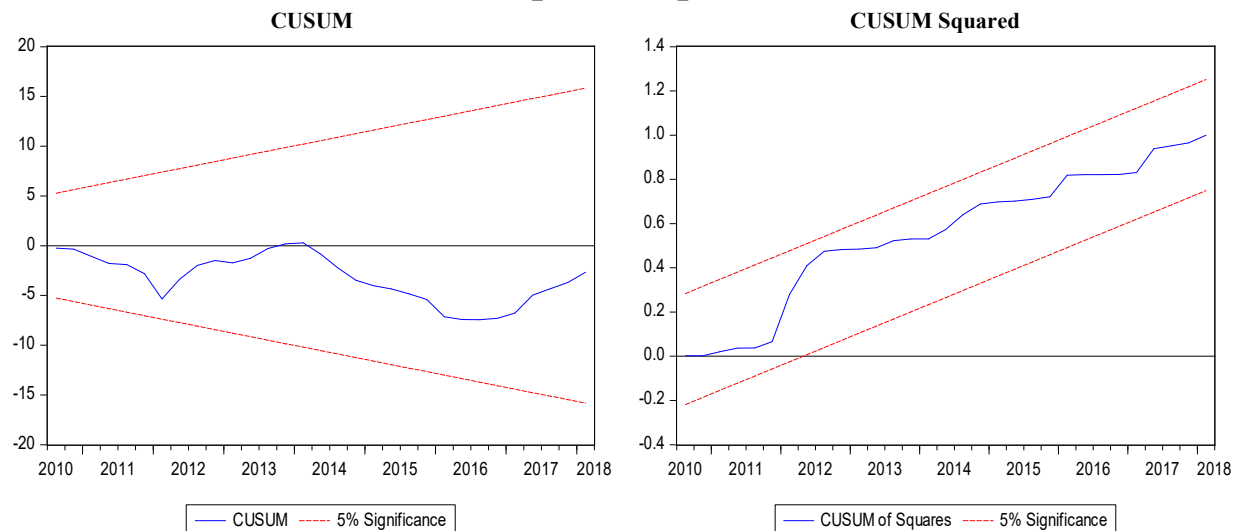
Note: The CUSUM parameter (and variance) stability test assess the robustness of the specified model, and Fig.B3 show that both parameters and variance of the model are stable under both cumulative sum (CUSUM) and CUSUM of the square tests, at 5% significance level.

Figure B2. Results of the dynamic stability for $\left[F(GE|GR)\right]$ model
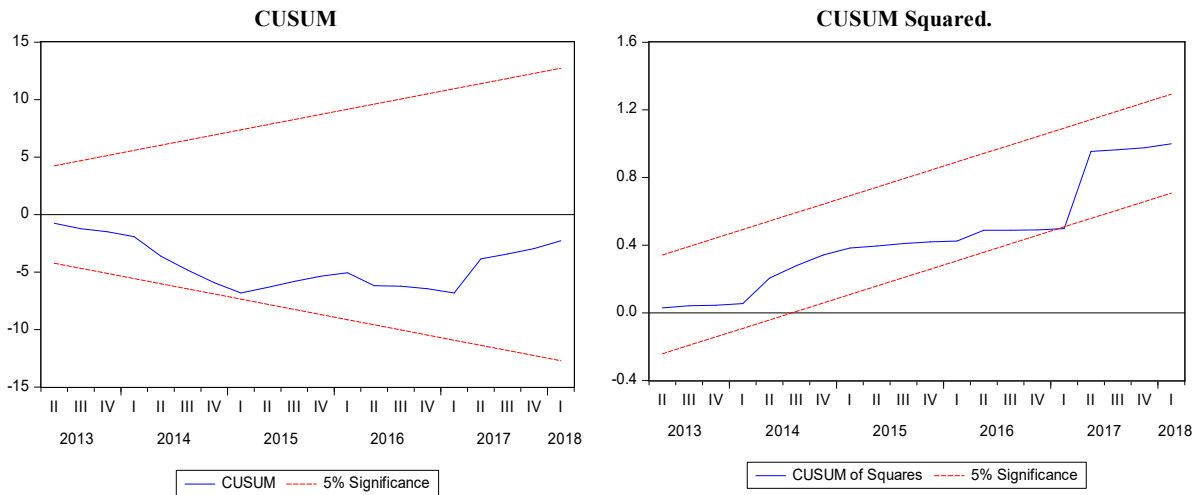
Note: The CUSUM parameter (and variance) stability test assess the robustness of the specified model, and Fig.B3 show that both parameters and variance of the model are stable under both cumulative sum (CUSUM) and CUSUM of the square tests, at 5% significance level.

References.

AbuAI-Foul, A., & Baghestani, H (2004). The Causal Relation between Government Revenue and Spending: Evidence from Egypt and Jordan. *Journal of Economics and Finance, 9,2,* 260-269.

Afonso A., & Rault, C. (2009). Bootstrap panel Granger-causality between government spending and revenue in the EU. *Economic Bulletin*, 29:2542–2548.

Ali R., & Shah, M. (2012). The casual relationship between government expenditure and revenue in Pakistan. *Interdisciplinary Journal of Contemporary Research in Business*, 3:323–329.

Al-Zeaud, H. A. (2015). The causal relationship between government revenue and expenditure in Jordan. *International Journal of Management & Business Research*, 5(2), pp. 117–127. http://ijmbr.srbiau.ac.ir/article_6383.html

Aregbeyen O., & Ibrahim, T. (2012). Testing the revenue and expenditure nexus in Nigeria: an application of the bound test approach. *European Journal of Social Sciences*, 27:374–380.

Arief, A., Weiss, M.A., & Jones, V.C.(2010). The Global Economic Crisis: Impact on Sub-Saharan Africa and Global Policy Responses. Congressional Research Service Report for Congress. Retrieved from https://fas.org/sgp/crs/row/R40778.pdf

Ahsan, S. M., Kwan, A. C., & Sahni, B. (1992). Public Expenditure and National Income Causality: Further Evidence on the Role of Omitted Variables. *Southern Economic Journal*, 58(3), 623-634.

Baghestani, H., & McNown, R.(1994). Do revenues or expenditures respond to budgetary Disequilibria? *Southern Economic Journal*, 61:311-22.

Baharumshah, A.Z., Jibrilla, A.A., Sirag, A., Ali, H.S., & Muhammad, I.M. (2016). Public Revenue-Expenditure Nexus in South Africa: Are there Asymmetries? *South African Journal of Economics*,84:520-537. DOI: 10.1111/saje.12130.

Bai, J., & Perron. P (2003). Computation and Analysis of Multiple Structural Change Models. *Journal of Applied Econometrics*, 18: 1–22.

Barnejee, A., Lumsdaine, R.L., & Stock, J.H.(1992). Recursive and Sequential Tests of the Unit-root and Trend-break hypotheses: Theory and International Evidence. *Journal of Business & Economic Statistics*, 10, 3, 271-287.

Blackley P (1986) Causality Between Revenues and Expenditures and the Size of Federal Budget. *Public Finance Quarterly,* 14:139–156.

Bohn H (1991) Budget balance through revenue or spending adjustments? Some historical evidence for the United States. *Journal of Monetary Economics*, 27:333–359.

Brown, R.L., J. Durbin, and J.M. Evans (1975). Techniques for testing the constancy of regression relationships over time. *Journal of the Royal Statistical Society*, Series B (Methodological), 37(2): 149–192.

Buchanan, J.M., & Wagner, R.W (1978). Dialogues concerning fiscal religion. *Journal of Monetary Economics*, 4:627-636.

Caporale, G. M., & Pittis, N. (1999). Efficient Estimation of Cointegrating Vectors and Testing for Causality in Vector Autoregressions. *Journal of Economic Surveys*, 13, 3–35.

Chang, T., & Chiang, G. (2009). Revisiting the Government Revenue-Expenditure Nexus: Evidence from 15 OECD Countries Based on the Panel Data Approach. *Czech Journal of Economics and Finance (Finance a úvěr),* 59(2),165-172.

Chang, T., Liu, W. R. and Caudill, S. B. (2002). Tax-and-Spend, Spend-and-Tax, or Fiscal Synchronization: New Evidence for Ten Countries. *Applied Economics*, 34 (12),1553-1561.

Clark, J., & Mizzra, S. (2006). Comparison of some common methods for detecting Granger Noncausality. *Journal of Statistical Computation and Simulation*, 76(3), 2017-231.

Darrat, A. F. (1998). Tax and spend, or spend and tax? An inquiry into the Turkish budgetary process. *Southern Economic Journal*, 64(4), 940–956. DOI:10.2307/1061212

Darrat, A. F. (2002). Budget Balance Through Spending Cuts or Tax Adjustments? *Contemporary Economic Policy,* 20 (3), 221-233. https://doi.org/10.1093/cep/20.3.221

Eita, J.H., & Mbazima, D. (2008). The Causal Relationship between Government Revenue and Expenditure in Namibia". *Journal of Economic and Financial Sciences*, 2(2): 175-186.

Elyasi, Y., & Rahimi, M. (2012). The Causality between Government Revenue and Government Expenditure in Iran. *International Journal of Economic Sciences and Applied Research,* 5 (1): 129-145.

Engle, R. F., and C. W. J. Granger. 1987. Cointegration and Error Correction: Representation, Estimation and Testing. *Econometrica*, 55:251-76.

Ewing, B., & Payne, J. (1998). Government revenue-expenditure nexus: Evidence from Latin America. *Journal of Economic Development*, 23, 57–69.

Ewing, B. T., Payne, J.E., Thompson, M.A., & Al-Zoubi, O.M (2006). Government expenditures and revenues: Evidence from Asymmetric Modeling. *Southern Economic Journal*, 73:190-200.

Ewing, B., & Payne, J. (1998). Government Revenue-Expenditure Nexus: Evidence from Latin America. Journal of Economic Development, 23, 57–69.

Friedman, M. 1978. The Limitations of Tax Limitation. *Policy Review Summer*, 5:7-14.

Ghartey, E. (2010). Cointegration and causal relationship between taxes and spending in Kenya, Nigeria and South Africa. *International Economic Journal*, 24:267–282.

Gonzalo, J. (1994) Five alternative methods of estimating long-run equilibrium relationships. *Journal of Econometrics*, 60, 203-233.

Granger, C.W.J., & Lin, J-L. (2005). Causality in the Long run. *Econometric Theory*, 11, 530-536.

Hansen, B. E (2001). The New Econometrics of Structural Change: Dating Breaks in U.S. Labour Productivity. *Journal of Economic Perspectives*, 15 (4): 117-128. DOI: 10.1257/jep.15.4.117.

IMF (2009). Impact of the Global Financial Crisis on Sub-Saharan Africa. African Department, International Monetary Fund, Washington: DC. Retried from: https://www.imf.org/external/pubs/ft/books/2009/afrglobfin/ssaglobalfin.pdf

IMF (2020). *World Economic Outlook database*. International Monetary Fund, Washington: DC. Accessed January 2020.

Islam, M.Q.(2001). Structural break, unit root, and the causality between government expenditures and revenues. *Applied Economics Letters*, 8, 565-567.

Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12, 231-254.

Johansen, S., & Juselius. K (1990). Maximum likelihood estimation and inference on cointegration: With applications to the demand for money. *Oxford Bulletin of Economics and Statistics* (May): 169-210.

Johansen, S. (1992). Cointegration in partial systems and the efficiency of single-equation analysis. *Journal of Econometrics,* 52 (3), 389–402.

Johansen, S. (1995). Likelihood-based inference in Cointegrated Vector Autoregressive Models. Oxford University Press.

Jones, J. D., & Joulfaian. D (1991). Federal government expenditures and revenues in the early years of the American republic: Evidence from 1792-1860. *Journal of Macroeconomics*, 13(1):133-55.

Kavase, K., & Phiri, A.(2018). Are fiscal budgets sustainable in South Africa? Evidence from provincial level data. *Business and Economic Horizons*, 14(2),415-423. ISSN: 1804-5006.

Kaya, A., & Şen, H. (2013). How to achieve and sustain fiscal discipline in Turkey: Rising Taxes, reducing government spending or a combination of both? *Romanian Journal of Fiscal Policy*, 4(1),1-26. ISSN 2069-0983. Retrieved from http://hdl.handle.net/10419/107948

Keho Y (2010) Budget balance through revenue or spending adjustments? An econometric analysis of the Ivorian budgetary process: 1960–2005. *Journal of Economics and International Finance*, 2:1–11.

Kollias C., & Paleologou S (2006) Fiscal policy in the European Union: tax and spend, spend and tax, fiscal synchronization or institutional separation? *Journal of Economic Studies*, 33:108–120.

Kremers, J. M., Erisccos, N. R., & Dolado, J. J. (1992). The Power of Cointegration Tests. *Oxford Bulletin of Economics and Statistics*, 54, 325-346.

Lusinyan L., & Thornton, J. (2007). The revenue-expenditure nexus: historical evidence for South Africa. *South African Journal of Economics*, 75:496–507.

Lutkepohl, H. 1982. Non-causality due to omitted variables. *Journal of Econometrics*, 19:367-78.

Magazzino, C (2013). Revenue expenditure nexus: a case study of ECOWAS. *Open-Assessment E-Journal*, 1–27. http://dx.doi.org/10.5018/economics-ejournal.ja.2013-13 7:1–27.

Manage, N. & Marlow, M. (1986). The Causal Relationship between Federal Expenditure and Receipts. *Southern Economic Journal*, 52(1), 617-629.

Marlow, M. L., and N. Manage. 1987. Expenditures and receipts: Testing for causality in state and local government finances. *Public Choice*, 53:243-55.

Masere, V.S., & Kaja, P. (2014). An Investigation of the Relationship between Government Expenditure and Revenue in a Multicurrency Economy: A Case of Zimbabwe. *Journal of Economics and Sustainable Development*, 5(14), 104-110. ISSN 2222-2855.

Mehrara, M., Pahlavani, M., & Elyasi, Y. (2011). Government Revenue and Government Expenditure Nexus in Asian Countries: Panel Cointegration and Causality. *International Journal of Business and Social Science*, 2(7),199-207.

Meltzer, A. H., & Richard, S.F (1981). A rational theory of the size of the government. *Journal of Political Economy*, 89:914-27.

Miller, S. M., & Russek. S.F. (1989). Co-integration and Error-Correction Models: The Temporal Causality Between Government Taxes and Spending. *Southern Economic Journal,* 57:221-29.

Musgrave, R. A. 1966. Principles of budget determination. In Cameron, A.H., & Henderson, W (eds.), *Public finance: Selected readings*, 15-27. New York: Random House.

Narayan, P. K., & Narayan, S. (2006). Government revenue and government expenditure nexus: Evidence from developing countries. *Applied Economics*, 38(3), 285–291.

National Treasury (2020). National Budget Speech. South Africa: Pretoria. 26 February 2020. http://www.treasury.gov.za/documents/national%20budget/2020/default.aspx

Ndahiriwe, K., & Gupta, R (2010). Temporal causality between taxes and public expenditures: the case of South Africa. *The Journal of World Economic Review*, 6:87–100.

NDP (2012). National Development Plan 2030. The Presidency, National Planning Commission. South Africa, Pretoria. Available at https://www.gov.za/issues/national-development-plan-2030

NGP (2011). New Growth Path Framework. National Department of Economic Development. South Africa, Pretoria. Available at http://www.economic.gov.za/communications/publications/new-growth-path-series

Nwosu D, Okafor H (2014) Government revenue and expenditure in Nigeria: a disaggregate analysis. *Asian Economic and Financial Review*, 4:877–892.

Nyamongo M, Sichei M., & Schoeman, N. (2007). Government revenue and expenditure nexus in South Africa. *South African Journal of Economic Management Sciences*, 10:256–268

Obeng S (2015) A Causality Test of the Revenue-Expenditure Nexus in Ghana. ADRRI *Journal of Arts and Social Sciences*, 11(11),1-19. ISSN: 2343-6891.

Owoye, O., & Onafowora, O. A. (2010). The relationship between tax revenues and government expenditures in European Union and non-European Union OECD countries. *Public Finance Review*, 39(3), 429–461. DOI:10.1177/1091142110386211.

Paleologou S (2013) Asymmetries in the Revenue-Expenditure Nexus: A Tale of Three Countries. *Economic Modelling*, 30:52–60.

Park, W.K. (1998). Granger Causality between Government Revenues and Expenditures in Korea. *Journal of Economic Development*, 23(1), 145-155.

Payne, J. E. (1998). The Tax-Spend Debate: Time Series Evidence from State Budgets. *Public Choice*, 95, 307-320.

Payne, J. E. (2003). A Survey of The International Empirical Evidence on the Tax-Spend Debate. *Public Finance Review,* 31:302-24.

Payne, J. E., Mohammadi, H., & Cak, M. (2008). Turkish Budget Deficit Sustainability and The Revenue Expenditure Nexus. *Applied Economics*, 40, 7: 823-830.

Peacock, A. T., & Wiseman, J. (1961). The Growth of Public Expenditure in the United Kingdom. Princeton, NJ: Princeton University Press for the Bureau of Economic Research.

Peacock, A. T., & Wiseman, J. (1979). Approaches to the Analysis of Government Expenditure Growth. *Public Finance Quarterly,* 7:3-23.

Perron, P. (1989). The Great Crash, the Oil Price Shock and the Unit root Hypothesis. *Econometrica,* 57:1361-401.

Perron, P. (2006). Dealing with Structural Breaks. Palgrave Handbook of Econometrics, 1, 278-352.

Perron, P. (2017). Unit Roots and Structural Breaks. *Econometrics*, 5, 22; 1-3. DOI:10.3390/econometrics5020022.

Phillips, P. C., & Perron, P. (1988). Testing for Unit Root in Time Series Regression. *Biometrica*, 75, 335-346.

Phiri, A. (2019). Asymmetries in the revenue–expenditure nexus: new evidence from South Africa. *Empirical Economics*, 56, 1515–1547.

Rahman, S.M.A., & Wadud, M.A (2014). Tax and Spend, Spend and Tax, Fiscal Synchronization or Fiscal Neutrality: Evidence from Bangladesh. *The International Journal of Applied Economics and Finance*, 8 (3), 98-108. DOI: 10.3923/ijaef.2014.98.108.

Ram, R.(1988). Additional evidence on causality between government revenue and government expenditure. *Southern Economic Journal*, 54:763–769.

Raza, S.A.., Hassan, S. Z., & Sharif, A.(2019). Asymmetric Relationship Between Government Revenues and Expenditures in a Developing Economy: Evidence from a Non-linear Model. *Global Business Review*, 20 (5): 1179-11951–17. DOI: 10.1177/0972150919846800

Ritcher, C., & Dimitrios, P. (2013). Tax and spend, spend and tax, fiscal synchronisation or institutional separation? Examining the case of Greece. *Romanian Journal of Fiscal Policy*, 4(2), 1-17.

Ross, K. L., & Payne, J.E. (1998). A Reexamination Of Budgetary Disequilibria. *Public Finance Review,* 26 (1): 67-79.

Saunoris, J.W.(2015). The Dynamics of the Revenue–Expenditure Nexus: Evidence from US State Government Finances. *Public Finance Review*, 43(1):108-134.

Saunoris J. W., & Payne, J.E (2010) Tax more or spend less? Asymmetries in the UK revenue-expenditure nexus. Journal of Policy Modeling, 32(4): 478–487.

Sennoga, E. (2008). Local government revenues and expenditures in Uganda: A VAR approach. Makerere University, Uganda: Kampala. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.559.9385&rep=rep1&type=pdf

Singh, B., & Sahni, B. S. (1984). Causality Between Public Expenditure and National Income. *The Review of Economics and Statistics*, 66(4), 630-644.

StatsSA (2020). Quarterly Labour Force Survey (QLFS) for 2019:Q4. P0211. Statistics South Africa. South Africa: Pretoria. 11 February 2020. Available at http://www.statssa.gov.za/?page_id=1854&PPN=P0211&SCH=7622

Stock, J.H., & Watson, M.W.(1988). Variable Trends in Economic Time Series. *Journal of Economic Perspectives*, 2:147-174.

Takumah, W. (2014). Cointegration and Causality Between Tax Revenue and Economic Growth in Ghana. *International Research Journal of Marketing and Economics*, 1(6), 30–44. ISSN 2349-0314.

Tiwari A., & Mutascu, M. (2016). The Revenues-Spending Nexus in Romania: a TAR and MTAR Approach. *Economic Research-Ekonomska Istraživanja*, 29(1):735–745.

Toda, H. Y., & Yamamoto, T. (1995). Statistical inference in vector autoregressions with possibly integrated processes. *Journal of Econometrics,* 66:225-50.

Vogelsang, T.J., & Perron, P. (1998). Additional Tests for a Unit Root Allowing for a Break in the Trend Function at an Unknown Time. *International Economic Review*, 39, 4, 1073-1100.

Von Furstenberg, G. M., Green, R. J., & Jeong, J.(1985). Tax and spend, or spend and tax? *Review of Economics and Statistics,* 68 (2): 179-88.

Wildavsky, A. (1988). The New Politics of the Budgetary Process. Glenview, IL: Scott, Foresman.

Wolde-Rufael, Y. (2006). The Revenue–Expenditure Nexus: The Experience of 13 African Countries. African Development Review, 20(2), 273-283. https://doi.org/10.1111/j.1467-8268.2008.00185.x

Zapata, H., & Rambaldi, A. (1997). Monte Carlo Evidence on Cointegration and Causation. *Oxford Bulletin of Economics and Statistics*, 59: 285-298.

Zapf, M., and J. E. Payne. 2009. Asymmetric Modelling of the Revenue-Expenditure Nexus: Evidence from Aggregate State and Local Government in the US. *Applied Economics Letters,* 16:871-876.

Zivot, E., & Andrews, D. W. K. (1992). Further Evidence on the Great Crash, the Oil Price Shock and the Unit root Hypothesis. *Journal of Business and Economic Statistics*, 10: 251-270.