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Fiscal policy in times of fiscal stress (or what to do when $r > g$)[☆]

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Abstract

South Africa runs a primary fiscal deficit and the long-term interest rate on government borrowing, r, is greater than the long-term economic growth rate, g. Without intervention, debt will continue to rise until there is a disorderly fiscal stop. Reforms to raise growth have not materialised, leaving fiscal consolidation as the second-best solution. Using a medium-sized, open-economy, fiscal DSGE model of South Africa, we show that the least cost policy is to impose a time-consistent fiscal policy rule with debt-to-GDP as the fiscal anchor and a pre-announced path for government consumption spending as the intermediate operational objective. This result obtains with and without explicit policy coordination between the fiscal and monetary authorities.

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1. Introduction

South Africa runs a large, persistent primary fiscal deficit, and, since 2016/17, the interest rate on government debt, r, has been greater than the long-run economic growth rate, g. Mathematically, this means sovereign debt accumulates without limit. A typical first-best 'optimal' policy approach would be to grow out of the problem—that is, implement measures to increase economic growth. In South Africa, however, the slow pace of economic reforms—particularly stabilizing the supply of electricity—means that there is a limit on economic growth.

What should be done? With slow economic growth expected for a number of years, there are no simple solutions. This paper complements and extends a series of papers that evaluate fiscal policy options in the recent South African context. Two other options—closing the primary deficit through tax increases or a debt-financed fiscal stimulus—have been either considered explicitly or can be indirectly inferred from the recent literature.[1] The results indicate that these options are unlikely to deliver the desired outcomes, in part because of the saturation of the tax base and the lack of credible fiscal programmes that will stimulate growth. For these reasons, we focus here on optimal fiscal policy through expenditure rules.

We use a medium-sized dynamic stochastic general equilibrium model with two policy-makers. The first is the fiscal authority, which has two discretionary instruments at its disposal to achieve its debt-stabilization objective: government consumption expenditure and government investment expenditure.[2] The second policy-maker is the monetary authority, which adjusts the short-term interest rate to target an inflation rate. This allows us to study the interactions between fiscal and monetary policy during fiscal consolidation. In our model, the policy options are evaluated using historical data, policy reaction functions, and counterfactual analysis with optimal simple rules. Our contribution is to explicitly model the welfare costs of different policy instruments and targets within a loss function to obtain the optimal fiscal policy response.

Reducing government consumption spending is found to bring the least painful fiscal adjustment—welfare is reduced less compared to other options. The demand implications of a consumption-led fiscal consolidation are offset by lower interest rates. These lower interest rates are as a result of two effects. First, the fiscal consolidation reduces the risk of a fiscal crisis, and so reduces the sovereign risk premium. This also reduces borrowing costs for the private sector, stimulating investment. Second, the reduction in government spending is deflationary, allowing the South African Reserve Bank space to reduce the policy rate. This (endogenous) monetary policy response counteracts the negative demand impact of fiscal policy, leaving g almost unaffected and even somewhat improved. With both long-term and short-term rates reduced, r adjusts downwards. r thus moves closer to g, and if the approach is pursued in a time-consistent manner, eventually $r < g$ and fiscal sustainability is restored. The effect is likely to be self-reinforcing, in that the reduction in the risk premium will reduce debt-service costs at the

[1] See Appendix A.4 for a summary of earlier complementary work on tax-based consolidations and for a review of the international literature on the effects of tax-based fiscal consolidations, see Alesina et al. (2019, 2020); the South African literature with similar results includes Makrelov et al. (2018), Kemp (2019), (2020b), and Kemp & Hollander (2020). We highlight why a debt-financed fiscal expansion contributes to $r > g$ in Section 3 below.

[2] The model is based on Kemp & Hollander (2020) and contains six fiscal instruments. Based on the evidence in Kemp (2020a,b) and Kemp & Hollander (2020), as well as the National Treasury's current fiscal strategy (National Treasury, 2021), we do not consider taxes and transfers as discretionary instruments to manage debt stabilization.

margin, further reducing government spending (see, e.g., David et al., 2022). In light of these findings, the National Treasury's current fiscal consolidation path to reduce government wages in real terms will restore fiscal sustainability with the least welfare cost.

In contrast, a large reduction in government investment spending reduces aggregate supply. That is, g is reduced, taking it further from r and worsening the fiscal position. Indeed, a strategy to reduce government consumption spending and increase government investment spending will support an improvement in the fiscal position by being growth-enhancing. In particular, if this investment spending is focused on the binding constraint—electricity—then growth is likely to rise quite significantly.

There are complementary measures that will assist the consolidation. These include adjusting the national borrowing profile. South Africa has over time extended the average maturity on debt and issued heavily to ensure healthy cash buffers. This action has largely been taken to spread rollover risk.[3] We estimate that the Treasury pays on average 6.5 per cent on its outstanding debt but receives 2 per cent on its cash holdings. A large cash position thus creates additional fiscal costs. Second, a credible fiscal consolidation strategy would allow for a complementary reduction in average maturities, which will support lower rates. In other words, there is an interlinked relationship between fiscal credibility and fiscal outcomes—weak fiscal credibility raises the sovereign risk premium, which, in turn, leads to higher interest costs and worse fiscal outcomes.

We argue that fiscal credibility may partially be restored through adopting a stricter expenditure rule. The current fiscal rule (a nominal non-interest expenditure ceiling) has proven insufficient. A common international approach is to use expenditure-to-GDP as the *fiscal instrument* (or a real expenditure rule) to meet a *fiscal target* of a stable debt-to-GDP ratio. Given the different economic impacts of different types of spending, such an approach should include different targets for different types of expenditure—that is, a reduced consumption expenditure-to-GDP target while maintaining investment-to-GDP.[4] An alternative approach would be to target a sustainable primary balance-to-GDP ratio over the medium term, akin to average-inflation targeting. However, we show that the Treasury is unlikely to achieve a debt-stabilizing fiscal balance within the medium-term expenditure framework. A more realistic and credible instrument would thus be to map a path for consumption spending to GDP. We also propose simple measures to protect service delivery, particularly expanding existing conditional grants to health and education, while reducing other intergovernmental transfers. This will ensure that service delivery is protected while spending is reduced.

The contribution of this paper is to propose an 'optimal' fiscal consolidation strategy that has the least impact on economic growth and inequality. Our results obtain with and without explicit policy coordination between the fiscal and monetary authorities.

The paper is set out as follows. In Section 2 we outline the fiscal policy problem statement, drawing where necessary from the existing body of literature on South Africa's fiscal position. Simply put, expenditure is currently too high for the revenue base. Stylized facts in Section 3 set out the context for our normative analysis. In Section 4 we set out our methodology for estimating the least-cost way of achieving the required fiscal consolidation. Section 5 sets out the results for optimal policy and policy coordination. The final section concludes, drawing potential policy lessons from our analysis.

[3] As of November 2021, ZAR423.4 billion of maturing debt expected to reduce fiscal space over the medium term (National Treasury, 2021).

[4] Hollander (2021) highlights the importance of taking into account the effect of disaggregated government expenditure components for fiscal policy objectives.

2. Fiscal sustainability when $r > g$

Sovereign debt is 'sustainable' when current policy will maintain debt around a long-run stable level and not lead to exploding—or imploding—debt (Blanchard & Quah, 1989; Blanchard, 1990; Buiter et al., 1985; Blanchard et al., 1991; Fourie & Burger, 2003; Blanchard, 2019).[5]

The conditions for stable debt can be easily derived. Debt-to-GDP at time t (b_t) is a function of debt in the previous period (b_{t-1}), the interest rate on debt (r_t), the economic growth rate (g_t), and the primary balance-to-GDP ratio (s_t).[6]

$$b_t = \frac{1 + r_t}{1 + g_t} b_{t-1} - s_t \tag{1}$$

Assuming debt remains stable over time ($b_t = b_{t-1} = b$), it then follows from Eq. (1) that the fiscal balance s consistent with *long-run* debt stability is given by:

$$s = \frac{r - g}{1 + g} b \tag{2}$$

Eq. (2) shows that when the cost of government borrowing is lower than the economic growth rate ($r < g$), a country can achieve a stable or declining debt-to-GDP ratio despite a (moderate) *negative* primary balance. In South Africa, however, $r > g$, which implies the debt-to-GDP ratio rises without limit as the numerator (debt) rises faster than the denominator (GDP).

In contrast, an alternative simple measure is to consider what primary balance is required to ensure debt does not accumulate *in a given period* ($\Delta b_t = 0$). The sustainability condition for the primary balance therefore becomes.[7]

$$pb_t^{sus} = \frac{r - g}{1 + g} b_{t-1} \tag{3}$$

The fiscal sustainability gap (pb_t^{gap})—the required fiscal adjustment for a given year—is therefore $pb_t^{gap} = pb_t^{sus} - s_t$.[8]

Table 1 shows the primary balance for South Africa required to stabilize debt in the fiscal years 2018/19 through 2025/26. In order to stabilize debt in the year 2023/24, for example, a sizeable fiscal adjustment of 2.6 per cent of GDP (or ZAR185.8 billion) is required.[9]

In Fig. 1 we present two estimates of $r - g$ using two measures of g—a 'long-run' potential measure from Fedderke and Mengisteab (2017) and the actual annual growth rates.[10] The data

[5] The following specification is based on the intertemporal government budget constraint—the so-called fiscal reaction function—popularized in academic research by Bohn (1995), (1998), (2007), (2011). In this literature, the sustainability of fiscal policy can be assessed by estimating a fiscal reaction function of the type presented in this analysis.

[6] In Blanchard (2019), x_t is used to denote the primary *deficit*, whereas in Blanchard et al. (2021) s is used to denote the primary *balance*. That is to say, $s_t = -x_t$. To avoid confusion, we use s_t for the primary balance and s for the long-run sustainable fiscal balance.

[7] We can further relax Eq. (3) to be some horizon h over which debt should be stabilized.

[8] For the whole post-1994 period, used in the empirical analysis, see Fig. 2 in Section 5.

[9] We project the primary balance in 2023/24 to be –1.9 per cent of GDP, and we estimate the corresponding debt-stabilizing primary balance to be 0.7 per cent of GDP. The fiscal sustainability gap is the difference between the two. The National Treasury projects a primary balance in that year of ZAR3.2 billion. The difference arises due to different assumptions on wages, overall spending, and the GDP deflator.

[10] For our approach to calculating r, r^{adj}, and g, see the Appendix.

Table 1
South Africa's unpleasant fiscal arithmetic.

Variable	Description	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25	2025/26
r^{adj}	Adjusted borrowing cost on government debt	6.7 %	6.5 %	6.1 %	6.4 %	6.5 %	6.5 %	6.4 %	6.5 %
g	Nominal growth in output	5.5 %	5.0 %	−2.1 %	12.3 %	7.8 %	5.5 %	6.3 %	6.3 %
b	Net domestic debt stock (% GDP)	47.0 %	52.7 %	64.7 %	65.4 %	67.15 %	69.4 %	70.7 %	74.9 %
pb^{sus}	Debt-stabilizing primary balance (% GDP)	0.8 %	0.7 %	4.5 %	−3.4 %	−0.8 %	0.7 %	0.1 %	0.1 %
s	Projected primary balance (% GDP)	−1.0 %	−2.5 %	−5.7 %	−1.2 %	−1.7 %	−1.9 %	−1.5 %	−1.2 %
$r^{adj} - g$	$r - g$	1.2 %	1.6 %	8.3 %	−5.9 %	−1.3 %	1.1 %	0.1 %	0.2 %
pb^{gap}	Adj. reqd to stabilize debt (% GDP)	−1.8 %	−3.2 %	−10.2 %	2.2 %	−0.9 %	−2.6 %	−1.6 %	−1.3 %
pb^{gap}	(ZAR, bn)	−98.6	−180.5	−565.7	137.8	−57.3	−185.8	−121.1	−100.9

Note: this table assumes no active fiscal consolidation, that is (1) non-compensation spending grows at CPI; (2) compensation grows at CPI +1 % pt in 2023/24 and CPI + 0.5 % pt thereafter; (3) revenue grows at nominal GDP; (4) long-term growth is 1.8 %; (5) GDP deflator and CPI are assumed to be 4.5 %. The full forecast table is in the Appendix. r is calculated as the adjusted nominal borrowing cost of existing debt (see Appendix A). Source: authors' compilation National Treasury data.

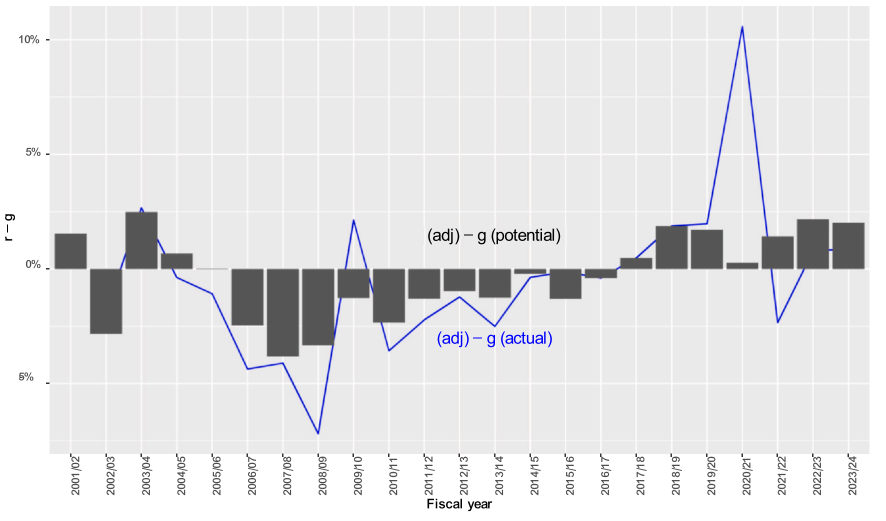

Fig. 1. Interest rate minus economic growth ($r-g$) using actual and potential growth, 2001/02–2023/24. Note: the figures presents estimates of $r-g$ using the adjusted nominal borrowing cost of existing debt (see Appendix A.1 for details about the calculation of r^{adj}) and two estimates of g (a long-run 'potential' measure from Fedderke and Mengisteab, 2017 and the actual annual growth rates). Using the actual growth rate of g in 2021/22 and 2022/23 leads to $r < g$, but these are one-off changes to a post-COVID economic recovery and terms of trade shock. The 'potential' or 'trend' growth rate (a measure of the long-run growth capacity of the economy) is more appropriate for long-run fiscal analysis.
Source: Authors' compilation based on National Treasury data.

shows that for the large part of the past two decades, $r-g < 0$ (or, put another way, $r < g$). It was only from FY 2016/17 that the relationship turned, and r was consistently above g. This has significant implications for the sustainable primary balance.

3. Why is $r > g$?

South Africa appears to be in the classic fiscal trap, with r persistently above long-run g since 2016/17. In this environment, the fiscal position deteriorates. A 'vicious circle' can materialize whereby the sovereign risk premium rises, which increases borrowing costs and dampens investment spending ($r > g$), making fiscal consolidation (or, more generally, counter-cyclical fiscal policy) more and more difficult, further deteriorating the fiscal position and raising the sovereign risk premium.[11]

There is a growing literature on examining South Africa's fiscal deterioration, including contributions by Calitz et al. (2014), (2016), Sachs (2021), and Loewald et al. (2020a).[12] This literature highlights the deterioration that took place after the global financial crisis.

Fiscal sustainability is best achieved through raising economic growth, g—following periods of debt accumulation, countries can 'grow out of debt' (Alesina et al., 2020). This sustainable

[11] See, for example, Tran (2018) for an analysis of fiscal sustainability in emerging market economies through the relationship between government debt and the sovereign risk premium.
[12] See, for example, Fourie and Burger (2003) for an analysis of fiscal sustainability before the global financial crisis.

outcome is often possible because the debt has been accumulated during periods of recession, and when the business cycle turns, debt naturally falls. But because reforms have not been successfully implemented, South Africa has an upper limit on g. The area where reform has arguably been slowest, and where the delays have been most damaging, is electricity provision. However, logistics constraints have also hampered growth.[13]

A second, related, reason for the fiscal deterioration is that South Africa has experienced a sustained increase in spending without growth. First, the observed rise in expenditure-to-GDP over the last decade, from around 25 per cent of GDP in the 2008/09 fiscal year (when South Africa posted a budget balance surplus) to around 31 per cent of GDP in the pre-COVID 2019/20 fiscal year (Fig. A1, top panel), has been largely concentrated in government consumption expenditure with very large increases in government wages (Sachs, 2021). Second, this lack of growth has meant that, despite ongoing increases in tax *rates*, revenue-to-GDP has remained relatively flat (Fig. A1, middle panel).[14]

The consequences of greater consumption expenditure and limited scope for revenue generation have led to a greater debt burden both absolutely and on an ongoing basis (i.e. debt-service costs). The result has been that it appears that spending has not delivered any meaningful macroeconomic impact, such as reducing the unemployment rate, which indeed has actually risen (Fig. A1, lower panel). Evidence by Hollander (2021) suggests that this feedback mechanism puts South Africa in a weak position to implement a debt-financed fiscal expansion. The final channel is the 'crowding out' channel—in countries with limited domestic savings, an increase in debt requires higher yields to divert savings towards sovereign debt (Baldacci & Kumar, 2010).

There is also some evidence that the National Treasury's borrowing strategy has increased r—particularly the long-dated maturity profile of debt and the relatively high levels of cash balances. As at end 2021, South Africa had cash balances of ZAR274 billion.[15] The unadjusted opportunity cost of this money is approximately ZAR10.5 billion per year.[16]

Finally, Sachs (2021, 17) characterizes recent fiscal policy as '[fiscal] austerity without consolidation'—that is, front-line services are being cut but headline fiscal metrics are not improving. That said, characterizing the reduction in services as 'austerity' to some extent oversimplifies the problem. Using education as an example, Spaull et al. (2020, 1) highlight that the above-inflation increases in teacher wages have crowded out spending—describing the result as a 'race between teacher wages and the budget'. In short, increases in the budget have not been able to match rising teacher salaries. The result is fewer, albeit better-paid, teachers.[17]

[13] For literature on South Africa's lack of growth and the fiscal consequences, see Bhorat et al. (2014), Burger (2018), Burger and Calitz (2019), Loewald et al. (2020a), Calitz (2020), and Sachs (2021).

[14] Kemp (2019), (2020b) provides detailed micro-level empirical work on the estimated elasticities of taxable income and the optimal tax rate for the top 10 per cent of income earners in South Africa. The relevant finding here is that legislated tax rates are significantly higher than the optimal revenue-maximizing level. As a result, raising consumption or marginal income tax rates further would likely induce a *negative* revenue response.

[15] See http://www.treasury.gov.za/comm_media/press/monthly/2204/mpff.pdf.

[16] This is based on the difference between the reported interest income on cash balances and the borrowing cost of the cash. The National Treasury argument for such large cash balances is that large redemptions are due in the next few years.

[17] The working paper version of this article goes on to highlight that whilst there is a strong link between South Africa's poor education outcomes and its weak long-term growth outlook and poverty (see, for example, Spaull, 2013; Gustafsson, 2014), rapid wage growth has had a serious impact on service delivery.

Reducing non-compensation spending so as to absorb rapid growth in compensation is better characterized as a reprioritization of the composition of spending, or, in other words, 'neither austerity nor consolidation'.

With compensation spending crowding out all other spending, the fiscal strategy has shifted to a focus on slowing down compensation spending. This strategy has had some success, and real wage growth turned negative in 2021/22 (National Treasury, 2021).

4. What to do when $r > g$?

4.1. Data and methods

This background sets out the context for our normative analysis. Faced with a view that fiscal policy is increasingly unsustainable, and growth is weak, we explore the nature of time inconsistency and the need for rules to guide optimal fiscal policy and macroeconomic policy coordination.

To evaluate different policy options for fiscal sustainability we use a dynamic stochastic general equilibrium (DSGE) framework, based on Kemp & Hollander (2020). The new-Keynesian open-economy fiscal DSGE model has the following notable characteristics. A nontrivial role for fiscal policy where a fiscal authority purchases the public consumption good, invests in public capital, issues bonds to refinance its debt, makes transfer payments between two types of households, and levies a consumption tax, a labour income tax, and a capital income tax. The fiscal authority's period-by-period budget constraint must be satisfied. Nominal price stickiness for all goods: domestic, foreign, imports, and exports. Nominal wage stickiness for Ricardian and non-Ricardian households. Rational, forward-looking Ricardian households and firms optimize their objective functions (utility and profits, respectively). Other real frictions include investment adjustment costs and habit persistence in consumption. The monetary authority follows a standard Taylor-type specification for its interest rate policy. The foreign economy follows a standard three-equation new-Keynesian setup. Since the DSGE model is not part of the contribution of this paper, we refer the reader to Kemp & Hollander (2020) for a comprehensive description of the model.[18]

We use 18 quarterly macroeconomic series over the period 1994Q1–2018Q4 to estimate, with Bayesian methods, a set of structural parameters and 21 shocks in our model.[19] We then determine the optimal (least-cost) policy responses by a standard welfare (quadratic loss) function. The optimal policy rules (or, generically, the estimated policy reaction functions) are used to run counterfactual simulations using the estimated structural parameters and identified

[18] DSGE models are useful tools for counterfactual policy analysis, but it is important to note that such models, while state-of-the-art, are still a stylized representation of the real world. Our empirical evaluation below is therefore constrained by the specification of the model and the well-traversed problems of using models for forward-looking policy evaluation. This model is being developed and tested for fiscal policy analysis for the National Treasury of South Africa. As such, we have made some minor corrections and updates to the original replication code to improve estimation efficiency and robustness. Our model estimation results here are not significantly different from those of Kemp & Hollander (2020).

[19] Table A4 provides a list of the observable variables and their sources. The estimation procedure uses the Metropolis-Hastings Markov-Chain Monte Carlo algorithm with 200 000 draws for three chains with a burn-in of 50 %. To ensure that the tails of the posterior mode are identified, the scale used for the jumping distribution is adjusted to ensure an acceptance rate of approximately 25 %. The model estimation diagnostics and results for this article are available upon request, along with the set of equilibrium linearized equations and variable and parameter descriptions.

historical shock processes. We evaluate both fiscal policy and optimal policy coordination with monetary policy against the estimated model results.

4.2. Fiscal rules for debt stabilization

South African fiscal policy has been time-inconsistent in the sense that the announced fiscal path (the 'expenditure ceiling') led to expectations that a fiscal consolidation would occur.[20] Accordingly, households, firms, and even monetary policy-makers adjusted their expectations about the path of fiscal borrowing.[21] As in a repeated game, the Treasury quickly lost credibility when its announced fiscal consolidation did not materialize.

Time consistency can be created through rules that credibly bind the policy-maker to a pre-announced policy path (Kydland & Prescott, 1977). The rule must meet two hurdles: (1) it must be consistently met; and (2) it must be effective in achieving fiscal sustainability. In the case of expenditure ceilings, Ljungman (2008, 17) argues that they should 'explicitly establish the relationship between expenditure under the ceiling, revenue, and the targeted fiscal balance or debt'. Indeed, the design of much European fiscal spending is framed within the context of the European Stability and Growth Pact, which provides for a debt ceiling of 60 per cent of GDP and a cap of 3 per cent of GDP for the budget deficit. Thus, the spending ceiling must achieve an outcome, and not be pursued for its own sake.

In 2012, South Africa adopted a nominal non-interest expenditure ceiling as the de facto primary fiscal policy rule (Sachs, 2015, 24).[22] The 2012 Medium Term Budget Policy Statement stated that 'During 2013/14 and 2014/15, spending will remain within the non-interest expenditure ceilings established in the 2012 Budget' (National Treasury, 2012, 21). From 2013, the Treasury reported against its expenditure ceiling target. The approach is a natural extension of the three-year expenditure framework adopted in February 1998, which originally committed the Treasury to publish a multi-year spending projection as part of a set of the post-apartheid fiscal policy reforms. Curiously, the relatively extensive literature on fiscal rules in the South African context (see, for example, Plessis & Boshoff, 2007; Burger et al., 2012; Burger & Marinkov, 2012) does not discuss at length the merits (or otherwise) of the nominal non-interest expenditure ceiling as a target.

The Treasury has largely met the nominal expenditure ceiling rule, and indeed in a number of successive budgets the nominal expenditure ceiling was revised downward. But clearly the ceiling has not achieved fiscal sustainability—the Treasury has consistently missed its own debt-to-GDP forecasts. Moreover, the repeated intention to meet a primary balance within the three-year spending framework has not been achieved.

[20] We use time inconsistency in the sense that a policy-maker that sets a policy at time t_0 has an incentive to renege on that policy at time t_1. Time (or dynamic) inconsistency is most often associated with monetary policy, but there is a rich literature on fiscal policy time inconsistency. For example, Fischer (1980) outlines the classic case of fiscal policy time inconsistency—a balanced budget fiscal path with a optimal mix of taxes is announced at time t_0, but at t_1 the fiscal authority reneges and changes the mix of taxes. See also the fiscal policy examples in Kydland & Prescott (1977, 1980). For quantitative evidence in a broader African and small open economy context, Carmignani (2010), Maravalle and Claeys (2012) document the widespread failure of fiscal policy to deliver, and more often impede, macroeconomic stability. The authors argue for counter-cyclical fiscal rules for macroeconomic stability and fiscal sustainability.

[21] Loewald et al. (2020a) outline the time inconsistency of South African fiscal policy in general terms.

[22] 'Nominal' or 'absolute' in the sense that the expenditure ceiling is expressed as the nominal rand value, in contrast to other expenditure rules which are expressed in real terms or relative to some other variable, such as GDP.

In defence of a nominal absolute target, there is the argument that a fiscal target should remain reasonably impervious to any cyclical factors, so that it acts as an automatic stabilizer. There is merit in this argument, but it does not follow that a nominal expenditure target fulfils such a role—other possible rules have long been considered (see, for example, Plessis & Boshoff, 2007; Burger et al., 2012; Burger & Marinkov, 2012, with the most obvious being a debt ceiling, expressed as a targeted debt-to-GDP ratio.

If the expenditure rule is expressed in real terms, it would adjust automatically to inflation. Alternatively, an expenditure-to-GDP target may be better at *sustainable* counter-cyclical fiscal policy because the cyclical adjustment can be borne mainly by revenue fluctuations—if spending-to-GDP remains reasonably constant through the cycle, and revenue-to-GDP is allowed to adjust, the fiscal deficit plays the role of the automatic stabilizer.[23]

Fiscal rules are only useful in so far as they achieve their intended outcome. Expenditure rules should therefore be thought of as 'intermediate targets'—achievable commitment devices with an end goal in mind, where the end goal may be the anchoring of debt. In this context, adhering to the (intermediate) expenditure target delivers credibility only if it can effectively achieve debt stabilization. Accordingly, the fiscal target would be better formulated in real terms such that any downward adjustment that is solely due to lower-than-expected inflation can then be correctly characterized as an 'inflation adjustment'.[24]

Following Leeper et al. (2010), (2017), Coenen et al. (2012), and Born et al. (2013), among others, the fiscal instruments are assumed to follow simple reaction functions ('feedback rules') with four features. First, a first-order autoregressive component captures the persistence of each instrument j (ϕ_j). Second, each instrument responds contemporaneously to deviations of output from its steady-state level (y_t), thereby controlling for automatic stabilizer effects ($\theta_{j,y}$). Third, all fiscal instruments are permitted to respond to deviations of government debt, in real terms, from its steady-state level (b_t), thereby controlling for public debt stabilization ($\theta_{j,b}$). Fourth, a stochastic component identifies the exogenous (i.e. discretionary or unanticipated) changes in the instruments (ε_t^j).

We focus our attention on government consumption, $c_{G,t}$, and government investment, $k_{G,t}$, expenditure reaction functions, given by:

$$c_{G,t} = \phi_{cG} c_{G,t-1} - \theta_{cG,y} y_t - \theta_{cG,b} b_t + \varepsilon_t^{cG} \tag{4}$$

$$k_{G,t} = \phi_{kG} k_{G,t-1} - \theta_{kG,y} y_t - \theta_{kG,b} b_t + \varepsilon_t^{kG} \tag{5}$$

The linear fiscal reaction functions in Eqs (4) and (5) are consistent with the idea that debt stabilization is an important consideration in the formulation of fiscal policy, and can approximate optimal rules for debt stabilization (see, e.g., Kirsanova et al., 2007; Michel et al., 2010; Schmitt-Grohé and Uribe, 2005). However, based on the seminal works of Bohn (1995, 1998, 2007, 2008, 2011), the necessary conditions for the intertemporal government budget (ITGB) constraint to hold are weak (see D'Erasmo et al., 2016 for a summary of Bohn's four major contributions to the empirical literature on debt sustainability tests). For the type of

[23] Tax buoyancy has, on average over the fiscal years 2009/10 through 2019/20, been slightly above 1 (see the Appendix for calculations).

[24] For the end target (debt sustainability) the fiscal authority focuses on both real debt and real output stabilization, individually, as opposed to debt-to-GDP or the primary-balance-gap-to-GDP ratios directly. Results for the latter are available on request. The former approach is taken so that policy coordination with the monetary authority can be directly compared by adding inflation as a variable (i.e. an objective for stabilization) in the welfare loss function.

specification adopted here (a linear fiscal reaction function), the debt-feedback coefficient must be positive ($\theta_{j,b} > 0$) for at least one instrument j in order to guarantee long-term fiscal solvency.[25] Bohn (2007) concludes that analyses such as ours are 'more promising for understanding deficit problems' as opposed to outright tests for fiscal solvency. Indeed, D'Erasmo et al. (2016) show that our DSGE approach remains a useful tool for conducting debt sustainability analysis.[26]

The inclusion of an automatic stabilizer component for output in the model's six fiscal rules controls for the endogenous behaviour of government expenditure and tax revenue over the business cycle. If the output gap enters the expenditure (tax) rules with a negative (positive) coefficient, any expansionary fiscal shock that brings about an increase in aggregate activity—and, therefore, an expansion in employment—by construction induces a reduction in spending (an increase in tax revenue). For example, a decline in transfers to households will in turn offset the possible increase in disposable income of non-Ricardian households stemming from the increase in economic activity and the concomitant increase in labour income. This might dampen the overall impact of the expansionary fiscal shock.

Accordingly, by adjusting these fiscal feedback rules, we can investigate the macroeconomic impact of using different instruments to stabilize debt (i.e. perform normative analysis), taking as given that the ITGB constraint holds. For example, by setting the feedback coefficients in the expenditure and tax equations to zero we can remove the feedback variables (output and/or debt) from one or more of the equations, and thereby isolate the output and/or debt-stabilizing effect of an instrument in response to a shock (see, e.g., Kemp & Hollander, 2020). In our analysis below, we compare the estimated model parameters based on South African data (our baseline) to that of the implied optimal parameter values required to meet the policy-maker's stabilization objective.

4.3. Optimal policy and policy coordination

Stähler and Thomas (2012) highlight two stylized results from the literature on optimal fiscal policy. First, small, permanent (i.e. credible) changes in fiscal instruments to service a new higher level of debt are preferred to large, temporary changes to return debt to its initial level. Second, mild counter-cyclical policy responses can have stabilizing and welfare-enhancing effects. For this reason, we allow for the fiscal authority to adjust the degree of the counter-cyclical response of its fiscal instrument to output deviations as well as debt. In Section 5, we characterize these two scenarios within the context of a 'soft consolidation' versus a 'hard consolidation', measured by the fiscal sustainability gap versus the deviation of debt-to-GDP from its steady state.

[25] Long-term fiscal solvency is the level of debt commensurate with current and future discounted primary balance surpluses over an infinite horizon. This proposition holds notwithstanding the fact that the data-generating process for fiscal variables (a stochastic process) generally satisfies the ITGB condition for fiscal solvency as well (D'Erasmo et al., 2016, 2504). That said, a DSGE model is less likely to be mis-specified because the discount factor appropriately discounts future primary balances determined by the state-contingent equilibrium pricing kernel (i.e. not the risk-free rate).

[26] For example, D'Erasmo et al. (2016), 2591) show that the 'results of the applications of the empirical [fiscal reaction function] and structural [DSGE] approaches paint a bleak picture of the prospects for fiscal adjustment in advanced economies to restore fiscal solvency and make the post-2008 surge in public debt ratios sustainable'.

The time-inconsistency problem has also had consequences for coordination. As in the classic exposition (Blinder, 1982, one can present fiscal and monetary policy as a repeated game between two equally powerful players—the fiscal authority and the monetary authority. The standard coordination outcome in game theory is that optimal coordination is achieved when each player has a clear understanding of the other's strategy. But fiscal policy time inconsistency creates uncertainty for the monetary policy authority, with Loewald et al. (2020a) noting that:

> to get more out of policy coordination, fiscal policy should move first, reducing risk premia and inflation expectations, dropping the neutral real rate, and allowing monetary policy to respond to weak growth.

Accordingly, we first evaluate fiscal policy by its ability to stabilize debt-to-GDP (thereby reducing the risk premium) without adversely affecting growth (which would raise the debt-to-GDP ratio, thus counteracting any attempt to stabilize nominal debt). We then compare the optimal fiscal policy outcome to one that coordinates with the monetary authority's objectives to stabilize output and inflation using its instrument—the short-term interest rate.

The monetary policy reaction function follows a standard Taylor-type rule that captures persistence in the short-term interest rate (ϕ_r), the degree of the response to inflation (ϕ_π) and output growth ($\phi_{\Delta y}$), and a stochastic component to identify exogenous policy changes (ε_t^r):

$$r_t = \phi_r r_{t-1} + (1 - \phi_r)(\pi_t^* + \phi_\pi(\pi_t - \pi_t^*) + \phi_{\Delta y}(y_t - y_{t-1})) + \varepsilon_t^r \tag{6}$$

where π_t^* is an exogenous time-varying inflation target.

In the model, the relevant interest rate for fiscal policy, r_t^{adj}, is an estimated function of the short-term interest rate and a sovereign risk premium, which is in turn a function of government debt-to-GDP and a risk premium shock to capture exogenous factors. We refer to the model-implied rate r_t^{adj} as the long-term interest rate.[27]

The success of policy can be measured by its ability to minimize instability in the target variables. Policy-makers must choose their respective θs and ϕs in Eqs (4), (5), and (6) to minimize a loss function $L_t \to 0$:

$$\min L_t = y_t^2 + \Theta_{\mathbb{X}}.\, \mathbb{X}_t^2 \tag{7}$$

where the welfare loss (L) is an increasing function of deviations to output (y_t) and one or more variables in the vector $\mathbb{X}$. $\Theta_{\mathbb{X}}$ is a vector of weights w corresponding to the policy target variables.

For the fiscal authority we consider output and debt (b_t) or output and the fiscal sustainability gap (pb_t^{gap}) as the targets. For the monetary authority we take output and inflation (π_t) as the relevant targets. Given that instability in the policy instrument is undesirable, $\Theta_{\mathbb{X}}$ also controls for variation in the set of policy instruments $\{c_{G,t}, k_{G,t}, r_t\}$.[28]

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[27] For the model estimation, we leave this variable as unobservable since it captures several difficult-to-calibrate factors related to the composition of debt and the realized debt-servicing costs of government (see the Appendix for a brief discussion on the calculation of r_t^{adj} used in Section 2, and see Fig. A3 for a comparison of actual rates versus the model-implied rate.). Furthermore, a single observable rate such as the risk-free rate or the ten-year government bond yield is not the relevant discount rate for fiscal solvency in the intertemporal budget constraint. As such, our implied long-term rate correctly satisfies the household's state-contingent equilibrium pricing kernel and the sovereign risk conditions stemming from debt.

[28] For a more detailed exposition of welfare analysis in a fiscal-monetary policy coordination setting see, e.g., Schmitt-Grohé and Uribe (2005), (2007); Marattin et al. (2011).

5. Results

We present the results from the counterfactual policy simulations in two parts. First, we estimate 'optimal simple rules', estimating the parameters associated with a least-cost path for given policy instruments and targets. Second, we present counterfactual scenarios where we estimate the outcome on key economic variables if the optimal simple rules for policy had been applied retrospectively.

Fig. 2 presents our two simple measures described in Section 2 for fiscal sustainability: the government debt-to-GDP ratio (left panel) and the fiscal sustainability gap (right panel). The sustainability gap measures the difference between the primary balance required to stabilize debt and the current primary balance over a given horizon h—for simplicity, we set $h = 1$ quarter. From 2009 we can observe rapidly rising government debt, which corresponds with cumulative negative fiscal sustainability gaps. These two measures guide our optimal policy analysis in Section 5. We consider the fiscal authority's attempts to stabilize debt-to-GDP around its steady-state level as a 'hard consolidation', whereas we consider a policy that minimizes the fiscal sustainability gap as a 'soft consolidation'. Targeting the fiscal sustainability gap can be considered as a minimal requirement for fiscal consolidation, whereas the debt-to-GDP ratio would be an aggressive consolidation. A gradual consolidation would lie between these two extremes and could be assessed by adjusting the horizon h over which the fiscal sustainability gap should be adjusted to stabilize debt, as noted in Section 2.

5.1. Optimal simple rules for fiscal policy

As highlighted above, one can imagine the fiscal–monetary coordination problem as a sequential game. When the monetary authority has concerns about the fiscal authority's credibility, the game becomes a standard prisoner's dilemma without coordination. In this game, the fiscal authority moves first and the monetary policy authority second. We run these scenarios sequentially: first, we analyse fiscal policy options and then add monetary policy coordination on the basis that the monetary policy authority responds to price and output signals from fiscal policy.

Tables 2 and 3 present the set of fiscal policy options for our 'soft' and 'hard' fiscal adjustment scenarios, respectively, evaluated against the loss function (Eq. (7)). The model solves

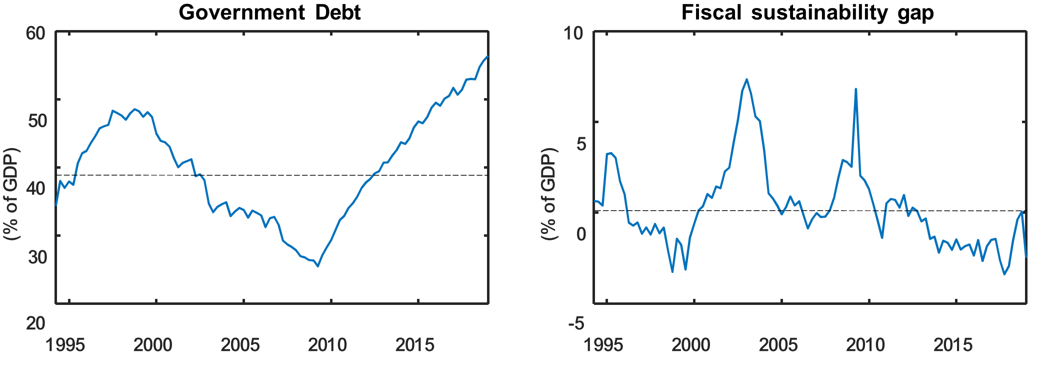

Fig. 2. Two measures for fiscal sustainability: debt-to-GDP stabilization (left) and fiscal sustainability gap (right). Source: authors' compilation.

Table 2
Optimal fiscal policy. Weights on policy targets: y, $pb^{gap} = 1$.

	Weights w on policy instrument (s)			
Policy parameter (s)	$w = 1$ Optimal values	$w = 0.5$	$w = 0$	Actual†
Gov. cons. response to output $\theta_{cG,y}$	0.11	0.10	0.03	0.11
Gov. cons. response to debt $\theta_{cG,b}$	0.09	0.11	0.32	0.18
Gov. invest. response to output $\theta_{kG,y}$	0.45	0.44	0.19	0.20
Gov. invest. response to debt $\theta_{kG,b}$	0.19	0.20	0.58	0.57
Loss function L	**2.79**	**1.59**	**0.30**	
Gov. cons. response to output $\theta_{cG,y}$	0.15	0.14	0.03	0.11
Gov. cons. response to debt $\theta_{cG,b}$	0.10	0.12	0.33	0.18
Loss function L	**0.53**	**0.45**	**0.30**	
Gov. invest. response to output $\theta_{kG,y}$	0.42	0.42	0.19	0.20
Gov. invest. response to debt $\theta_{kG,b}$	0.20	0.20	1.00	0.57
Loss function L	**2.53**	**1.44**	**0.32**	

Note: the table presents the optimal values of a set of policy parameters under our 'soft' adjustment scenario. The optimal values minimize the loss function. We vary the weights on the two instruments. † Estimated parameter value based on historical experience. Source: authors' calculations.

Table 3
Optimal fiscal policy. Weights on policy targets: y, $b = 1$.

	Weights w on policy instrument (s)			
Policy parameter (s)	$w = 1$ Optimal values	$w = 0.5$	$w = 0$	Actual†
Gov. cons. response to output $\theta_{cG,y}$	0.09	0.01	−0.66	0.11
Gov. cons. response to debt $\theta_{cG,b}$	0.11	0.30	1.38	0.18
Gov. invest. response to output $\theta_{kG,y}$	0.44	0.30	0.15	0.20
Gov. invest. response to debt $\theta_{kG,b}$	0.20	0.40	0.66	0.57
Loss function L	**3.23**	**2.18**	**0.34**	
Gov. cons. response to output $\theta_{cG,y}$	0.13	0.10	−0.68	0.11
Gov. cons. response to debt $\theta_{cG,b}$	0.13	0.16	1.42	0.18
Loss function L	**0.95**	**0.83**	**0.34**	
Gov. invest. response to output $\theta_{kG,y}$	0.42	0.41	−0.66	0.20
Gov. invest. response to debt $\theta_{kG,b}$	0.20	0.21	2.30	0.57
Loss function L	**2.90**	**1.81**	**0.60**	

Note: the table presents the optimal values of a set of policy parameters under our 'hard' adjustment scenario. The optimal values minimize the loss function. We vary the weights on the two instruments. † Estimated parameter value based on historical experience. Source: authors' calculations.

for an optimal simple rule that would achieve the objective at the least cost. We assume equal weights $w = 1$ on the policy target variables in the loss function (Eq. (7)), but we allow the weight on the policy instrument to vary from 1 to 0. For each fiscal adjustment scenario we estimate the optimal simple rules together and individually. The final column in the tables shows the actual estimated parameter values based on the historical data.

First, we consider the soft adjustment scenario in Table 2. When both fiscal instruments are under the policy-maker's control, and when instability in the fiscal instruments is not a concern (w = 0), welfare losses are minimized the most. Interestingly, the optimal parameters for investment expenditure are very close to the actual estimated values based on the historic experience. This result implies that, at least when $w = 0$, the historic response of government investment to output and debt dynamics has been optimal. As a result, welfare losses are also minimized when the government consumption response to output ($\theta_{cG,y}$) and debt ($\theta_{cG,b}$) are the only parameters under the fiscal authority's control. Compared to the actual experience, however, the required degree of responses to optimally stabilize output and the fiscal sustainability gap is four times smaller for output (0.03 vs 0.11) and almost twice as large for debt (0.33 vs 0.18).

If we consider that the fiscal authority puts more weight on instability in government consumption expenditure (for example, this could be due to inertial government wages) we arrive at optimal parameter values closer to that of the actual experience. Going forward, this result implies that if government can achieve their fiscal consolidation path by reducing growth in consumption expenditure (i.e. placing less weight on instrument instability) they would achieve optimal debt stabilization under our soft scenario (i.e. stabilizing debt at the current level). This would require a stronger reduction in spending to the current level of debt, while placing negligible weight on output. Indeed, it is clear that when government places *less* weight on instability in its instruments, optimal policy requires greater adjustment to debt as opposed to output. The greater the weight on instrument instability, the greater the weight on the response of the fiscal rules to output. That said, it is clear that welfare losses are minimized best when government consumption expenditure is used as the active fiscal rule to achieve fiscal sustainability.

Turning to the hard adjustment scenario in Table 3, our above conclusions become even more apparent. To achieve rapid fiscal consolidation requires a significantly larger response to debt and, in fact, a *procyclical* response to output for the government consumption expenditure rule (recall that in Eqs (4) and (5) the *sign* in front of the coefficients is negative; a negative parameter *value* therefore implies a positive correlation). If some weight is placed on instrument instability, however, the optimal fiscal rule follows similarly to that of the soft scenario. It is also important to point out that instability in government investment expenditure contributes far more to welfare losses and would appear to be less appropriate as an active tool for debt stabilization (see also Stähler and Thomas, 2012).

These insights from the model, given the historic experience, validate the National Treasury's recent focus on compensation spending reduction in real terms and highlight the importance of time-consistent policy (emphasized in Sections 3 and 4).[29] First, there are significant gains from adopting a fiscal rule for consumption expenditure over investment expenditure. Second, the flexible use of fiscal instruments to adjust according to a rule is crucial for managing debt sustainability, because placing too much weight on stable government spending inhibits the fiscal authority's ability to manage its debt trajectory.

5.2. Optimal simple rules for policy coordination

Tables 4 and 5 show the optimal policy responses assuming coordination between the fiscal and monetary authorities. Here, the objective of policy coordination is to stabilize a combined loss function that includes output, the fiscal target, and inflation.

[29] In the working paper version of this article we label these as stylized facts # 4 and #5.

Table 4
Optimal policy coordination. Weights on policy targets: y, pb^{gap}, $\pi^C = 1$.

Policy parameter (s)	Weights w on policy instrument(s) $w = 1$ Optimal value	$w = 0.5$	$w = 0$	$w = 0$	Actual†
Gov. cons. response to output $\theta_{cG,y}$	0.15	0.14	0.02	0.03	0.11
Gov. cons. response to debt $\theta_{cG,b}$	0.10	0.12	0.35	0.33	0.18
Int. rate response to inflation ϕ_π	1.57	1.58	1.63	–	1.57
Int. rate response to output $\phi_{\Delta y}$	0.39	0.39	0.42	–	0.39
Loss function L	**0.55**	**0.46**	**0.31**	**0.31**	
Gov. invest. response to output $\theta_{kG,y}$	0.42	0.42	0.19	−0.41	0.20
Gov. invest. response to debt $\theta_{kG,b}$	0.20	0.20	1.03	1.85	0.57
Int. rate response to inflation ϕ_π	1.62	1.63	3.35	–	1.57
Int. rate response to output $\phi_{\Delta y}$	0.42	0.43	1.21	–	0.39
Loss function L	**2.54**	**1.44**	**0.27**	**0.76**	

Note: the table presents estimated optimal values for fiscal expenditure instruments and monetary policy. Policy co-ordination objectives include output, inflation, and the relevant fiscal target. Source: authors' calculations.

Table 5
Optimal policy coordination. Weights on policy targets: y, b, $\pi^C = 1$.

Policy parameter (s)	Weights w on policy instrument (s) $w = 1$ Optimal value	$w = 0.5$	$w = 0$	$w = 0$	Actual†
Gov. cons. response to output $\theta_{cG,y}$	0.13	0.07	−0.91	−0.68	0.11
Gov. cons. response to debt $\theta_{cG,b}$	0.13	0.07	1.79	1.42	0.18
Int. rate response to inflation ϕ_π	1.58	1.82	2.02	–	1.57
Int. rate response to output $\phi_{\Delta y}$	0.40	0.53	0.63	–	0.39
Loss function L	**0.96**	**0.78**	**0.31**	**0.35**	
Gov. invest. response to output $\theta_{kG,y}$	0.42	0.42	−2.62	−0.65	0.20
Gov. invest. response to debt $\theta_{kG,b}$	0.20	0.20	5.89	2.28	0.57
Int. rate response to inflation ϕ_π	1.64	1.66	2.13	–	1.57
Int. rate response to output $\phi_{\Delta y}$	0.43	0.44	8.36	–	0.39
Loss function L	**2.90**	**1.79**	**0.17**	**0.61**	

Note: the table presents estimated optimal values for fiscal expenditure instruments and monetary policy. Policy co-ordination objectives include output, inflation, and the relevant fiscal target. Source: authors' calculations.

We find that the actual weights in the South African Reserve Bank's (SARB) estimated Taylor rule response function are 1.57 on inflation and 0.39 on output growth. These values compare reasonably well to the canonical coefficients from Taylor (1993)—1.5 for the inflation gap and 0.5 on the output gap—and the values used in the SARB's quarterly projection model—1.57 for the inflation gap and 0.54 on the output gap.[30]

Under our soft scenario (Table 4) we find that the optimal policy rules for both fiscal instruments, under coordination, follow closely the actual estimated values when instrument instability receives a non-zero weight (w = 1 and w = 0.5). We again observe that the best coordination result obtains with a government consumption expenditure rule. In fact, welfare losses are the same ($L = 0.31$) for both optimal policy coordination and when only government consumption expenditure is considered. Furthermore, a fiscal rule for government consumption generally performs better than one for government investment. Even though welfare loss is slightly less under coordination with a government investment rule when $w = 0$, it requires a much stronger counteracting response by the monetary authority to both inflation and output (more than double the magnitude). This scenario is highly unlikely given the SARB's historical reaction to inflation and output. In other words, an investment rule requires active coordination with monetary policy, whereas a consumption rule does not. Furthermore, an investment rule would require much greater sensitivity in government investment decisions to debt developments, which would be suboptimal, as borne out in the previous analysis.

Under our hard scenario (Table 5) the above results are again made more stark. The optimal fiscal rules respond more aggressively against debt accumulation and more procyclically to output as instability in the policy instruments become less of a concern. We observe again that fiscal sustainability can be optimally achieved independent of coordination under a government consumption rule.

These findings can be corroborated with those in Hollander (2021), where an investment stimulus leads to a monetary policy response (an increase in interest rates) as a result of higher inflation and output. But the effect of monetary policy on the long-term interest rate is offset by a lower risk premium. This is in contrast to the increase in the risk premium associated with a positive consumption shock.

The results also indicate that both fiscal and monetary authorities place significant weight on variability in their policy instruments (optimal values and actual estimated values are much closer when w = 1 and w = 0.5). As noted in the preceding discussion (Section 5.1), in the current environment of high debt and low growth, fiscal instruments must be flexible enough to adjust (according to a rule) to control debt and/or provide demand-side management.

For monetary policy, in contrast, instrument *stability* is desirable, not only because it is used to indicate the stance of monetary policy, but because volatility in the interest rate can led to an erosion of credibility (and thus a de-anchoring of inflation expectations) as well as financial instability.[31]

[30] The original 1993 Taylor rule does not control for interest rate persistence through an autoregressive term (ϕ_R in Eq. (6)). Using the original Taylor specification, Bold and Harris (2018) estimate a coefficient of 1.56 on inflation expectations and 0.751 on the output gap for South Africa. Note also that our Taylor rule specification includes the growth rate of output as opposed to the output gap. This difference should not influence the results meaningfully since Kemp & Hollander (2020), on which our model is based, apply a more detailed specification for the Taylor rule in their estimation with similar data. We simplify the Taylor rule in our analysis here for comparability with the fiscal rules.

[31] Optimal monetary policy results in Table A5 in the Appendix confirm that monetary policy is only suboptimal to the extent that there is interest rate smoothing.

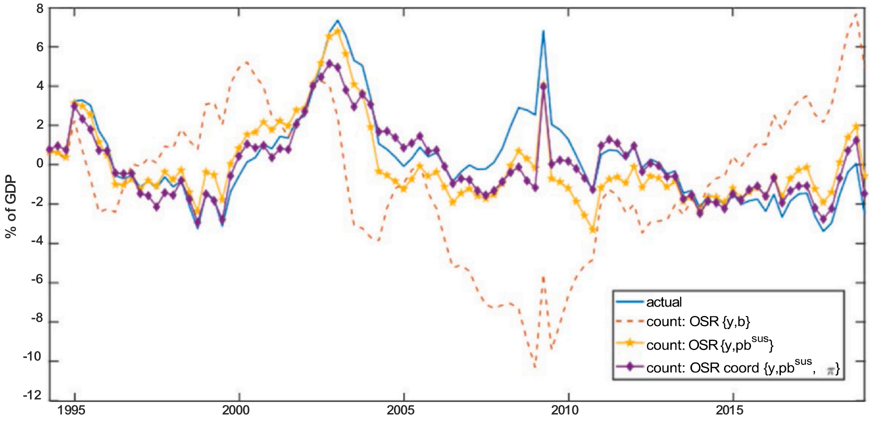

Fig. 3. Fiscal sustainability gap. Note: OSR $\{y,\ b\}$ = real expenditure rule with debt target (hard scenario); OSR $\{y,\ pb^{sus}\}$ = real expenditure rule with sustainability gap target (soft scenario). OSR $\{y,\ pb^{sus},\ \pi\}$ = fiscal-monetary policy coordination (soft scenario).
Source: authors' compilation.

Our optimal fiscal policy is to reduce government consumption expenditure in response to rising debt. To the extent that the optimal fiscal policy response is deflationary, the findings here suggest that monetary policy can counteract the associated output losses.

5.3. Counterfactual scenarios

The second approach to presenting the results is to run a counterfactual exercise, estimating the effects of a different policy setting across the entire sample period. That is, we compare the actual estimated paths to counterfactual scenarios with our estimated optimal simple rules. This exercise provides a 'what-if' approach to analyse what the effects would have been of different policy settings on past outcomes, as a guide to understanding the outcome of future policy settings (for a discussion of how DSGE models are used in this way, see Christiano et al., 2018). An alternative approach is to undertake a series of forecasts assuming different policy settings. This does, however, require assumptions on the post-COVID future and a DSGE model that is suited to forecasting. While this is our intended avenue for future research, we take a retrospective approach using the structural parameters and shock processes estimated from the South African data.

In Figs. 3 and 4 we present the fiscal sustainability gap and government debt-to-GDP under the different scenarios: soft fiscal adjustment, hard fiscal adjustment, and policy coordination in the soft fiscal adjustment scenario. To highlight the interaction between fiscal policy and monetary policy we show the results using government investment expenditure as the policy instrument.[32]

[32] As shown in the previous section, policy coordination provides minimal welfare improvement when government consumption expenditure is the fiscal instrument. Two key reasons for this are (1) the degree of interest rate smoothing, and (2) the limited demand-side impact of government consumption on output and inflation (see Hollander, 2021; Kemp & Hollander, 2020. Figs. A4, A5, and A6 in the Appendix present the counterfactual results for GDP, inflation, the short-term interest rate, and the long-term interest rate. These counterfactual results highlight the economic impact of the application of the optimal simple rule of the fiscal response presented here.

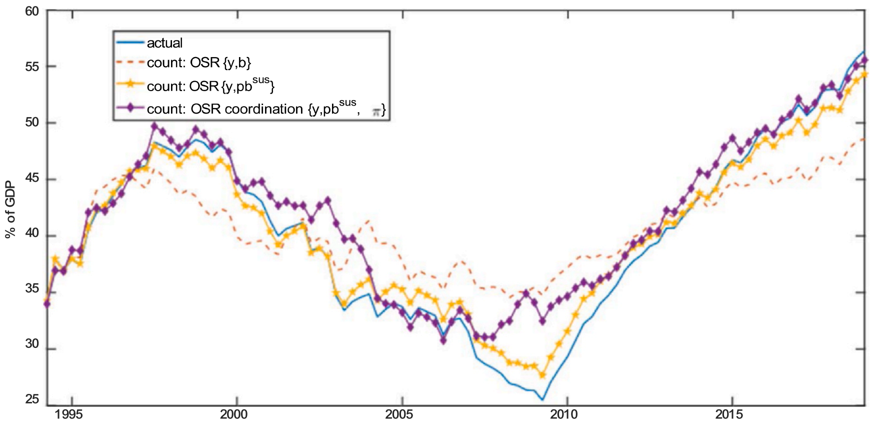

Fig. 4. Debt-to-GDP stabilization. Note: OSR $\{y, b\}$ = real expenditure rule with debt target (hard scenario); OSR $\{y, pb^{sus}\}$ = real expenditure rule with sustainability gap target (soft scenario). OSR $\{y, pb^{sus}, \pi\}$ = fiscal-monetary policy coordination (soft scenario).
Source: authors' compilation.

The counterfactual results show a somewhat nuanced result for optimal policy over the entire period. During the fiscal boom period of 2005–11, the optimal policy response indicates higher levels of government investment spending than was experienced, and this government investment is funded through an accumulation of debt. As a result, during the 2005–11 period, the debt-to-GDP ratio is higher in the optimal policy scenario than in the actual scenario. Accordingly, we observe cumulative *negative* fiscal sustainability gaps over the same period. These results are significantly stronger as we move from the soft scenario to the hard scenario. Under the soft scenario we observe some gains for policy coordination from 2007 onwards.

Given the investment stimulus between 2005 and 2011, we observe a significant increase in output above trend (Fig. A4). Under policy coordination, these gains are more than offset by the monetary authority (Fig. A5), who responds to the positive demand-side effects of government investment. This result reaffirms earlier findings that government investment should not be an active instrument for debt stabilization since we find (1) better welfare gains from a government consumption expenditure rule, and (2) a limited role for policy coordination.

In the following period, as debt-to-GDP climbs above its average level for the period, the optimal response is to cut back spending. Over this period we observe limited gains from a soft consolidation approach as well as under policy coordination. Here, our results from Section 5.1 again suggest that fiscal consolidation based on a rule for lower government consumption expenditure would ensure that debt rises at a slower pace without significant adverse output losses from less investment (in both the short and long run) and irrespective of how monetary policy responds. In fact, a credible commitment to reduce government consumption expenditure to achieve fiscal sustainability will likely be accommodated by the monetary authority to the extent that it dampens aggregate demand.

Finally, Fig. 5 shows government debt deviations from the steady state. Here, we can more clearly observe how the aggressive fiscal rule (the hard scenario) stabilizes debt significantly more than our soft scenario, even under policy coordination. The 'right' approach for fiscal authorities would be to consider a target for fiscal sustainability between these extremes.

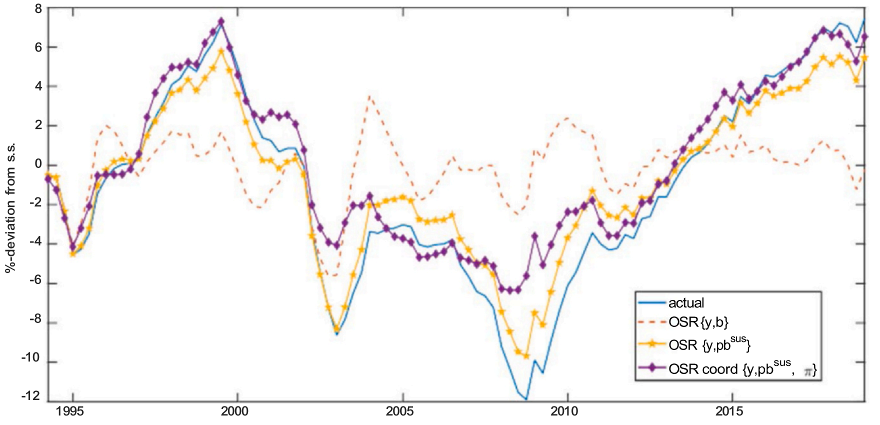

Fig. 5. Government debt. Note: OSR $\{y, b\}$ = real expenditure rule with debt target (hard scenario); OSR $\{y, pb^{sus}\}$ = real expenditure rule with sustainability gap target (soft scenario). OSR $\{y, pb^{sus}, \pi\}$ = fiscal-monetary policy co-ordination (soft scenario).
Source: authors' compilation.

6. Conclusion

This paper considers an optimal policy mix for South Africa. The analysis builds on a set of stylized facts, of which the following are important for the conclusion. First, due to severe energy constraints the economy is operating close to potential growth and the aggregate supply curve is vertical. Any short-term demand stimulus will not meaningfully increase output, and will likely only lead to rising prices. Thus, the standard policy advice of counter-cyclical fiscal and monetary policy is not possible. Second, r is greater than g. When debt-servicing costs exceed economic growth, fiscal policy is constrained and a fiscal expansion will only create debt. Third, fiscal policy has become time-inconsistent, which has led to a loss of fiscal policy credibility. Time inconsistency has become a significant feature of both arms of fiscal policy—announced expenditure reductions (particularly in government wages) are in doubt, while corporate tax cuts have been long promised but not delivered. The extent of forecast ('fiscal projection') errors and the estimated long-run steady states (trends) of economic variables are crucially important for policy decision-making and credibility.

What are the implications? The first is that restoring fiscal policy credibility is critical. A credible fiscal consolidation path would support lower interest rates—both the risk premium in the long-term interest rate and the policy rate. On one hand, stabilizing debt will lead to a lower risk of sovereign debt default and therefore lower pricing of risk in the long-term yield on government debt. On the other hand, the SARB's actions, through the policy rate, will to some extent counteract the negative welfare implications of the fiscal consolidation. This response needs to be balanced against a strong preference for policy rate smoothing and the choice of the fiscal instrument—consumption and/or investment expenditure—that will be used to achieve fiscal sustainability. We show that an optimal rule for government consumption expenditure provides the best welfare gains for output and debt stabilization, whether or not policy is coordinated with the monetary authority.

Fiscal policy also needs to balance short- versus long-term fiscal sustainability objectives. Fiscal consolidation will come with some welfare costs, but these costs can be minimized with the right choice of instrument. The welfare costs of a measured fiscal consolidation are outweighed by the welfare costs of doing nothing—which is a fiscal crisis—as well as an aggressive ('hard') consolidation—which would not only be politically infeasible but also difficult to calibrate and implement.

Appendix A. Appendix

A.1. Calculation of r_t^{adj}

Following Blanchard (2019), we use the *after tax net* interest cost to the sovereign net of taxes. On a weekly basis, the Treasury issues a combination of fixed interest and inflation-linked debt at different maturity profiles. Debt is serviced on a coupon basis (equivalent to a fixed interest rate) not on a floating rate. Thus, to obtain an estimate of the maturity-adjusted cost of debt, it is necessary to construct the maturity profile of the Treasury using the coupon rates at which the debt was originally issued at the time of issuance. This is an extensive exercise. Here we use an approximation: the actual gross interest paid as a percentage of the nominal outstanding debt, which we call the 'gross nominal effective interest rate' or the 'gross nominal average borrowing cost' on gross government debt.

The correct measure of r is the borrowing cost of net debt.[33] The National Treasury publishes cash holdings numbers on a monthly basis and interest income.

The corresponding primary balance is the primary balance adjusted for interest income (i.e. non-interest revenue less non-interest expenditure).[34]

To do this, we have obtained the ownership structure of all debt (pension funds, insurers, foreign holders, etc.) from the monthly National Treasury data.[35] We estimate the tax payments of offshore versus onshore bond holders, taking into account that there is a withholding tax regime that creates a differentiation between the two types. See Table A1.

Table A1
Calculation of r and r_t^{adj}.

		2017/18	2018/19	2019/20
Debt service costs (NT table 3)		162,644.6	181,849.1	204,769.4
Interest income (NT table 3)		3484.8	6833.6	8276.1
Net interest payments		**159,159.77**	**175,015.45**	**196,493.24**
Average debt (SARB QB S-57)		2127,524	**2367,589**	**2689,706**
End of period debt (NT table 10)		2260,367	2545,183	2997,770
Average borrowing cost on government debt (nominal) debt at end of period		7.0%	6.9%	6.6%
Average borrowing cost on government debt (nominal) average debt over period	r_t	7.5%	7.4%	7.3%
Tax income on government debt (derived from STRATE holdings data)		14,550	17,234	20,835
Average borrowing cost on government debt (nominal, adjusted for tax income)	r_t^{adj}	6.8%	6.7%	6.5%
Nominal growth in output	g_t	6.3%	4.8%	4.6%
Net domestic debt stock as percentage of GDP	b_t	45.7%	48.3%	53.7%

(*continued on next page*)

[33] The IMF definition of net debt is gross debt minus financial assets corresponding to the same debt instruments. Cash from borrowings corresponds to this definition, but other 'assets' that the sovereign might have, such as airlines, are excluded.

[34] The National Treasury calculates the primary balance as all revenue less non-interest expenditure. The difference is approximately 0.1 per cent of GDP. According to the preliminary year-end revenue figures, interest revenue was ZAR6.7 billion in 2020/21.

[35] See http://www.treasury.gov.za/comm_media/press/monthly/monthly_2021.aspx; this is also presented in figure 7.2 of the Budget Review.

Table A1 (*continued*)

		2017/18	2018/19	2019/20
Debt-stabilizing primary balance	pb_t^{sus}	0.2%	0.8%	0.9%
National Treasury primary balance		– 1.0%	– 1.0%	– 2.7%
$r-g$		0.7%	2.1%	2.0%
Fiscal adjustment required (%GDP)		– 1.2%	– 1.8%	– 3.6%
Fiscal adjustment required (ZAR)		– 55,054.62	– 89,118.15	– 185,710.17
Interest income (% of cash)		1.5%	2.8%	3.1%

Source: authors' calculations based on National Treasury data.

From the detailed calculations, we can undertake a forecast of the fiscal adjustment required to achieve fiscal stabilization (Table A2).

Table A2
Calculation of r_t^{adj}: forecast.

Fiscal arithmetic		2018/19	2019/20	2020/21	2021/22	2022/23	2023/24
Average borrowing cost on government debt (nominal)	r_t	6.7%	6.5%	6.2%	6.4%	6.7%	6.7%
Nominal growth in output	g_t	4.8%	4.6%	– 1.9%	8.8%	5.9%	5.8%
Net domestic debt stock as percentage of GDP	b_t	48.3%	53.7%	69.3%	72.5%	73.7%	73.8%
Debt-stabilizing primary balance	pb_t^{sus}	0.8%	0.9%	4.4%	– 1.5%	0.5%	0.6%
Projected primary balance	pb_t	– 1.0%	– 2.7%	– 6.4%	– 3.2%	– 1.2%	– 0.1%
Gap		2.1%	2.0%	– 10.9%	– 1.7%	– 1.7%	– 0.7%
Fiscal adjustment required (ZAR)		**– 89,118**	**– 185,710**	**– 544,635**	**– 91,659**	**– 97,223**	**– 45,060**

Source: authors' calculations based on National Treasury data.

A.1.1. Calculation of g

We approach the calculation of g in two ways. The first is to use the annual nominal growth rate in output. This provides a year-on-year growth rate, and subsequently allows for an *in-year* estimate of the sustainable fiscal balance. This is not necessarily what policy-makers are concerned with. Rather, given significant external shocks (not least of which is the 2020–21 COVID-19 pandemic), long-term estimates of g are arguably better for deriving long-run estimates of a sustainable fiscal stance. (Equally, our estimates of r rely on relatively slow-changing effective borrowing costs, rather than using volatile yields.) There have been a number of estimates of long-run sustainable growth.[36] Here, we use the potential growth estimates of Fedderke and Mengisteab (2017) overlaid with more updated estimates from the SARB using a similar methodology. This allows us to generate two series for $r-g$.

A.2. Calculation of debt-stabilizing primary balance

Source: authors' calculations.

[36] Including Havemann and Kerby (2021), who estimate using three centuries of data.

MACROECONOMIC PROJECTIONS												
R billion/percentage change	**2018/19**	**2019/20**	**2020/21**	**2021/22**	**2022/23**	**2023/24**	**2024/25**	**2025/26**	**2026/27**	**2027/28**	**2028/29**	**2029/30**
Real GDP growth	1.3%	0.1%	-7.2%	6.2%	1.8%	1.6%	1.8%	1.8%	1.8%	1.8%	1.8%	1.8%
Nominal GDP growth	5.5%	5.0%	-2.1%	10.9%	5.3%	5.5%	6.3%	6.3%	6.3%	6.3%	6.3%	6.3%
CPI inflation	4.6%	4.2%	2.9%	4.9%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
GDP at current prices (R billion)	**5,418.3**	**5,686.7**	**5,566.2**	**6,173.8**	**6,501.0**	**6,856.4**	**7,288.4**	**7,747.5**	**8,235.6**	**8,754.5**	**9,306.0**	**9,892.3**
GDP deflator		4.9%	5.1%	4.7%	3.5%	3.9%	4.5%	4.5%	4.5%	4.5%	4.5%	4.5%
Main budget revenue	**1,275.3**	**1,345.9**	**1,238.4**	**1,483.2**	**1,517.5**	**1,581.3**	**1,680.9**	**1,786.8**	**1,899.4**	**2,019.0**	**2,146.2**	**2,281.5**
%GDP	*23.5%*	*23.7%*	*22.2%*	*24.0%*	*23.3%*	*23.1%*	*23.1%*	*23.1%*	*23.1%*	*23.1%*	*23.1%*	*23.1%*
Growth year-on-year		*5.5%*	*-8.0%*	*19.8%*	*2.3%*	*4.2%*	*6.8%*	*6.3%*	*6.3%*	*6.3%*	*6.3%*	*6.3%*
Expenditure												
Expenditure ceiling	1,307.1	1,418.5	1,487.4	1,570.9	1,641.6	1,715.5	1,792.6	1,873.3	1,957.6	2,045.7	2,137.8	2,234.0
Contingency reserve	–	–	–	*3.0*	*5.0*	*5.0*	*5.0*	*5.0*	*5.0*	*5.0*	*5.0*	*5.0*
Compensation add-on							–	–	–	–	–	–
Other non-interest expenditure[2]	17.6	67.8	69.0	53.0	42.5	43.4	46.1	50.0	50.0	50.0	50.0	50.0
Non-interest expenditure	**1,324.8**	**1,486.2**	**1,556.4**	**1,623.9**	**1,684.1**	**1,758.8**	**1,838.8**	**1,923.3**	**2,007.6**	**2,095.7**	**2,187.8**	**2,284.0**
Debt-service costs	181.8	204.8	232.6	269.2	304.9	341.2	380.3	420.8	470.6	522.0	574.7	628.7
Debt-service cost estimate		193.8	226.7	273.6	299.9	336.2	375.3	415.8	465.6	517.0	569.7	623.7
Debt-service costs (% avg debt)		6.8%	6.5%	6.5%	6.7%	6.7%	6.7%	6.3%	6.3%	6.4%	6.4%	6.4%
Main budget expenditure	**1,506.6**	**1,691.0**	**1,789.0**	**1,893.1**	**1,989.0**	**2,100.0**	**2,219.1**	**2,344.1**	**2,478.2**	**2,617.7**	**2,762.5**	**2,912.7**
	27.8%	*29.7%*	*32.1%*	*30.7%*	*30.6%*	*30.6%*	*30.4%*	*30.3%*	*30.1%*	*29.9%*	*29.7%*	*29.4%*
Main budget balance	**-231.3**	**-345.1**	**-550.6**	**-409.9**	**-471.4**	**-518.7**	**-538.2**	**-557.3**	**-578.9**	**-598.7**	**-616.2**	**-631.2**
	-4.3%	*-6.1%*	*-9.9%*	*-6.6%*	*-7.3%*	*-7.6%*	*-7.4%*	*-7.2%*	*-7.0%*	*-6.8%*	*-6.6%*	*-6.4%*
Primary balance	**-49.5**	**-140.3**	**-318.0**	**-140.7**	**-166.5**	**-177.5**	**-157.8**	**-136.5**	**-108.2**	**-76.7**	**-41.5**	**-2.5**
	-0.9%	*-2.5%*	*-5.7%*	*-2.3%*	*-2.6%*	*-2.6%*	*-2.2%*	*-1.8%*	*-1.3%*	*-0.9%*	*-0.4%*	*-0.0%*
BORROWING REQUIREMENT												
Main budget balance	-231.3	-345.1	-550.6	-409.9	-471.4	-518.7	-538.2	-557.3	-578.9	-598.7	-616.2	-631.2
Redemptions	-15.6	-70.7	-67.6	-65.2	-113.0	-154.7	-155.8	-160.0	-160.0	-160.0	-160.0	-160.0
Gross borrowing requirement	**-246.9**	**-415.8**	**-618.3**	**-475.1**	**-584.4**	**-673.4**	**-694.0**	**-717.3**	**-738.9**	**-758.7**	**-776.2**	**-791.2**
	-4.6%	*-7.3%*	*-11.1%*	*-7.7%*	*-9.0%*	*-9.8%*	*-9.5%*	*-9.3%*	*-9.0%*	*-8.7%*	*-8.3%*	*-8.0%*
GOVERNMENT DEBT												
Gross loan debt end of period	**2,788.3**	**3,261.3**	**3,935.7**	**4,313.9**	**4,835.7**	**5,398.8**	**5,980.5**	**6,697.7**	**7,436.6**	8,195.2	8,971.5	**9,762.7**
	51.5%	***57.4%***	***70.7%***	***69.9%***	***74.4%***	***78.7%***	***82.1%***	***86.5%***	***90.3%***	*93.6%*	*96.4%*	***98.7%***
Average gross loan debt		3,024.8	3,598.5	4,124.8	4,574.8	5,117.3	5,689.7	6,339.1	7,067.2	7,815.9	8,583.4	9,367.1
Net loan debt	**2,545.2**	**2,997.8**	**3,601.8**	**4,089.0**	**4,519.6**	**4,935.2**	**5,342.7**	**6,417.7**	**7,156.6**	**7,915.2**	**8,691.5**	**9,482.7**
	47.0%	***52.7%***	***64.7%***	***66.2%***	***69.5%***	***72.0%***	***73.3%***	***82.8%***	***86.9%***	***90.4%***	***93.4%***	***95.9%***

1. Assume that revaluation stays constant over period

2. Debt then rises by gross borrowing requirement plus revaluation

3. To avoid circular reference, use cash projection as published by Treasury

Spending assumptions

Expenditure ceiling grows at CPI

Compensation grows at CPI +0.5%

Non-interest expenditure constant at R50 billion p.a.

A.3. *Calculation of tax buoyancy*

Table A3
Tax revenue performance: outcomes and projections, 2009/10–2019/20 (annual % change).

	2009/10	2010/11	2011/12	2012/13	2013/14	2014/15	2015/16	2016/17 estimate	Average to 2016/17	2017/18	2018/19	2019/20 projections
PIT	**5.1**	**10.6**	**10.3**	**10.2**	**12.3**	**13.9**	**9.9**	**10.6**	**10.4**	**10.0**	**10.6**	**10.5**
buoyancy	*0.9*	*1.0*	*1.1*	*1.3*	*1.5*	*2.1*	*1.7*	*1.5*	*1.4*	*1.4*	*1.3*	*1.3*
CIT	**− 18.4**	**− 1.5**	**14.1**	**5.0**	**11.3**	**4.3**	**3.3**	**5.2**	**2.9**	**5.5**	**6.1**	**8.0**
buoyancy	*− 3.1*	*− 0.1*	*1.6*	*0.6*	*1.3*	*0.6*	*0.6*	*0.7*	*0.3*	*0.7*	*0.8*	*1.0*
VAT	**− 4.1**	**24.1**	**4.1**	**12.6**	**10.5**	**9.9**	**7.5**	**4.3**	**8.6**	**7.5**	**7.9**	**7.9**
buoyancy	*− 0.7*	*2.2*	*0.5*	*1.6*	*1.2*	*1.5*	*1.3*	*0.6*	*1.0*	*1.0*	*1.0*	*1.0*
Electricity levy[1]	–	**49.5**	**28.7**	**24.2**	**10.5**	**3.0**	**8.7**	–	**20.8**			
buoyancy	–	*4.6*	*3.2*	*3.0*	*1.2*	*0.5*	*1.5*	–	*2.3*			
Fuel levy	**15.9**	**19.4**	**6.3**	**10.4**	**8.1**	**25.3**	**2.5**	–	**12.6**			
buoyancy	*2.7*	*1.8*	*0.7*	*1.3*	*1.0*	*3.8*	*0.4*	–	*1.7*			
Tax revenue[2]	**− 4.2**	**12.6**	**10.2**	**9.6**	**10.6**	**9.6**	**8.5**	**7.7**	**8.1**	**10.5**	**9.7**	**8.9**
NGDP growth	*5.9*	*10.8*	*9.0*	*8.0*	*8.5*	*6.6*	*5.8*	*7.2*	*7.7*	*7.3*	*8.0*	*8.1*
Tax buoyancy[3]	**− 0.7**	**1.2**	**1.1**	**1.2**	**1.2**	**1.5**	**1.5**	**1.1**	**1.0**	**1.4**	**1.2**	**1.1**

Note: (1) electricity levy introduced in 2009/10; (2) (gross) tax revenue excl. non-tax revenues, SACU payments, and consolidated budget; (3) tax buoyancy is calculated by dividing total tax revenue growth by nominal GDP growth. Source: authors' calculations based on data from the National Treasury and SARS.

A.4. Why does expenditure have to carry the burden of the fiscal consolidation?

Why does expenditure have to carry the burden of the fiscal consolidation? Why can't tax rates simply be increased? First, Kemp (2019), (2020b) provides detailed micro-level empirical work on the estimated elasticities of taxable income and the optimal tax rate for the top 10 per cent of income earners in South Africa. The relevant finding here is that legislated tax rates are higher than the optimal revenue-maximizing level. As a result, raising consumption or marginal income tax rates further would likely induce a negative revenue response. Second, robust estimates of tax revenue multipliers on historical data remain elusive. On one hand, Makrelov et al. (2018) and Kemp (2020a) find that tax revenue *increases* produce negative fiscal multipliers and are thus largely counterproductive for a consolidation strategy amid weak economic growth. Indeed, relative to spending multipliers, tax multipliers are more distortionary, are subject to greater model uncertainty, and are smaller in weak economic environments. On the other hand, Kemp & Hollander (2020) and Hollander (2021) provide evidence for disaggregated fiscal instruments using a micro-founded general equilibrium framework. Their results suggest that an exogenous *decrease* in tax revenue for all three tax instruments, respectively, raises government debt and reduces output and inflation, which results in an elevated risk premium. Given the contradictory evidence, taxes alone cannot be relied on to bring about the required primary balance adjustment.

For example, Kemp & Hollander (2020) find that VAT is the least distortionary tax measure for households. Now, consider that the primary deficit in 2019/20 (pre-COVID) was ZAR140.3 billion, and, in the same year, domestic VAT revenue was ZAR346.7 billion. A 40 per cent increase in VAT collections, equivalent to an increase in the VAT rate of approximately 6 % points, would be required to close the primary deficit. Such a large increase is likely to be highly distortionary and any estimated tax elasticity is likely to break down. The 2019/20 fiscal year was to some extent an anomaly. In 2017/18 and 2018/19, the primary deficit was ZAR45.9 and ZAR49.5 billion, respectively, and the corresponding VAT rate increase would have needed to be 2 % points, over and above the 1 % point increase announced in the 2018 Budget. For non-financial firms, Kemp & Hollander (2020) suggest that capital tax increases, in the long run, could partially finance an investment-driven fiscal stimulus. But this approach is unlikely, given that marginal corporate income taxes have fallen consistently and considerably around the world since 1980, with South Africa above the world average statutory (marginal) rate of 23 per cent and is set to lower it further from 28 per cent to 27 per cent from 2022.[37] At the same time, South African corporate income tax collection (including taxes on property) as a share of net operating surplus has increased consistently from 10per cent to 20 per cent over the period 1994–2018.

Fig. A1 puts the scale of required revenue increases into context. Between 2009/10 and 2019/20, the gap between expenditure-to-GDP and revenue-to-GDP averaged around 5 % points. Assuming a perfectly linear relationship between tax rates and revenue (i.e. no negative multiplier), to close this gap revenue would need to rise from 25 per cent of GDP to 30 per cent of GDP—equivalent to ZAR240 billion. It is difficult to see how such a large tax increase, even if it were phased in over many years, could not harm growth.

[37] See https://taxfoundation.org/publications/corporate-tax-rates-around-the-world.

A.5. Extra tables and figures

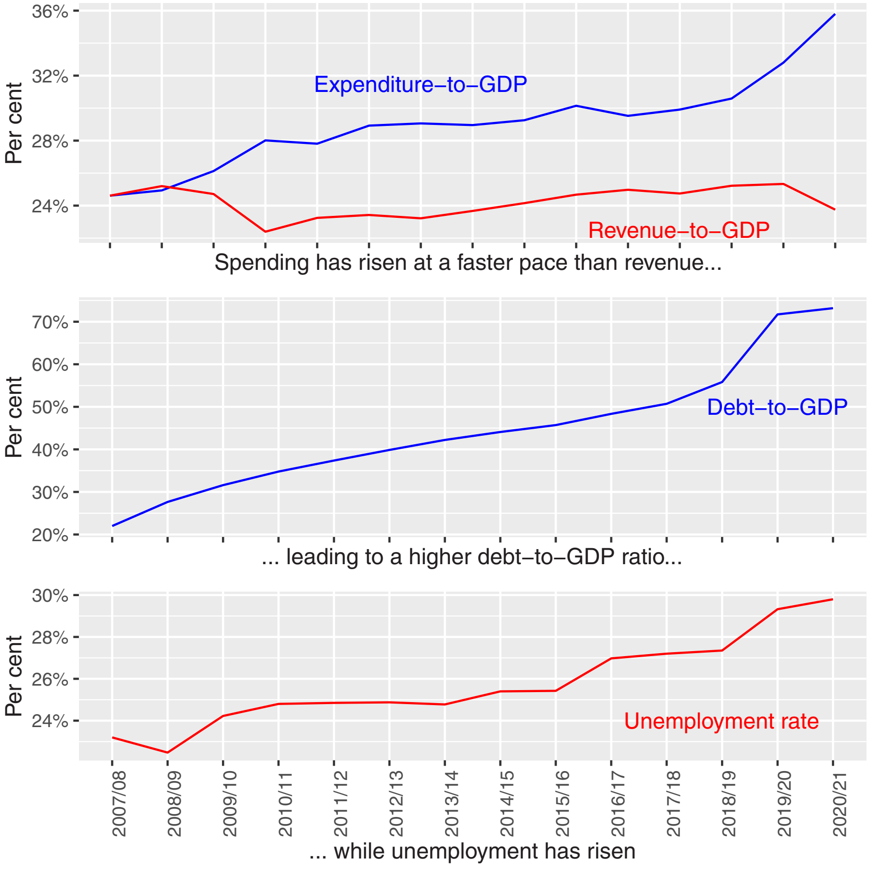

Fig. A1. Spending has delivered neither growth nor employment. Source: authors' compilation based on National Treasury and Statistics South Africa data..

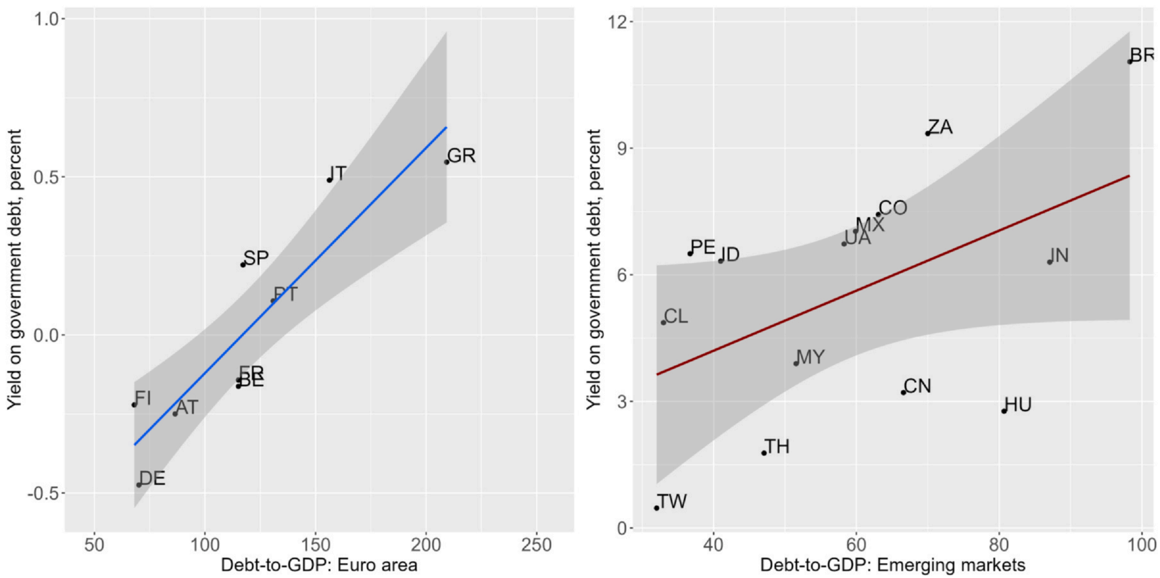

Fig. A2. Debt-to-GDP and yields, 2021. Note: there is a positive correlation between nominal bond yields and debt-to-GDP ratios in both the eurozone (LHS) and emerging markets (RHS). The left-hand panel shows that in the eurozone, (i.e. controlling for currency risk) countries with higher debt-to-GDP ratios have higher yields. In the right-hand panel we do a similar exercise with emerging markets. A simple correlation suggests a positive relationship, but even on this basis South Africa is an outlier. This observation implies a potential nonlinear relationship between debt-to-GDP and debt-service costs (see, e.g., Tran, 2018. As debt-to-GDP rises, the yield on each additional borrowed rand rises. This interaction creates a compounding effect on total debt-service costs as both the rate and amount of interest payable rises. Similarly, efforts to reduce debt-to-GDP can become self-reinforcing. As debt-to-GDP reduces, yields reduce. Debt can be refinanced at lower rates, reducing interest costs and total spending. Source: authors' compilation based on data from the Institute of International Finance.

Table A4
Observable variables.

Variable	Description	Source
Domestic economy		
$\Delta\ln(\tilde{Y}_t)$	Real GDP	South African Reserve Bank
$\Delta\ln(\tilde{E}_t)$	Non-agricultural employment	
$\Delta\ln(\tilde{W}_t)$	Real remuneration per worker in the non-agricultural sector	
$\Delta\ln(\tilde{G}_t)$	Government consumption	
$\Delta\ln(\tilde{I}_{G,t})$	Public sector investment	
$\Delta\ln(\tilde{TR}_t)$	Government transfers to households	
$\tilde{B}_t/\tilde{Y}_t$	Government debt to GDP	
$\tilde{R}_t$	Repo rate	
$\tilde{\pi}_{C,t}$	CPI inflation	Statistics South Africa
$\tilde{\pi}_{IM,t}$	Import inflation	
$\tilde{\pi}_{X,t}$	Export inflation	
$\tilde{\bar{\pi}}_{C,t}$	Inflation target	Kemp & Hollander (2020)
$\Delta\tilde{\tau}_t^w$	Labour tax rate	
$\Delta\tilde{\tau}_t^k$	Capital tax rate	
$\Delta\tilde{\tau}_t^c$	Consumption tax rate	
Foreign economy		
$\Delta\ln(\tilde{Y}_t^*)$	Real GDP (trade weighted)	GPM, CEPREMAP
$\tilde{R}_t^*$	Policy interest rates (trade weighted)	
$\tilde{\pi}_t^*$	CPI inflation (trade weighted)	

Table A5
Optimal monetary policy.

Weights on policy targets: $y, \pi^C = 1;\ r = w$				
	Weights w on policy instrument			
	$w = 1$	$w = 0.5$	$w = 0$	
Policy parameter(s)	Optimal values			Estimated
Int. rate response to inflation ϕ_π	3.15 / 1.59	3.33 / 1.60	3.59 / 1.66	1.57
Int. rate response to output $\phi_{\Delta y}$	0.98 / 0.40	1.06 / 0.40	1.18 / 0.42	0.39
Int. rate persistence ϕ_R	– / 0.66	– / 0.56	– / 0.03	0.87
Loss function L	**0.13 / 0.14**	**0.13 / 0.13**	**0.12 / 0.11**	
Weights on policy targets: $y, pb^{sus} = 1;\ \pi^C = w$				
	Weights w on policy goal (inflation)			
	$w = 1$	$w = 0.5$	$w = 0$	
Parameters	Optimal values			Estimated
Int. rate response to inflation ϕ_π	2.97	3.04	3.13	1.57
Int. rate response to output $\phi_{\Delta y}$	1.01	1.05	1.10	0.39
Loss function L	**0.29**	**0.28**	**0.28**	

Weights on policy targets: y, $b = 1$; $\pi^C = w$

	Weights w on policy goal (inflation)			
	$w = 1$	$w = 0.5$	$w = 0$	
Parameters	Optimal values			Estimated
Int. rate response to inflation ϕ_π	3.24	3.24	3.24	1.57
Int. rate response to output $\phi_{\Delta y}$	1.29	1.31	1.32	0.39
Loss function L	**0.52**	**0.51**	**0.51**	

Source: authors' calculations.

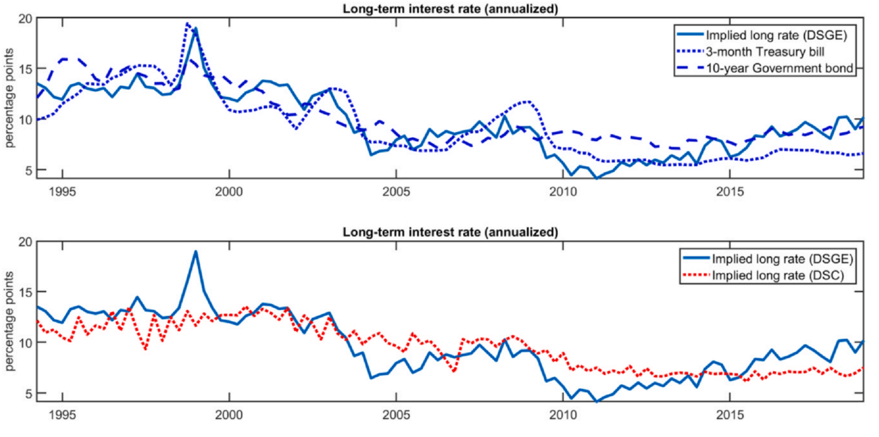

Fig. A3. Long rate: implied vs actual. Source: authors' compilation.

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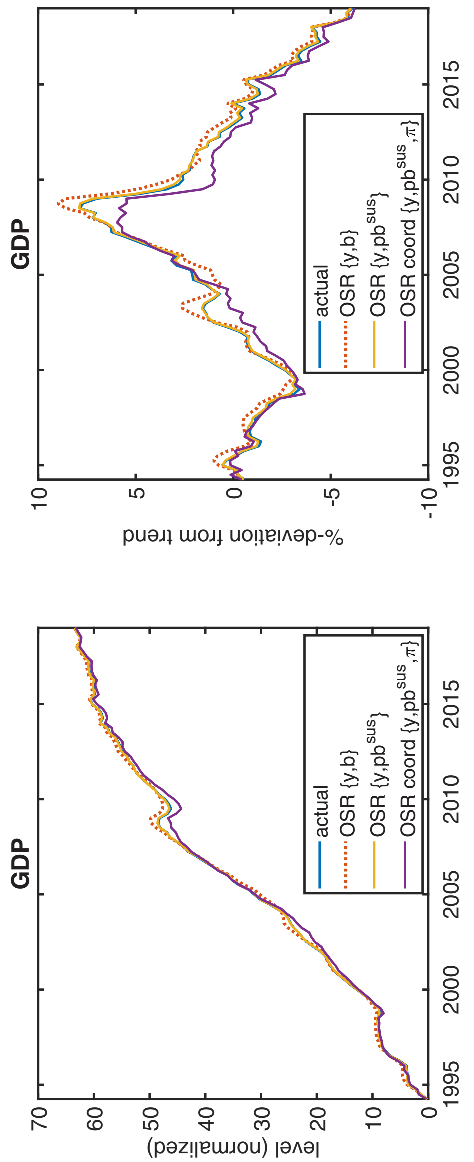

Fig. A4. Output (GDP). Source: authors' compilation.

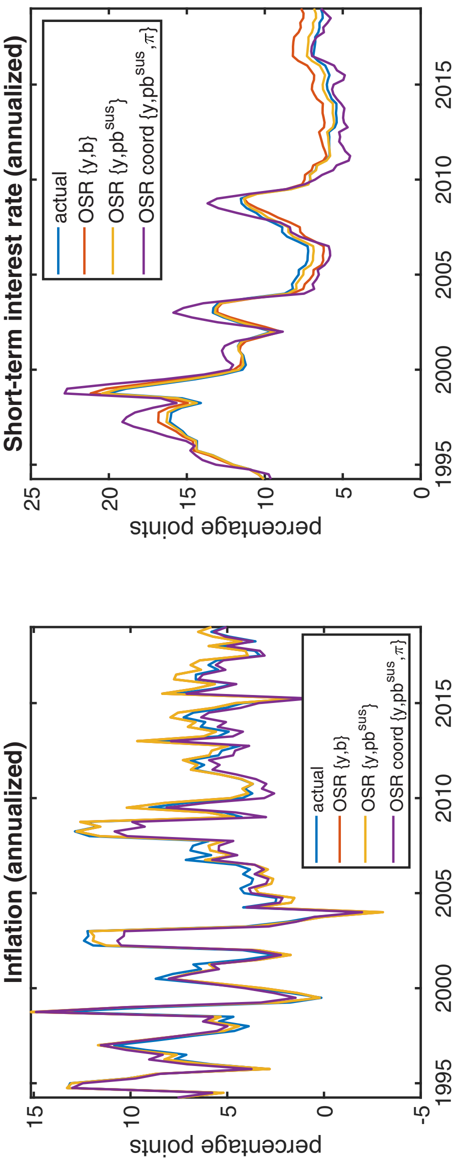

Fig. A5. Inflation and the short-term (policy) rate. Source: authors' compilation.

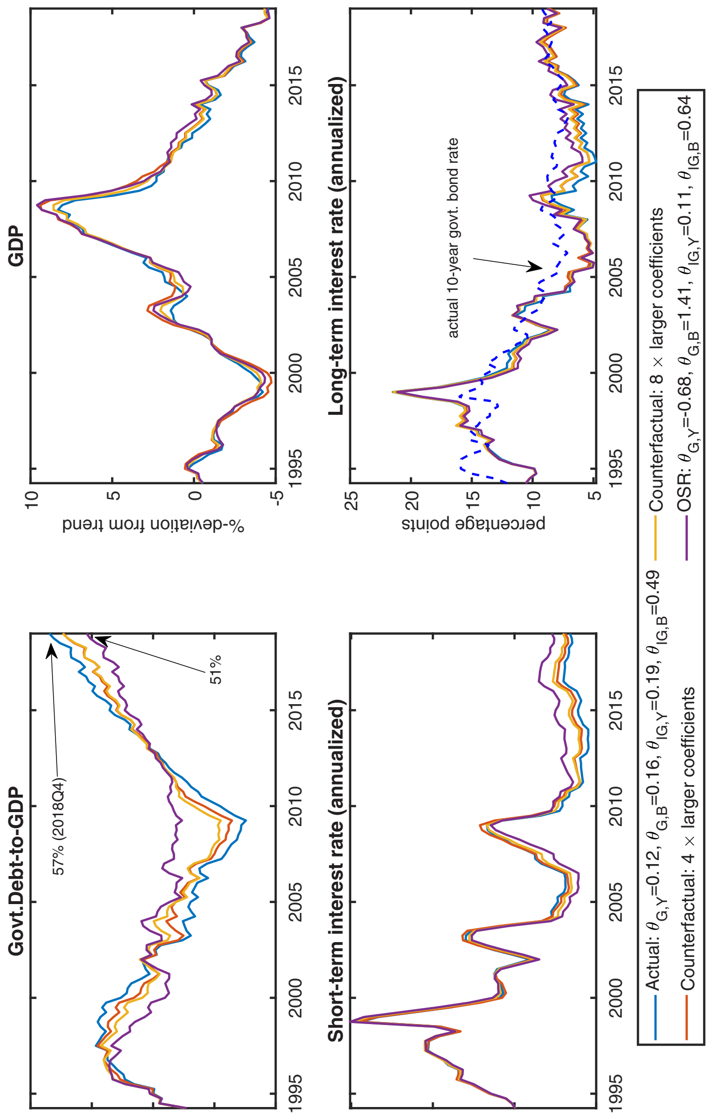

Fig. A6. Counterfactual analysis. Source: authors' compilation.

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