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Government size and risk premium

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Abstract: Given the rise in the government debt level in recent times, this paper aims to examine the effect of an increase in government size on risk premium and its transmission in the economy. We jointly identify the term spread shock (originating at the short end and the long end) and the government size shock, using max share identification. Term spread shock originating at the long end is driven by higher risk premium, unlike the shock originating at the short end, and increases inflation and reduces growth. The results suggest that the increase in the share of government expenditure in GDP (size) increases long-term rates by increasing the risk (term premium) and hence obstructs the transmission of monetary policy. As expected, the effect of government size on risk premium is more pronounced during recessions compared to expansions. By including a news shock about future economic activity, we rule out that the effect of government size shock on term premium is not driven by a news shock. We estimate the parameters of a New Keynesian model with term premium by matching the responses in data with responses from the model. The model can generate a similar rise in risk premium due to the increase in government size, and the estimated parameters suggest that the coefficient of risk aversion during recession is more than twice that of during expansions.

Key words: government debt, interaction between fiscal and monetary policy, fiscal consolidation

JEL classification: E43, H11, H12

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1 Introduction

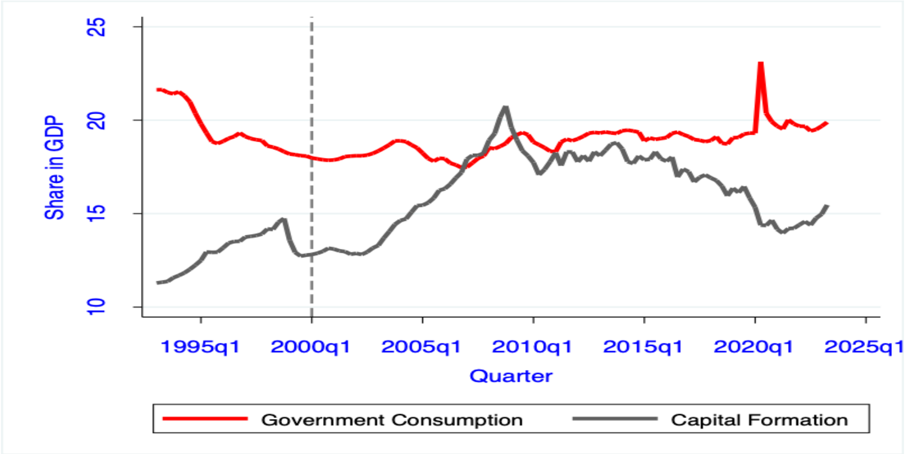
After a sustained period of decline, the government debt to GDP ratio increased very sharply in South Africa in the 2010s. Like other countries, South Africa also implemented fiscal stimulus during the financial crisis; the economy recovered quickly, but it never achieved the pre-crisis growth that kept decelerating further throughout the last decade. The share of government expenditure in GDP (*government size*) kept increasing and the debt to GDP ratio increased by more than 40 percentage points in the last decade. A large part of the increase in government debt to GDP ratio is due to the increase in external debt, which grew by almost three times during the same period. The increase in government size clearly led to crowding out of private investment and has been accompanied by a decline in the share of investment to GDP ratio and the GDP growth rate. This suggests that the debt-driven fiscal expansion has not been good for the growth rate, and has also increased unemployment in South Africa (Havemann and Hollander 2022).

The rate of inflation was moderate in the last decade and the overnight policy rate kept declining, but the long rates (ten-year sovereign bond yield) were increasing, leading to a substantial increase in the term spread (Figure 1). The simultaneous decline in growth and increase in term spread is puzzling, as the existing literature suggests that the increase in term spread is associated with economic expansion (Benzoni et al. 2018). The term spread can increase because of the increase in future average short-term rates driven by anticipation of future activities or decline in short-term rates due to anticipated favourable supply shock, as in Kurmann and Otrok (2013). It can also increase due to an increase in risk premium (term premium) due to greater size of the government. Erasmus and Steenkamp (2022) decompose term spread into expectations of future average short-term rates and a risk premium, and find that a large part of the increase in term spread in South Africa is driven by increase in risk premium (term premium). The increase in risk premium has ensured that the long rates have kept increasing despite the lowering of short-term policy rates. Since the usual monetary transmission channel is broken due to the increase in risk premium, it is clear that monetary policy alone cannot support growth by keeping the policy rate lower.

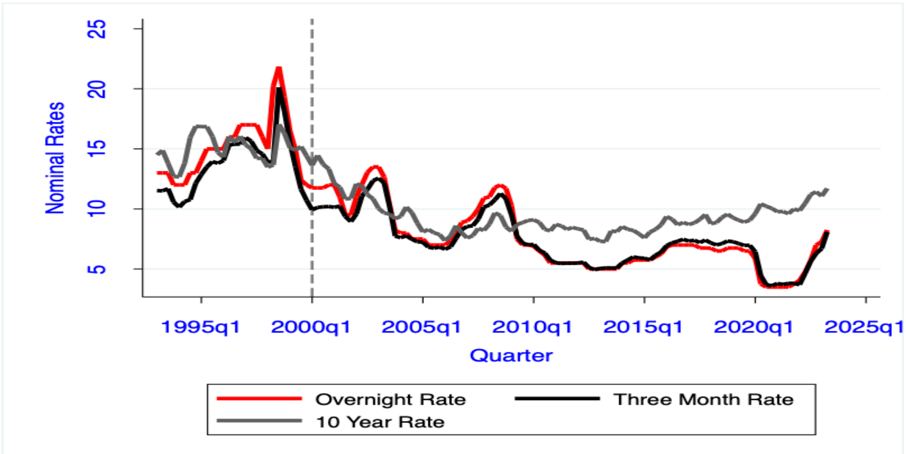
This is because monetary policy aims to move long-term rates that determine investment and durable consumption in a desired direction by moving short-term rates, but it has failed to do so. Also, by keeping the policy rate lower, monetary policy is not able to support government borrowing and stabilize government debt, as the long-term rates are determined in the debt market, and monetary policy has little control over that.

The macro-finance models of term structure and term premium used by Rudebusch and Swanson (2012), Bretscher et al. (2020), and Horvath et al. (2022) suggest that both government expenditure and the level of debt are important determinants of term premium. Bretscher et al. (2020) estimate the empirical and model-implied responses due to a shock to the government spending level and government spending uncertainty, and suggest that the model-implied responses are similar to the empirical responses in the data. On the other hand, Horvath et al. (2022) estimate the parameter of a similar model with generalized method of moments, and the simulated data from the model generates a level of term premium which is comparable to the term premium in the data. The inflation risk premium plays an important role in generating risk premium in Horvath et al. (2022), but both Bretscher et al. (2020) and Horvath et al. (2022) consider the level of government spending, and implement a shock to the level of government spending.

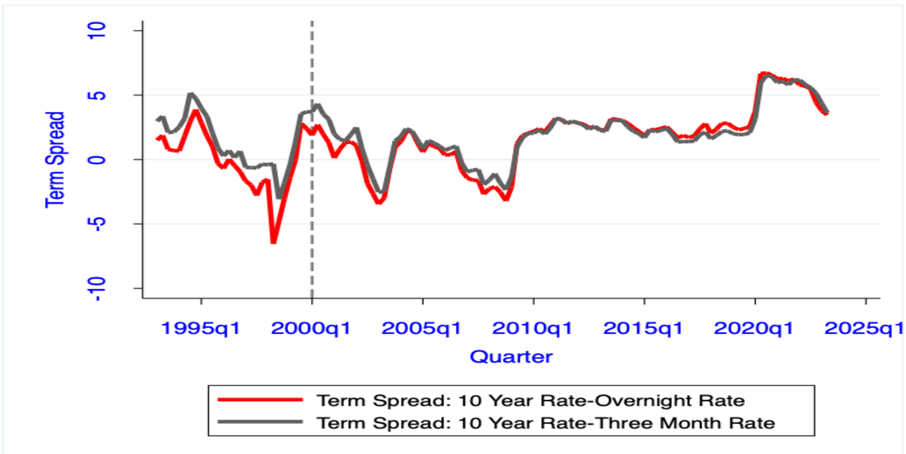
Figure 1: Share of capital formation and government consumption in GDP; interest rates and term spreads



(a) Share of GDP



(b) Interest rates



(c) Term spreads

Source: authors' elaboration based on data from the Federal Reserve Bank of St. Louis.

Based on this, in this paper we explore the effect of an increase in the size of the government on the South African economy. In particular, we focus on the increase in the term spread and the deceleration in the growth rate. We choose the size of the government instead of government expenditure because there has been a noticeable increase in the size of the government in South Africa in the last decade (Figure 1). The size of the government has been widely used in New Keynesian models to evaluate fiscal policies (Justiniano et al. 2010).[1] Previous studies focus on the level of the term premium, whereas the focus of this paper is on the response of the term premium to an exogenous change in the size of the government.

Since the size of the government and term premium are related, in this paper we first estimate a term spread shock similar to Kurmann and Otrok (2013).[2] This shock explains the maximum share in the forecast error variance of the term spread. Kurmann and Otrok (2013) argue that the term spread shock resembles a shock to future productivity where the Federal Reserve lowers the interest rate and the shock increases output and decreases inflation. This makes the shock a favourable supply shock, as in Kurmann and Otrok (2013). But, in the case of South Africa, our results suggest that this shock reduces growth, short-term interest rate, and inflation. This is counterintuitive and could be the result of incorrect identification, as the term spread can increase due to an increase in the long end of the rate or decrease in the short end of the rate.

We further consider the term spread shocks originating at the short and the long end of the interest rates, which is missing in Kurmann and Otrok (2013). We estimate a model with term spread, log GDP, log consumer prices, and overnight rate, and restrict the contemporaneous response of the overnight rate due to term spread shock to zero and obtain the **term spread shock originating at the long end**. Similarly, we estimate another model with term spread, log GDP, log consumer prices, and ten-year rate, and restrict the contemporaneous response of the ten-year rate due to term spread shock to zero and obtain the **term spread shock originating at the short end**. Although we do not observe the term premium data, the response of term spread and short-term rates gives us the response of the term premium. The results suggest that the term spread shock originating at the long end is driven by an increase in term premium, whereas the term spread shock originating at the short end does not lead to significant effect on the term premium in the beginning. This is as expected and gives us confidence that these two shocks are correctly identified.

Moreover, the term spread shock originating at the long end increases inflation and reduces growth—inducing negative covariance between growth and inflation—unlike unrestricted term spread shock originating at the short end. Rudebusch and Swanson (2012), Bretscher et al. (2020), and Horvath et al. (2022) argue that it is essential for a shock to cause a negative covariance between inflation and growth/consumption to drive the term premium. This is because higher inflation reduces the bond price, and an investor would demand a premium for holding assets whose value is decreasing during periods of decreasing consumption. Results obtained in this paper suggest that only the term spread shock originating at the long end produces the negative covariance between growth and inflation and is theoretically consistent. The focus in this paper is on the government size shock that is expected to increase the term premium based on the literature. Since the shock at the long end is driving the term premium, the identification of government size shock in the absence of this shock could lead to bias.

Hence, we jointly identify two orthogonal shocks: term spread shock originating at the long end, and a government size shock. Government size is measured as the ratio of government final consumption expenditure to GDP. It is important to jointly identify these shocks, as the term spread shock originating at the long end leads to an increase in term premium; excluding that shock may lead to mis-identification of the government size shock as the government size shock is expected to increase the term premium as well. The identification strategy also helps to disentangle the exogenous increase in term premium from the increase in term premium driven by government size. These shocks explain the maximum share in

[1] The government size shock could be different from the government expenditure shock because it assumes that the fiscal multiplier is less than 1. du Rand et al. (2023) argue that the fiscal multiplier is significantly lower than 1 in South Africa.

[2] This serves two purposes. First, it helps us in analysing the effect of the term spread shock in the South African economy. Second, when we extend the model to include the size of the government and identify two shocks (term spread and government size shocks), it ensures that the government size shock is not contaminated by the term spread shock.

the forecast error variance of the term spread and government size. It is important to mention that in the case of one such shock there is an analytical solution available in Kurmann and Otrok (2013). But in the case of two (joint) shocks, there is no analytical solution available and hence we use optimization to obtain these two shocks jointly. This is a contribution to the literature that aims to identify multiple shocks based on the share in the forecast error variance, which is also known as max share identification in the structural vector auto regression (SVAR) literature.

We find that the government size shock increases the term spread and decreases growth. Further, the government size shock generates the negative covariance between inflation and output (inflation and consumption); we obtain the response of the term premium due to a shock to government size. The response of the term premium suggests that most of the increase in term spread due to government size shock is driven by the increase in the term premium. Since the government size shock leads to a higher risk premium, this is the likely reason that the growth rate has been declining in South Africa in the last decade.

We further identify expansionary, neutral, and recessionary government size shocks by restricting the response of output due to the government size shock to be ≥ 0, $= 0$, and ≤ 0, respectively, for two time periods $t = 0$ and $t = 1$. The neutral government size shock is effectively a government expenditure shock, as this is change in government size $\frac{G}{Y}$ without any change in Y. These additional estimations help us to explore the non-linearity in response of the term premium due to government size shock. As expected, we find that recessionary government size shock induces the highest increase in the term premium due to the government size shock among all four government size shocks estimated in this paper: unrestricted, expansionary, neutral, and recessionary. Further, the recessionary government size shock also induces the highest negative correlation between the response of output and inflation due to government size shock among these four models.

Andreasen et al. (2023) argue that uncertainty shocks have more pronounced effects in recession and they conclude that risk matters more in recession. A greater size of government is a risk for the household as it reduces the household's ability to smooth an adverse shock. For example, a higher government size may imply a lower after-tax wage and that reduces the ability of households to smooth shocks by utilizing the intensive labour margin. Similar to Andreasen et al. (2023), we find that these risks are higher during recessions. We also find that unrestricted and recessionary shocks produce identical response of the term premium. This is expected because an unrestricted shock leads to a substantial reduction in output and hence we conclude that a government size shock is essentially a recessionary shock, but different from a typical demand shock as it does not cause a decline in inflation.

Since the neutral government size shock is identified by restricting the response of output to zero, this is effectively a shock to government expenditure only,[3] and the response of the term premium from this model can be compared with the response of the term premium in the literature. Rudebusch and Swanson (2012), using a theoretical model, obtain a response of 0.17 basis points response of the term premium, which is substantially lower than a ~ 20 basis point response of the term premium due to the government expenditure shock in this paper. It is important to mention that the objective in Rudebusch and Swanson (2012) was to estimate a level of term premium in the model which is comparable to the level of term premium in the data. But in this paper we are interested in the response of the term premium due to government size and expenditure shocks.

The changes in the government size could also be driven by the news about future productivity. News about increasing future productivity may allow a government to consolidate and vice versa. This news

[3] This could still be different from the typical government expenditure shock considered in the literature because in these studies the response of output is not restricted. Since we create scenarios for the response of output, we consider this type of government expenditure shock and call it a neutral government expenditure shock.

shock may also influence the term spread as in Kurmann and Otrok (2013). Hence, we bring a news shock to productivity similar to Barsky and Sims (2011) and Gortz et al. (2022). The identification is the same, but we use GDP instead of total factor productivity (TFP) and the shock maximizes the forecast error variance of GDP but does not affect GDP contemporaneously. We estimate a model with three orthogonal shocks: an exogenous term spread shock originating at the long end; a government size shock; and a news shock. The response of the term premium due to the government size shock remains very similar to the previous model with two structural shocks. These results suggest that the larger size of the government is increasing the market risk, keeping long-term rates high due to higher term premium, despite lowering of rates by the central bank. In other words, the large size of the government is not allowing the usual monetary transmission.

In the next step, we write a macro-finance model that is similar to the model in Rudebusch and Swanson (2012) and Horvath et al. (2022) to explain the responses obtained from SVAR. The focus in Rudebusch and Swanson (2012) and Horvath et al. (2022) is to generate a level of term premium that is comparable to the term premium in the data. Rudebusch and Swanson (2012) do estimate the response of the term premium to a government spending shock from the theoretical model, but that shock generates very low response of the term premium compared to the response of the term premium due to government expenditure and size shocks.

This paper aims to analyse the response of the term premium to a shock to the size of the government which differs from Rudebusch and Swanson (2012). Hence we introduce a shock to the size of the government that is similar to Justiniano et al. (2010). We estimate the parameters of the model by minimizing the distance between responses of the term premium due to expansionary and recessionary government size shocks from the SVAR model. This is similar to the approach in Basu and Bundick (2017). The estimated coefficients from these two shocks are able to identify the recessionary and expansionary period as we explain in detail in the paper. The model is able to generate a similar response of the term premium due to the expansionary and recessionary government size shocks, although it requires a higher value of risk aversion. This is expected given the significantly higher response of the term premium obtained in this paper using the data. Most importantly, we find that risk aversion in recession is more than twice the value during expansion. This is another contribution to the literature on the term premium in macro-finance models.

The plan of the paper is as follows. Section 2 explains the identification of shocks from SVAR, and the estimation of the response of the term premium using the response of the term spread and short-term rate, and gives a brief overview of the data from the South African economy. Section 3 presents the responses and share in forecast error variance of the model variables due to term spread, government size, and news shocks. Section 4 presents the New Keynesian model of term structure. Section 5 presents the results from the model, followed by concluding remarks in Section 6.

2 Empirical framework and data

2.1 Empirical framework

A general SVAR model is given by:

$$A_0 y_t = a + \sum_{j=1}^{p} A_j y_{t-j} + \varepsilon_t$$

The reduced form model is given by:

$$y_t = b + \sum_{j=1}^{p} B_j y_{t-j} + u_t$$

where $b = A_0^{-1}a$, $B_j = A_0^{-1}A_j$, and $u_t = A_0^{-1}\varepsilon_t$. The covariance matrix of the reduced form shocks $E(u_t, u_t') = \sum = \left(A_0^{-1}\right)\left(A_0^{-1}\right)'$ is known. We assume that $E\left(\varepsilon_t\varepsilon_t'\right) = I$. We can write the impulse response matrix at horizon h:

$$IR^h = C(h)A_0^{-1}$$

where $C(h)$ is the hth element in the expansion if $\left[I_n - \sum_{j=1}^{p} B_j L^j\right]^{-1}$, where $h = 0, 1, H$ and $C(0) = I_n$. The element in row (i) and column (j) denotes the response of the ith variable due to shock associated with the jth variable. The matrix A_0^{-1} is unknown and needs to be estimated to calculate the structural impulse response IR^h. The reduced form covariance matrix is known and one can do Cholesky decomposition of the same to estimate the A_0^{-1} as given by:

$$\sum = PP' = \left(A_0^{-1}\right)\left(A_0^{-1}\right)'$$

This implies $A_0^{-1} = P$. But as shown in Uhlig (2004), the matrix P obtained by Cholesky decomposition is not the only matrix that satisfies the above, as we can write:

$$\sum = PQQ'P'$$

for any orthonormal matrix Q $(QQ' = I)$. This gives us $A_0^{-1} = PQ$ and hence the structural impulse response can be written as:

$$IR^h = C(h)PQ$$

The response of the ith variable due to a shock associated with the jth variable is given by:

$$IR^h(i, j) = e_i^{'}C(h)PQe_j = e_i^{'}C(h)Pq_j = c_{ih}'q_j$$

where q_j is the jth column of Q and c_{ih}' is the ith row of $C(h)P$. The important point is that $Q = I_n$ gives the identification based on Cholesky decomposition, and additional identification such as sign restrictions can be achieved by imposing restrictions on Q.

The forecast error variance of the ith variable due to a shock associated with the jth variable at horizon h is given by

$$\sum_{h=0}^{h=h} IR^h(i, j)'IR^h(i, j) = \sum_{h=0}^{h=h} q_j' c_{ih} c_{ih}' q_j = q_j'\left(\sum_{h=0}^{h=h} c_{ih}c_{ih}'\right) q_j$$

The diagonal elements of $\sum_{h=0}^{h=h} c_{ih}c_{ih}'$ contain the forecast error variance of the ith variable due to the given shocks. The forecast error variance of the ith variable due to all shocks is given by $\sum_{h=0}^{h=h} c_{ih}'c_{ih}$. Hence the share of the jth variable in the forecast error variance of the ith variable is given by

$$FEV(i, j, h) = \frac{q_j'\left(\sum_{h=0}^{h=h} c_{ih}c_{ih}'\right) q_j}{\sum_{h=0}^{h=h} c_{ih}'c_{ih}}$$

We define

$$FEV(i, h) = \frac{\left(\sum_{h=0}^{h=h} c_{ih}c_{ih}'\right)}{\sum_{h=0}^{h=h} c_{ih}'c_{ih}}$$

2.2 Term spread shock

We identify the term spread shock based on the share of forecast error variance decomposition. This is purely agnostic and driven by data. We put very minimal restrictions on identification which is hard to disagree with. We order term spread as the first variable in the VAR model and identify the first column of Q using the following optimization problem

$$q_1^* = \arg\max_{q_1} q_1' FEV(1, h) q_1$$

subject to

$$q_1' FEV(1,h) q_1 \geq q_1' FEV(j,h) q_1 \quad \text{for } j = 2,3,4$$

The objective function maximizes the share of the first shock, which we refer to as term spread shock in forecast error variance of term spread. In the literature, this type of identification is known as max share identification. The constraint implies that the share of the variance explained by the term spread shock of term spread is higher than the share of term spread shock in the forecast error variance of other variables. The identification is intuitive. One can choose variables which are important for term spread determination and to forecast term spread. The identified shock is the one which explains the maximum share of the forecast error variance. In other words, this is the source of variation which is driving term spread away from its predicted value based on the variables in the model and hence is an exogenous shock.

The baseline model is estimated with term spread (difference between ten-year rate and three-month rate), log GDP, log consumer prices, and one of the interest rates, overnight or ten-year yield (long-term rate). The choice of the variable is based on the New Keynesian paradigm; growth, inflation, and interest rate represent a reasonable set of variables for policy analysis (Ireland 2011). The central bank of South Africa targets inflation, and most of the inflation-targeting central banks have an interest rate reaction function that can be obtained using inflation and growth. These inflation-targeting central banks respond to deviation of inflation from the target level, and deviation of output from steady-state/potential output. The New Keynesian model in Section 4 contains this type of reaction function which is also known as the Taylor rule. We estimate all models with two lags as based on information criterion. These results are given in Online Appendix A.9.

2.3 Term spread shocks originating at short and long ends

We make a distinction in the term spread movements caused by the movement at the short end and the long end of the rate. The term spread change at the short end is likely to be driven by policy changes, as the central bank has reasonable control over the interest rate at the short end. Such policy-driven rate can change if the central bank lowers interest rates anticipating a productivity shock, as in Kurmann and Otrok (2013), or it could be interest rate hikes by the central bank due to an adverse markup/cost push shock. The term spread at the long end of the rate is driven by a change in the risk perception (i.e. term premium). The change in risk premium can arise due to higher inflation expectations or higher government debt, which increases the probability of insolvency of the government. If the government debt is only issued in the domestic currency, then inflation risk and insolvency risk are the same as government can always inflate away the debt in case of an insolvency-like scenario. But this is unlikely to be the case in South Africa, with a substantial amount of foreign debt.

Kurmann and Otrok (2013) identify a term spread shock using a similar approach but do not make a distinction between term spread shock arising at the long end and the short end of the term structure. The earlier literature on term spread summarized by Wheelock and Wohar (2009) generally finds that the yield spread is positively associated with future GDP growth even when a short-term interest rate is included, but they do not make an explicit distinction between term spread caused by movement at the short and the long end as undertaken in this paper. Hamilton and Kim (2002) decompose the yield spread into an expected interest rate component and a term premium component, finding that both have predictive power for future economic activity, but the term spread shock is likely to be caused by both ends of the market. We identify shocks originating at the short and long ends, and the long end shock may arise purely due to a change in term premium. The conflicting result in the literature on the effect of term spread shock could be partly driven by the fact that the existing literature does not make a distinction between term spread caused by movement at the long or short ends. In the case of four-variable models, the optimization problem is given by:

$$q_1^* = \arg\max_{q_1} q_1' FEV(1,h) q_1$$

subject to

$$q_1' FEV(1,h) q_1 \geq q_1' FEV(j,h) q_1 \text{for } j = 2,3,4$$
$$e_4' C(h) P Q e_1 = e_4' C(h) P q_1 = 0$$

The first constraint is the same as before. The last constraint implies that the term spread shock does not lead to change in the long-term rate (overnight rate) contemporaneously and hence term spread shock is driven by the short end (long end) of the rate. We order term spread as the first variable and the long-term rate (overnight) rate as the fourth variable.

2.4 Term spread and government size shocks

We estimate another set of models in which we include the share of government expenditure in GDP, which is referred to as *government size* in this paper. The share of government expenditure is likely to influence the term spread by causing long-term rates to rise due to higher inflation expectations. It can also raise long-term rates due to increased risk premiums associated with long-term bonds. The optimization problem is given by:

$$q_1^*, q_2^* = \arg\max_{q_1, q_2} q_1' FEV(1,h) q_1 + q_2' FEV(2,h) q_2$$

subject to

$$q_1' FEV(1,h) q_1 \geq q_1' FEV(j,h) q_1 \text{for } j = 2,3,4,5$$
$$q_2' FEV(2,h) q_2 \geq q_2' FEV(j,h) q_2 \text{for } j = 1,3,4,5$$
$$q_1' q_2 = 0$$

where the objective function is to maximize the sum of the share of the term spread explained by term spread shock and the share of government size explained by government size shock. The first constraint implies that the share of the variance explained by the term spread shock is higher than the share of term spread shock in the forecast error variance of other variables. The second constraint implies that the share of the variance explained by the government size shock is higher than the share of government size shock in the forecast error variance of other variables. The third constraint implies that these two shocks are orthogonal (structural). Similar to our four-variable cases, we make a distinction between term spread driven by the long or short end of the rate and add one additional constraint which implies that term spread shock does not affect the long-term (overnight) rate contemporaneously. We do not restrict the contemporaneous response of the interest rate due to a shock to the size of the government. We order the term spread as the first variable and the long-term rate (overnight) as the fifth variable in the VAR model. The optimization problem is given by:

$$q_1^*, q_2^* = \arg\max_{q_1, q_2} q_1' FEV(1,h) q_1 + q_2' FEV(2,h) q_2$$

subject to

$$q_1' FEV(1,h) q_1 \geq q_1' FEV(j,h) q_1 \text{for } j = 2,3,4,5$$
$$q_2' FEV(2,h) q_2 \geq q_2' FEV(j,h) q_2 \text{for } j = 1,3,4,5$$
$$q_1' q_2 = 0$$
$$e_5' C(0) P Q e_1 = e_5' C(0) P q_1 = 0$$

where the first three constraints are the same as before. The last constraint implies that the term spread shock originates at either the short or long end, depending upon the model.

2.5 Expansionary, recessionary, and neutral government size shock

Andreasen et al. (2023) argue that uncertainty shocks have more pronounced effects in recession and they conclude that risk matters more in recession. The government size in this paper is defined as $\frac{G}{Y}$. The shock arises when the government expenditure multiplier is lower than 1, and in that case only $\frac{G}{Y}$ increases. A government expenditure multiplier greater than 1 will raise Y more than G and hence will not cause a government size shock. The government size shock can cause three scenarios for output: increase, decrease, and no effect on output (neutral). The third one of these is also a shock to the government expenditure because it changes $\frac{G}{Y}$ without affecting y. This allows us to compare our results with the existing results in the literature, which obtain the response of the term premium due to government expenditure shock as in Rudebusch and Swanson (2012). These three scenarios also allow us to compare the response of the term premium due to government size originating in different situations, as in Andreasen et al. (2023). We can estimate the nonlinear responses by separating the estimating models with inequality constraints on the behaviour of output due to government size shock, as we explain below. Based on these three scenarios, we create expansionary, recessionary, and neutral government size shocks. This helps us in evaluating the internal consistency of the model that the recessionary government size shock must create higher increase in term premium. The optimization problem is given by:

$$q_1^*, q_2^* = \arg\max_{q_1, q_2} q_1' FEV(1,h) q_1 + q_2' FEV(2,h) q_2$$

subject to

$$q_1' FEV(1,h) q_1 \geq q_1' FEV(j,h) q_1 \text{for } j = 2,3,4,5$$
$$q_2' FEV(2,h) q_2 \geq q_2' FEV(j,h) q_2 \text{for } j = 1,3,4,5$$
$$q_1' q_2 = 0$$
$$e_5' C(0) P Q e_1 = e_5' C(0) P q_1 = 0$$

where the above constraints are the same as before. We use additional constraints to make distinctions between these three shocks.

Recession

$$e_3' C(0) P q_2 \leq 0 \qquad e_3' C(1) P q_2 \leq 0$$

Expansion

$$e_3' C(0) P q_2 \geq 0 \qquad e_3' C(1) P q_2 \geq 0$$

Neutral

$$e_3' C(0) P q_2 = 0 \qquad e_3' C(1) P q_2 = 0$$

where $e_3' C(0) P q_2$ and $e_3' C(1) P q_2$ gives the response of output due to government size shock at times 0 and 1 and two consecutive periods of decline in output is defined as a recession.

2.6 Term spread, government size, and news shocks

We further extend the empirical setting to bring a news shock about productivity. This is important because Kurmann and Otrok (2013) argue that news about future productivity leads to large swings in term spread. The optimization problem is given by:

$$q_1^*, q_2^*, q_{23}^* = \arg\max_{q_1, q_2} q_1' FEV(1,h) q_1 + q_2' FEV(2,h) q_2 + +q_3' FEV(3,h) q_3$$

subject to

$$\begin{aligned}
q_1' FEV(1,h) q_1 &\geq q_1' FEV(j,h) q_1 \text{for } j = 2,3,4,5 \\
q_2' FEV(2,h) q_2 &\geq q_2' FEV(j,h) q_2 \text{for } j = 1,3,4,5 \\
q_3' FEV(3,h) q_3 &\geq q_3' FEV(j,h) q_3 \text{for } j = 1,2,4,5 \\
q_1' q_2 &= 0 \\
q_1' q_3 &= 0 \\
q_2' q_3 &= 0 \\
e_5' C(0) P Q e_1 = e_5' C(0) P q_1 &= 0 \\
e_3' C(0) P Q e_3 = e_5' C(0) P q_3 &= 0
\end{aligned}$$

where the first two constraints are the same as before. The third constraint implies that the share of the variance explained by the news shock of GDP is higher than the share of news shock in the forecast error variance of other variables. The next three constraints imply that these three shocks are orthogonal. The seventh constraint is the same as before and the last constraint implies that the news shock does not affect GDP contemporaneously. In the case of five variables also, we replace GDP growth with investment growth and consumption, and estimate two additional five-variable models. We also use alternative measures of size of the government and term spread and estimate two more models. These results are similar to the results reported here and are given in the Online Appendix. We do not have data on the term premium to estimate a model with term premium and obtain its response directly, but the empirical setting used in this paper allows the estimation of the response of the term premium due to the shocks and we explain that in the next section.

2.7 From term spread to term premium

In general, the expectations hypothesis gives the long rates as the expected value of the future short-term rate. We write the long rates as the sum of the expected value of the future short-term rates and term premium φ_t^m:

$$i_t^m = E_t \frac{1}{m} \left\{ \sum_{j=0}^{m-1} i_{t+j} \right\} + \varphi_t^m$$

We can write the spread (i.e. the difference between the long-term rates and short-term rates (slope)) as:

$$\underbrace{(i_t^m - i_t)}_{\text{Slope}} = \underbrace{\left(\frac{1}{m} E_t \left\{ \sum_{j=0}^{m-1} i_{t+j} \right\} - i_t \right)}_{\text{average expected future short rate – short rate}} + \underbrace{\left[i_t^m - \frac{1}{m} E_t \left\{ \sum_{j=0}^{m-1} i_{t+j} \right\} \right]}_{\text{term premium}}$$

where the slope is made up of the term premium and the difference between the average of the expected future short rates and current short rate. The term premium can be written as

$$\varphi_t^m = \left(i_t^m - \frac{1}{m} E_t \sum_{j=0}^{m-1} i_{t+j} \right) = (i_t^m - i_t) - \left(\frac{1}{m} E_t \sum_{j=0}^{m-1} i_{t+j} - i_t \right)$$

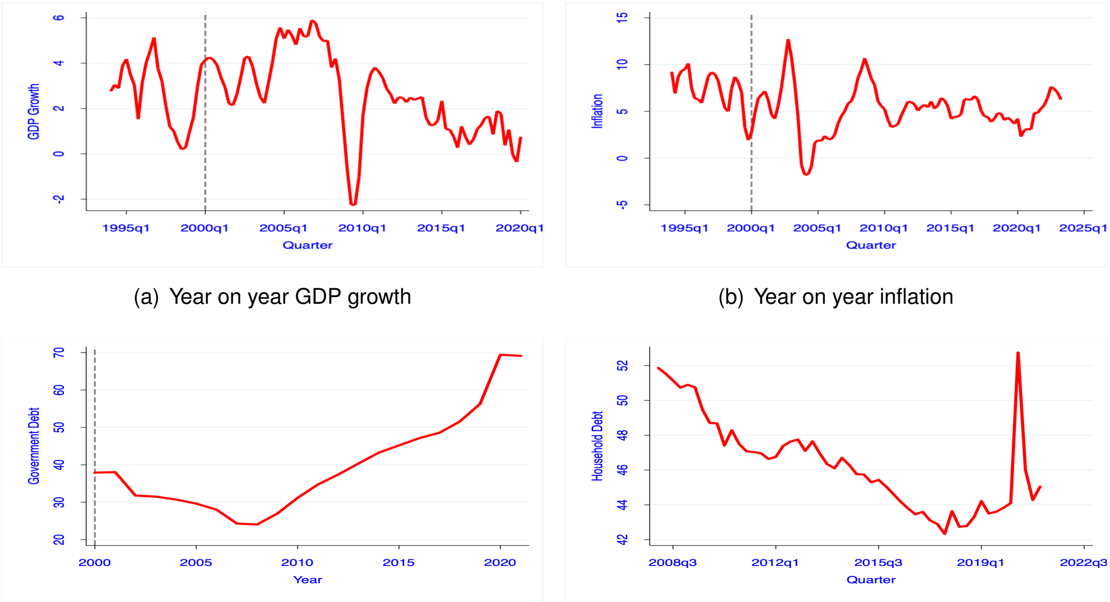
The difference between the slope and the excess of the average of the expected future short rates compared to the current short-term rates gives the term premium. We do not observe the term premium and hence cannot estimate the response of the term premium directly using the VAR model. But we can estimate the response of the term premium indirectly by estimating the response of all the items on the right-hand side. We know the response of the spread from the model containing the overnight rate. This gives us the response of $(i_t^m - i_t)$ at each point in time. From the same model, we obtain the response of $\frac{1}{m}E_t\left\{\sum_{j=0}^{m-1} i_{t+j}\right\}$ using a 40-quarter moving average of the response of i_t, and the same model gives us the response of i_t. This way, we obtain responses of the term premium due to a shock to the term spread shock, and a shock to the size of the government. We use the term spread $(i_t^m - i_t)$ as the difference between the ten-year and three-month rate and the overnight rate as i_t. In the above specification, three-month and overnight rates are denoted by i_t. Since these two rates are very similar—but not the same—this allows us to estimate the response of the term premium.

2.8 Data

The national accounts data is obtained from the Federal Reserve Bank of St. Louis and is for the time period 1993Q1 to 2023Q2. We use consumer prices, overnight interest rate, three-month rate (yield), ten-year rate (yield), government final consumption expenditure, private final consumption expenditure, and GDP. The interest rate and government debt data have also been obtained from the Federal Reserve Bank of St. Louis. As we can see from Figure 2, there has been a substantial increase in the debt to GDP ratio in the last decade. It increased from $\sim 25\%$ to 70%. This has been partly driven by the rising share of the government expenditure in GDP, as shown in Figure 1. The leveraging by government has been accompanied by a deleveraging of the private sector, and the share of household debt to GDP was declining in most of the last decade, followed by an increase towards the end of the decade, which jumped during COVID-19. The South African economy did not recover completely from the great financial crisis of 2008, and despite a V-shaped recovery, growth has been declining steadily in the last decade (Figure 3). Inflation was benign during the last decade despite the buildup in government debt, and the very recent rise in inflation is partly driven by higher global commodity prices that led to an increase in inflation in most parts of the world. Against this background, we aim to understand the reasons for the increase in term spread and its transmission in the South African economy.[4]

[4] The Online Appendix gives the link to the data sources used in this paper.

Figure 2: Growth, inflation, and government and household debt



(a) Year on year GDP growth

(b) Year on year inflation

(c) Central government debt (% of GDP)

(d) Household debt (% of GDP)

Source: authors' elaboration based on data from the Federal Reserve Bank of St. Louis.

3 Results: SVAR

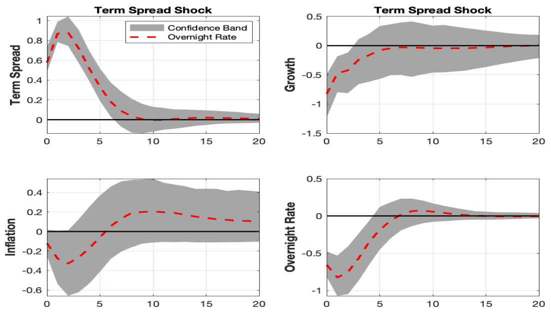
3.1 Unrestricted, short end, and long end term spread shock

We estimate the baseline models along the lines of Kurmann and Ortok (2013). The baseline model is estimated with term spread (the difference between the ten-year and three-month rates), log of GDP, log of consumer price, and either overnight or ten-year rate. We use two lags as all information criteria suggest two lags and the VAR satisfies the stability condition, with two lags to do meaningful impulse response analysis.[5] We use $h = 20$ (i.e. the share in forecast error variance over 5 years). Kurmann and Ortok (2013) argue that term spread is driven by accommodating monetary policy which is reacting to positive news shock, and this shock leads to an increase in output and a decline in inflation. Hence the term spread shock behaves as a favourable supply shock.

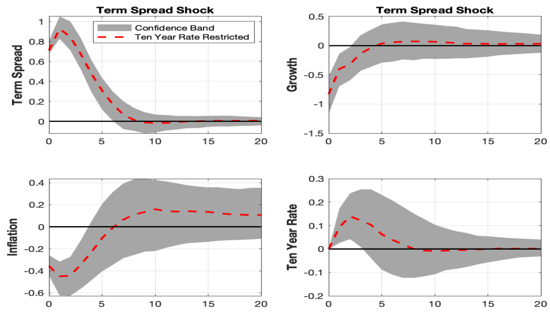
The baseline model (unrestricted term spread shock) for South Africa with the overnight rate, which is comparable to Kurmann and Ortok (2013), indeed suggests that the term spread increase is driven by the decline in the short-term rate (Figure 3(a)). But unlike Kurmann and Ortok (2013), we find that it leads to a decline in GDP and inflation, although the effect on inflation is not statistically significant. Since we use log GDP, the results suggest that the term spread shock causes a negative growth of $\sim 1\%$ at impact and the negative effect persists for four quarters. The term spread shock driven by lowering of the short-term rates behaves as a negative demand shock, which is puzzling. This is the core issue in the South African economy, where the lowering of the short-term rate has failed to stimulate growth and has been accompanied by decreasing growth rate.

[5] Results related to lag length selection and stability tests are provided in Online Appendix A.9.

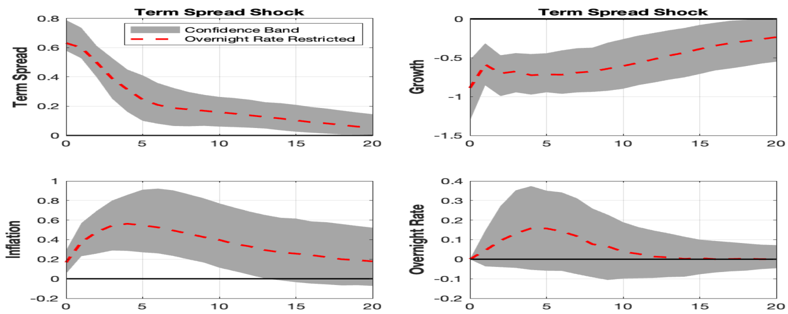
Figure 3: Response of model variables due to unrestricted term spread shock and term spread shock originating at the short and long end



(a) Unrestricted term spread shock



(b) Term spread shock at short end

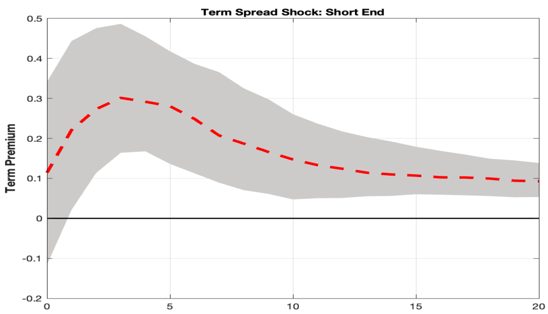


(c) Term spread shock at long end

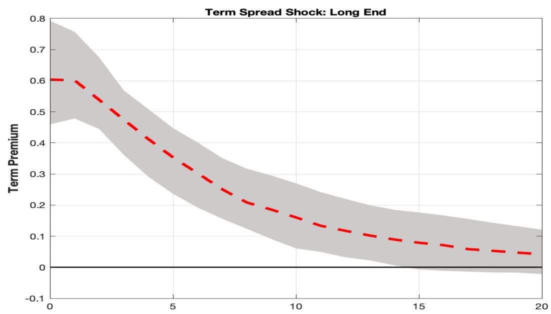
Note: we use four variables (term spread, log GDP, log consumer price, and either overnight or ten-year rate) in the SVAR and estimate three models. The term spread is the difference between a ten-year rate and a three-month rate. We identify the term spread shock that explains the maximum forecast error variance of term spread and also explains the higher variance of term spread compared to other variables. The shaded areas represent the one standard deviation confidence band of responses of variables due to the term spread shock. (a) The responses of the variable due to term spread shock from a model including the overnight rate. (b) The responses of the variable due to term spread shock from a model including the ten-year rate but the contemporaneous response of the ten-year rate due to term spread shock is restricted to zero. (c) The responses of the variable due to term spread shock from a model including the overnight rate but the contemporaneous response of the overnight rate due to term spread shock is restricted to zero. The sample period is 1993Q1–2023Q2.

Source: authors' compilation.

Figure 4: Response of term premium due to unrestricted term spread shock and term spread shock originating at the long end



(a) Unrestricted term spread shock



(b) Term spread shock at the long end

Note: we use four variables (term spread, GDP, consumer price, and either overnight or ten-year rate) in the SVAR and estimate three models. The term spread is the difference between a ten-year rate and a three-month rate. We identify the term spread shock that explains the maximum forecast error variance of the term spread and also explains the higher variance of the term spread compared to other variables. The shaded areas represent the one standard deviation confidence band of responses of variables due to the term spread shock. (a) The response of the term premium due to the term spread shock from a model including the overnight rate. (b) The responses of the term premium due to term spread shock from a model including the overnight rate, but the contemporaneous response of the overnight rate due to term spread shock is restricted to zero. The sample period is 1993Q1–2023Q2.

Source: authors' compilation.

To resolve this puzzle, we allow the term spread shock to originate either by movement at the short end of the rate or the long end of the rate. This is the novelty in the identification used in this paper, and we achieve it by restricting the contemporaneous response of the overnight rate and long-term rate due to term spread shock. If we restrict the contemporaneous response of the ten-year rate due to the term spread shock, then the **shock originates at the short end** of the rate and responses are given in Figure 3(b). These responses (price and GDP) are very similar to the responses due to the term spread shock from the unrestricted model. Hence we conclude that the term spread shock from the unrestricted model originates at the short end, which is also clear from the movement of the overnight rate due to this shock (Figure 3(a)). One important point to note about these two sets of responses is that they produce positive covariance between growth and inflation and hence even if they raise the term premium, that would not be theoretically consistent. This is because in theory a shock that induces negative covariance between growth and inflation is likely to cause a higher term premium (Rudebusch and Swanson 2012).

If we restrict the contemporaneous response of the overnight rate due to term spread shock, then the **shock originates at the long end** of the rate and responses are given in Figure 3(c). The term spread shock originating at the long end leads to an increase in inflation and decrease in growth and hence induces a negative covariance between growth and inflation. Although this shock also induces similar reduction in GDP at impact, the negative effect is persistent and lasts up to five years. The maximum increase in price due to this shock is $\sim 0.5\%$ and occurs by the end of the fourth quarter. We conclude that out of these three models only the term spread shock originating at the long end can cause increase in term premium that is theoretically consistent.

We show the response of the term premium due to the two shocks (unrestricted term spread shock and the restricted one originating at the long end) in Figure 4. This is because in only these two models can we estimate the response of the term premium. These two shocks lead to an increase in the term premium. The shock originating at the short end[6] does not lead to an increase in the term premium in the beginning, but it has a minor effect on the risk premium after a few quarters, though it does not induce the theoretically consistent response of inflation and growth as mentioned before. The shock originating at the long end is driven by a change in risk premium, induces significant increase in term premium (Figure 4(b)), and reduces growth and increases inflation (Figure 3(c)).

Hence, only the term spread shock originating at the long end is a meaningful shock to understand the behaviour of the term premium.[7] Figure 5 gives the share of term spread shock in the forecast error variance of the model variables. As expected, the term spread shocks in three models explain the entire variance of the term spread in the beginning, but this decreases with time. The unrestricted term spread shock explains around 40% of the variation in overnight rate, suggesting that it is indeed driven by movements at the short end. It explains 15% and 10% of the forecast error variance of output and inflation, respectively, by the fifth year. The term spread shock originating at the short end explains 5% of the forecast error variance of the ten-year rate by the fifth year. It also explains around 10% of the forecast error variance of output and inflation by the fifth year.

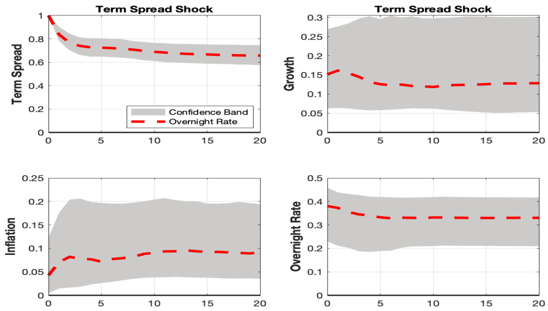
The share of the term spread shock originating at the long end in the forecast error variance of the term spread goes down to 50% by the end of year five. The term spread shock originating at the long end explains around 30% of the forecast error variance of output by the fifth year. The term spread shock originating at the long end explains around 20% of the forecast error variance of inflation by the third year, and this increases to $\sim 15\%$ by the end of the fifth year. It is important to mention that the term spread shock originating at the long end explains the higher proportion of the forecast error

[6] The unrestricted shock and shock originating at the short end produce similar response of output and prices.

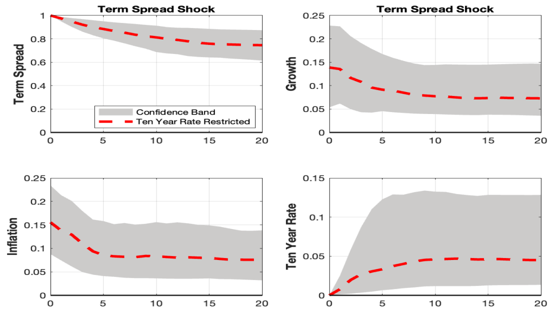
[7] We replace log GDP with log consumption and log investment and estimate two additional four-variable models. These results are similar to the reported results in the paper and are available on request.

variance of output and inflation compared to the unrestricted term spread shock and the term spread shock originating at the short end.

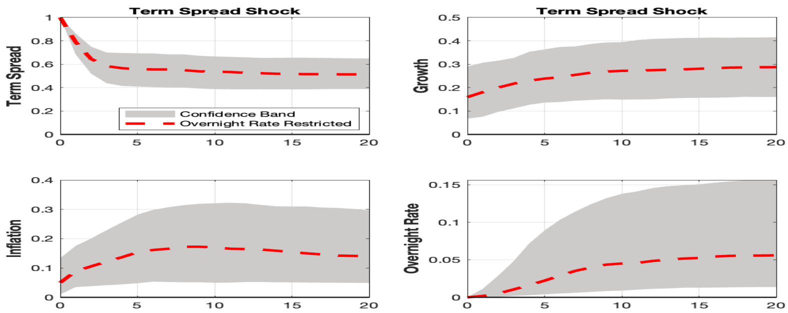
Figure 5: Share of unrestricted term spread shock and term spread shock originating at the short and long end in forecast error variance of the model variables



(a) Unrestricted term spread shock



(b) Term spread shock at the short end



(c) Term spread shock at the long end

Note: we use four variables (term spread, GDP, consumer price, and either overnight or ten-year rate) in the SVAR and estimate three models. The term spread is the difference between a ten-year rate and a three-month rate. We identify the term spread shock that explains the maximum forecast error variance of the term spread and also explains the higher variance of the term spread compared to other variables. The shaded areas represent the one standard deviation confidence band of the share of the term spread shock in forecast error variance of variables. (a) The share of the term spread shock in the forecast error variance of variables from a model including the overnight rate. (b) The share of the term spread shock in the forecast error variance of variables from a model including the ten-year rate but the contemporaneous response of the ten-year rate due to term spread shock is restricted to zero. (c) The share of the term spread shock in the forecast error variance of variables from a model including the overnight rate but the contemporaneous response of the overnight rate due to term spread shock is restricted to zero. The sample period is 1993Q1–2023Q2.

Source: authors' compilation.

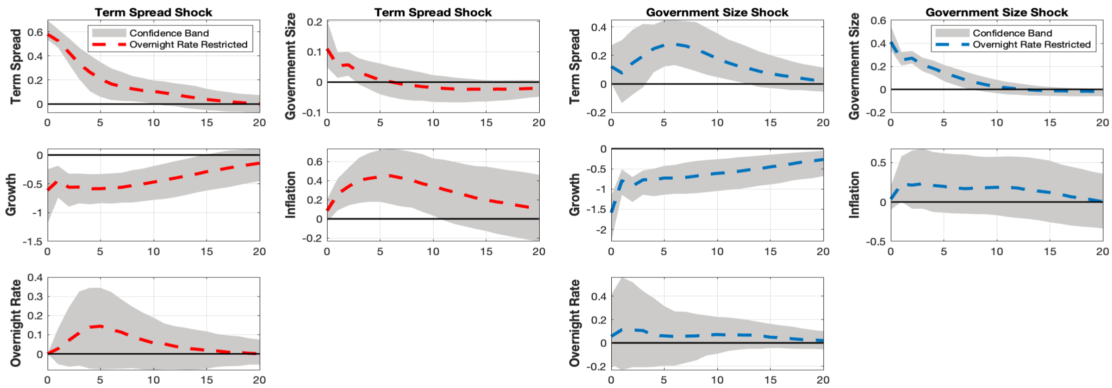
One obvious shock driving these co-movements—increase in term spread and inflation and decrease in growth—could be the increasing size of the government in South Africa. We explore this in the next section. Hence we keep the term spread shock originating at the long end in the next section, as this shock increases the term premium, which is theoretically consistent. This is because in the absence of this shock, the shock to the size of the government can be confounded with the term spread shock at the long end, as the government size shock is also expected to increase the term premium.

3.2 Term spread and government size shocks

We extend the model with size of the government and identify two shocks simultaneously: a term spread shock originating at the long end which is endogenously driving the term premium, and the government size shock that is likely to influence the term premium.

As argued before, we implement joint estimation of these two shocks, as in the absence of the term spread shock originating at the long end, the government size shock may not be identified. The government size shock is likely to increase the risk premium,but some of the increase in risk premium could be purely exogenous, which is captured by the term spread shock originating at the long end. *This strategy helps* *us in estimating the unbiased estimate of the effect of government size shock on risk premium, which is one of the main objectives of this paper.*The size of the government is defined as the share of government expenditure to GDP, and we use national accounts data for this. As mentioned before, we obtain these data from the Federal Reserve Bank of Saint Louis, and the link for the same is provided in the Online Appendix. The response of the model variable due to term spread and government size shocks is given in Figure 6.

Figure 6: Response of model variables due to term spread shock originating at the long end and unrestricted government size shock



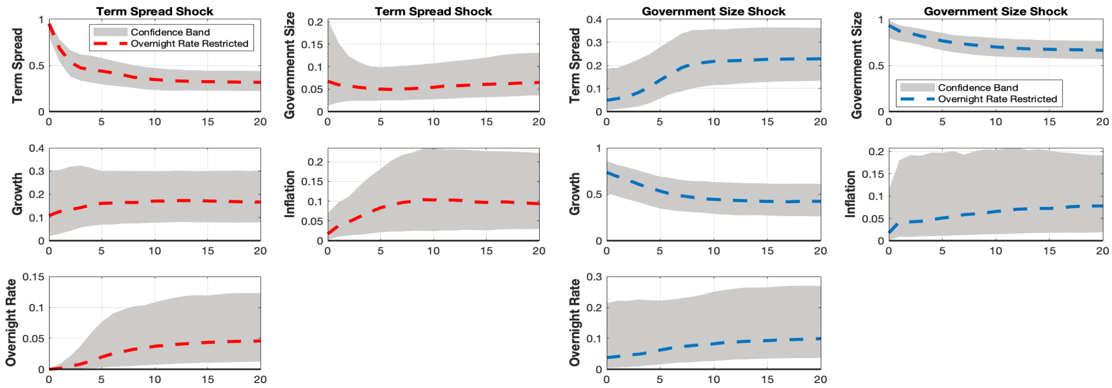
(a) Term spread shock at long end (b) Government size shock

Note: we use five variables (term spread, government size, GDP, consumer price, and overnight rate) in the SVAR. Term spread is the difference between a ten-year rate and a three-month rate. The size of the government is given by the ratio of the government final consumption expenditure to GDP. We jointly identify two shocks—term spread shock originating at the long end and government size shock—that maximize the sum of the share of these two orthogonal shocks in the forecast error variance of the respective variables. The shaded areas represent the one standard deviation confidence band of responses of variables due to the term spread shock. (a) The responses of the variable due to the term spread shock from a model including the overnight rate but the contemporaneous response of the overnight rate due to term spread shock is restricted to zero. (b) The responses of the variable due to government size shock from a model including the overnight rate but the contemporaneous response of the overnight rate due to term spread shock is restricted to zero. The correlation between the response of log GDP and log consumer prices due to the government size shock is –0.71 and is statistically significant. The sample period is 1993Q1–2023Q2.

Source: authors' compilation.

The term spread shock originating at the long end produces a similar response in variables as given in Figure 3(c), which gives us confidence that the strategy is able to identify the shocks correctly. The term spread shock originating at the long end leads to an increase in the government size, but the effect is short-lived. Government size shock leads to a permanent reduction in growth rate and the impact effect is almost thrice of the term spread shock originating at the long end and is more persistent. It is important to mention that we do not restrict the contemporaneous response of the overnight rate and the long-term rate due to a shock to the size of the government. A shock to the size of the government leads to higher term spread in the medium run. Figure 7 gives the share of the term spread and the government size shock in the forecast error variance of the model variables. The shares of the term spread shock in the forecast error variance of growth, inflation, and interest rates are similar to the ones reported in Figure 5(c). The term spread shock explains around 5% of the forecast error variance of the size of the government. The government size shock explains very little variance of the term spread in the beginning, but by the fifth year this becomes almost 20%. This suggests that the changes in term spread are driven by changes in the size of the government, and this is also evident in the data.

Figure 7: Share of term spread shock originating at the long end and unrestricted government size shock in the forecast error variance of model variables



(a) Term spread shock at long end

(b) Government size shock

Note: we use five variables (term spread, government size, GDP, consumer price, and overnight rate) in the SVAR. Term spread is the difference between a ten-year rate and a three-month rate. The size of the government is given by the ratio of the government final consumption expenditure to GDP. We jointly identify two shocks—term spread shock originating at the long end and government size shock—that maximize the sum of the share of these two orthogonal shocks in the forecast error variance of the respective variables. The shaded areas represent the one standard deviation confidence band of the responses of variables due to the term spread shock. (a) The share of the term spread shock in forecast error variance of variables from a model including the overnight rate but the contemporaneous response of the overnight rate due to term spread shock is restricted to zero. (b) The share of government size shock in forecast error variance of variables from a model including overnight rate but the contemporaneous response of the overnight rate due to the term spread shock is restricted to zero. The sample period is 1993Q1–2023Q2.

Source: authors' compilation.

This shock explains almost 100% of the forecast error variance of the size of the government in the beginning, but in the medium run the share declines. Most importantly, this shock explains around 50% of the forecast error variance of growth and 10% of inflation. The shock explains $\sim$ 10% of forecast error variance of the short-term rates by the fifth year. This suggests that a shock to the size of the government raises term spread and decreases growth. We estimate additional five-variable models for South Africa in which we replace log GDP with log consumption and log investment one by one and also use alternative measures of government size and term spread. As expected, the government size shock has more persistent negative effect on capital formation compared to consumption. Higher size of the government creates risk and this should matter more for investment. These results are given in the Online Appendix and are similar to those reported here.

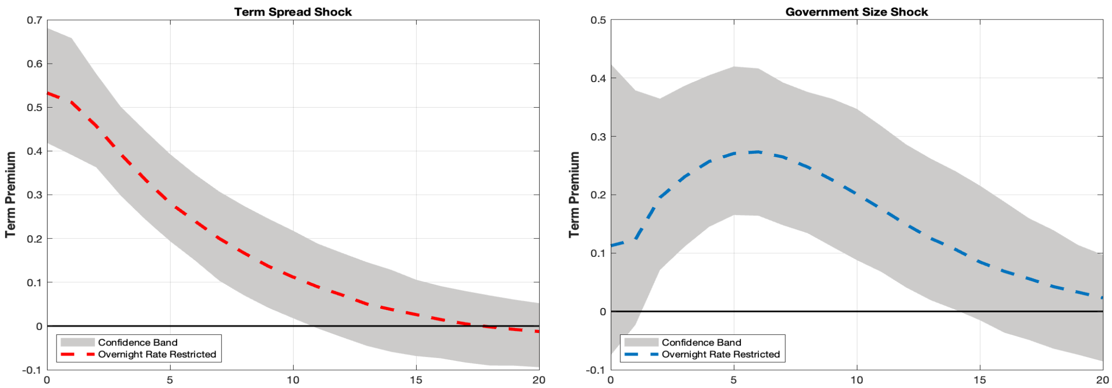
The results presented in this section suggest that a shock to the size of the government increases the term spread and also that via movement in long-term rates in the medium run. The long-term rates could increase because of higher expected value of the future rates or it can increase due to an increase in risk or term premium. A shock to the size of the government is likely to influence the term premium by generating a negative covariance between consumption and inflation, which is essential for increase in term premium (Bretscher et al. 2020; Horvath et al. 2020; Rudebusch and Swanson 2012). The shock to the size of the government generates a negative covariance between inflation and growth (Figure 6). Although the effect on inflation is not statistically significant in the model with log GDP, we compute the correlation between the response of log GDP and log consumer prices due to the government size shock and that turns out to be –0.71 and is statistically significant.[8]

This also generates a negative covariance between consumption growth and inflation, as shown in the Online Appendix. Although we do not have explicit data on the term premium to estimate a model with

[8] The correlation between the response of log private final consumption expenditure and log consumer prices due to the government size shock is –0.73, and the correlation between the response of log gross fixed capital formation and log consumer prices due to the government size shock is –0.72. Both of these correlations are statistically significant.

the term premium and obtain its response, the empirical setting used in this paper allows the estimation of the response of the term premium due to the shocks, as done in the previous sections. Figure 8 presents the response of the term premium due to term spread shock originating at the long end and government size shocks.[9] Including the size of the government does not influence the response of the term premium due to the term spread shock. The term spread shock at the long end continues to be driven by an increase in risk premium, unlike the term spread shock originating at the short end, as shown in the previous section. Further, we see that the increase in term spread due to the government size shock is mostly driven by an increase in term premium. This is the reason that the term spread shock is contractionary in South Africa.[10]

Figure 8: Response of the term premium due to the term spread shock originating at the long end and government size shock



(a) Term Spread Shock at Long End (b) Government Size Shock

Note: we use five variables (term spread, size of the government, GDP, consumer price, and overnight rate) in the SVAR. Term spread is the difference between a ten-year rate and a three-month rate. The size of the government is given by the ratio of the government final consumption expenditure to GDP. We jointly identify two shocks—term spread shock originating at the long end and government size shock—that maximize the sum of shares of these two orthogonal shocks in forecast error variance of the respective variables. The shaded areas represent the one standard deviation confidence band. The red and blue lines give the responses of the term premium due to term spread and government size shock, respectively, from a model including the overnight rate but the contemporaneous response of the overnight rate due to the term spread shock is restricted to zero. The sample period is 1993Q1–2023Q2.

Source: authors' compilation.

3.3 Expansionary, recessionary, and neutral government size shock

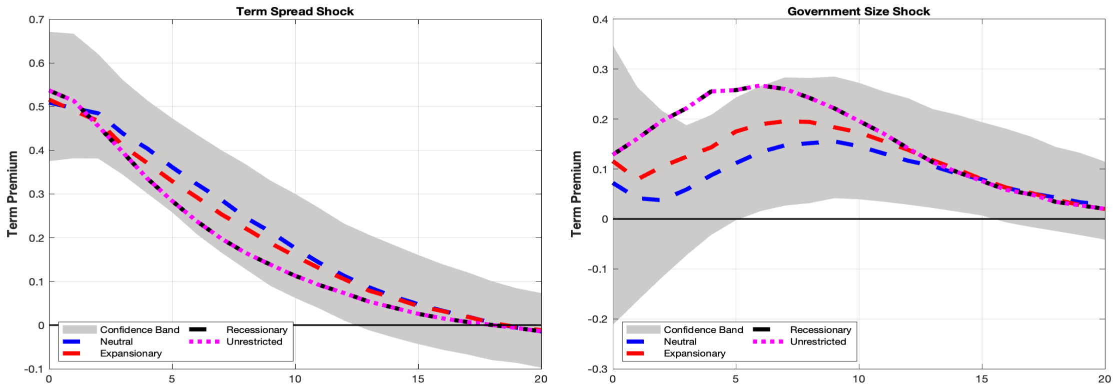
In the previous section we identified the unrestricted government size shock. In this section we estimate additional five-variable models for South Africa to identify expansionary, neutral, and recessionary government size shocks. The expansionary government size shock is identified by restricting the response of output due to government size shock to be ≥ 0 for two time periods $t = 0$ and $t = 1$. Neutral government size shock is identified by restricting the response of output due to government size shock to be $= 0$ for two time periods $t = 0$ and $t = 1$. Recessionary government size shock is identified by restricting the response of output due to government size shock to be ≤ 0 for two time periods $t = 0$ and $t = 1$. These restrictions were explained in Section 2.5. The responses of model variables and forecast error variance decomposition from these models are given in the Online Appendix. Here we only report the response of term premium due to the two identified shocks.

[9] These responses are also significant at the 95% confidence interval and these results are available on request.

[10] Kurmann and Ortok (2013) suggest that the term spread shock in the United States is driven by the news about future productivity, which allows the Federal Reserve to lower the interest rates. This increases output and decreases inflation, unlike what we see in South Africa as explained in the previous section. Cascaldi-Garcia (2017) refutes the claims in Kurmann and Ortok (2013), and in response to that, Kurmann and Ortok (2017) argue that Cascaldi-Garcia (2017) does not make any distinction between positive and negative news and that is problematic, and as the distinction between positive and negative news is made, the claims of Kurmann and Ortok (2013) remain true.

As we can see from Figure 9, both the recessionary and unrestricted government size shocks produce identical response of the term premium and hence it confirms that the unrestricted shock is a recessionary shock in the model. But both expansionary and neutral government size shocks also lead to higher term premium. The neutral government size shock is identified by restricting the response of output due to government size shock to zero, and hence this is a shock to the government expenditure. Rudebusch and Swanson (2012) are able to generate a term premium response of **0.17 basis points** only compared to a **20 basis points** response of term premium in this paper. It is important to mention that Rudebusch and Swanson (2012) use a theoretical model and their objective is to generate the level of term premium in the model which is compared to the level of the term premium and data. Unlike us, they do not aim to estimate the response of the term premium due to government expenditure or size shock. The confidence band in Figure 9 is given for the response of the term premium due to the neutral government size shock and we conclude that a recessionary government size shock produces statistically higher term premium than the neutral and expansionary government size shocks. Hence we can say that an increase in the size of the government leads to significant risk in the bond market and these risks are even higher in times of recession. We also find that the term spread shock originating at the long end produces an identical response of the term premium in the models estimated with unrestricted and recessionary government size shock. The recessionary government size shock produces the highest negative correlation between output and prices and the expansionary government size shock produces the smallest negative correlation between output and inflation among the four government size shocks estimated in this paper. These are provided in the Online Appendix.

Figure 9: Response of the term premium due to the term spread shock originating at the long end and recessionary, neutral, and expansionary government size shocks



(a) Term spread shock at the long end

(b) Government size shock

Note: we use five variables (term spread, size of the government, GDP, consumer price, and overnight rate) in the SVAR. Term spread is the difference between a ten-year rate and a three-month rate. The size of the government is given by the ratio of the government final consumption expenditure to GDP. We jointly identify two shocks—term spread shock originating at the long end and the government size shock—that maximize the sum of shares of these two orthogonal shocks in the forecast error variance of the respective variables. Panels (a) and (b) show the responses of the term premium due to the term spread and government size shocks, respectively, from a model including the overnight rate, but the contemporaneous response of the overnight rate due to the term spread shock is restricted to zero. The shaded areas represent the one standard deviation confidence band of responses due to the respective shocks obtained from the model having neutral government size shock. The neutral government size shock is identified using the additional restriction that government size shock does not affect the output for two time periods $t = 0$ and $t = 1$. The expansionary government size shock is identified using the additional restriction that government size shock increases the output for two time periods $t = 0$ and $t = 1$. The recessionary government size shock is identified using the additional restriction that government size shock decreases the output for two time periods $t = 0$ and $t = 1$. The sample period is 1993Q1–2023Q2.

Source: authors' compilation.

3.4 Term spread, government size, and news shocks

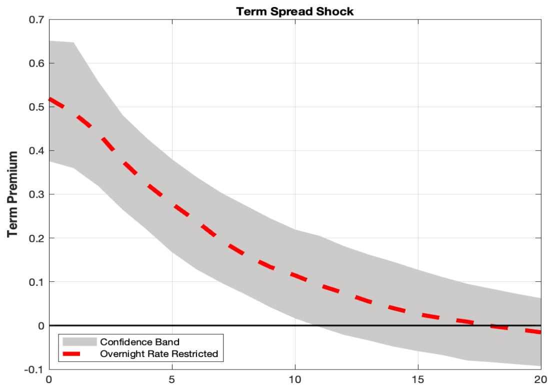
Kurmann and Ortok (2013) argue that the term spread could be driven by news about future productivity. The government size is also likely to be influenced by news about future productivity. Expected slowdown in the economy may lead to increasing the size of the government and vice versa. To rule out this channel, we extend the model to include a news shock similar to Barsky and Sims (2011).

The responses of model variables and forecast error variance decomposition from the model is given in the Online Appendix. Here we only report the response of the term premium due to these three shocks. The news shock is expected to increase the output observed in advance. The news shock explains the maximum share in forecast error variance of log GDP but does not affect the log GDP contemporaneously. The responses of the model variables and forecast error variance decomposition due to the three shocks are given in the Online Appendix. The responses of the model variables due to the term spread shock originating at the long end and the government size shock are similar to Figure 6.

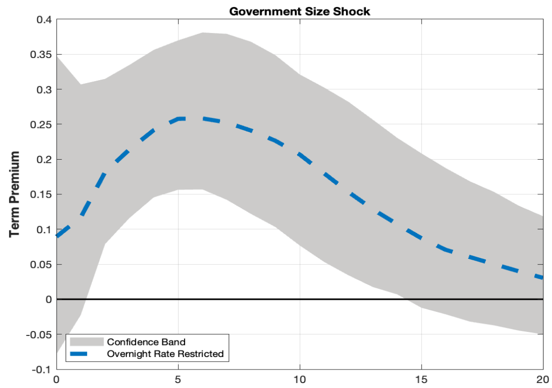
The news shock leads to a reduction in the overnight rate which is similar to the findings in Kurmann and Ortok (2013). The news shock leads to an increase in output as in Gortz et al. (2022), with lag as expected and decreased inflation, but these effects are not statistically significant. The news shock also leads to fiscal consolidation as expected. The share of the term spread shock originating at the long end and the government size shock in the forecast error variance of the model variables are given in the Online Appendix. These are similar to the results shown in Figure 7, except that we find the government size shock becoming more important in explaining the variation in output. Figure 10 gives the response of the term premium due to these three shocks. The response of the term premium due to the government size shock and the term spread shock originating at the long end is similar to Figure 8. The news shock increases the term premium, but the effect is short-lived.

In the next section we present a New Keynesian model with the term premium. In the literature this type of model has been used to generate the level of term premium comparable to the data. In this paper we aim to generate the response of the term premium in this model which is comparable to the response of the term premium due to government size in the data. We estimate the parameters of the model by impulse response matching. In other words, the parameters of the model are identified using the condition that it produces similar response of these variables due to a shock to the size of the government. The model is similar to Horvath et al. (2022), except that we introduce a shock to the size of the government, which is our focus.

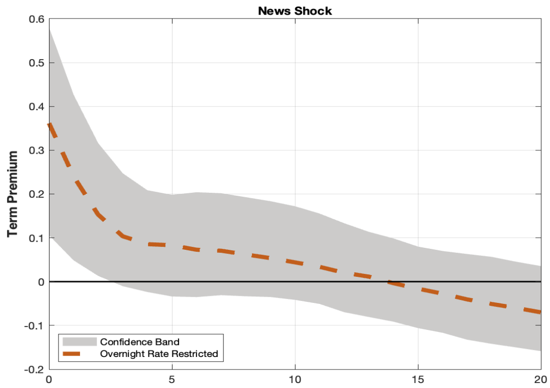
Figure 10: Response of the term premium due to the term spread shock originating at the long end, unrestricted government size, and news shocks



(a) Term spread shock at long end



(b) Government size shock



(c) News shock

Note: we use five variables (term spread, size of the government, GDP, consumer price, and overnight rate) in the SVAR. Term spread is the difference between a ten-year rate and a three-month rate. The size of the government is given by the ratio of the government final consumption expenditure to GDP. We jointly identify three shocks—term spread shock originating at the long end, government size shock, and news shock—that maximize the sum of the share of these three orthogonal shocks in the forecast error variance of the respective variables. The shaded areas represent the one standard deviation confidence band. The red, blue, and orange lines give the responses of the term premium due to term spread, government size, and news shock, respectively, from a model including the overnight rate, but the contemporaneous response of the overnight rate due to the term spread shock is restricted to zero. The sample period is 1993Q1–2023Q2.

Source: authors' compilation.

4 Model

4.1 Household

The model is based on the New Keynesian DSGE model of Rudebusch and Swanson (2012), Kisacikoglu (2020), and Horvath et al. (2022). Rudebusch and Swanson (2012) and Horvath et al. (2022) investigate the role of government expenditure shock in driving the term premium. As mentioned before, we use government size shock instead of government expenditure shock as we are interested in investigating the role of government size shock in driving the term premium. Hence the fiscal block of the model in this paper is different from these studies. The household continuation value of utility (V_t) is of Epstein–Zin form and is given by

$$V_t = U\left(C_t, L_t\right) + \beta\left[E_t V_{t+1}^{1-\alpha}\right]^{\frac{1}{1-\alpha}} \text{ if } U\left(C_t, L_t\right) \geq 0$$

$$V_t = U\left(C_t, L_t\right) - \beta\left[E_t\left(-V_{t+1}\right)^{1-\alpha}\right]^{\frac{1}{1-\alpha}} \text{ if } U\left(C_t, L_t\right) < 0$$

where C_t is household consumption and L_t is the labour hours. The Epstein–Zin preferences allow the risk aversion to be separated from intertemporal elasticity of substitution by having an additional parameter α. A higher degree of risk aversion is required to generate a reasonable term premium in the data, and Epstein–Zin preferences allow that without reducing the intertemporal elasticity of substitution. To be consistent with the balanced growth path, the following functional form is used for $U(C_t, L_t)$ as argued in Rudebusch and Swanson (2012):[11]

$$U(C_t, L_t) = \frac{C_t^{1-\varphi}}{1-\varphi} + \chi_0 Z_t^{1-\varphi} \frac{(1-L_t)^{1-\eta}}{1-\eta}$$

χ_0 is calibrated to give a steady-state ratio of leisure to labour as 2. The nominal budget constraint is given by

$$(1-\tau_t) W_t L_t + R_{t-1} B_{t-1} = B_t + P_t C_t$$

where W_t is the nominal wage in time period t, τ_t is the labour income tax rate in time t and B_t is the nominal bond holding at time t. The availability of nominal bonds creates an intertemporal market and allows the households to smooth consumption. In real terms, the budget constraint is given by

$$(1-\tau_t) w_t L_t + R_{t-1} \frac{b_{t-1}}{\pi_t} = b_t + C_t$$

where Z_t is a deterministic productivity trend. The Lagrangian of the household problem is given by

$$\mathcal{L} = V_0 - E_0 \sum_{t=0}^{\infty} \omega_t \left(\frac{C_t^{1-\varphi}}{1-\varphi} + \chi_0 Z_t^{1-\varphi} \frac{(1-L_t)^{1-\eta}}{1-\eta} + \beta \left[E_t V_{t+1}^{1-\alpha} \right]^{\frac{1}{1-\alpha}} - V_t \right) +$$
$$+ E_0 \sum_{t=0}^{\infty} \beta^t \lambda_t \left((1-\tau_t) w_t L_t + R_{t-1} \frac{b_{t-1}}{\pi_t} - b_t - C_t \right)$$

where ω_t and λ_t are Lagrange multipliers. The first-order condition with respect to consumption is given by

$$\frac{\partial \mathcal{L}}{\partial C_t} = \omega_t C_t^{-\varphi} - \beta^t \lambda_t = 0 \implies \lambda_t = \frac{\omega_t C_t^{-\varphi}}{\beta^t}$$

The first-order condition with respect to labour is given by

$$\frac{\partial \mathcal{L}}{\partial L_t} = -\omega_t \chi_0 Z_t^{1-\varphi} (1-L_t)^{-\eta} + \beta^t \lambda_t (1-\tau_t) W_t = 0$$

Combining the first-order condition with respect to consumption and labour, we obtain the household's intratemporal substitution condition given by

$$Z_t^{1-\varphi} \chi_0 (1-L_t)^{-\eta} = C_t^{-\varphi} (1-\tau_t) W_t$$

The first-order condition with respect to bond is given by

$$\frac{\partial \mathcal{L}}{\partial B_t} = -\lambda_t + \beta \lambda_{t+1} \frac{R_t}{\pi_{t+1}} = 0$$

Using the household first-order condition with respect to consumption, we obtain

$$\frac{\omega_t C_t^{-\varphi}}{\beta^t} = \beta \frac{\omega_{t+1} C_{t+1}^{-\varphi}}{\beta^{t+1}} \frac{R_t}{\pi_{t+1}}$$

[11]Andreasen (2012) uses a non-separable utility function in labour and consumption that is consistent with a balanced growth path too.

The first-order condition with respect to the value function is given by

$$\frac{\partial \mathscr{L}}{\partial V_t} = \omega_{t-1}\beta \left[E_t V_t^{1-\alpha}\right]^{\frac{\alpha}{1-\alpha}} V_t^{-\alpha} = E_{t-1} w_t$$

This gives us $E_t w_{t+1}$, and using it we obtain the household consumption Euler equation:

$$1 = \beta \left(\frac{C_t}{C_{t+1}}\right)^{\varphi} \left(\frac{V_{t+1}}{\left[E_t V_{t+1}^{1-\alpha}\right]^{\frac{1}{1-\alpha}}}\right)^{-\alpha} \frac{R_t}{\pi_{t+1}}$$

where $\Lambda_{t,t+1} = \frac{\pi_{t+1}}{R_t} = \beta \left(\frac{C_t}{C_{t+1}}\right)^{\varphi} \left(\frac{V_{t+1}}{\left[E_t V_{t+1}^{1-\alpha}\right]^{\frac{1}{1-\alpha}}}\right)^{-\alpha}$ is the real stochastic discount factor. Since we have a trend in the model, we make the value function stationary by dividing both sides with $Z_t^{1-\varphi}$. We need two auxiliary equations to write the value function as in Rudebusch and Swanson (2012) and Horvath et al. (2022). This is required to improve the numerical accuracy of the model:

$$\frac{\left[E_t V_{t+1}^{1-\alpha}\right]^{\frac{1}{1-\alpha}}}{Z_t^{1-\varphi}} = \frac{Vk_t}{Z_t^{1-\varphi}} = \bar{V}\gamma^{1-\varphi} \left(\frac{Ve_t}{Z_t^{1-\varphi}}\right)^{\frac{1}{1-\alpha}}$$

$$\frac{Ve_t}{Z_t^{1-\varphi}} = \frac{E_t V_{t+1}^{1-\alpha}}{\left[\bar{V}\gamma^{1-\varphi}\right]^{1-\alpha} \left(Z_t^{1-\varphi}\right)^{1-\alpha}}$$

where $\bar{V}$ is the steady-state value of the value function and is given by $\bar{V} = \frac{\frac{c^{1-\varphi}}{1-\varphi} + \chi_0 \frac{(1-L)^{1-\eta}}{1-\eta}}{1-\beta}$; c is the steady-state value of the stationary variable $c_t = \frac{C_t^{1-\varphi}}{Z_t^{1-\varphi}}$; and γ is the steady-state value of $\frac{Z_t}{Z_{t-1}}$, and we assume it to be 1. We derive the household's consumption-only coefficient of relative risk aversion as in Rudebusch and Swanson (2012) in the presence of labour income tax, and it is given by[12]

$$R^c(a;\theta) = \frac{\varphi}{1 + \frac{(1-L)}{L}\frac{\varphi}{\eta}} + \alpha \frac{(1-\varphi)}{1 + \frac{(1-L)(1-\varphi)}{L(1-\eta)}}$$

This is a steady-state measure. Although the steady-state tax rate or steady-state share of the government expenditure in GDP does not enter the risk aversion, it does not mean that they do not influence risk aversion. Higher government expenditure is like a wealth shock to households, and households respond by increasing labour hours. Hence higher government expenditure in the steady state implies higher steady-state labour hours and that implies higher values of consumption-only coefficient of relative risk aversion for reasonable values of α, θ, and η. We can write the consumption-only coefficient of relative risk aversion as

$$R^c(a;\theta) = \frac{1}{\frac{1}{\varphi} + \frac{(1-L)}{L\eta}} + \alpha \frac{1}{\frac{1}{(1-\varphi)} + \frac{(1-L)}{L(1-\eta)}}$$

which further becomes

$$R^c(a;\theta) = \frac{1}{IES + \text{Frisch elasticity}} + \alpha \frac{1}{\frac{1}{(1-\varphi)} + \frac{\eta}{(1-\eta)}}$$

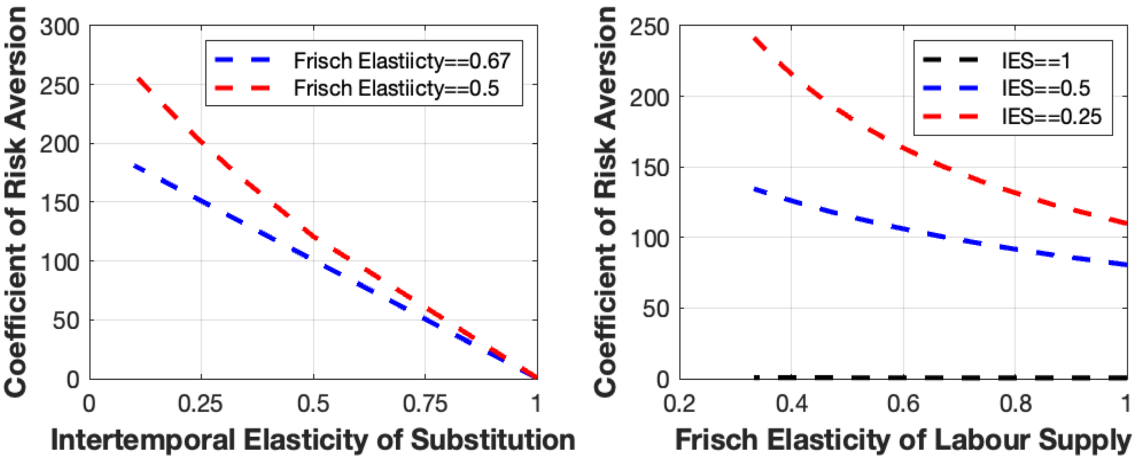
[12]The consumption-only coefficient of risk aversion is curvature of household value function with respect to the assets. It is related to the Arrow (1965) and Pratt (1998) measure of risk aversion, which is defined as the curvature of period utility with respect to consumption. It is basically the one-shot payment that a household is willing to make today to avoid a risk of size σ in the next period when σ becomes very small. The detailed derivation is given in Online Appendix B.

where we use $\frac{(1-L)}{L(1-\eta)}$ as the Frisch elasticity of labour supply. A model with the usual preferences will give consumption-only coefficient of relative risk aversion as:

$$R^c(a;\theta) = \frac{1}{IES + \text{Frisch elasticity}}$$

In this case, the higher values of IES and Frisch elasticity imply lower value of consumption-only coefficient of relative risk aversion. This is intuitive as higher value of both allows higher smoothing of consumption arising due to any adverse exogenous shock. In the case of Epstein–Zin preferences, the relationship of consumption-only coefficient of relative risk aversion with IES is dependent on Frisch elasticity. In Figure 11 we show the relationship between the coefficient of risk aversion and IES for two values of Frisch elasticity. Despite the dependence on Frisch elasticity, we find that the coefficient of risk aversion declines with higher value of IES. The relationship of consumption-only coefficient of relative risk aversion with Frisch elasticity is dependent on IES too. As expected, an IES value of 1 implies very low values for the coefficient or risk aversion for any value of Frisch elasticity. Similar to the usual preferences, we find that coefficient of risk aversion declines with higher value of Frisch elasticity, but for $IES = 1$ it marginally increases with higher value of Frisch elasticity.

Figure 11: Coefficient of risk aversion



Note: we assume $\alpha == -200$.

Source: authors' compilation.

The final goods producers, intermediate goods producers, and the conduct of monetary policy are similar to the standard New Keynesian model, and hence we have provided these in the Online Appendix.

4.2 Government

Real public spending (G_t) evolves as a time-varying fraction of real output, as in Justiniano et al. (2010);

$$G_t = \left(1 - \frac{1}{\kappa_t}\right) Y_t$$

κ_t determines the size of the government. Higher values of κ_t imply higher values of $\frac{G}{Y}$. This shock is the same as the government size shock implemented in the empirical section. We need a similar shock in this model as we aim to estimate the parameters of the model using impulse response matching. The government size shock (κ_t) follows the stationary stochastic process given by:

$$\log(\kappa_t) = (1-\rho_\kappa)\log(\kappa) + \rho_\kappa \log(\kappa_{t-1}) + \varepsilon_{\kappa,t} \quad 0 \le \rho_\kappa < 1 \qquad \varepsilon_{\kappa,t} \sim N(0, \sigma_\kappa^2)$$

$(1 - \frac{1}{\kappa})$ gives the steady-state value of government consumption to output ratio, which we calibrate with data. The government budget constraint is given by:

$$B_t + W_t L_t \tau_t = R_{t-1} B_{t-1} + G_t$$

which in real terms is given by

$$b_t + w_t L_t \tau_t = \frac{R_{t-1} b_{t-1}}{\pi_t} + G_t$$

The model requires a fiscal rule that sets taxes based on debt level and business cycle.

$$\tau_t - \bar{\tau} = \rho_\tau (\tau_{t-1} - \bar{\tau}) + \rho_{\tau b} \left(\frac{b_t - b}{y} \right) + \rho_{\tau y} \left(\frac{y_t - y}{y} \right) + \varepsilon_t^\tau$$

$$\varepsilon_t^\tau \sim N\left(0, \sigma_\tau^2\right)$$

where τ_t is the tax rate at time t, $\bar{\tau}$ is the steady-state tax rate, ρ_τ is the persistence in the tax rate, $\rho_{\tau b}$ is the sensitivity of the tax rate to the government debt to GDP ratio, $rho_{\tau y}$ is the sensitivity of the tax rate to the output gap. The tax rule is similar to the discussion in Leeper et al. (2010). The steady-state tax rate is calculated using the steady-state values of the model parameters. Higher values of debt to GDP ratio and higher size of the government imply higher steady-state tax rate in the model.

4.3 Bond pricing

The price of a default-free n-period zero-coupon bond that pays \$1 at maturity can be described with a recursive formula:

$$p_t^{(n)} = E_t \left[\Lambda_{t,t+1} p_{t+1}^{n-1} \right]$$

The continuously compounded return to maturity on the n-period zero-coupon bond is defined to be

$$r_t^n = \frac{-1}{n} \log\left(p_t^n\right)$$

where r_t^n is the net rate and log if R_t^n. We define the risk-neutral bond price as

$$\hat{p}_t^n = e^{-r_t} E_t \hat{p}_{t+1}^{n-1}$$

The implied term premium is defined as the difference between the yield expected by the risk-averse investor minus the yield expected by the risk-neutral investor.

4.4 Aggregation

The aggregate output in the economy is given by:

$$Y_t = S_t^{-1} A_t K_t(i)^{1-\theta} \left(Z_t L_t(i)\right)^\theta$$

where $K_t = \bar{k} Z_t$. The aggregate output depends on the dispersion in price in the economy given by

$$S_t = \left[\int \left[\frac{P_t(i)}{P_t} \right]^{-\varphi_m/\theta} di \right]^\theta$$

The aggregate resource constraint in the economy is given by:

$$Y_t = C_t + I_t + G_t$$

$I_t = (1 - \delta + \gamma) Z_t \bar{k}$ is the investment required to keep capital constant on the balanced growth path.

5 Results from the estimated model

We set the Calvo parameter (ξ) to 0.8, which implies an average contract length of about five quarters, which is same as in Horvath et al. (2022). Rudebusch and Swanson (2012) calibrate this to 0.78. We calibrate the discount factor to be 0.99, which implies a nominal steady-state interest rate of 4% (Table 1). We calibrate the value of L_{max} as 3 and L as 1. This gives $\frac{L_{max}-L}{L}$ as 2. We calibrate the labour share to be 0.66, which is standard in the literature. The calibration implies a net markup of 25%. Our calibration implies debt to GDP ratio of 70% and the share of government in GDP at 20%, which is consistent with the South African economy in recent years explained in the data section. We also estimate additional models with debt to GDP ratio of 25%. This is because the debt was at a low level in the early 2010s and this also allows us to compare the parameters, especially the risk aversion parameter, required on different levels of debt to match the response of the term premium due to government size shock. We further calibrate the parameters related to other shocks in the model and these calibrated parameters are given in Table 2.[13]

Table 1: Calibrated parameters

Parameter	Value	Description
β	0.99	Discount factor
$\frac{L_{max}-L}{L}$	2	Leisure labour ratio
δ	0.25	Annual depreciation 10%
θ	0.66	Labour share
ξ	0.8	Calvo parameter
φ_m	5	Net markup (25%)
b/y	0.70	Debt to GDP ratio
κ	5/4	$(1-\frac{1}{\kappa})$ Share of government expenditure in GDP (20%)

Source: authors' compilation.

Table 2: Calibrated parameters

Parameter	Value	Description
Standard deviation of shocks		
σ_a	0.04	Standard deviation of technology shock
$\sigma_{\varphi m}$	0.04	Standard deviation of markup shock
σ_τ	0.04	Standard deviation of tax shock
σ_i	0.04	Standard deviation of interest rate shock
		Persistence of shocks
ρ_a	0.80	Persistence of technology shock
$\rho_{\varphi m}$	0.80	Persistence of markup shock
Monetary policy		
ρ_i	0.6	Interest rate persistence
ρ_π	0.3	Sensitivity of interest rate to inflation
ρ_g	0.2	Sensitivity of interest rate to output gap

Source: authors' compilation.

We obtain the remaining parameter estimates from the model using the following optimization

$$\xi^* == \arg\min_{\xi} \left[\hat{\Psi} - \Psi(\xi)\right]' V^{-1} \left[\hat{\Psi} - \Psi(\xi)\right]$$

where $\hat{\Psi}$ contains the response of the term premium due to the shock to the size of government from the VAR model explained in the previous section. ξ contains the parameter being estimated, and $\Psi(\xi)$

[13] Initially, we attempt estimating these parameters by matching the response of other variables due to the shock to the size of the government in the model and data. But these estimation attempts give a very poor fit of the response of the term premium in the model with data and hence we further calibrate these parameters which are not essential for the response of the term premium due to the shock to the size of government.

is the response of the same variables due to a shock to the size of the government from the model. We take V as an identity matrix. We only estimate parameters related to the shock to the size of the government, tax rule, and preference parameters related to households which determine consumption-only coefficient of risk aversion that is important for the response of the term premium and moving average of inflation. We estimate two sets of parameters, one for expansionary government size shock and another for recessionary government size shock. We only match the response of the term premium and government size shock as we focus on the response of the term premium.

Table 4 gives the estimated parameters based on the responses due to expansionary and recessionary government size shocks. Descriptions of these coefficients are given in Table 3. Columns 2 and 3 are with a debt to GDP ratio of 70% and government size of 20%. Column 4 is with a debt to GDP ratio of 25%. The intertemporal elasticity of substitution refers to the percentage change in consumption between present and future due to 1 percentage point change in real interest rate.

Table 3: Description of estimated coefficients

Symbol	Description
σ_k	SD govt. size shock
ρ_k	Persistence govt. size shock
ρ_τ	Persistence in tax rate
$\rho_{\tau b}$	Sensitivity of tax to debt ratio
$\rho_{\tau y}$	Sensitivity of tax to output gap
θ_π	Moving average inflation
φ	$\frac{1}{\varphi}$ is intertemporal elasticity of substitution
η	$\frac{L_{max}-L}{L\eta}$ Frisch elasticity of labour supply
α	Coefficient associated with risk aversion

Source: authors' compilation.

Table 4: Estimated parameters using impulse response matching

Coefficient	Expansionary	Recessionary	Recessionary
σ_k	0.0437	0.0629	0.0639
ρ_k	0.9065	0.8030	0.7940
ρ_τ	0.0390	0.0455	0.1555
$\rho_{\tau b}$	0.1518	–0.0190	0.0944
$\rho_{\tau y}$	–0.0064	–0.8157	–0.8526
θ_π	–0.1709	0.4302	0.2574
φ	9.5189	6.2822	22.9289
η	9.8948	4.8178	3.4636
α	–1,515.1	–6,789.0	–1,704.9

Note: we match the response of the term premium due to expansionary and recessionary government size shock in the SVAR with the response of the term premium due to government size shock from the New Keynesian model. Columns 2 and 3 are with a debt to GDP ratio of 70% and government size of 20%. Column 4 is with a debt to GDP ratio of 25%. All other parameters are kept at calibrated values given in Tables 1 and 2.

Source: authors' compilation.

The intertemporal elasticity of substitution is much higher in recession (0.16) compared to expansion (0.11). Kilponen et al. (2022) show that the equilibrium real interest rate elasticity of output is in the range 0.05–0.20 in the United States. The estimate obtained in this paper lies in the range of estimates provided by Kilponen et al. (2022), and that gives us confidence that the parameters have been correctly identified. The Frisch elasticity of labour supply in recession (0.41) is twice that of expansion (0.20). These are similar to the findings in Attanasio et al. (2018), although we have lower magnitude. Attanasio et al. (2018) argue that Frisch elasticity of labour supply varies from 1.53 in normal times to 1.61 in the first quarter of a recession to 1.71 after four quarters. These results suggest that the parameters are able to distinctly identify the expansionary and recessionary periods.

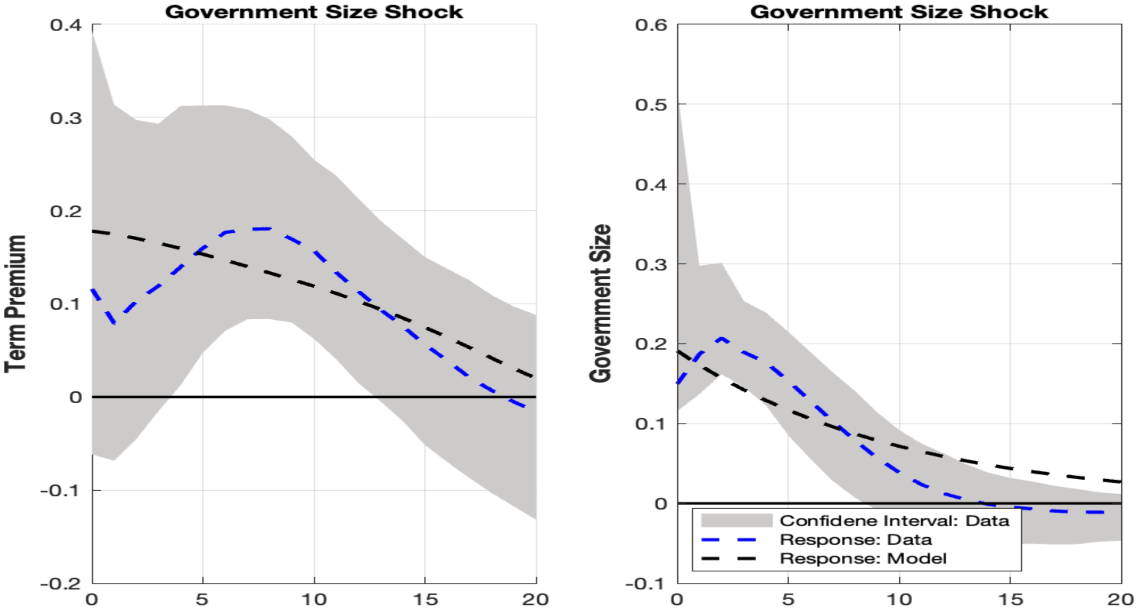
The persistence of tax rate is similar in the two scenarios but higher with lower levels of government debt. As expected, the sensitivity of tax to debt ratio is positive in expansion but marginally negative in recession. This implies that in expansion the increase in debt ratio is followed by higher taxes, unlike the recession where the debt ratio could also be rising due to a fall in output and that would lead to lower tax collection. Most importantly, during the expansion tax does not respond to the output gap (very low negative value), but during recessions tax rises. This suggests that tax is not working as an automatic stabilizer as it should. Ideally the tax rate should have been higher in expansion than in recession.

The government expenditure shock has higher variance and lower persistence in the recessionary period compared to the expansionary period. Most importantly, the coefficient α determining the risk is much higher in the recessionary period compared to the expansionary period. The consumption-only coefficient of risk aversion in recession (9,521.1) is more than twice the value in expansion (4,430.3). As explained before, the consumption-only coefficient of risk aversion is given by $R^c(a;\theta) = \frac{1}{IES + \text{Frisch elasticity}} + \alpha \frac{1}{\frac{1}{(1-\varphi)} + \frac{\eta}{(1-\eta)}}$. This is expected and corroborates the findings of Andreasen et al. (2023), who argue that risk matters more in the recession. These estimates were done assuming the debt to GDP ratio of 70%. We estimate parameters using a debt to GDP ratio of 25% to analyse the effect of debt on risk aversion, and this is given in column 4 of Table 4. The intertemporal elasticity of substitution is lower and Frisch elasticity of labour supply is higher. Although the estimate of α is lower, the consumption-only coefficient of risk aversion is almost twice the value of the consumption-only coefficient of risk aversion obtained with debt to GDP ratio of 70%. This suggests that a lower level of debt with higher risk aversion is required to generate the similar response in term premium.

The coefficient of risk aversion estimated in this paper is much higher than in Rudebusch and Swanson (2012) and Horvath et al. (2022). Rudebusch and Swanson (2012) are only able to generate a term premium response of 0.17 basis points with a coefficient of risk aversion of 110. Given that the term premium response in this paper is more than 100 times the term premium response from the theoretical model in Rudebusch and Swanson (2012), the higher value of risk aversion in this paper is justifiable if we compare it with a conventional log utility function that has a risk aversion coefficient of 1. Moreover, the quantification of risk aversion in terms of a number is problematic, as it is hard to make sense of a particular number. But our results suggest that the risk aversion is more than double in recession that in expansion, which is intuitive and easy to understand.

Figures 12 and 13 give the response of the term premium and government size shocks and corresponding responses from the model based on the estimated parameters. As we can see, the response from the model lies in the confidence band of the response from the data and hence we argue that this New Keynesian model can generate similar response of the term premium due to government size shock. This is because the government size shock in the model and the data are almost identical. Figure 14 gives the response of the term premium and government size shocks and corresponding responses from the model based on the estimated parameters with debt to GDP ratio of 25%, and these responses are statistically identical.

Figure 12: Response of variables due to the expansionary government size shock



Note: the SVAR data is the five-variable model with overnight rate. The model is the New Keynesian model with parameters given in Tables 1, 2, and 4.

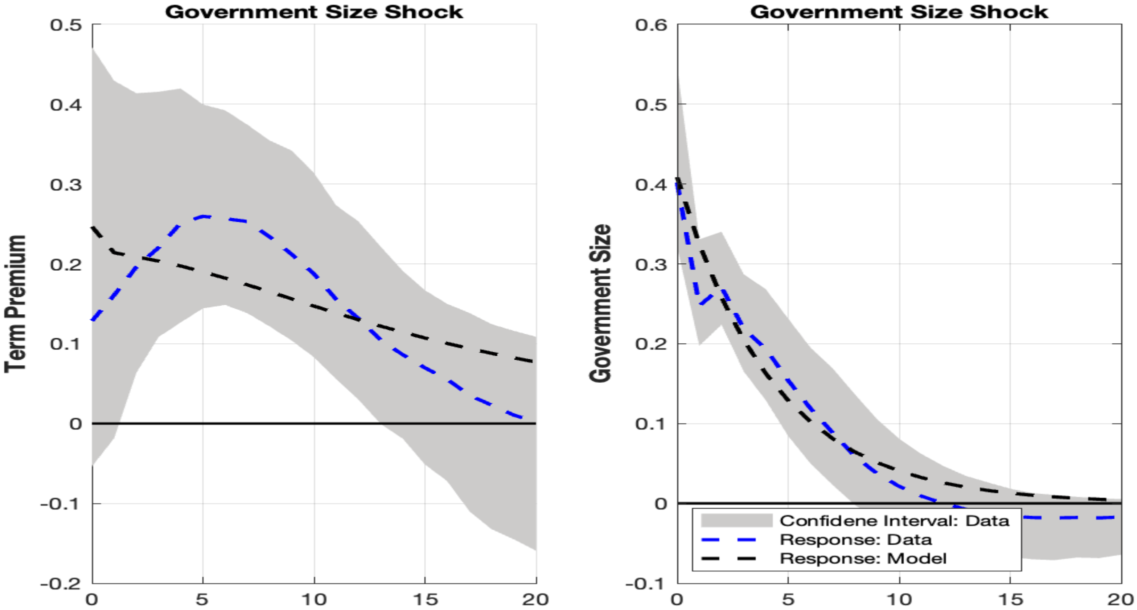
Source: authors' compilation.

Figure 13: Response of variables due to the recessionary government size shock.

Note: the SVAR data is the five-variable model with overnight rate. The model is the New Keynesian model with parameters given in Tables 1, 2, and 4.

Source: authors' compilation.

Figure 14: Response of variables due to the recessionary government size shock



Note: the SVAR data is the five-variable model with overnight rate. The model is the New Keynesian model with parameters given in Tables 1, 2, and 4.

Source: authors' compilation.

6 Conclusion

In the 2010s the growth of GDP declined significantly in South Africa alongside increasing size of the government and an increase in term spread, which is puzzling. In the literature, the term spread increase has been associated with economic expansion (Benzoni et al. 2018). But the existing literature does not make the explicit distinction between term spread originating at the short and long ends. The term spread can change due to movement in policy rate (short end) or due to change in risk premium (long end). We estimate three term spread shocks: unrestricted term spread shock, and restricted spread shock originating at the short and long ends. Although we do not have term premium data for South Africa, the SVAR model allows us to estimate the response of the term premium due to the shocks using the expectations hypothesis of term structure. The results suggest that the term spread shock at the long end is indeed driven by an increase in risk premium (term premium), unlike the term spread shock originating at the short end. Moreover, the term spread shock originating at the long end increases inflation and reduces growth, generating a negative covariance between these two variables unlike the unrestricted term spread shock and the term spread shock originating at the short end. Hence we conclude that the term spread shock originating at the long end generates an increase in term premium, which is theoretically consistent.

We augment the model with the size of the government and jointly identify exogenous shocks to the size of the government and term spread shocks originating at the long end using max share identification. This is because the size of the government and term premium are related and we do not want the shock to the size of the government to be confounded with term spread shock. We find that the shock to the size of the government increases the term spread and inflation and decreases growth in South Africa. Further, we find that the increase in term spread due to this shock is driven mostly by an increase in term premium. Hence we argue that the size of the government is a bottleneck in promoting growth as it is increasing market risk (i.e. term premium), which is increasing the long-term rate, hurting investment and growth. This also makes monetary policy ineffective as the central bank is not able to lower long-term rates despite lowering the short-term rates. Hence fiscal consolidation is the way forward for the South African economy. The right way to achieve fiscal consolidation is still a question that needs to be answered.

We further identify expansionary, neutral, and recessionary government size shocks by restricting the response of output due to government size shock. The neutral government size shock is effectively a government expenditure shock as this arises due to change in G and not Y. We find that recessionary government size shock induces the highest increase in the term premium and highest negative correlation between output and consumption due to government size shock. Four government size shocks are estimated in this paper: unrestricted, expansionary, neutral, and recessionary. A higher size of the government is a risk for the household as it reduces the household ability to smooth adverse shocks and, as expected, these risks are higher in recession.

Both term spread and government size could be driven by news about future economic activity. To rule out the possibility that the observed effect of government size on the term premium could be driven by these confounding factors, we estimate a model with three orthogonal shocks: term spread shock originating at the long end, government size, and news about future economic activity. The results suggest that the effect of a government size shock on the term premium is not influenced by the inclusion of the news shock. This suggests that the identification strategy used in this paper is able to identify the exogenous movement in the government size and its effect on the term premium.

In the next stage we formulate a macro-finance model of the term premium and estimate the parameters of the model, matching the response of the term premium due to government size shock in the model and the data. The model is able to generate a similar response of the term premium as seen in the data, but it requires a high value of consumption-only coefficient of risk aversion. Most importantly, the estimated coefficient of risk aversion is doubled during recession compared to expansion times. These results suggest that an increase in the size of the government in the last decade has obstructed monetary policy transmission and led to slow down in the growth rate. Fiscal consolidation is necessary for effective monetary transmission and to stimulate growth in the medium run.

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