Annexures

1 Data description

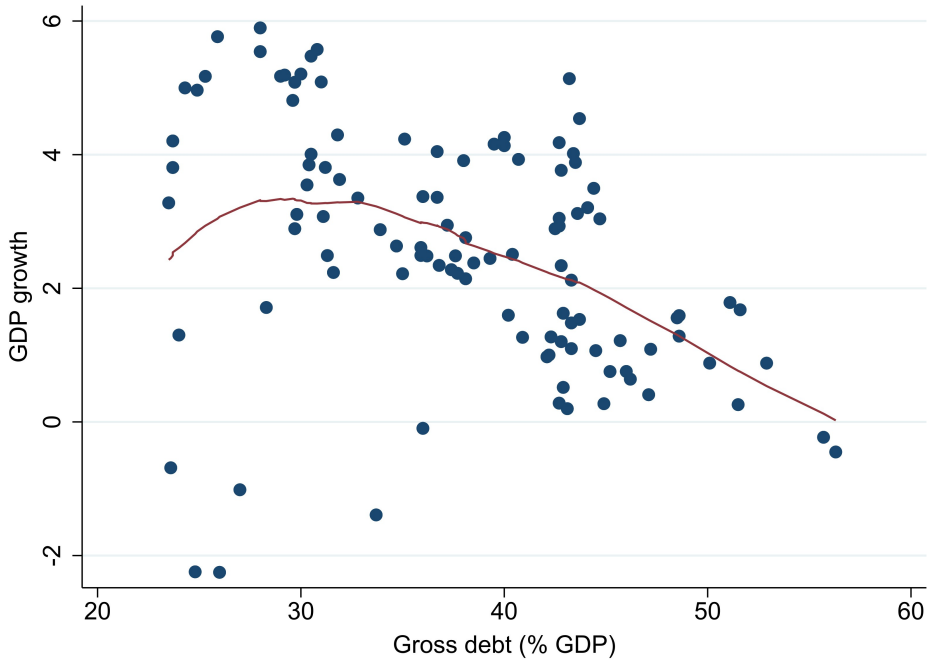
This section provides a description and transformation of the data used in the paper. All the data, except the GDP deflator, South African risk premium, precious metals and coal indices data, was obtained from the SARB (https://www.resbank.co.za/en/home). Nominal variables were deflated using the GDP deflator. Precious metals and coal indices are from the International Monetary Fund's external data indices file (https://www.imf.org/en/Home). The data for credit to the private sector, real house prices and share prices are obtained from the Federal Reserve Economic Data (FRED) by the Federal Reserve Bank of St. Louis (https://fred.stlouisfed.org/). The South African risk premium data is obtainable from Bloomberg (https://www.bloomberg.com/). Where applicable, the mnemonic or identity of the data is provided in brackets as indicated by the source of the data. R million is millions in South African local currency (rand).

Inflation (KBP7170A): average of the monthly total consumer prices (all urban areas). The variable is measured in percentage. **Bank rate (KBP1401M)**: average of the monthly bank rate (lowest rediscount rate at SARB). The variable is measured in percentage. **Exchange rate (KBP5339M)**: average of monthly foreign exchange rate: SA cents per USA dollar middle rates (R1 = 100 South African cents). The variable is measured in South African cents. **Long-term rates (KBP2003M)**: average of the monthly yield on loan stock traded on the stock exchange: Government bonds - 10 years and over. The variable is measured in percentage. **Consumer price index (KBP7170N)**: average of the monthly total consumer prices (all urban areas). The variable is an index. **Gross debt-to-GDP ratio (KBP4116K)**: total gross loan debt of national government as a percentage of GDP. **Government deficit (KBP4420K)**: national government deficit/surplus as a percentage of GDP. **Government expenditure (KBP4434K)**: national government expenditure as a percentage of GDP converted to R million using nominal GDP and then deflated. **Government revenue (KBP4433K)**: national government revenue as a percentage of GDP converted to R million using nominal GDP and then deflated. **South African risk premium**: South African JP Morgan Emerging Market Bond Index (EMBI+) strip spread – which is the difference in yields between dollar-denominated South African debt and US debt of equal maturity – measured in basis points. **GDP deflator**: Calculated using nominal and real GDP and re-indexed to 2015Q1. **Real gross domestic product (KBP6006D)**: GDP at constant 2015 prices measured in R million. **Nominal GDP (KBP6006L)**: GDP at market prices, current prices. Seasonally adjusted at an annual rate and measured in R million. **Credit to the private sector (CRDQZABPUBIS)**: credit to the private non-financial sector by domestic banks and measured in R million. Seasonally adjusted. **Real house prices (QZAR628BIS)**: real residential property prices for South Africa, index 2010=100. Seasonally adjusted. **Share prices (SPASTT01ZAQ661N)**: total share prices for all shares for South Africa, index 2015=100. Seasonally adjusted. **M2 money supply (KBP1373M)**: average of the monthly M2 monetary aggregate and measured in R million. Seasonally adjusted. **Precious metals price index**: precious metals price index, 2016 = 100, includes gold, silver, palladium and platinum price indices, averaged to quarterly. **Coal price index**: coal price index, 2016 = 100, includes Australian and South African coal, averaged to quarterly. **Inflation expectations - two years (KBP7125K)**: inflation expectations of all surveyed participants (business, professional forecasters and trade unions): two years ahead. Measured in per-

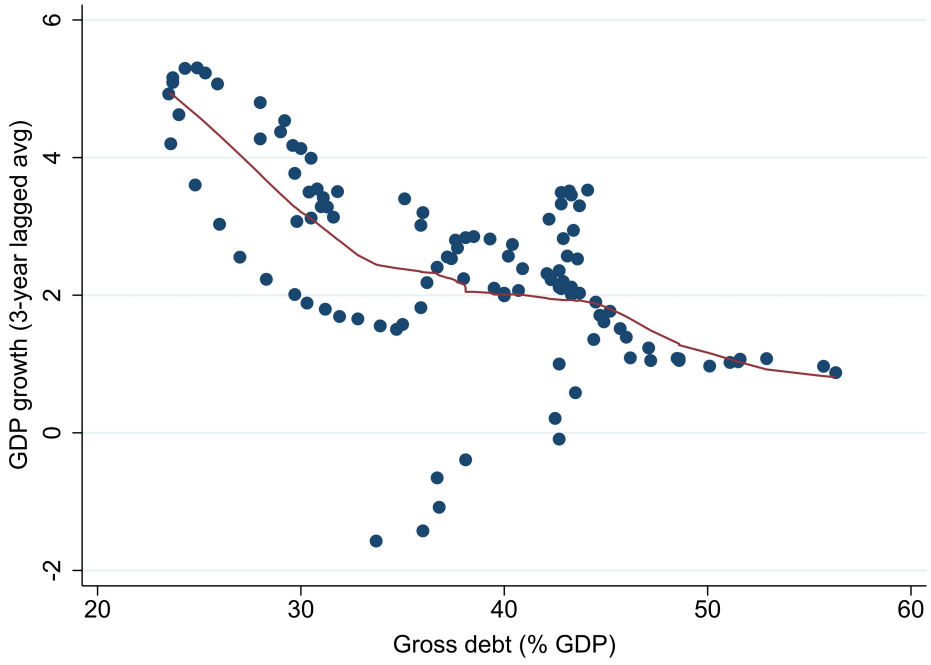
centages. **Employment index (KBP7009L)**: total employment in the non-agricultural sectors. **Private investment (KBP6109D)**: gross fixed capital formation: private business enterprises (investment) in 2015 prices and measured in R million. **Medium-term (MT) rates - 5 to 10 years (KBP2002M)**: average of the monthly yield on loan stock traded on the stock exchange: government bonds – 5 to 10 years and measured in percentage points. **MT rates - 3 to 5 years (KBP2000M)**: average of the monthly yield on loan stock traded on the stock exchange: government bonds – 0 to 3 years and measured in percentage points. **MT rates - 0 to 3 years (KBP2001M)**: average of the monthly yield on loan stock traded on the stock exchange: government bonds – 3 to 5 years and measured in percentage points.

2 Figures

Figure B1: Real economic growth and debt-to-GDP ratio



(a) Contemporaneous real GDP growth



(b) Lagged real GDP growth

Source: Authors' calculations.
Note: The figure shows the lowess regression of the three-year forward rolling average for real economic growth on government debt-to-GDP ratio.

3 The Bayesian VAR model

The BVAR model is estimated using the Minnesota prior and the sum-of-coefficients prior (see Robertson and Tallman (1999) and Blake and Mumtaz (2012) for a detailed discussion on the two priors). The Minnesota prior incorporates the belief that the endogenous variables in the BVAR follow a random walk process for variables that are stationary or an autoregressive process of order 1, AR(1), for variables that need to be differenced to be stationary. The prior is implemented using the normal inverse Wishart prior, which assumes the coefficients of the BVAR, A_l, are normally distributed while the covariance structure of the error terms, Σ, is inverse Wishart. This prior is incorporated by letting the mean of the BVAR coefficients equal one for stationary variables and zero for the variables that follow the AR(1) process:

$$E_t[(A_l)_{ij}|\Sigma] = \begin{cases} \delta_i & \text{for } i = j \text{ and } l = 1 \\ 0 & \text{otherwise} \end{cases} \qquad Var[(A_l)_{ij}|\Sigma] = \begin{cases} \frac{\lambda}{l} & \text{for } i = j, \forall l \\ \frac{\lambda}{l}\frac{\Sigma_{ij}}{\sigma_j^2} & \text{for } i \neq j, \forall l \end{cases} \tag{1}$$

where δ_i takes the value of 0 or 1. The ratio Σ_{ij}/σ_j^2 is included in the prior standard deviation to account for different measurement units of the variables. The hyper-parameter λ controls the tightness of the prior. For $\lambda \to \infty$, the prior is uninformative, and for $\lambda \to 0$, the prior is implemented tightly. The hyper-parameter σ_i is the standard deviation of the error terms of the AR process for each variable on its own lags and is estimated from the sample via ordinary least squares (OLS). The Minnesota prior is implemented by creating dummy variables ${Y^1}_d$ and ${X^1}_d$, using the following equation:

$${Y^1}_d = \begin{pmatrix} diag(\delta_1\sigma_1, ..., \delta_N\sigma_N)/\lambda \\ 0_{N\times(P-1)\times N} \end{pmatrix} \qquad {X^1}_d = \begin{pmatrix} J_P \otimes diag(\sigma_1, ..., \sigma_N)/\lambda & 0_{NP\times 1} \end{pmatrix} \tag{2}$$

where $diag(\delta_1\sigma_1, ..., \delta_N\sigma_N)/\lambda$ and $J_P \otimes diag(\sigma_1, ..., \sigma_N)/\lambda$ governs the prior of the coefficients of the first lag of each variable where $\delta_i = 1$, where $i = 1, ..., N$ for the random walk process. The dummy variables that govern the prior on other lags $0_{N\times(P-1)\times N}$ and $0_{NP\times 1}$ imply a prior mean of 0 (Blake and Mumtaz 2012).

The second prior used in the model is the sum-of-coefficients prior, also known as the no-cointegration prior. This prior is used to reflect the belief that the variables in the model follow a random walk process, sometimes with a drift. It is useful especially when modeling a relationship between variables with different frequencies, such as macrovariables and financial variables, or stock and flow variables (Caruso, Reichlin and Ricco 2019). The prior is implemented by creating N dummy observations, one for each variable, centred around 1 for the sum-of-coefficients for own lags for each variable and 0 for other variables (Giannone, Lenza and Primiceri 2015). The dummy variables are constructed as follows:

$${Y^2}_d = \begin{pmatrix} diag(\frac{\bar{y}_{0,1}}{\tau}, ..., \frac{\bar{y}_{0,N}}{\tau}) \end{pmatrix} \qquad {X^2}_d = \begin{pmatrix} y_d, ..., y_d, 0 \end{pmatrix} \tag{3}$$

where $\bar{y}_{0,i}$ where $i = 1, ..., N$ is the mean for each variable calculated using the first p variables. We set $p = 4$. The hyper-parameter τ controls the variance of the prior with $\tau \to \infty$ indicating an uninformative prior and $\tau \to 0$ indicating a tight prior of no cointegration. In order to assign a high probability to models in which the variance of the series is explained by the stochastic trend more than it is explained by the deterministic trend (i.e. $c = 0$), the sum-of-coefficients prior is supplemented with

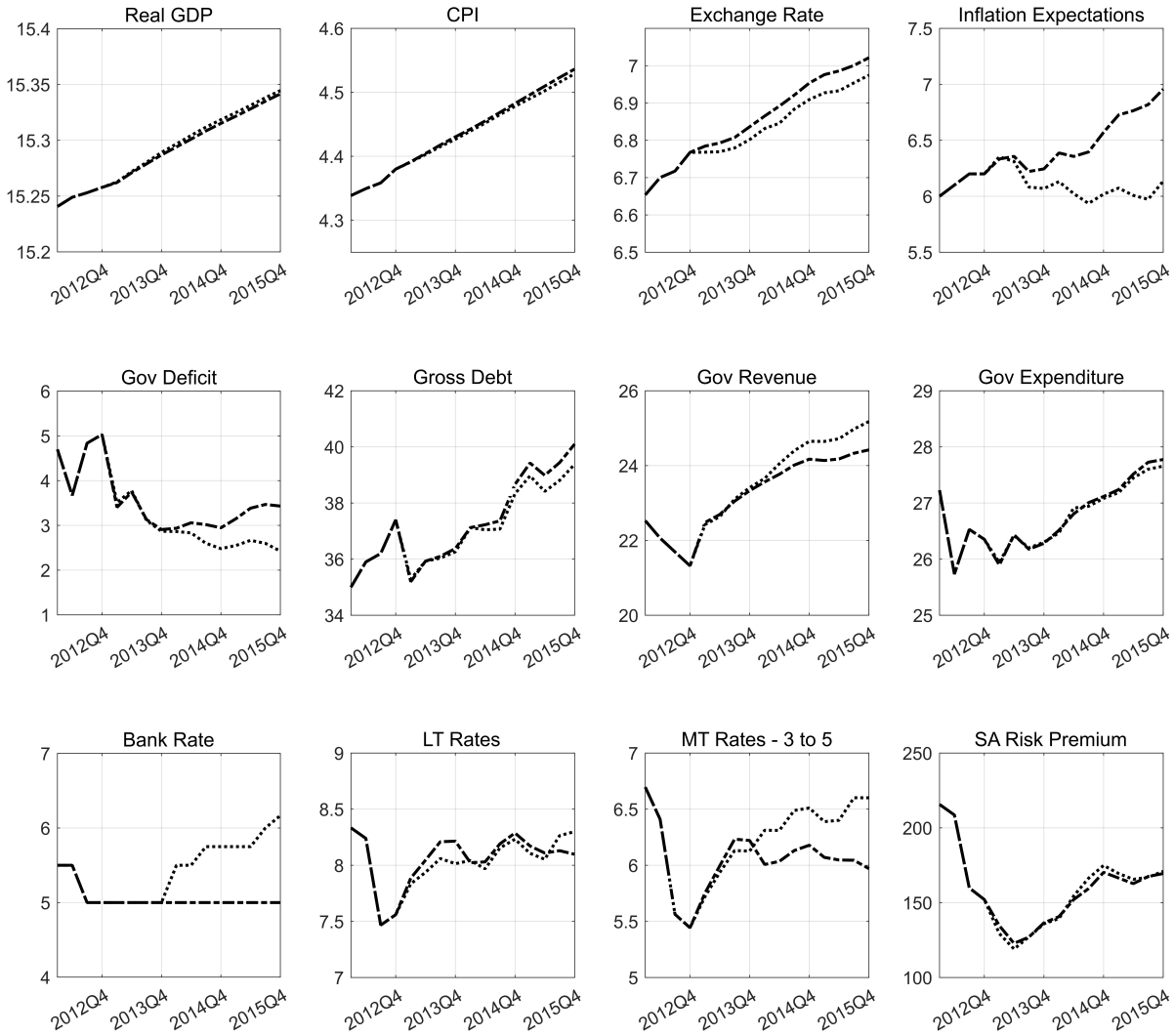
dummy variables ${Y^3}_d$ and ${X^3}_d$:

$$ {Y^3}_d = \begin{pmatrix} 0_{1\times N} \end{pmatrix} \qquad {X^3}_d = \begin{pmatrix} 0_{1\times Np} & \epsilon \end{pmatrix} \tag{4} $$

where the hyper-parameter ϵ is set to a loose prior of 10^6 (Caruso, Reichlin and Ricco 2019). For further discussion on conditional forecasting, see Bańbura, Giannone and Lenza (2015).

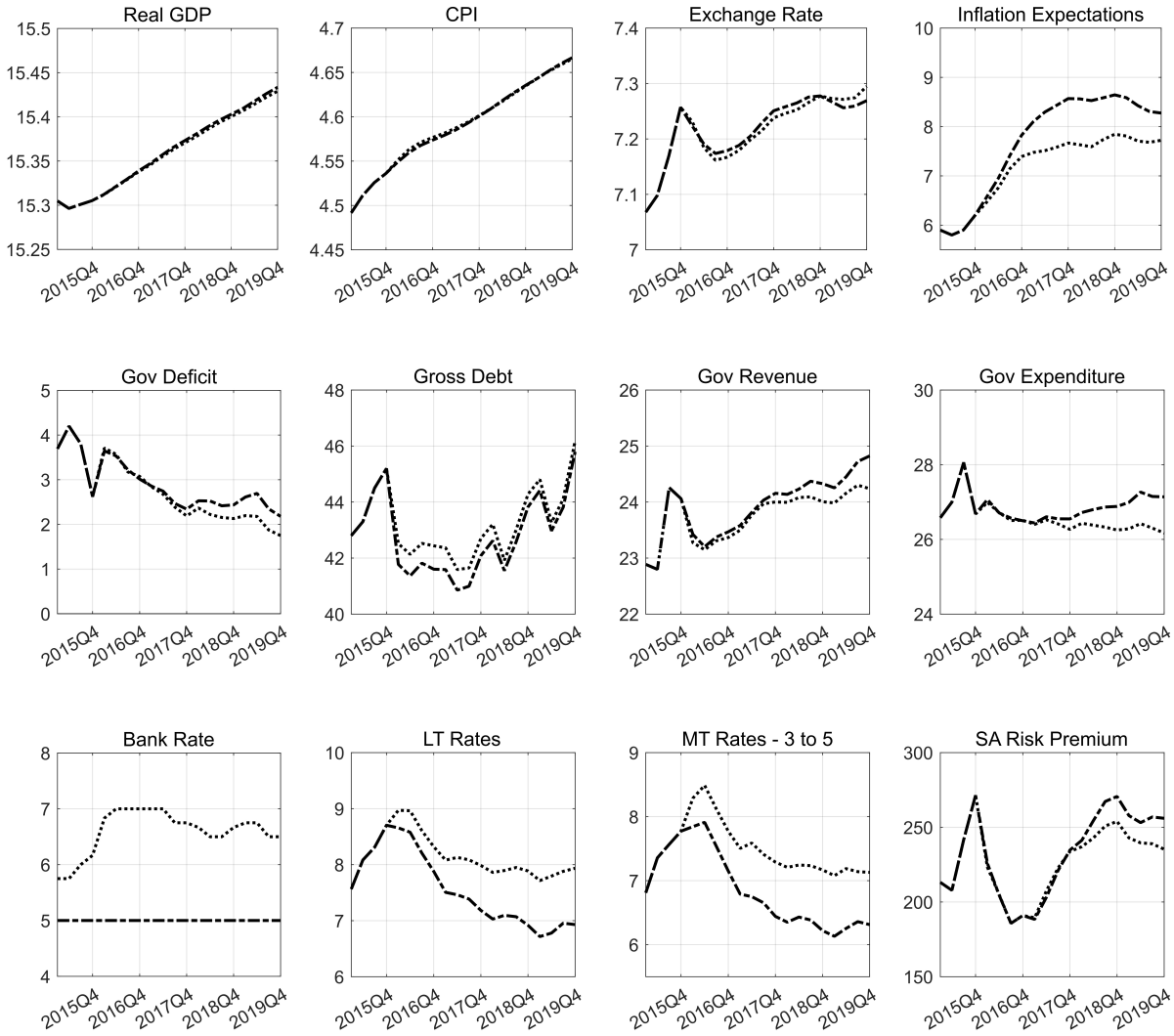
4 Additional results

Figure D1: Conditional forecasting on the policy rate and debt – 2012Q1 to 2015Q4



Source: Authors' calculations.
Note: This figure shows the conditional forecast for the 2012Q1 to 2015Q4 period. The dotted line shows the median of the conditional forecast as in Figure **??**. The dashed line shows the median of the conditional forecast when we impose no change in the monetary policy rate.

Figure D2: Conditional forecasting on the policy rate and debt – 2015Q1 to 2019Q4



Source: Authors' calculations.

Note: This figure shows the conditional forecast for the 2012Q1 to 2019Q4 period. The dotted line shows the median of the conditional forecast as in Figure **??**. The dashed line shows the median of the conditional forecast when we impose no change in the monetary policy rate.