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Debt-financed fiscal stimulus in South Africa

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ABSTRACT
Levels of government debt-to-GDP have been rising substantially for over a decade in emerging market economies such as South Africa, which has led to much debate around the implementation of large-scale debt-financed fiscal stimulus programs in response to the economic fallout of the global covid-19 pandemic. Debt-financed fiscal policies directly stimulate aggregate demand through government expenditure or tax cuts, but their effectiveness is highly dependent on direct crowding-out of private sector expenditure, spill-over effects to the private sector through a higher risk premium on interest rates, and the interaction between fiscal policy and monetary policy. Using an open-economy dynamic stochastic general equilibrium model for South Africa, we identify the effect of six different fiscal policy instruments on short-term and long-term interest rates. These disaggregated expenditure and revenue shocks raise long-term real yields between 18 and 29 basis points, but there are non-negligible differences in the dynamic responses to each fiscal instrument. Our main findings suggest that, in the context of fiscal sustainability, an investment-driven debt-financed fiscal stimulus programme would reduce the government debt-to-GDP ratio, especially in periods of economic slack when monetary policy would typically be more accommodative. In fact, since the global financial crisis, monetary policy has reduced the burden of fiscal adjustment in response to rising debt and a rising risk premium. But further shocks to the risk premium could offset any gains from the current stance of monetary policy (for example, a credit rating shock raises the long-term government bond rate 155 basis points).

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1. Introduction

For over a decade, emerging market economies such as South Africa have seen their levels of government debt-to-GDP rise substantially, which has led to much debate around fiscal sustainability and sovereign debt risk.[1] Even so, with the economic fallout of the global covid-19 pandemic, governments implemented large-scale debt-financed fiscal stimulus (DFFS) programmes. DFFS programmes directly stimulate aggregate demand through

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government expenditure or tax cuts, but their effectiveness is highly dependent on direct crowding out of private sector expenditure (Afonso & Sousa, 2012; Kemp, 2020a; Kemp & Hollander, 2020; Traum & Yang, 2015), spill-over effects to the private sector through a higher risk premium on interest rates (Augustin, Boustanifar, Breckenfelder, & Schnitzler, 2018; De Bruyckere, Gerhardt, Schepens, & Vander Vennet, 2013; Peter & Grandes, 2005), and the interaction between fiscal policy and monetary policy (Ascari & Rankin, 2013; Ganelli & Rankin, 2020; Ramey, 2019). An important facet of this debate, that has received limited attention in the literature, surrounds the quantitative and dynamic effects of DFFS programmes on interest rates.[2]

Estimating the effects of government debt and deficits on interest rates therefore requires disentangling the effects of fiscal policy from other influences. The most obvious influences are the effects of the business cycle and associated monetary policy actions on debt, deficits, and interest rates. For example, if automatic fiscal stabilisers raise deficits during recessions, while at the same time long-term interest rates fall in response to monetary policy accommodation, deficits and interest rates could be negatively correlated even if the partial effect of deficits on interest rates is positive. Furthermore, observing changes in government deficits can reflect either changes in government expenditures or shifts in the timing and receipt of taxes, and observing debt accumulation may reflect valuation changes to the stock of existing debt (if foreign denominated) or rising debt-service costs, as opposed to DFFS. To isolate these factors, as well as the behaviour of households and firms over time, we motivate the use of a dynamic stochastic general equilibrium approach.

Empirical research typically uses the deficit-to-GDP ratio or the debt-to-GDP ratio to measure the effect of government debt on interest rates (see, e.g., Afonso & Martins, 2012; Engen & Hubbard, 2005; Fedderke, 2020; Gamber & Seliski, 2019; Hauner & Kumar, 2011; Laubach, 2009; Strauch, Paesani, & Kremer, 2006). We first test this relationship in the South African data and compare these results to a standard new-Keynesian dynamic stochastic general equilibrium (DSGE) model which includes an ad-hoc specification for government debt (deficits) as a proxy for DFFS. We identify the transmission mechanisms of DFFS on interest rates to operate through demand-side stimulus in the aggregate resource constraint and the risk premium on borrowing.[3] For example, an increase in government expenditure that is financed through debt will have a direct impact on aggregate demand (assuming crowding out is limited). The subsequent rise in inflation and output triggers an automatic response by the monetary authorities to raise the short-term interest rate. At the same time, higher debt (or deficits) raises the risk premium, which dampens output and inflation further.

Our reduced-form empirical results highlight the difficulty of identifying fiscal policy shocks, which is also well documented in the literature (see, e.g., Engen & Hubbard, 2004; Gamber & Seliski, 2019; Hauner & Kumar, 2011; Kemp, 2020a; Laubach, 2009; Peppel-Srebrny, 2021; Ramey, 2019). Furthermore, empirical evidence on the effect of government debt on interest rates in South Africa is very limited (see, e.g., Fedderke, 2020).[4]

These reduced-form estimates measure the average effect of changes in debt and deficits on interest rates without controlling for the specific fiscal policy that generated the change or how policy-makers, households, and firms will respond.[5] A DSGE model with a non-trivial fiscal block, in contrast, theoretically identifies channels of influence on interest rates that are specific to changes in fiscal policy, which are also time consistent (i.e., the *optimal* decisions of households and firms are invariant to changes in government policy). Specifically, with the incorporation of disaggregated expenditure and tax variables, a fiscal DSGE model can more reliably identify the net effect of government DFFS on interest rates.[6] We subsequently identify the effect of six different fiscal policy instruments (consumption spending, investment spending, transfers, consumption taxes, capital taxes, and labour taxes) on short-term and long-term (nominal and real) interest rates.

Our main results are as follows. The effect of debt-financed fiscal expenditure on long-term real yields are 18 basis points (bp) for a 1 per cent increase in transfers, 26 bp for a 1 per cent increase in consumption spending, and 29 bp for a 1 per cent increase in investment. Although the net effect of debt-financed fiscal expenditure on real yields closely corresponds to our reduced-form DSGE and vector autoregression (VAR) estimates, the dynamic adjustment of disaggregated expenditure instruments are markedly different.[7] Notably, investment-driven DFFS initially reduces the government debt-to-GDP ratio through its positive demand-side stimulus, whereas transfers and spending typically lead to crowding out (i.e., a reduction in aggregate demand) and a larger increase in debt. Furthermore, the divergences between these disaggregated expenditure components are dampened by the endogenous response of monetary policy to changes in aggregate demand (output and inflation). These findings suggest that an investment-driven DFFS produces more favourable outcomes for fiscal sustainability, as well as during recessionary episodes when monetary policy and fiscal policy are both expansionary.

The effect of debt-financed fiscal tax cuts and/or revenue shortfalls on short- and long-term interest rates are, in contrast, remarkably similar across the disaggregated tax revenue components.[8] A 1 pp decrease in consumption tax revenue (VAT), labour income tax revenue (PIT), and capital tax revenue (CIT) all raise long-term nominal and real rates by approximately 13 bp and 19 bp, respectively. This increase in the long-term interest rate is driven by a higher risk premium as opposed to the endogenous response of the short-term interest rate. These results highlight the importance of a stable and predictable stream of tax revenue over the business cycle to eliminate the contractionary effect of cumulative fiscal revenue shortfalls that need to be financed through debt issuance.

In summary, we show that reduced-form estimates provide quantitatively similar results to that of the combined effect of DFFS on interest rates in a fiscal DSGE model with disaggregated expenditure and tax instruments. But for fiscal policy analysis, there are non-negligible differences in the responses of households, firms, and the monetary authority to each fiscal policy shock. For example, a large or persistent DFFS driven by government investment, as opposed to government consumption, would lead to far more favourable economic and fiscal outcomes. In fact, an investment-driven DFFS could reduce the government debt-to-GDP ratio in periods of economic slack, when monetary policy would typically be more accommodative. But, given the importance of the risk premium in debt financing and the effect of credit rating shocks, we conclude that if South African fiscal policy remains unsustainable a negative feedback loop between increasing debt servicing costs and rapid debt accumulation may push the country into a sovereign debt crisis and economic distress (see, e.g., Alcidi & Gros, 2019).[9]

2. Reduced-form estimates

This section presents empirical estimates of the relationship between South African government debt (and deficits) and interest rates. Gamber and Seliski (2019) identify three important challenges when estimating this relationship: cyclical effects versus long-term effects, debt versus deficits, and short-term versus long-term interest rates. Our findings motivate the use of a DSGE approach to better identify the effect of DFFS programmes on interest rates.

The first challenge is to separate the cyclical (short- to medium-term) effects on interest rates from long-term effects. For example, during a cyclical downturn, the response of interest rates to debt depends on the degree of crowding out, changes in aggregate demand, and the response of monetary policy, whereas in the long term a higher level of debt can crowd out the steady-state capital stock. That is, if debt-financed government expenditure crowds out private capital formation it will lead to a higher marginal product of capital and, therefore, a higher equilibrium real interest rate. In this study, we focus on the cyclical component (up to five years), and transform the data accordingly.

The second challenge is to understand how interest rates respond to government debt versus government deficits. Most early empirical research focused on measuring the response of interest rates to government deficits (Spiro, 1988, 1990). More recently, the role of debt (a stock variable) has received equal attention, which has led to much debate in the literature about whether to measure the response of interest rates to debt or to deficits (Gamber & Seliski, 2019; Laubach, 2009). Indeed, the two approaches are connected, but each metric contains its own relevant information. That is, accumulated deficits should be commensurate to the stock of debt, assuming no valuation changes or debt restructuring, but the period-by-period dynamics of the government budget or even the distinction between net and gross government debt mean that each variable contains (possibly) relevant information that can help identify the effect of government DFFS on the macroeconomy. Importantly, a DSGE approach incorporates both the stock (debt) and flow (deficits) effects of DFFS on the macroeconomy.

The third challenge is to identify (differentiate) the impact of government debt and deficits on long- and short-term interest rates. Most previous studies have focused on the effect of government debt and deficits on long-term interest rates. Another important issue, however, is how changes in debt and deficits affect short-term rates or the slope of the yield curve (the term spread).[10] The reason for identifying this transmission mechanism is that fiscal policy can have an indirect effect on the short-term interest rate through its effect on aggregate demand (due to the response of monetary policy to inflation and output growth) or it can have a direct effect on the term spread through risk premia (e.g., inflation risk, exchange rate risk, and debt default risk).[11] Further, it is also important to differentiate between real and nominal effects because fiscal sustainability, for example, depends on the real yield on government debt (Calitz, Du Plessis, & Siebrits, 2014; Fourie & Burger, 2003).

2.1. The relationship between government debt and interest rates

This section estimates the empirical relationship between government debt and interest rates with basic linear model regressions as a benchmark for our structural model analysis. We focus our attention on short- and long-term nominal interest rates as well as the term spread. We also compare the results to the relationship between government deficits and interest rates. The following section establishes measures for the sensitivity of real and nominal interest rates to debt and deficits with structural models.

Figure 1 shows the relationship between government debt and the term spread (left panel) and the government budget balance and the term spread (right panel). The term spread is the difference between the ten-year government bond rate and the three-month Treasury bill rate. Both debt and deficits show a strong relationship to the term spread where increases in government debt and *deficits* are associated with a wider term spread. The simple linear ordinary least squares (OLS) regressions for the above relationship give

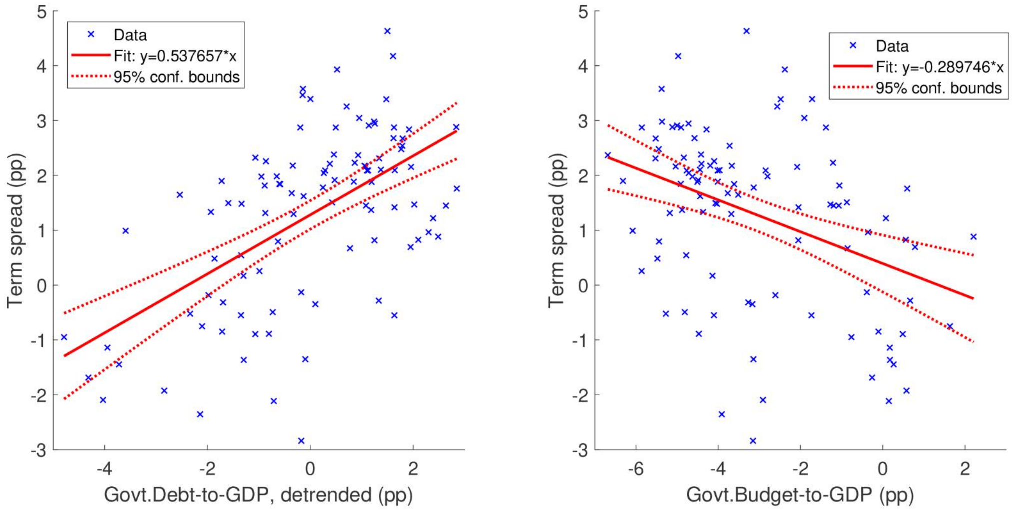

Figure 1. The relationship between government debt (deficits) and interest rates.
Source: author's compilation based on SARB data.

$$i^{(10y)} - i^{(3m)} = 0.01_{(0.001)} + 0.54_{(0.08)} \left(\frac{\text{Debt}}{\text{GDP}}\right) \tag{1}$$

$$i^{(10y)} - i^{(3m)} = 0.004_{(0.003)} - 0.29_{(0.07)} \left(\frac{\text{Budget}}{\text{GDP}}\right) \tag{2}$$

with R^2 values of 0.33 and 0.15 for the period from 1994Q1 to 2018Q4. Standard errors are given in parentheses.

On the surface, it would appear that increases in debt are purely associated with greater risk. For example, government debt accumulation increases the probability of a sovereign default, which is priced into the term premium between short-maturity debt and long-maturity debt. However, regressing government debt (deficits) on the individual rates reveals a different picture:

$$i^{(10y)} = 0.03_{(0.004)} + 0.43_{(0.08)} \left(\frac{\text{Debt}}{\text{GDP}}\right) + \beta X \tag{3}$$

$$i^{(10y)} = 0.03_{(0.003)} - 0.27_{(0.06)} \left(\frac{\text{Budget}}{\text{GDP}}\right) + \beta X \tag{4}$$

$$i^{(3m)} = -0.01_{(0.005)} - 0.54_{(0.08)} \left(\frac{\text{Debt}}{\text{GDP}}\right) + \beta X \tag{5}$$

$$i^{(3m)} = -0.006_{(0.007)} + 0.30_{(0.07)} \left(\frac{\text{Budget}}{\text{GDP}}\right) + \beta X \tag{6}$$

where X is an $n \times 1$ vector of control variables and β the corresponding $1 \times n$ coefficient matrix. The coefficient on government debt-to-GDP (budget-to-GDP) represents the sensitivity of interest rates to government debt (deficits). The corresponding R^2 values for the above regressions are: 0.81, 0.79, 0.83, and 0.79, respectively. The coefficients and significance levels are robust to alternative specifications.[12]

The effect of an increase in government debt (deficits) is associated with a *higher* long-term interest rate and a *lower* short-term interest rate. The transmission mechanism to

Table 1. Sensitivity of interest rates to government debt (deficits).

	VAR (Govt debt) basis points	DSGE (govt debt) basis points	VAR (Govt deficit) basis points	DSGE (Govt deficit) basis points
$SIGD_0$				
$i^{(10y)}$	24	34	11	27
$i^{(3m)}$	19	15.5	−2.5	−13
$r^{(10y)}$	24	23	24.5	40
$SIGD_{max}$				
$i^{(10y)}$	24	33	11	27
$i^{(3m)}$	19	15	−2.5	−13
$r^{(10y)}$	24	23	24.5	40

Note: $r^{(10y)}$ is the inflation-adjusted (real) long-term interest rate. For the DSGE model, the long rate is not observed, but implied by the endogenous risk premium over the short-term interest rate.
Source: author's compilation based on SARB data.

long-term rates follows through the term (risk) premium, whereas the association with short-term rates is more likely indirect. That is, in general equilibrium, the extent to which DFFS impacts aggregate demand (and therefore inflation and output) reciprocates a response from the monetary authority. But if government expenditure on consumption and capital goods crowds out private sector spending to the extent that output and inflation (aggregate demand) fall, we would observe a fall in the short-term interest rate. Furthermore, an increase in government borrowing competes with the private sector for the flow of saving (both domestic and foreign), which can crowd out investment in private capital and push up real interest rates.

The results from Equations (3)–(6) suggest that the net effect of debt-financed fiscal interventions are contractionary due to crowding out and a higher risk premium on borrowing (and therefore higher debt servicing costs and sovereign risk spill-overs to the private sector). Specifically, a 1 pp increase in the ratio of government debt (deficit) to GDP leads to, on average, a 43 (27) bp increase in long-term government bond yields, and a 54 (30) bp reduction in short-term Treasury bill yields. These results are slightly larger than that found in the literature for advanced economies (e.g., Gamber & Seliski, 2019; Laubach, 2009). Typically, the estimates found in the literature are for *real long-term* interest rates and suggest that a 1 pp increase in the debt-to-GDP (deficit-to-GDP) ratio raises real rates by 3 (20) bp. Although we find a larger effect for debt than for deficits for South Africa, the net effect on real rates (shown in Table 1) is 10–17 bp larger for deficits than for debt.

It is important to again note that the effect of government debt on the short-term and long-term interest rate does not, necessarily, occur contemporaneously. We can deduce this since the net effect of the individual regressions for $i^{(3m)}$ and $i^{(10y)}$ do not correspond with the regression coefficients for the term spread regressions (Equations 1 and 2). Section 2.2 highlights these disparities using a structural VAR model and a standard new-Keynesian DSGE model with an ad-hoc role for government debt (deficits) as a proxy for DFFS.

2.2. Debt or deficits? The problem with identifying debt-financed fiscal stimulus

Figures 2 and 3 compare impulse responses between a standard new-Keynesian DSGE model with an ad-hoc specification for government debt (deficits) and a structural VAR model. The DSGE model is adapted from Smets and Wouters (2007). Together with the fiscal variable (debt-to-GDP or deficit-to-GDP), the DSGE model is estimated using data for output, employment, private consumption, private investment, inflation, real wages, and the short-term interest rate.[13] The fiscal variable enters the aggregate resource constraint

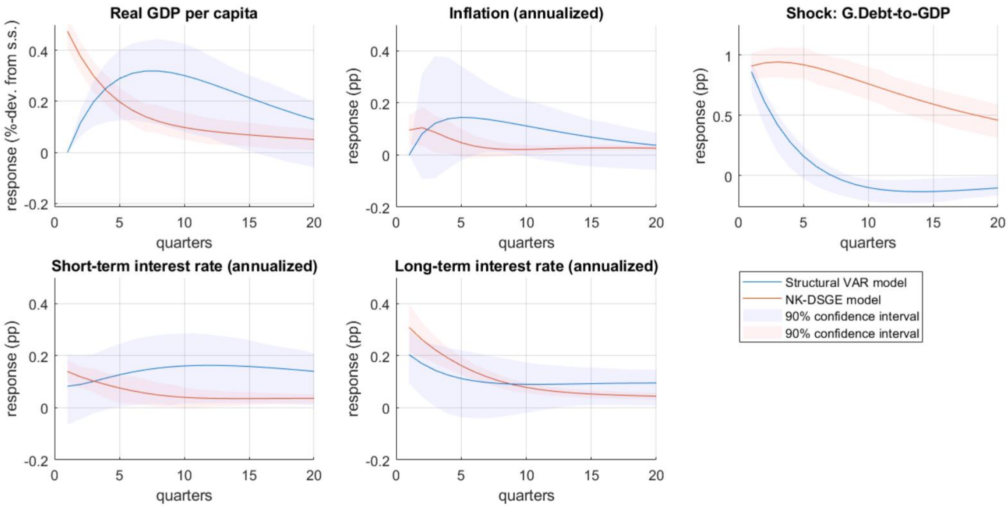

Figure 2. Impulse response function comparison: DSGE vs VAR—estimated shock to government debt-to-GDP.
Source: author's compilation based on SARB data.

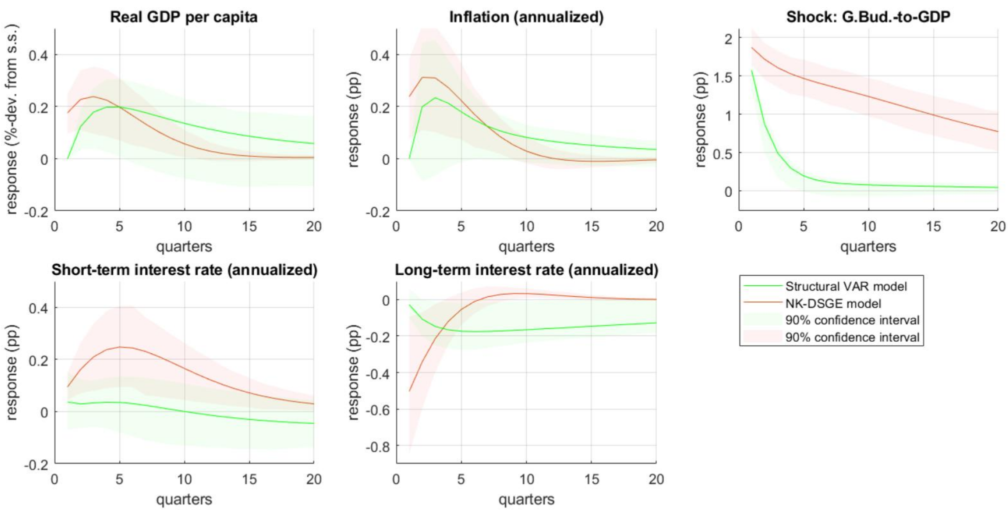

Figure 3. Impulse response function comparison: DSGE vs VAR—estimated shock to government budget-to-GDP.
Source: author's compilation based on SARB data.

and the risk premium on financial assets to capture the demand-side channel for DFFS and to incorporate the strong empirical relationship between sovereign risk in the ratio of debt (or deficits) to GDP and the term spread. For the VAR, we adopt the following recursive ordering $\{y, \pi, G, i^{(3m)}, \quad i^{(10y)}\}$ for the Choleski decomposition, where G is detrended debt-to-GDP, y is detrended real GDP per capita, and π is consumer price inflation (annualized).[14] The results highlight the ambiguous effects of fiscal policy when debt and deficits serve as proxies for debt-financed government intervention. This identification issue is used to motivate a disaggregated approach in a more detailed fiscal DSGE framework.[15]

On one hand, a shock to the debt-to-GDP ratio (Figure 2) appears to capture the expected effects of DFFS: an increase in debt-financed expenditure or tax cuts raises aggregate demand (real output and inflation) which results in a positive response of the short-term interest rate (a proxy for the endogenous response of monetary policy) as well as the long-term interest rate. The initial larger responses of the long-term interest rate suggests an elevated risk premium. The DSGE results highlight this fact most clearly since the long-term rate is the implied rate of the model which incorporates the observed dynamics of debt.

On the other hand, Figure 3 provides a counter-intuitive response for government deficits. In particular, a reduction in the fiscal deficit as a ratio of GDP (analogous to an increase in the budget balance-to-GDP ratio, as shown in Figure 3) leads to an increase in aggregate demand, and therefore short-term interest rates. A possible reason for this result can be associated with the net effect of changes in government expenditure and tax revenue. For example, it is unclear whether discretionary (exogenous) fiscal policy is properly identified apart from automatic (endogenous) fiscal policy or whether there is a spurious relationship with GDP such that fiscal consolidation (stimulus) occurs during the boom (bust) phases of the business cycle. In other words, counter-cyclical fiscal policy implies that we will observe fiscal deficits during recessions and fiscal surpluses (or smaller deficits) during expansions.[16] For the long-term rate, the effect of a reduction in the deficit-to-GDP ratio (and therefore the accumulation of the government debt-to-GDP ratio) is to lower the risk premium.

As a comparison to the benchmark results from Section 2.1 and the fiscal DSGE results in Section 3, we focus on two measures for the response of interest rates to government debt (deficits): the maximum interest rate response to the initial estimated government debt (deficit) shock, and the maximum interest rate response to the maximum debt (deficit) response. Specifically, the sensitivity of the interest rate to government debt (deficits) can be calculated as follows:

$$\mathrm{SIGD}_0 = \frac{\max \Delta i_t^{(k)}}{\Delta G_0} \tag{7}$$

$$\mathrm{SIGD}_{\max} = \frac{\max \Delta i_t^{(k)}}{\max \Delta G_t} \tag{8}$$

where $\Delta i^{(k)}$ is the percentage point change in either the short-term rate or long-term rate, max defines the period when the maximum response is reached, and ΔG is the percentage point change in the relevant fiscal variable. Table 1 provides SIGD results based on the mean estimates in Figures 2 and 3.

The results are very similar across each type of model. A shock to government debt raises both the short- and long-term interest rates, which leads to a 24 bp increase in the real long-term interest rate for the VAR model and 23 bp for the DSGE model. For government deficits, the long-term real interest rate also rises by a similar amount (24.5 bp for the VAR model and 40 bp for the DSGE model), but the short-term interest rate response is negative. This result highlights the difficulty with identifying the transmission mechanisms of DFFS and motivates explicit modelling of fiscal instruments to properly analyse fiscal policy interventions.

3. Fiscal policies in a DSGE model

The fiscal DSGE model used for this analysis is based on Kemp and Hollander (2020). The model is estimated using Bayesian methods with 21 shocks and 18 observable variables over the sample period 1994Q1 to 2018Q4. The domestic variables are output, employment, inflation, real wages, short-term interest rate, import inflation, export inflation, government debt-to-GDP, and the inflation target. The foreign variables, which are based on the weighted-average series from South Africa's main trading partners, are output, inflation, and the short-term interest rate. The six fiscal policy variables are estimated by six fiscal reaction functions that respond to output and debt. Appendix B describes the fiscal DSGE model in more detail.[17]

3.1. Debt-financed fiscal expenditure

Figure 4 plots the impulse response functions to the three government expenditure shocks: consumption, investment, and transfers.[18] The combined effect of these shocks (far right panels) are an increase in aggregate government expenditure (peaking at 2.92 per cent after two quarters), an increase in the debt-to-GDP ratio (peaking at 0.84 per cent after six quarters), and an increase in the risk-adjusted (long-term) interest rate (peaking at 11 bp after four quarters). Although the results are broadly in line with the empirical findings in Figure 2, we notice markedly different results for the individual expenditure components.

First, identified government expenditure shocks all lead to higher debt (with peak deviations from the steady state of 0.2, 0.4, and 0.5 percent for consumption spending, investment expenditure, and fiscal transfers, respectively), but only investment expenditure leads to a notable increase in output. In fact, the initial response of debt-to-GDP to investment is negative for five quarters. The strong stimulus of investment leads to a positive response of the short-term interest rate as a result of the monetary authority's response to higher inflation and output. The effect of monetary policy on the long-term interest rate is therefore partly offset by a lower risk premium. In contrast, crowding out effects from government spending and transfers lead to an accommodative response by the monetary authorities. For these two fiscal expenditure shocks, however, the significant rise in the debt-to-GDP ratio leads to a higher risk premium, which offsets the fall in the short-term rate. It is clear from Figure 4 that the disaggregated dynamics of fiscal policy intervention

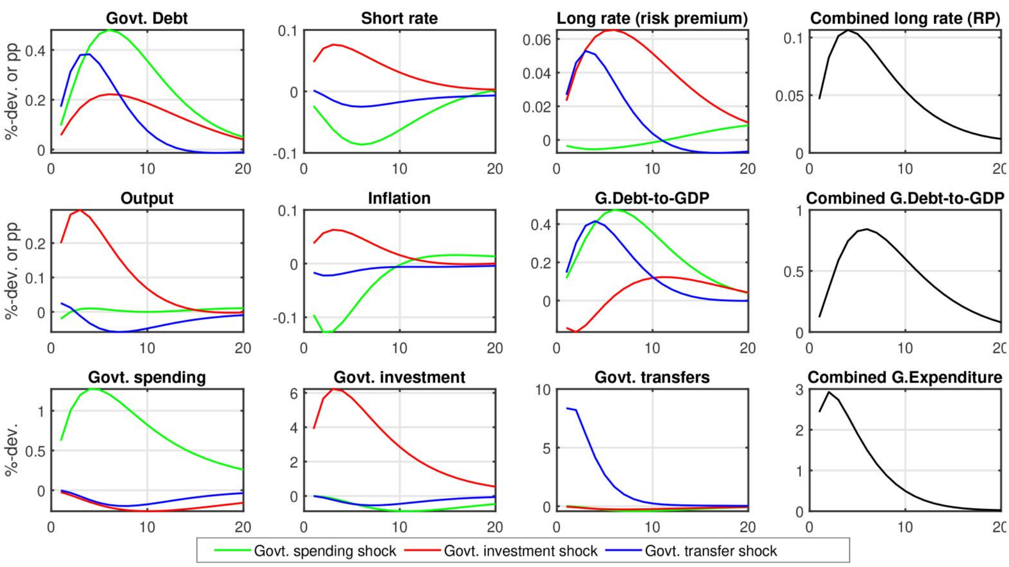

Figure 4. Impulse response functions for government expenditure shocks.
Source: author's compilation based on SARB data.

Table 2. Sensitivity of interest rates to government debt-to-GDP.

	Combined basis points	Govt spending basis points	Govt investment basis points	Govt transfers basis points
$SIGD_0$				
$i^{(10y)}$	88	7	−46	36
$i^{(3m)}$	21	2	−53	1
$r^{(10y)}$	155	105	−25	51
RP	120	70	−15	49
$SIGD_{max}$				
$i^{(10y)}$	13	2	53	13
$i^{(3m)}$	3	0.4	62	0.4
$r^{(10y)}$	22	26	29	18
RP	17	17	17	17

Note: $i^{(10y)}$ is the implied long rate based on the short-term interest rate response and the endogenous response of the risk premium to the debt-to-GDP ratio. $r^{(10y)}$ is the inflation-adjusted long rate. *RP* is the risk premium.
Source: author's compilation based on SARB data.

have markedly different dynamic effects on the business cycle and interest rates. These results also highlight the important role for investment expenditure in fiscal sustainability (for recent empirical evidence, see Peppel-Srebrny (2021) and citations therein).[19]

Table 2 gives the SIGD values for each expenditure component for the long rate, short rate, real long rate, and the risk premium. First, it is interesting to note that the maximum effect of debt on the real interest rate and the risk premium are very similar across all components. The effect of debt-financed fiscal expenditure on long-term real yields are 18 bp for a 1 pp increase in transfers, 26 bp for a 1 pp increase in consumption spending, and 29 bp for a 1 pp increase in investment. Furthermore, the net effect of debt-financed fiscal expenditure on real yields closely corresponds to our reduced-form DSGE and VAR estimates (22 bp vs 23 bp). However, the driving forces behind them are markedly different: investment-driven DFFS primarily raises the real interest rate through its indirect effect on the business cycle and therefore the response of the short rate, whereas consumption spending and transfers primarily influence real interest rates through the risk premium.

The model results document these effects as follows. First, an investment-driven DFFS initially reduces the government debt-to-GDP ratio through its positive demand-side stimulus, whereas transfers and spending typically lead to crowding out (i.e., a reduction in output) and a larger increase in debt. Government consumption spending puts additional upward pressure on the real interest rate through weaker aggregate demand (namely, disinflation). Second, the divergences between these disaggregated expenditure components are dampened by the endogenous response of monetary policy to changes in aggregate demand (output and inflation). These findings suggest that investment-driven DFFS produces more favourable outcomes for fiscal sustainability, as well as during recessionary episodes when monetary policy and fiscal policy are both expansionary. We theoretically identify these transmission mechanisms in Section 5.

3.2. Debt-financed fiscal tax cuts/revenue shortfalls

Figure 5 plots the impulse response functions to temporary negative tax revenue shocks for consumption (VAT), capital (CIT plus property), and labour (PIT). In contrast to expenditure shocks, the effect of debt-financed fiscal tax cuts (or, more likely, revenue shortfalls) exhibit very similar effects on the business cycle and interest rates. An exogenous decrease in tax revenue raises government debt and reduces output and inflation. That is, debt-financed fiscal revenue shortfalls unambiguously reduce aggregate demand and raise the debt-to-GDP ratio, which results in an elevated risk premium.[20]

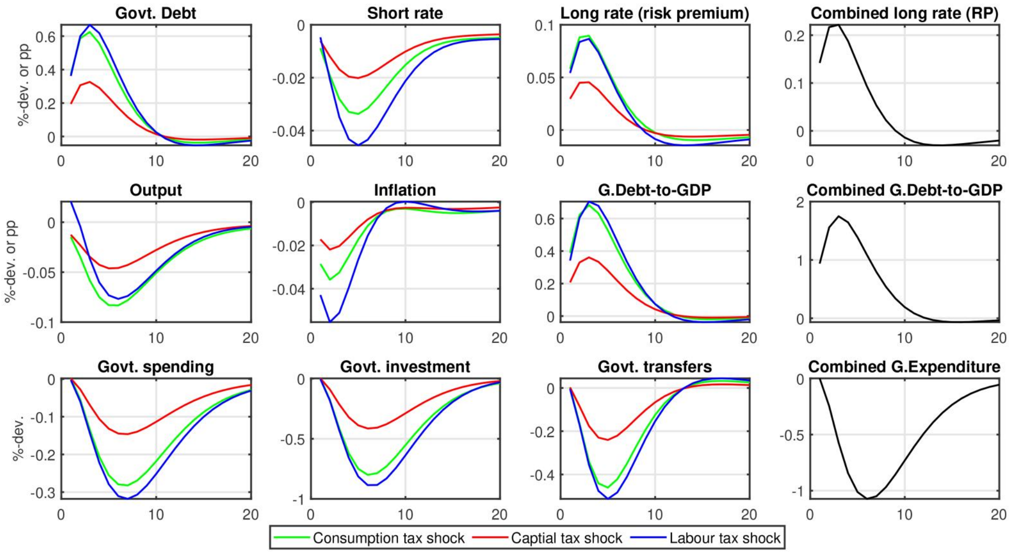

Figure 5. Impulse response functions for government tax revenue shocks.
Source: author's compilation based on SARB data.

Table 3. Sensitivity of interest rates to government debt-to-GDP.

	Combined basis points	VAT basis points	CIT basis points	PIT basis points
$SIGD_0$				
$i^{(10y)}$	24	23	22	25
$i^{(3m)}$	−1	−1	−2	−1
$r^{(10y)}$	35	32	32	41
RP	32	30	30	36
$SIGD_{max}$				
$i^{(10y)}$	13	13	13	12
$i^{(3m)}$	−1	−1	−1	−1
$r^{(10y)}$	19	18	19	20
RP	17	17	17	17

Note: $i^{(10y)}$ is the implied long rate based on the short-term interest rate response and the endogenous response of the risk premium to the debt-to-GDP ratio. $r^{(10y)}$ is the inflation-adjusted long rate. *RP* is the risk premium.
Source: author's compilation based on SARB data.

As a result, the effects of debt-financed fiscal revenue shortfalls on short- and long-term interest rates are remarkably similar across the disaggregated tax revenue components. Table 3 shows that a 1 pp increase in consumption tax revenue (VAT), labour income tax revenue (PIT), and capital tax revenue (CIT) all raise long-term nominal and real rates by approximately 13 bp and 19 bp, respectively. This increase in the long-term interest rate is driven by a higher risk premium as opposed to the endogenous response of the short-term interest rate.

These results highlight the importance of a stable and predictable stream of tax revenue over the business cycle to eliminate the contractionary effect of cumulative fiscal revenue shortfalls that need to be financed through debt issuance. In other words, regardless of the government's long-run gross borrowing requirement, unanticipated revenue shortfalls—a mismatch between the actual and the projected borrowing requirement—lead to lower output, higher debt, and a higher long-term real interest rate. In fact, Calitz, Siebrits, and Stuart (2016) show that errors in the National Treasury's projections of GDP and key fiscal aggregates have been substantial and rising since 2000.[21] They point out that such persistent inaccuracies are linked to fiscal distress (e.g., persistent deficits, excessive debt burdens, and output-destabilizing procyclicity) and ineffective fiscal policy (i.e., the erosion of fiscal credibility).

4. Decomposing the transmission mechanisms of debt, interest rates, and spending

Our results thus far establish non-negligible differences in the responses of households, firms, the monetary authority, and the risk premium to each disaggregated fiscal policy shock. We now establish the importance of the three key theoretical transmission mechanisms in response to debt-financed fiscal expenditure shocks: the endogenous feedback of government debt-to-GDP in the risk premium, the endogenous response of monetary policy to fiscal policy, and the degree of crowding in/out between public and private sector expenditure. We focus our results on the responses of government debt, output, the short-term interest rate, government consumption, government investment, and the government debt-to-GDP ratio.

4.1. The risk premium and government debt-to-GDP

Figure 6a,b show the responses of the variables to a government consumption shock and a government investment shock, respectively, with and without the endogenous feedback of the risk premium in the long-term interest rate. Expressed in log-linearized terms, we have $\gamma^B = 0.04$ (estimated value) and $\gamma^B = 0$ (no risk premium response):

$$r_t^{(10y)} = r_t^{(3m)} + \underbrace{\gamma^B(b_t - y_t) + \varepsilon_t^{RP}}_{\text{risk premium}} \quad (RP_t) \tag{9}$$

where b_t is real government debt, y_t is real output (GDP), and ε_t^{RP} is the exogenous component of the risk premium—that is, the risk premium shock. Since $\varepsilon_t^{RP} = 0$ in this exercise, the risk premium can be inferred by the response of the debt-to-GDP ratio $(b_t - y_t)$.

The results clearly show that accounting for the endogenous feedback of government debt accumulation in a higher long-term funding rate significantly dampens the impact of government consumption spending on output (by 0.06 per cent at maximum response, with a cumulative effect of 0.7 per cent after 20 quarters). Without the negative feedback mechanism through the risk premium, the accumulation of debt is 1.22 per cent lower (after 20 quarters) and the debt-to-GDP ratio peaks at 0.2 percentage points lower (after 6 quarters). In addition, the response of the short-term interest rate is muted, which understates the negative impact of the risk premium in response to debt-financed government expenditure (we turn to this channel in Figure 7a). Finally, the impact of a government investment shock on debt-to-GDP is more muted because of the positive impact on output. The risk premium therefore plays a relatively minor role.

4.2. The response of monetary policy to fiscal stimulus

The monetary authority sets the short-term interest rate according to a standard interest rate reaction function (a Taylor rule) of the following log-linear form:[22]

$$r_t^{(3m)} = \phi_R r_{t-1}^{(3m)} + (1 - \phi_R)\left(\phi_\pi \pi_{C,t} + \phi_{\Delta y} \Delta y_t\right) + \eta_t^R \tag{10}$$

where $\pi_{C,t}$ is consumer price inflation, Δy_t is aggregate output growth, and η_t^R represents a serially uncorrelated shock to the nominal interest rate.

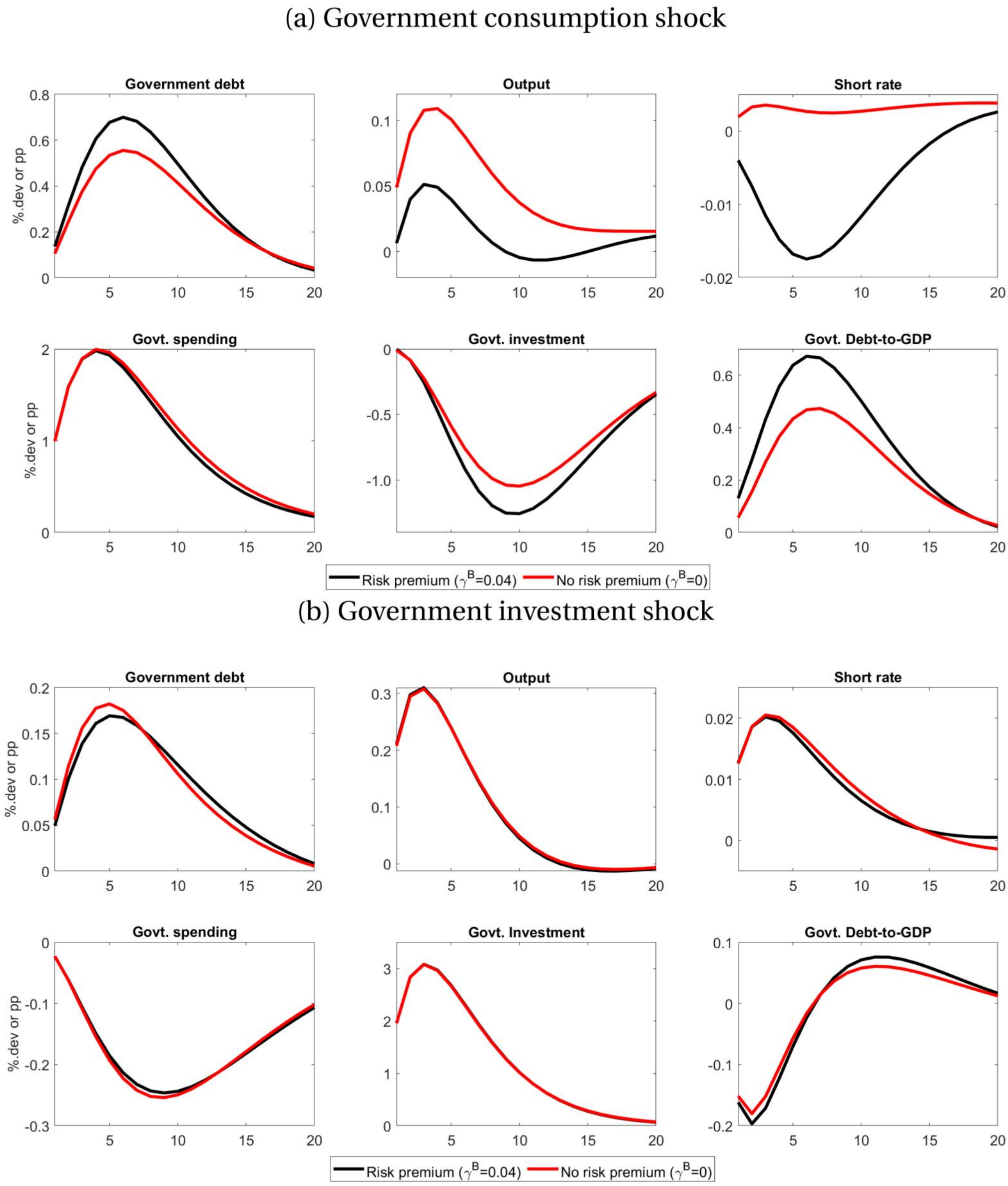

Figure 6. Risk premium feedback.
Source: author's compilation based on SARB data.

Figure 7a,b show the responses of the variables to a government consumption shock and a government investment shock, respectively, with degrees of monetary policy reaction through the short-term interest rate. Specifically, we compare the estimated model responses to a "dovish" monetary policy, which responds mildly to inflation and not at all to output ($\phi_\pi = 1.1$; $\phi_{\Delta y} = 0$), and a "no response" monetary policy, which is captured by additionally setting ϕ_R to 0.99 such that the endogenous response to inflation and output is negligible.[23]

In contrast to the previous result (which highlighted a stronger role for the risk premium in response to government consumption), monetary policy has a greater

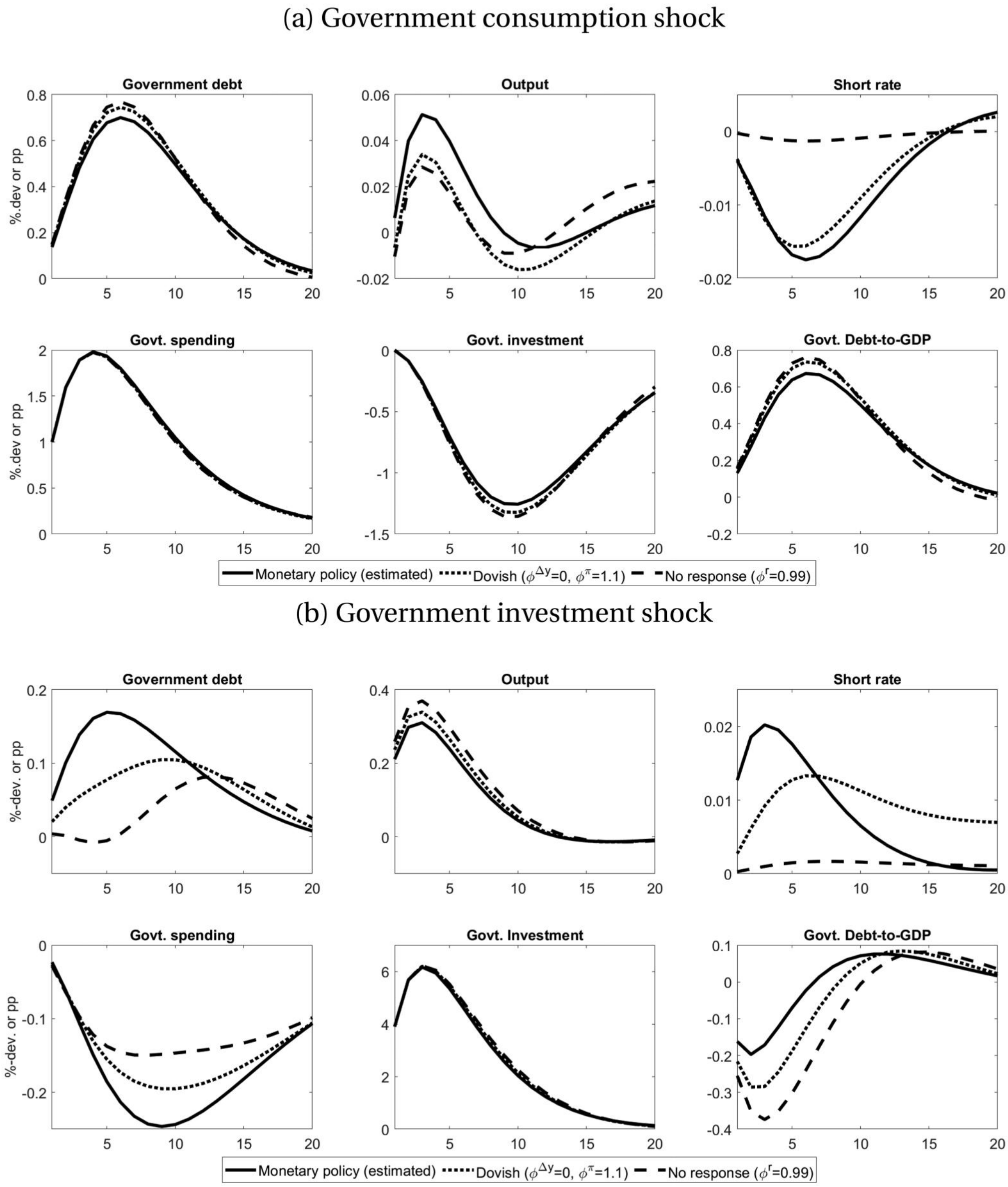

Figure 7. Monetary policy reaction.
Source: author's compilation based on SARB data.

influence on government investment. Because the government investment shock is expansionary (i.e., both output and inflation rise),[24] a more muted monetary policy response leads to greater output gains and significantly less debt accumulation, whereas if monetary policy does not accommodate the government consumption shock (because of its disinflationary effect), more debt is accumulated and the impact of government spending on aggregate output is more muted. These results highlight the importance of policy coordination and provide strong motivation for government investment stimulus in periods of economic slack when monetary policy would typically also be accommodative.

4.3. Direct crowding in/out of private consumption and physical capital

The third transmission mechanism involves the elasticity of substitution between private and public goods. Formally, aggregate consumption $\tilde{C}_{h,t}$ of household h is defined as a constant elasticity of substitution (CES) aggregate:

$$\tilde{C}_{h,t} = \left(\alpha_G^{\frac{1}{\nu_G}}(C_{h,t})^{\frac{\nu_G-1}{\nu_G}} + (1-\alpha_G)^{\frac{1}{\nu_G}}(G_t)^{\frac{\nu_G-1}{\nu_G}}\right)^{\frac{\nu_G}{\nu_G-1}} \tag{11}$$

where $C_{h,t}$ denotes the household's consumption of private goods and G_t measures government consumption. α_G is a share parameter and ν_G measures the elasticity of substitution between private consumption and government consumption, with ν_G greater than zero. As ν_G tends to 0 private and public consumption become perfect complements, and as ν_G tends to infinity private and public consumption become perfect substitutes, and the Cobb–Douglas case is obtained when ν_G tends to 1.[25]

Public and private capital formation are independently accumulated through public and private investment. Each intermediate-good firm (*f*) has access to the same public capital stock, such that physical capital used in production is a CES aggregation of private capital services $K^s_{f,t}$ and the public capital stock $K_{G,t}$:

$$\tilde{K}_{f,t} = \left(\alpha_K^{\frac{1}{\nu_K}}(K^s_{f,t})^{\frac{\nu_K-1}{\nu_K}} + (1-\alpha_K)^{\frac{1}{\nu_K}}(K_{G,t})^{\frac{\nu_K-1}{\nu_K}}\right)^{\frac{\nu_K}{\nu_K-1}} \tag{12}$$

where α_K is a share parameter, and, analogous to the CES consumption aggregate, the parameter ν_K governs the elasticity of substitution between private capital services and the public capital stock. When ν_K tends to 0 private capital services and public capital are perfect complements, and when ν_K tends to infinity they are perfect substitutes. ν_K equal to 1 gives the Cobb–Douglas case.[26]

Figure 8a,b show the responses of the variables to a government consumption shock and a government investment shock, respectively, with degrees of crowding in or out. Kemp and Hollander (2020) estimate ν_G and ν_K to be 0.92 and 1, respectively, with confidence intervals of [0.683, 1.319] and [0.606, 1.231]. For the baseline ("original") model estimated here, we calibrate $\nu_G = \nu_K = 1$ and use values of 0.65 (complements) and 1.35 (substitutes) to test the sensitivity of the impulse responses to the degree of crowding in (complements) and crowding out (substitutes). The results show that the degree of *direct* crowding in/out has a minor influence on the transmission mechanisms of government investment shocks. For government consumption expenditure, the influence on output and debt is more noticeable but relatively mild in magnitude. That said, given the current state of South Africa's "savings-constrained economy", the potential complementarities between private and public expenditure should not be dismissed (see, e.g., Duval & Furceri, 2018; Faulkner, Loewald, & Makrelov, 2013; Faulkner & Loewald, 2008; Loewald, Faulkner, & Makrelov, 2019).

5. Shocks to the risk premium and monetary policy

Figure 9 plots the impulse response functions to a positive monetary policy shock, risk premium shock, and foreign monetary policy shock. The combined effect of these shocks (far right panels) are a decrease in aggregate government expenditure (peaking at −1.38 per cent after eight quarters), an increase in the debt-to-GDP ratio (peaking at 2.54 per cent after four quarters), and an increase in the risk-adjusted (long-term) interest rate (peaking at 1.83 pp after one quarter). The magnitude and duration of output and government debt responses to domestic monetary policy and risk premium shocks are very similar, whereas

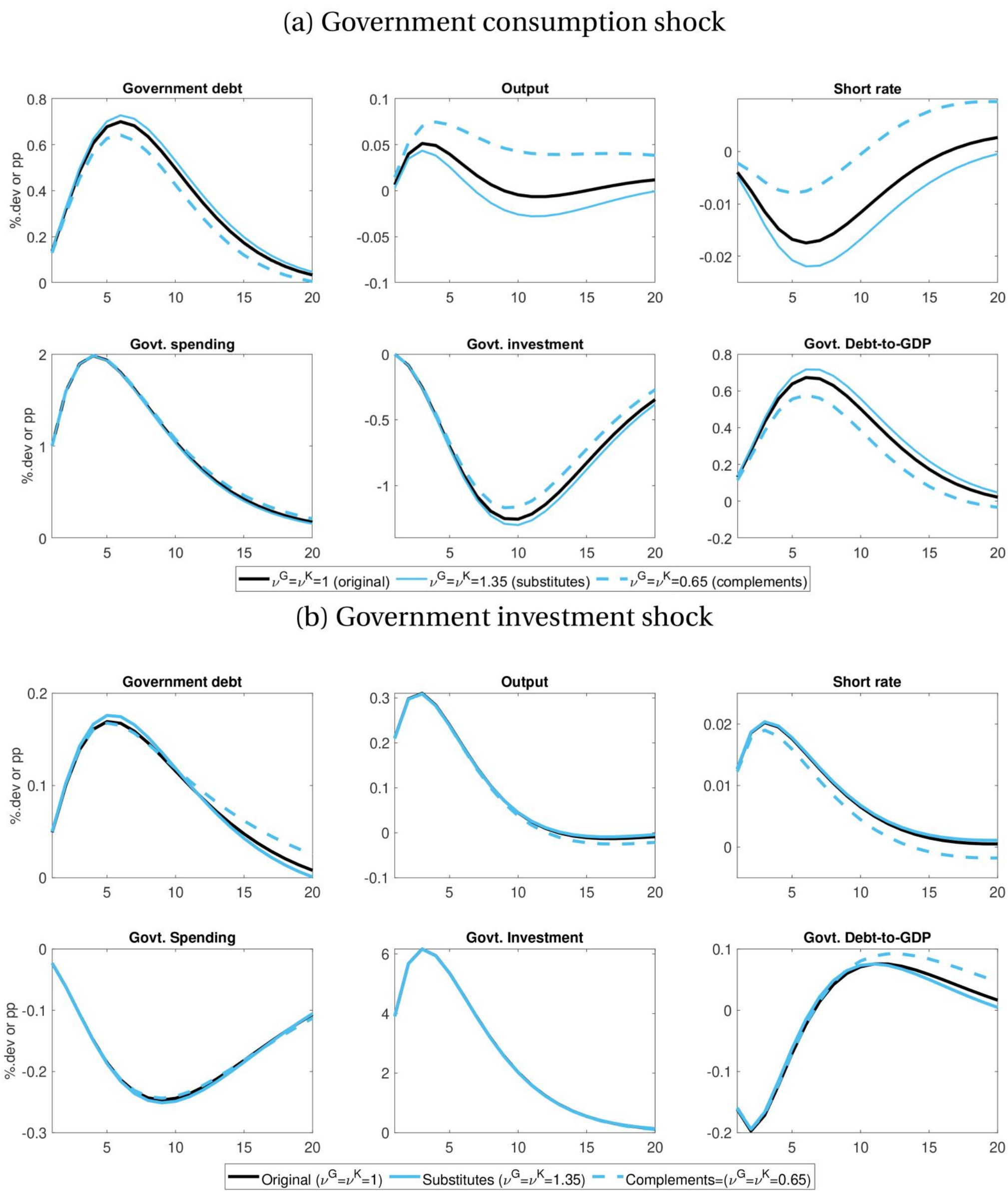

Figure 8. Crowding in and crowding out.
Source: author's compilation based on SARB data.

the role of foreign monetary shocks is qualitatively similar, but muted.[27] Notably, even controlling for correlated foreign shocks in the domestic monetary policy reaction function, foreign monetary policy contributes less than 1 per cent of the forecast error variance decomposition. In contrast, monetary policy and risk premium shocks contribute approximately 14 per cent and 10 per cent, respectively, to the forecast error variance of debt-to-GDP after five years (see Table A1).[28] For inflation, domestic monetary policy shocks reduce inflation more than shocks to the risk premium by more than 20 bp after two quarters.

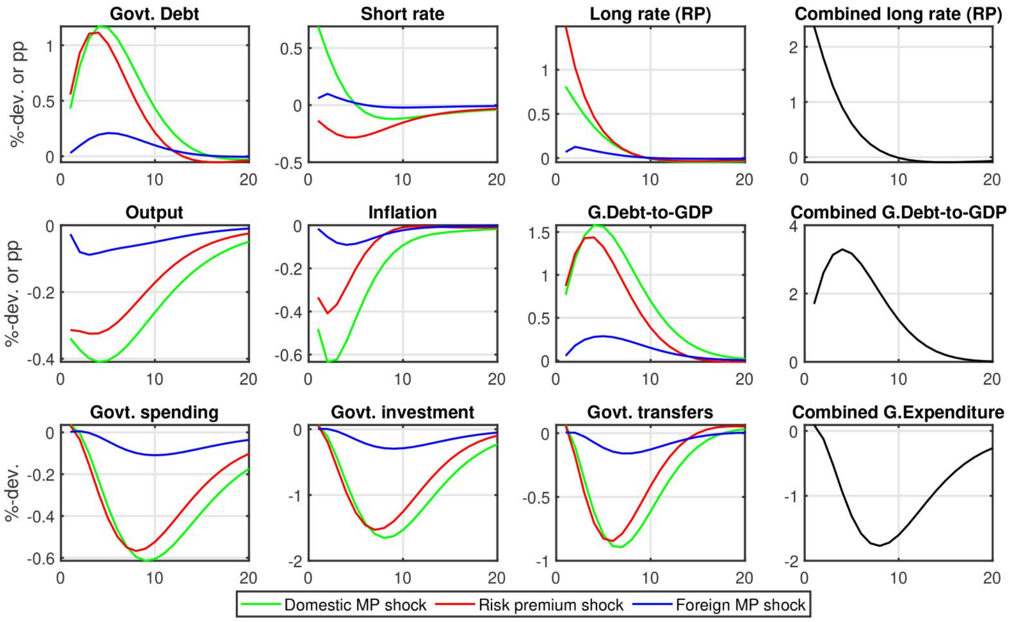

Figure 9. Impulse response functions for interest rate shocks.
Source: author's compilation based on SARB data.

5.1. Credit rating shocks

Risk premium shocks have weakened the transmission of monetary policy easing to the real economy in South Africa (Greenwood-Nimmo, Steenkamp, & van Jaarsveld, 2022). The sources of the risk premium shocks may arise from various domestic (pull) and foreign (push) factors, such as political risk or global risk aversion. Credit rating changes, in particular, reflect the probability of a sovereign default, and by implication, the future sovereign risk associated with the projected level of government debt-to-GDP. We identify credit rating shocks in Figure 10. The dates of credit rating changes are based on Fitch ratings on long-term domestic and foreign government debt (see Figure A1). For the quarter in which the rating upgrade or downgrade occurs (including any change to the economic outlook), we assume that innovations to the risk premium are entirely attributable to the credit rating change, which may overlap with outlook and ratings changes by the other two agencies. We also assume that changes to the rating outlook provide anticipatory effects. In total, there are nine upgrades and eight downgrades between 1994Q1 and 2018Q4.

Shocks to the risk premium that arise from credit rating changes are larger than average risk premium shocks not associated with credit ratings. A credit rating shock raises the long-term government bond rate by 155 bp. This result is in line with Hanusch, Hassan, Algu, and Soobyah (2016) and South African Reserve Bank (2016), who find that a downgrade (by one agency) raises bond yields by 80–104 bp, which can rise a further 60 bp if a second rating agency follows suit. Achieving fiscal sustainability at a lower level of debt-to-GDP would not only reduce the endogenous response of the risk premium to rising debt, it would reduce the negative consequences of further credit downgrading.[29]

6. Conclusion

We show that reduced-form regression and model estimates provide quantitatively similar results to that of the combined effect of debt-financed fiscal stimulus on interest rates in a

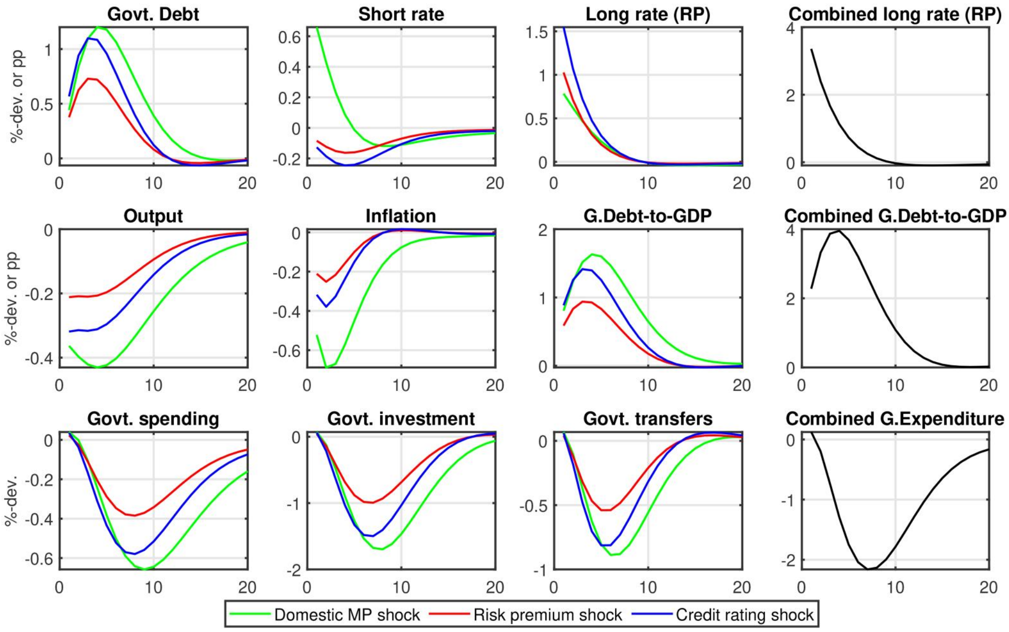

Figure 10. Impulse response functions for interest rate shocks.
Source: author's compilation based on SARB data.

fiscal DSGE model with disaggregated expenditure and tax instruments. That said, for fiscal policy analysis there are non-negligible differences in the responses of households, firms, and the monetary authority to each fiscal policy shock. For example, a large and persistent debt-financed programme driven by government investment, as opposed to government consumption, would lead to far more favourable economic and fiscal outcomes in South Africa. This view is strengthened by the fact that such a historically high public debt level has been reached. Moreover, as in the current environment, an investment-driven fiscal policy could reduce the government debt-to-GDP ratio in periods of economic slack, when monetary policy would typically be more accommodative.

In contrast to expenditure shocks, debt-financed tax cuts (and/or fiscal revenue shortfalls) exhibit very similar effects on the business cycle and interest rates. An exogenous decrease in tax revenue raises government debt and reduces output and inflation. That is, debt-financed fiscal revenue shortfalls unambiguously reduce aggregate demand and raise the debt-to-GDP ratio, which results in an elevated risk premium. These results highlight the importance of a stable and predictable stream of tax revenue over the business cycle to eliminate the contractionary effect of cumulative fiscal revenue shortfalls that need to be financed through debt issuance. That is, since shortfalls in fiscal revenue are contractionary, the extent of forecast errors (the difference between fiscal projections and realised values) is crucially important for policy decision-making and credibility.

The responses of monetary policy and the risk premium to debt-financed fiscal stimulus are particularly important. The results show that the risk premium response and the monetary policy response matter most for government consumption shocks and government investment shocks, respectively. These findings reaffirm the mounting empirical evidence that the composition of expenditure matters for fiscal sustainability and that policy coordination between fiscal and monetary authorities can greatly enhance debt-financed fiscal stimulus programmes. Direct crowding in/out is relatively less important for the efficacy of fiscal stimulus, but because we do not account for types of consumption and investment expenditure (for example, employee compensation, R&D, or infrastructure), the potential for complementarities between private and public expenditure policies should not be dismissed. Future research focused on such macroeconomic policy coordination and strategic complementarities would help guide policy decisions to improve macroeconomic outcomes.

Finally, shocks to the short-term interest rate (attributable to monetary policy) and the long-term interest rate (attributable to the country risk premium) contribute 14 per cent and 10 per cent of the long-run variance of government debt-to-GDP. Since the global financial crisis, monetary policy has reduced the burden of fiscal adjustment in response to rising debt and a rising risk premium (see Figure A3). Going forward, shocks to the risk premium (such as further credit rating downgrades, greater political uncertainty, or an increase in global risk aversion) could offset any accommodating stance of monetary policy. If fiscal policy remains unsustainable, a negative feedback loop between increasing debt servicing costs (through a higher risk premium) and rapid debt accumulation may push the country into a sovereign debt crisis and economic distress. This paper provides further support to the contention that macroeconomic models used for policy assessment should control for such factors.

Notes

1. A sustainable fiscal policy means that the public debt-to-GDP ratio remains stable, at or below some benchmark, over the medium to long term. Fiscal sustainability also implies that government should maintain a primary surplus if the real interest rate on government debt exceeds the real economic growth rate (Fourie and Burger, 2003). As this is the case for South Africa, going forward, the government cannot sustain a fiscal position of dissaving.
2. In a comprehensive survey, Ramey (2019) points out the 'dearth of research' on the macroeconomic effects of fiscal policy up to the global financial crisis. Much can be said about the effect of DFFS on interest rates—a key transmission mechanism for fiscal multipliers (see, e.g., Ganelli and Rankin, 2020) and fiscal sustainability (Calitz et al., 2014; Fourie and Burger, 2003).
3. The 'term premium' in long-term government interest rates serves as a proxy for the economy-wide (or country) risk premium (see, e.g., Erasmus and Steenkamp, 2022a, 2014b; Soobyah and Steenkamp, 2020a, 2014b). One key reason for this is that corporate yields are largely determined by (i.e., benchmarked against) sovereign yields in South Africa (Peter and Grandes, 2005).
4. The South African literature has focused predominantly on the effect of government debt on growth, the effect of interest rates or spreads on the macroeconomy, and the spillover effects of credit ratings or sovereign risk (see, e.g., Fedderke, 2020; Mhlaba and Phiri, 2019; Mothibi, 2019; Peter and Grandes, 2005; Soobyah and Steenkamp, 2020a, b).
5. Peppel-Srebrny (2021) raises a similar point to motivate their econometric approach and contribution to the literature. In fact, the author finds no existing literature that empirically tests the relevance of the composition of government budget deficits for government bond yields.
6. In addition, Ramey (2011) shows that anticipation ('news') matters for DFFS. A DSGE model incorporates agents that are forward-looking and it can control for anticipated fiscal policy ('fiscal news') shocks (Born et al., 2013).
7. In Section 4 we show that the responses of monetary policy and the risk premium to DFFS are particularly important, whereas *direct* crowding in/out is relatively less important for the efficacy of fiscal stimulus.
8. Since tax revenue data is used, as opposed to tax rates, a 'tax cut' is indistinguishable from a 'fiscal revenue shortfall' or even changes to the tax base. Because the results indicate that 'tax cuts' are contractionary, the term 'fiscal revenue shortfalls' is used to broadly capture all of these intensive margin effects. One way to identify exogenous tax cuts would be to separately identify historically administered changes in tax rates (see, e.g., Kemp, 2020b).
9. For example, in a small open economy like South Africa, a sovereign debt crisis typically leads to capital outflows (and therefore a large exchange rate depreciation), financial sector instability, and

tighter credit conditions (through higher borrowing costs and stricter creditworthiness) which severely affects the efficient functioning of the real economy.

10. The term spread is measured by the difference between short-term and long-term interest rates on government debt, typically the three-month and ten-year bond yields.
11. The dynamics (supply) of government debt (both stock and flow) can also influence monetary policy (because government debt provides collateral for liquidity operations and it expands the consolidated government balance sheet, which is inflationary) and financial stability policy (because government debt serves as a high-quality liquid asset, it is typically exempt from risk-weighted capital requirements, and it is a benchmark for market pricing of debt).
12. Notably, with inflation, real GDP per capita (detrended), and the long or short nominal interest rate (depending on the dependent variable).
13. The selection of the seven non-fiscal variables follow from Smets and Wouters (2007). Data for the ten-year government bond yield is excluded from the DSGE estimation due to the limited number of shocks in the model (i.e., eight shocks to match eight variables). The implied long-term interest rate is determined by the risk premium, which has an endogenous component based on the fiscal variable such that higher debt raises sovereign debt risk and an exogenous component that follows an AR(1) stochastic process.
14. Although standard model selection criteria prefer an unrestricted model with four lags over both lower order lags and restricted versions of the model, we show results for a restricted VAR(1) model that matches the the DSGE model equations. One exception being that we allow for lagged effects from the fiscal variable *G* on all of the other variables in the system. For the fiscal DSGE model analysis in the following section, the individual-level paths for debt and output (GDP) are determined by the model to match the observed debt-to-GDP ratio. For the comparison exercise in this section, we therefore remove the fourth degree polynomial trend from government debt-to-GDP. The more standard alternative transformation to log-difference real government debt provides similar results in the unrestricted VAR(4) model. All of these results are available on request.
15. For a comprehensive analysis of alternative identification approaches for fiscal policy in econometric models, see Kemp (2020a).
16. Historical evidence for South Africa suggests that fiscal policy has responded counter-cyclically to debt accumulation since the 1960s (Burger et al., 2012; Calitz et al., 2014), but over the business cycle (as measured by GDP) the findings reject any consistent counter-cyclical policy (Plessis et al., 2007; Plessis and Boshoff, 2007). Assuming government debt and output grow at constant rates, the log-linear detrended series are correlated –0.84 (–0.74) in nominal (real) terms over the sample period 1994Q1 to 2018Q4. Trend quarterly growth for both government debt and output is 2.46 per cent in nominal terms, and 0.74 per cent and 0.73 per cent, respectively, in real terms (both deflated using the GDP deflator). While fiscal interventions may not systematically respond to output, the data clearly suggests strong counter-cyclical behaviour of debt to output. Kemp and Hollander (2020) show that government expenditure responds counter-cyclically to both real debt and real output, but typically more strongly to debt, which is in line with optimal stabilization policies (Hollander and Havemann, 2022). There is therefore a clear policy trade-off between debt and output stabilization.
17. Figure A.2 plots the estimated implied long-term interest rate with the three-month Treasury bill rate, the ten-year government bond yield, and the effective interest rate derived from the ratio of debt-service costs to outstanding gross debt (annualized and based on deseasonalized monthly data). The implied rate, which is consistent with the government budget balance, tracks the market rates and effective rate derived from debt-service costs very closely. After some minor corrections to the original replication code, the estimated version of this model still follows closely to that of Kemp and Hollander (2020). Since the DSGE model is not part of the contribution of this paper, the full model description, prior selection, estimation diagnostics, and posterior parameter estimates are available upon request.
18. Public sector (government) investment is the sum of fixed capital formation by general government and public corporations.
19. Using panel data for 31 EU and OECD economies from 1990, Peppel-Srebrny (2021) shows that primary budget deficits due to higher government current (non-investment) expenditure (such as social benefits and employee compensation) intensify sovereign risk in the form of significantly higher bond market rates. In contrast, a higher deficit due to investment, on average, leads to lower long-term government bond yields because markets tend to price in a positive return on investment, which is favourable for growth. These results obtain after controlling for the short-term interest rate and under various specifications, which provides strong evidence that this mechanism operates primarily through the sovereign risk premium. We theoretically identify this transmission mechanism in Figure 6a,b.

20. It is again worth noting that, based on how effective tax rates are calculated, it is unclear what the dominant effects of tax policy and tax efficiency and collection are. We take an agnostic and model-consistent view that the identified shocks (to the effective tax rates) are exogenous changes to *realized* tax revenue. This could incorporate several legislative and non-legislative effects due to, for example, marginal tax rate changes, bracket creep, tax base changes, changes to the elasticity of taxable income, anticipated tax policy, and unanticipated tax revenue windfalls and shortfalls. The effect of negative shocks to tax revenue are therefore contractionary due to lower government expenditure, higher debt servicing costs (through both debt accumulation and a higher risk premium), and relatively weak tax multiplier effects on private consumption and investment.
21. From 2001/02 to 2010/11, Calitz et al. (2016) find that forecast errors for revenue projections account for 71.2 per cent of the errors in the budget balance-to-GDP ratios. Such inaccuracies appear commonplace internationally. In fact, official South African forecasts of budget balances have been relatively accurate by international standards.
22. In the estimated version of the model we account for a time-varying inflation target. Since it is exogenous, it is excluded from the equation.
23. For the estimated model, the parameter values for $\{\phi_R, \phi_\pi, \phi_{\Delta y}\}$ are $\{0.87, 1.57, 0.38\}$.
24. See Figure 4 for the inflation response.
25. It is assumed that valuable government consumption enters the households' utility function in a non-separable way. This feature has two important implications. First, under this specification shocks to government consumption affect optimal private consumption decisions directly. This stands in contrast to the indirect wealth effect associated with separable government consumption. Second, the feature implies that it is theoretically possible to generate co-movements between private and government consumption, conditional on the estimated degree of complementarity.
26. Public capital augments private production at no direct cost for the firm. Therefore, it can be interpreted as an externality to the private productive sector. Financing of public capital is not factored into the cost accounting of firms as it takes place through the general tax system. Private physical capital services (i.e., the usage of private capital in production) includes variable capital utilization. Finally, the stock of public capital is assumed to grow at the same speed as private capital services along the balanced growth path of the model. The log-linear expression for aggregate capital used in production is: $\tilde{k}_t = \alpha_K^{\frac{1}{\nu_K}} (k^s/\tilde{k})^{\frac{\nu_K - 1}{\nu_K}} k_t^s + (1 - \alpha_K)^{\frac{1}{\nu_K}} (k_G/\tilde{k})^{\frac{\nu_K - 1}{\nu_K}} k_{G,t}$. The log-linear expression for aggregate consumption (Equation 11) follows analogously.
27. The estimated effects of the risk premium on output and inflation are broadly comparable to the impulse responses of term premium shocks estimated by Soobyah and Steenkamp (2020b) (see Figures 14 and 16).
28. The contributions of monetary policy and the risk premium to output, debt, output growth, and debt growth are similar in magnitude for both shocks (see Table A1).
29. We do not account for possible non-linearities with respect to credit ratings or debt levels (threshold effects).

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Appendix A. Extra tables and figures

See Table A1 and Figures A1–A3.

Table A1. Forecast error variance decompositions at 1-quarter, 1-year, and 5-year horizons.

	Output			Govt. debt			Govt. debt-to-GDP		
Shocks	1-quart.	1-year	5-years	1-quart.	1-year	5-years	1-quart.	1-year	5-years
Tech. and labour	5.1	4.6	5.8	4.1	1.4	3.3	0.7	1.1	4.0
Markup	30.6	48.2	57.7	20.0	19.0	48.7	16.1	27.1	53.3
Demand	13.8	13.8	14.6	2.1	5.7	7.3	7.7	9.7	10.3
G. spending	8.2	7.3	3.5	3.6	6.0	5.8	2.6	3.3	2.9
G. revenue	0.2	0.3	0.8	26.7	20.4	7.7	13.7	12.3	4.5
Monetary policy	22.8	14.6	10.2	17.5	23.2	14.8	26.7	23.8	14.0
Risk premium	18.9	10.2	5.9	25.9	24.3	11.6	32.3	22.5	10.0
Foreign	0.4	0.6	1.6	0.1	0.1	0.9	0.2	0.2	1.1
Total	100	100	100	100	100	100	100	100	100
Shocks	Output growth			Govt. debt growth			Long-term rate		
	1-quart.	1-year	5-years	1-quart.	1-year	5-years	1-quart.	1-year	5-years
Tech. and labour	7.3	14.4	13.8	1.3	5.4	4.8	0.3	1.5	4.5
Markup	29.9	36.4	41.0	20.6	29.9	44.5	6.5	30.9	38.5
Demand	13.5	11.2	10.7	2.1	4.4	3.8	0.1	1.1	8.5
G. spending	8.0	7.0	6.8	3.7	4.6	3.7	0.0	0.2	0.5
G. revenue	0.2	0.6	0.9	27.5	18.6	14.1	0.2	0.6	0.6
Monetary policy	22.2	16.0	14.3	18.1	17.6	13.9	23.1	18.0	13.3
Risk premium	18.5	13.2	11.6	26.6	19.5	15.1	69.7	47.6	33.9
Foreign	0.4	1.1	0.9	0.1	0.1	0.2	0.0	0.1	0.2
Total	100	100	100	100	100	100	100	100	100

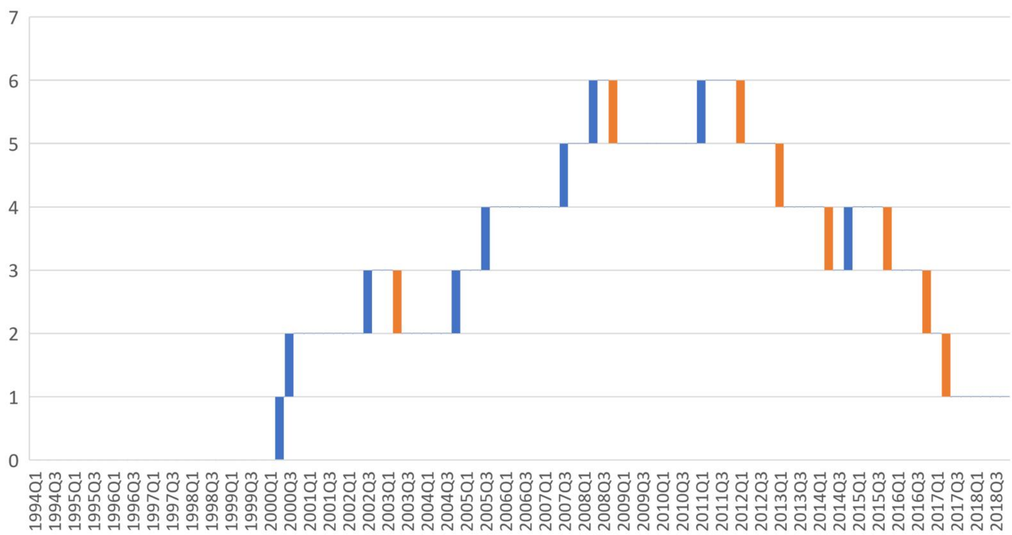

Figure A1. Credit rating changes (Fitch).
Source: author's compilation based on SARB data.

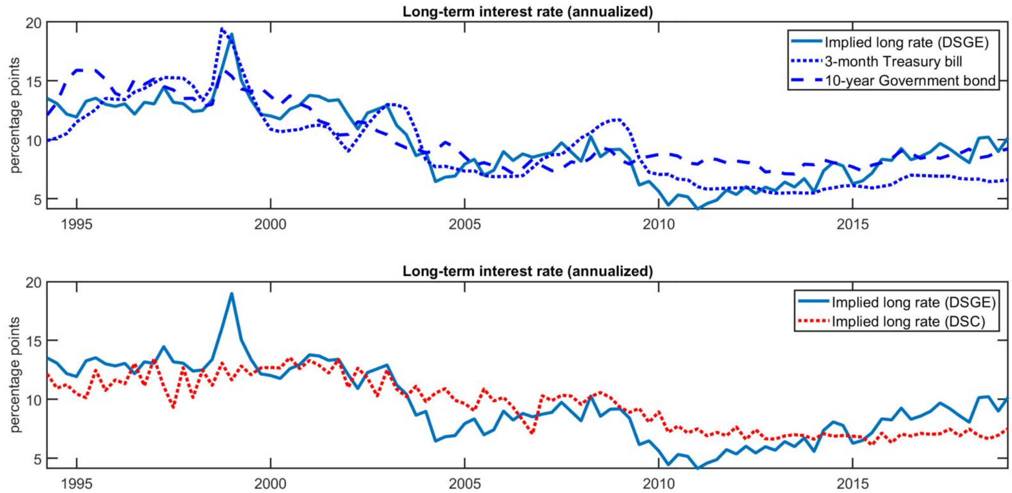

Figure A2. Long rate: implied vs actual.
Source: author's compilation based on SARB data. Note: DSC is the effective rate derived from debt service costs over outstanding debt.

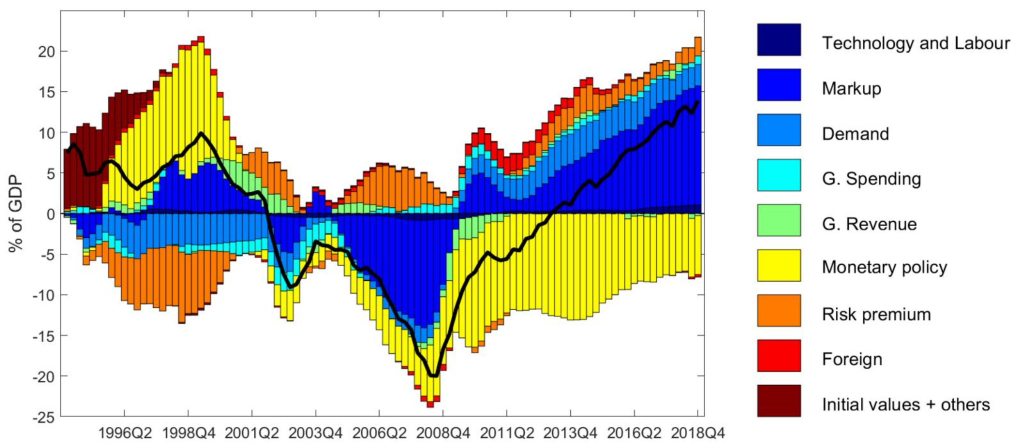

Figure A3. Historical decomposition of government debt to GDP.
Note: all shocks are grouped into their respective categories except the risk premium shock. Monetary policy includes shocks to the inflation target, but this accounts for a very small amount of the variability of debt.
Source: author's compilation based on SARB data.

Appendix B. National treasury's fiscal DSGE model

The fiscal DSGE model developed for the National Treasury is based on Kemp and Hollander (2020). The small open economy model structure therein closely follows that of Adolfson, Laséen, Lindé, and Villani (2007) and Christoffel, Coenen, and Warne (2008), while incorporating a more active role for fiscal policy along the lines of Coenen, Straub, and Trabandt (2013).

The basic open economy structure is relatively standard: households consume both domestic and imported consumer goods, while optimising agents can invest in domestic and foreign bonds. The optimising households rent capital to firms and decide how much to invest each period, with changes to the rate of investment, as well as changes to the rate of capital utilisation, subject to adjustment costs. Each household supplies a differentiated labour service to firms, allowing them to set their wage in a Calvo (1983) manner.

The model contains three types of firms: domestic producers, importers, and exporters. Domestic firms employ labour and capital in production. A differentiated good is produced by each type of firm. Prices are set with Calvo-type staggered pricing, but with a variation that allows for the indexation to past inflation (see, e.g., Rabanal & Lopez-Salido, 2006).

Finally, monetary policy follows a standard Taylor-type rule, while the foreign economy is assumed to be exogenous to the small open economy, and it is estimated as a standard three-equation new-Keynesian model.

The standard small open economy new-Keynesian framework is extended, along the lines of Coenen et al. (2013), to include a more active role for fiscal policy. The specification of the fiscal sector balances the need for a high degree of detail, which is essential for analysing the quantitative effects of fiscal policy innovations, and tractability, which allows for the identification of the relevant transmission mechanisms. Specifically, the model includes (1) non-Ricardian (or rule-of-thumb) consumers to facilitate a direct transmission mechanism for government transfers; (2) government consumption in the aggregate consumption basket of households (i.e., a constant elasticity of substitution aggregator), thereby supplying direct utility; (3) public capital which can either be a complement or a substitute for private capital; (4) time-varying distortionary taxes; and (5) a set of fiscal rules governing the discretionary and automatic responses of fiscal variables.