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Term premium and rate expectation estimates from the South African yield curve

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Term premium and rate expectation estimates from the South African yield curve

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Abstract

Long-term interest rates have two major drivers: expectations of future short term interest rates and the term premium. We show that the term premium embedded in South African long rates has risen over the last year and is significantly higher than in advanced economies like the United States. Our modelling results suggest that a higher term premium tends to have adverse impacts on domestic activity and the currency. Higher short rate expectations, on the other hand, tend to have the opposite effect on the economic slack, consistent with such expectations being informative about the outlook for domestic growth and inflation.

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1 Introduction[1]

Long-term interest rates have two major drivers: expectations of future short term interest rates and the term premium. The expected path of short-term interest rates is affected by the current Reserve Bank repurchase rate and the outlook for the economy (such as inflation expectations and risk perceptions). The term premium reflects the compensation investors require to lock in an investment in an asset rather than rolling over a series of short term investments. The term premium is affected by uncertainty over future drivers of nominal interest rates, including inflation uncertainty and credit and liquidity premia, and these risks tends to be greater at longer maturities. This is one reason why the slope of the yield curve is generally positive.

Our paper is the first to estimate the term premium embedded in the South African yield curve. The approach we use is based on Adrian et al. (2013), hereafter referred to as the ACM method (see Appendix section A.1 for details on methodology), which has become the standard approach used among central banks (see for example Blake et al. 2015 for a United States and Latin American comparison). The ACM framework belongs to class of models called 'affine models' that assume that yields are a linear function of state factors (such as the 'risk-free rate' or macroeconomic variables) that determine the term structure. Compared to competing approaches, the framework we use is relatively simple (as it uses principal components and Ordinary Least Squares estimation), while it is flexible enough to capture various yield curve shapes. The most common competing approaches rely on maximum likelihood estimation (such as Kim and Wright 2005[2]) which can be affected by optimisation problems associated with the existence of multiple local optima (Gilli et al. 2010). Another category of alternative approaches are structural in nature. Rudebusch and Swanson (2012), for example, derive a term premium as the difference between the observed yield to maturity on the bond and the risk-neutral yield to maturity and then they relate it to the non-stochastic steady-state bond price in a dynamic stochastic general equilibrium model.

We describe the dynamics of estimates of the South African term premium, as estimated over a sample of January 2000 to July 2019. We show that the term premium embedded in South African long rates has risen over the last year and is significantly higher than in the United States. We also provide comparisons of the South African term premium to those from peer economies.

Another contribution of our paper is to assess the macroeconomic impact of shocks to the term premium and short rate expectation measures. We show that a higher South

[1]Thanks to David Fowkes and two anonymous referees for useful comments and suggestions.

[2]The other difference between the approach of Adrian et al. (2013) and Kim and Wright (2005) is that Adrian et al. (2013) regress the factors from the state factors on the yields and excess holding returns, whereas Kim and Wright (2005) include an expectations survey component and estimate the entire model in one go using maximum likelihood instead of the third step approach used in Adrian et al. (2013) method.

African term premium tends to be associated with increased economic slack and a weaker currency, while increases in short rate expectations have the opposite impact on the output gap, consistent with such expectations being informative about the outlook for domestic growth and inflation. Our modelling results therefore suggest that the recent rise in the term premium embedded in yields has likely contributed to disappointing growth outcomes.

2 Estimates of the term premium and rate expectations

2.1 Stylised facts about the yield curve components in South Africa

Our estimates suggest that the term premium has fluctuated substantially since 2000: it has fluctuated between almost -2 and 8 per cent and was estimated to be approximately 1.5 per cent at the end of the sample, up from close to 1 per cent about a year before (Figure 1). Analysts tend to focus on a 10 year horizon when estimating the term premium, and the estimate at this horizon is the most volatile, given higher uncertainty at a long horizon. The expectations component, which should be closely aligned with the average policy rate expected over the following 10 years, has been much more stable than the term premium but has also trended lower over the last year. Like the estimates for other countries, estimates of the South Africa term premium have tended to be correlated across tenors, and the same is true for the estimates of short rate expectations (Figure 2).

Figure 1: Expectations of the short rate and the 10-year bond term premium for South Africa

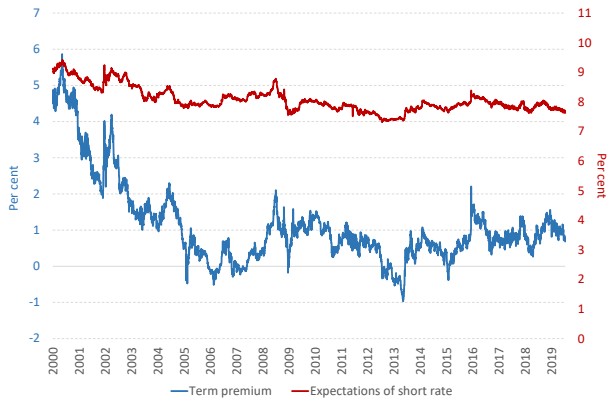


Figure 2: Term premia and expectations across tenors

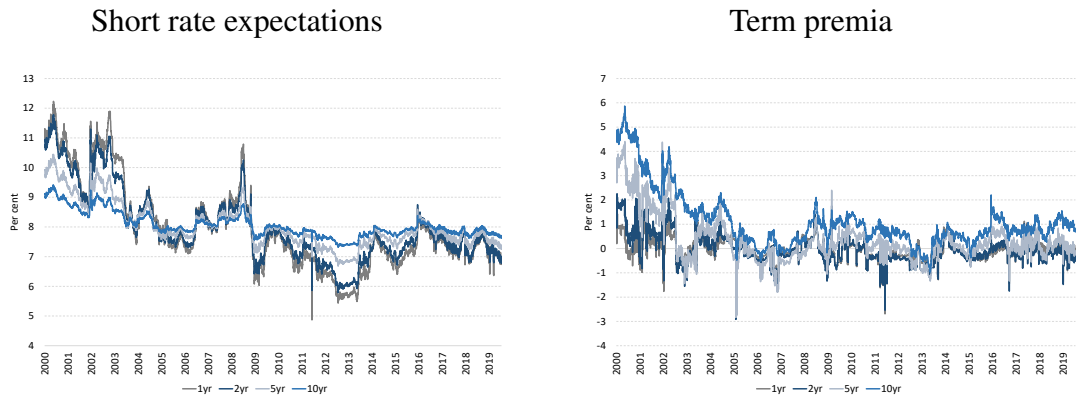
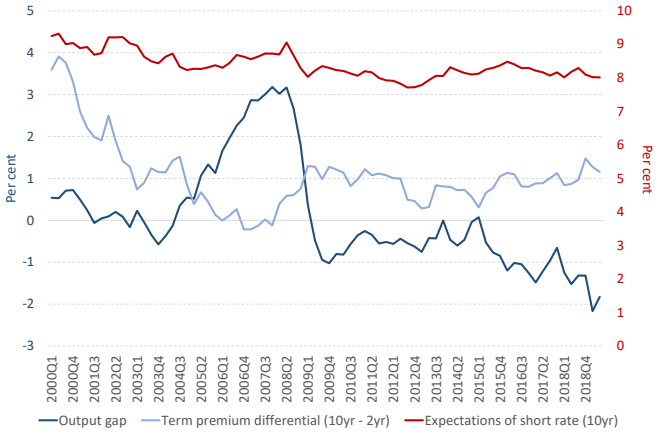


Figure 3: The expectation component, output gap and 2y and 10year term premium differential

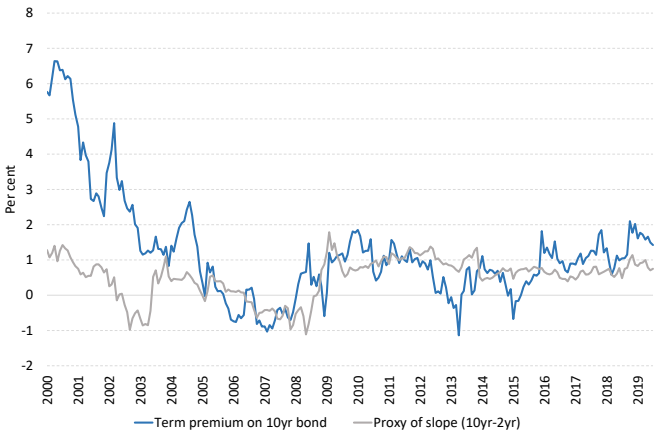


Note: SARB official ex-post output gap estimate. Source: SARB, authors calculations.

Theoretically, real yields on bonds reflect the compensation investors require to postpone consumption. Under normal circumstances, one would expect the term premium to be higher during periods of elevated risk or higher uncertainty about future growth. The term premium tends to spike during bouts of macroeconomic uncertainty (such as around the bursting of the dotcom bubble between 2001 and 2002 and the Global Financial Crisis (GFC) in 2008), but also bouts of political uncertainty (such as after the dismissal of the South African Finance Minister Nene in late 2015 and ahead of sovereign credit rating downgrades in 2016). Consistent with what Adrian et al. (2013) show for the US, the term premium tends to increase during downturns, with a negative correlation with measures of excess demand (slack) like the output gap. The negative output gap post-GFC has also coincided with a fall in the expectations component (Figure 3). The decline in the expectations component since early 2018 is consistent with

a worsening outlook for the economy and falling inflation expectations that have translated into slightly lower expectations for future short term rates. The estimated term premium has been highly correlated with the difference between the 10year-2year term premium differential over time (Figure 4). This suggests that there is a lot of inertia on the front-end of the curve. Past steepenings in the yield curve, for example, have tended to be accompanied by increases in the term premium, and therefore expectations of higher growth or inflation (or the risk around the outlook for these variables). Indeed, there is also a mildly counter-cyclical relationship between the term premium differential and the output gap, consistent with international evidence.

Figure 4: Comovement between slope of the yield curve and term premium



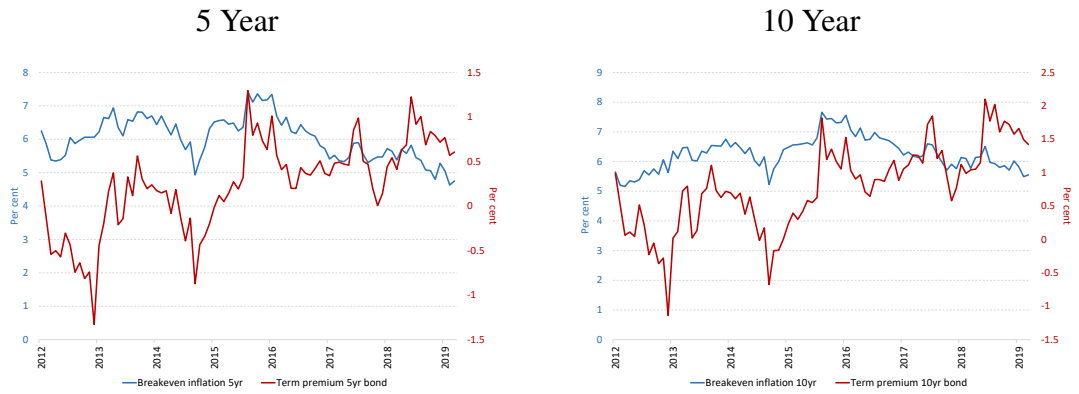
Source: Bloomberg, author calculations.

The counter-cyclical nature of the term premium could reflect several factors, including a positive relationship between inflation uncertainty and risk premia. Although there is low positive correlation between inflation risk premium embedded in bond yields and the term premium over history, the reduction in breakeven inflation since 2016 has not borne out in a reduction in the term premium (Figure 5).[3] Figure 6 suggests that the estimated term premium has tended to co-move with the uncertainty about the outlook for short rates (measured as the difference between analyst's surveyed expectations of the 3 month money market rate in one years' time and the implied 1-year:3-month forward rate), although it is striking how these have diverged since 2015. Over that period, movements in the expectations component has generally been consistent with the rate

[3]The breakeven inflation rate is difference between the yields on nominal and inflation-indexed bonds of the same maturity. Breakeven inflation captures the required compensation investors demand for being exposed to inflation but also for the uncertainty about future inflation (i.e. inflation risk). Somewhat surprisingly, in simple regressions, inflation volatility is the only measure of inflation uncertainty that shows any association with the term premium, and only at a monthly frequency. Unfortunately, several measures of inflation uncertainty are not available back to 2000.

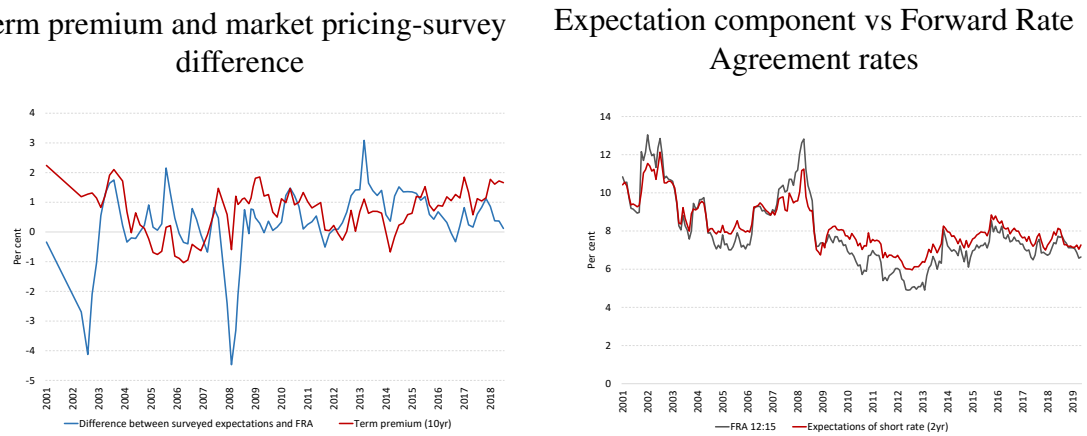
expectations by the rates from 3 month rates at a 12 month maturity from forward rate agreements (FRAs).

Figure 5: Breakeven inflation and the term premium



Source: Bloomberg, authors calculations.

Figure 6: Estimates vs market expectations

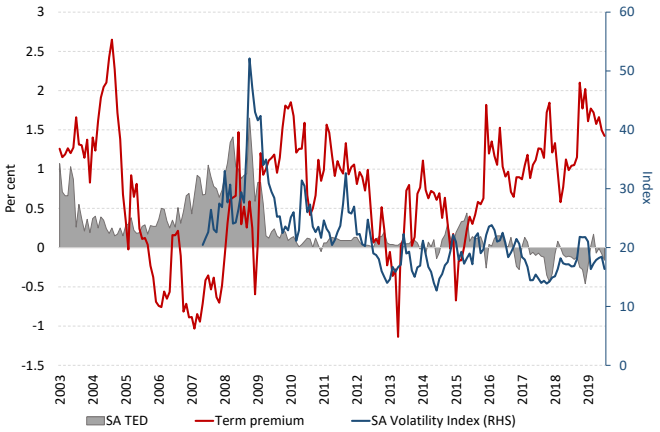


Source: Bloomberg, authors calculations.

Changes in the term premium are often related to jumps in domestic money market liquidity and risk aversion. Figure 7 shows that there are times when the term premium moves together with the difference between the 3 month JIBAR and 3 month T-bill rate ('TED spead') as well as the Johannesburg Stock Exchange (JSE) Securities South African Volatility Index (SA VIX) such as in the lead-up to and aftermath of the GFC, and the decline in SA VIX and SA TED spread in 2016, and the spike in SA VIX in the second half of 2018. However, the full sample correlations of these measures of risk aversion and liquidity with term premium is surprisingly low.[4]

[4]In simple ordinary least square regressions, sovereign risk proxies (CDS spread and EMBI+) can

Figure 7: The term premium, volatility and liquidity



Source: Bloomberg, authors calculations.

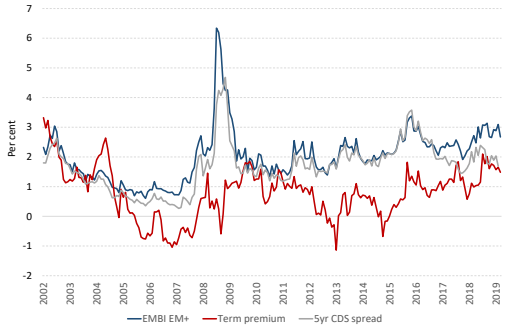
The term premium is correlated with other risk measures, including our preferred proxy for the South African risk premium in the SARB Quarterly Projection Model (QPM) (which is the EMBI+ for South Africa, Figure 8).[5] It is notable that the EMBI+ however increased much less dramatically during global and South African events, while surveyed political climate measures have increased dramatically since the GFC. Even though the EMBI+ and CDS spread should capture sovereign risk, their denomination in US dollars implies that they do also capture some global risk, whereas the term premium should react more strongly to domestic shocks.

explain some of the increase in the term premium over the last year: at a quarterly frequency about a third of the increase. US bond market volatility is statistically significant only at daily and monthly frequencies, but has dragged down the premium over the last year in simple regressions. This is consistent with findings for the US by Mallick et al. (2017), but not those from Callaghan (2019) for New Zealand. The US VIX is generally not statistically significant in regressions at a daily frequency, and in model specifications where it is, its contribution to explaining movements in the term premium is low and, over a post-GFC sample, its coefficient is negative.

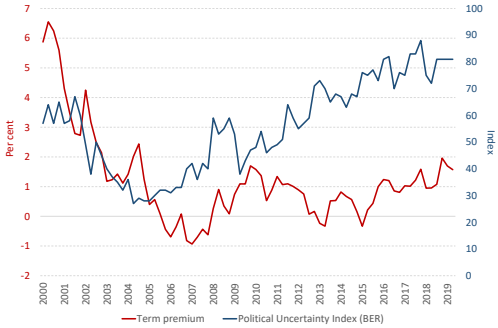
[5]That said, the correlation between the term premium and South Africa's Financial Conditions Index based on Kabundi and Mbelu 2017 is close to zero.

Figure 8: Term premium vs risk measures

Measures of South Africa's risk premium



Domestic political uncertainty

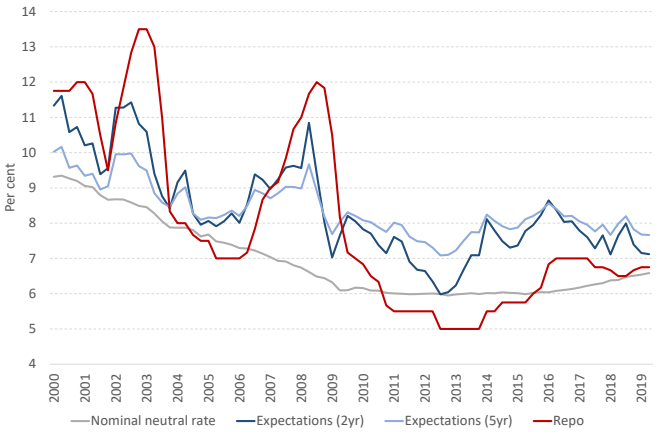


Source: Bloomberg, BER, authors calculations.

The decomposition suggests that relatively high level of interest rates in South Africa mostly reflect the high level of the expectations component (Figures 1 and 9). This reflects a relatively high level of the neutral interest rate, which is the rate consistent with the potential growth of the economy and inflation at the SARB's target rate, and this rate anchors the entire yield curve. The difference between the neutral rate and the policy rate can also be used to assess whether monetary policy is expansionary or contractionary. Since the GFC, the estimate of the short rate expectations have generally been higher than SARB estimates of the nominal neutral rate and the repurchase rate (repo), but they have followed the same broad profile. The repo cut in July 2019 (not shown given the use of quarterly frequency data) has meant that monetary policy is assessed to be slightly stimulatory based on estimates as at 2020 Quarter one, with a slightly upward sloping path expected for overnight rates (i.e. rates expected to rise over a 2 and 5 year horizon).[6]

[6]The neutral rate is unobservable, and therefore difficult to estimate with a high degree of accuracy. As a result, the uncertainty bands around the point estimate are large. It is also difficult to assess what the impact of a gradual shift towards neutrality would be on the term premium. There is some US evidence that tighter monetary policy tends to raise bond market volatility and in that way also the term premium (see Mallick et al. 2017).

Figure 9: The nominal neutral rate and short rate expectations



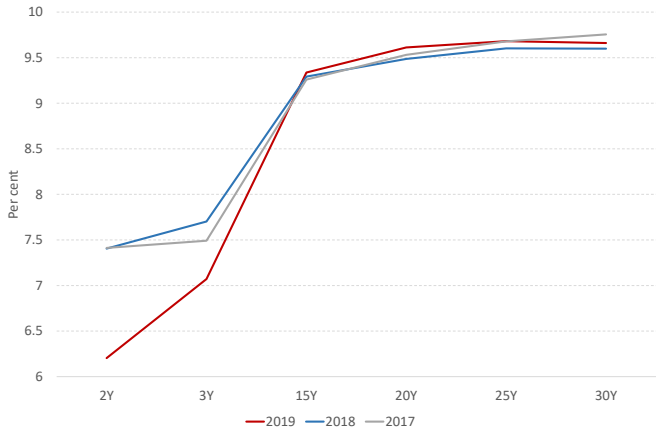
Source: SARB, authors calculations.

South Africa's long-term borrowing costs have been rising towards the end of the sample, despite lower inflation expectations and lower short-term interest rates. Ten-year government bonds were returning around 9.5 percent at the end of the sample, compared to a post-crisis average of around 8.9 percent. The South African term premium has been rising quite steadily since 2015, with spikes around episodes of heightened risk (including 'Nenegate' in late 2015, and the 2017 medium term budget, which announced a severe fiscal deterioration). From trough to peak, the term premium has risen by about 200 basis points. Taking a longer average, it was 65 basis points higher in 2019 than it was for the period 2015-2018. Were it not for this term premium, long-term borrowing costs would now likely be around 8 percent, comparable to their lowest-ever level, in line with significantly lower inflation expectations, as well as an accommodative monetary policy stance.

2.2 Can the term premium explain recent yield curve changes?

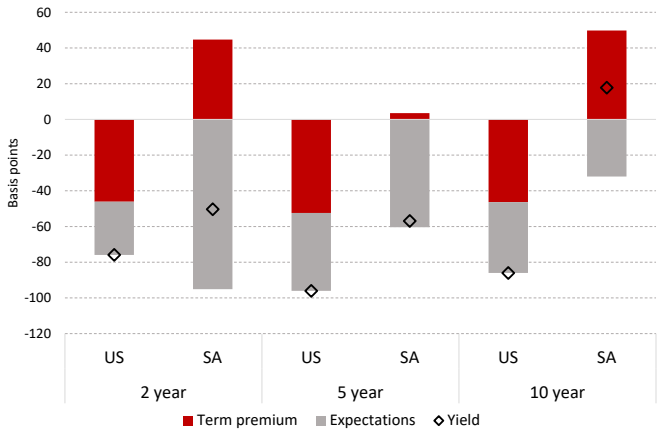
South Africa stands out internationally for having a particularly steep yield curve. The South African yield curve steepened further in mid-2019, driven by a fall at the short end (Figure 10). At the short end of the curve, rate expectations have fallen by almost a 100 basis points since June 2018, while the term premium has risen by over 40 basis points. Interestingly, at a 5 year horizon, the term premium has not increased substantially, while short rate expectations are down by 50 basis points. For 10 year yields, the 30 basis point fall in expectations of average short term interest rates have been offset by a 50 basis point increase by the term premium (Figure 11). Since monetary policy operates through the impact of the yield curve on consumption and investment decisions, offsetting term premium changes can have important implications for monetary policy. This is considered more formally in the next section.

Figure 10: Steepening of the South African Yield Curve



Note: Dates used: 16 July 2017/8/9.

Figure 11: Contribution to yield curve changes



Note: Change in each component between June 2018 and June 2019. Source: Bloomberg and authors' calculation.

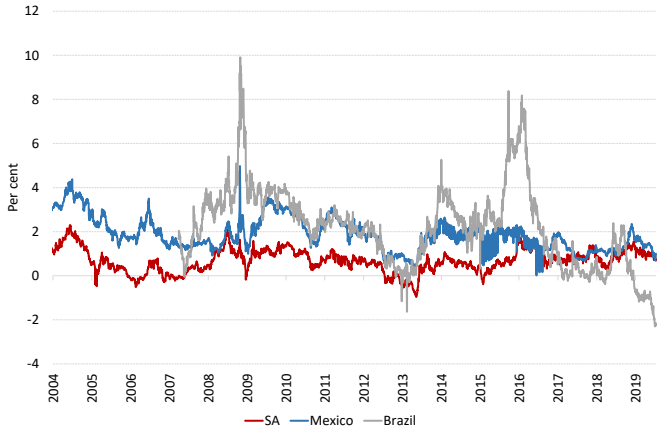
The recent behaviour of the South African yield curve also stands out internationally. In a large number of economies, yield curves inverted in mid-to-late 2019. When rates at the short end are above long term rates, it normally reflects expectations of lower growth and inflation. Interpreted this way, the global curve inversion may be suggestive of global growth risk that is to the downside.[7] While the South African term premium has

[7]Given inversion in many economies, particularly the US, there is a live debate about whether the yield curve is still a reliable barometer of the outlook for growth. One factor that has distorted the predictive ability of the yield curve is quantitative easing. For example, estimates from Bonis et al. (2017) suggest that quantitative easing caused a 100 basis point fall in the US 10 year term premium. The term premium has also been on a long-term decline since the early 1990s (Cohen et al. 2018), so that the slope of the

historically been highly correlated with the US term premium, it has diverged materially from its US equivalent since mid-2015 (Figure 17 in Appendix A.2). Implied short-rate expectation differentials have narrowed over the last two years, on the back of expectations of policy tightening in the US and easing in South Africa.

As an indication of whether the dislocation between the South African and US term premium could reflect deterioration of South Africa's fiscal metrics or heightened political uncertainty, we estimate term premia from zero coupon rates for two other emerging markets that have recently experienced public finance issues and elevated political uncertainty. We find that the South African term premium has recently had similar magnitude to the Mexican premium, but that the Brazilian premium has been much more volatile and has behaved more like the US term premium since late 2018 (Figure 12). Formally assessing the drivers of movements in the term premium requires the development of a structural model which is beyond the scope of this paper, but planned as follow up research to this paper.

Figure 12: Comparison of estimates of the term premium of other emerging markets



Source: Bloomberg, author estimations.

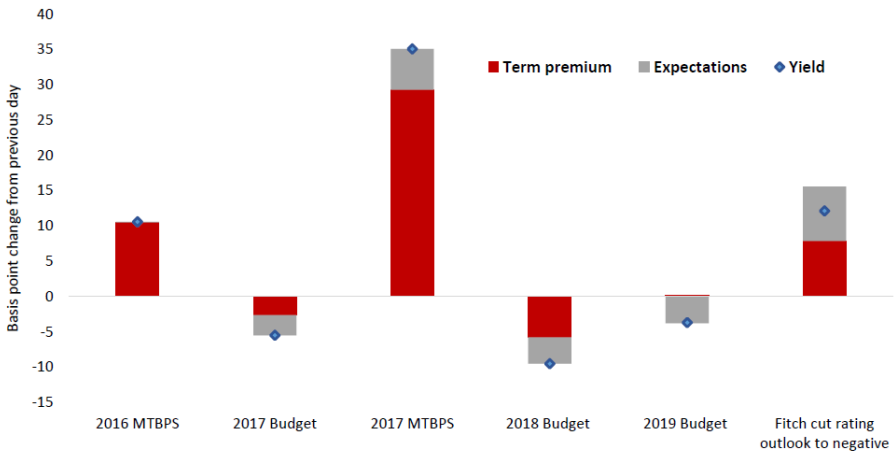
The provide an illustrative assessment of the possible contribution of fiscal policy to the relative steepness of the South African yield curve, Figure 13 summarises the association between changes in the components of the 10 year government bond yield the day after recent Budget speeches, Medium-Term Budget Policy Statements (MTBPS) and recent sovereign credit rating reviews. Fiscal and ratings announcements appear to have some impact on the term premium. The term premium increased following the 2016 MTBPS, the 2017 MTBPS, the 2019 Budget, and after Fitch's sovereign credit rating outlook revision for South Africa, suggesting that these announcements led to a revision to market perceptions of fiscal risks and the economic outlook. The 2017

yield curve has been exceptionally flat by historical standards and the recent inversion has been caused by relatively small changes in the outlook for short rates.

and 2018 Budget Reviews (which highlighted fiscal consolidation plans and improved growth projections) appeared to coincide with small falls in the term premium.[8] However, future work needs to develop approaches to accurately measure South African fiscal uncertainty and fiscal shocks, and frameworks to assess their impacts on the economy.

A relatively steep yield curve likely also reflects South Africa's relatively long term structure of government debt and large proportion of local currency debt. This contributes to a steeper curve as investors must be compensated for the maturity and exchange rate risk that they are exposed to. This is likely to mean that global shocks have a stronger effect on South Africa yields by increasing the required compensation. Formally modelling these inter-relationships is beyond the scope of this paper, but the next section provides an illustration of the relationship between term premium shocks and the South African currency and other macroeconomic aggregates.[9]

Figure 13: Fiscal announcements and shifts in the yields



[8]The 5 year credit default swap spread on sovereign debt, a proxy of sovereign risk, rose on the day of the 2017 MTBPS (although by only about 8 basis points), while the spread fell by over 140 basis points on the day of the 2018 Budget Review, consistent with the downward shift at the long-end of the yield curve after that announcement.

[9]The increase in the relative term premia with the US has been consistent with the depreciation of the exchange rate since early 2018, although the high historical correlation between the term premium differential with the US and the exchange rate (over 0.7 since 2002) has weakened substantially over the last year.

3 Impact of term premium and interest rate expectation shocks

To assess the macroeconomic impacts of higher term premium, we use a Structural Vector Autoregression model with a Cholesky decomposition, with the following specification:

$$Y_t = AY_{t-1} + \varepsilon_t \tag{1}$$

where Y_t is a five dimensional (5×1) vector of variables ordered in the following sequence: output gap, headline inflation, the expectations component of the 10 year yield, the term premium on a 10 year bond yield, and the log of the real effective exchange rate. A is a (5×1) vector of coefficient terms, and ε_t is the corresponding (5×1) vector of reduced form residuals. We set the lag length at 1 given the relatively short sample available and based on lag selection tests, although a lag length of 2 did not make a significant difference to the results.

The ordering used implies that the identified term premium shocks have been purged of contemporaneous impacts from growth, inflation and yield expectations before assessing the impact of term premium shocks on the economy.[10] Figure 14 suggests that a higher term premium has a similar impact to a negative demand shock: increasing economic slack significantly (with a peak impact of about 0.3 percentage points on the output gap after about 7 quarters). In response to a 100 basis point shock to the term premium, the real effective exchange rate depreciates by around 1.5 percent. The impact on inflation is negative eventually, with a peak impact of about 0.1 percent after about 6 quarters.[11] One possible explanation for the small impact on inflation is that the inflation impulse from a weaker exchange rate may offset some of the decline in inflation associated with reduced capacity pressures.

Shocks to the short rate expectations, on the other hand, tend to act more like positive demand shocks: higher expected interest rates foreshadow higher growth and inflation. A 100 basis point surprise to expectations of future average short rates leads to around 0.25 percentage point increase in the output gap and a very small impact on inflation on impact. Interestingly, the model suggests that expectations shocks are associated with a depreciation of the real exchange rate.[12] The impacts of term premium and

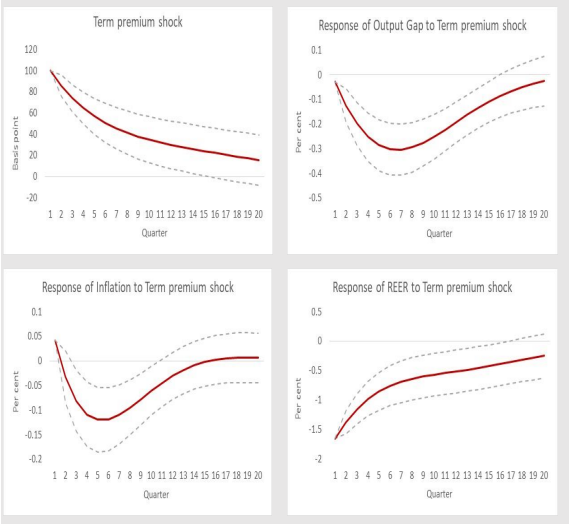
[10] Ordering the exchange rate before the term premium did not change the qualitative results displayed in Figure 14. The exchange rate is expressed in log terms (and in real terms to ensure stationarity), while the other variables are in year-on-year growth rates. The output gap measured used is based on an HP filter to ensure stationarity over the sample used (2000Q1-2019Q2).

[11] Using core inflation in the model instead of headline CPI inflation did not change this result.

[12] The latter is consistent with the findings of Hnatkovska et al. (2016), who show that developing country exchange rates can depreciate following an increase in interest rates if the impact on the output

expectations shocks are slightly weaker than the estimates from Callaghan (2019) for New Zealand, although our model incorporates the exchange rate and uses different measures of economic slack and inflation than Callaghan (2019).[13]

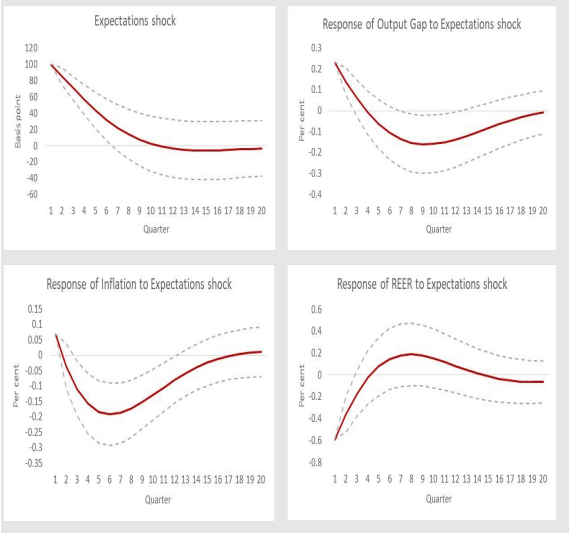
Figure 14: Response to a term premium shock



gap and on the fiscal balance is sufficient to offset the impact on foreign demand for domestic currency.

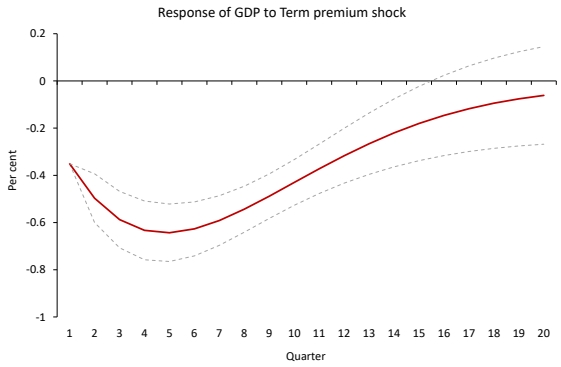
[13]We also considered models that included investment and the qualitative results were largely unchanged for the variables in the benchmark model, with investment falling in response to term premium shocks, although the exchange rate impact was slightly larger on impact. Estimating the model on monthly data with the growth rate of manufacturing production substituted for the output gap produced similar results, although only the impacts of term premium shocks on inflation and the currency was significant, and in the case of expectations shocks, only the response of the currency was significant.

Figure 15: Response to a rate expectation shock



As a robustness check of the impact of term premium shocks on output, we repeat the modelling exercise replacing the output gap with the rate of economic growth. These estimates suggest that a 100 basis point term premium shock weakens growth by around 0.6 percentage points, at the point of maximum impact, which is about four quarters after the shock.[14]

Figure 16: GDP response to 100 basis points term premium shock



Since different drivers of the term premium would likely imply differences in the transmission to the economy, future work will formally decompose the term premium using a structural framework. Given the recent emergence of meaningful political and

[14]Unfortunately, we are not aware of comparable estimates of the impact of term premium shocks on growth against which to measure the plausibility of these estimates. For the United States, Hamilton and Kim (2002) find that there is a positive relationship between the term premium and future economic growth. However, Rudebusch et al. (2007) use a structural model to argue that the relationship is likely negative in theory.

fiscal uncertainty in South Africa, it will also be important for future research to consider approaches that can take time-varying relationships and larger information sets into account.

4 Conclusion

When faced with a shock to long term interest rates, a central bank needs to understand the underlying drivers of such a change when assessing how monetary policy should react. Higher long-term interest rates could reflect a combination of changes to the term premium and short rate expectations.

South Africa's long-term borrowing costs have risen, despite lower inflation expectations and lower short-term interest rates. We show that recent upward pressure on long-rates has been coming from a higher term premium. In particular, we show that a 30 basis point fall in the expectations component over the last year of the sample was offset by an increase in the term premium of about 50 basis points.

Our modelling results suggest that the recent rise in the term premium embedded in yields has likely contributed to disappointing growth outcomes. Our estimates suggest, for example, that a 100 basis point term premium shock weakens growth by around 0.6 percentage points, at the point of maximum impact, which is about four quarters after the shock. The estimated effect on inflation is more ambiguous, with the disinflationary impact of weaker demand offset by currency depreciation, as risk deters investors.

These estimates cannot be transferred directly to South Africa's experience, which has been about a sustained upward trend in the term premium rather than a one-off shock. Nonetheless, this mechanism helps to explain how sovereign debt accumulation has likely weakened growth. In addition, it is one of the key channels through which an improved fiscal balance could benefit the economy over time.

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A Appendix

A.1 A term structure decomposition of the South African yield curve

Adrian et al. (2013), hereafter referred to as the ACM method, is a commonly used approach developed by researchers at the New York Federal Reserve Bank to decompose the yield curve into a term premium component and an expectations component. The ACM framework belongs to class of models called 'affine models' that assume that yields are a linear function of state factors (such as the 'risk-free rate' or macroeconomic variables) that determine the term structure.

We first construct a smooth yield curve for South Africa using end-of-day and end-of-month zero-coupon yields from Bloomberg to obtain yields across all maturities based on the Svensson framework (Svensson 1994).[15] We then extract five principal components from the curve that describe the level, slope and three curvature factors and their dynamics are modelled in a vector autoregressive (VAR) process. We assume that there exists a vector of state variables X_t which consists of the five principal components that evolves as a VAR process:

$$X_{t+1} = \mu + \phi X_t + \upsilon_t \tag{2}$$

By regressing these factors on their on lagged levels, the pricing (state) factors are decomposed into predictable components and innovation components.

The parameters that determine the relationship between the pricing factors and yields are restricted to ensure the absence of arbitrage opportunities. The assumption of no arbitrage implies that there exists a stochastic discount factor or pricing kernel M_{t+1} which discounts the expected future price of a zero-coupon government bond P_t^{n-1} maturing in n periods to the current period, such that

$$P_t^n = E_t[M_{t+1} P_{t+1}^{n-1}] \tag{3}$$

Being risk-averse, investors demand compensation for the risk associated with investments in long maturity bonds. Yields need to be adjusted to ensure that they reflect risk-adjusted expectations of average short rates. This assumption ensures that pricing from the model is consistent with the absence of arbitrage opportunities in the sovereign bond market. This is generally a reasonable assumption in highly liquid markets where speculators rapidly eliminate any arbitrage opportunities that may appear.

The pricing kernel is assumed to take the following exponential form:

[15] The Svensson model adds on a fourth curvature term to the Nelson-Siegel framework (apart from the level, slope and curvature parameters), which increases the model's flexibility to fit different curve shapes.

$$M_{t+1} = exp(-r_t - 1/2\lambda_t^{'}\lambda_t - \lambda_t^{'}\Sigma^{-1/2}\upsilon_{t+1}) \tag{4}$$

where $r_t = lnP_t^1$ is a continuously compounded one-period risk-free rate, based on the assumption that bond prices are affine in the state variables and these pricing factors:

$$lnP_t^n = A_n + B_n^{'}X_t + \mu_t^n \tag{5}$$

and λ_t is the market price of risk, which is assumed to be affine in the estimated factors:

$$\lambda_t = \Sigma^{-1/2}(\lambda_0 + \lambda_1 X_t) \tag{6}$$

Arbitrage-free excess holding returns is calculated as:

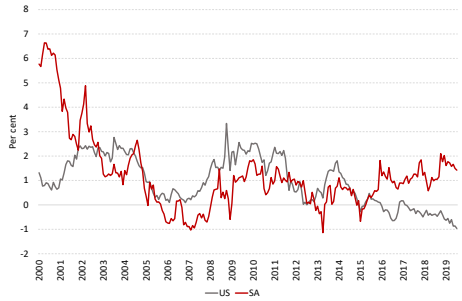
$$rX_{t+1}^{n-1} = lnP_{t+1}^{n-1} - lnP_t^n - r_t \tag{7}$$

In the second step of estimation, excess bond returns from equation 7 are regressed on the lagged levels of pricing factors and pricing factor innovations to obtain a vector of risk premium parameters (described in detail in Adrian et al. 2013). Restrictions are then placed on the system to ensure the no-arbitrage condition holds. By setting the risk premium parameters (λ_0 and λ_1) to zero, risk-neutral yields are obtained as the model-implied average expected future short-term interest rate obtained by forecasting pricing factors from the VAR model (referred to as the expectations component). The term premium is obtained by subtracting the expected component from the model-implied fitted yield.

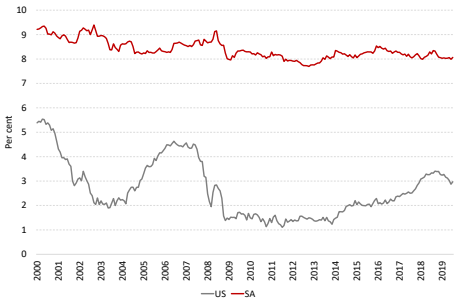
A.2 Additional charts

Figure 17: Comparison with US yield curve components

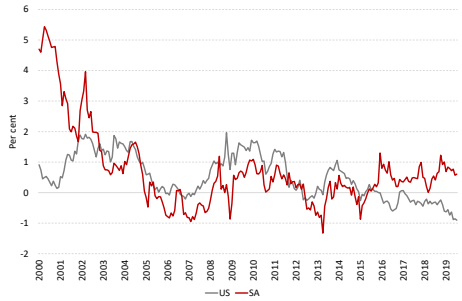
Term Premium (10 Year)



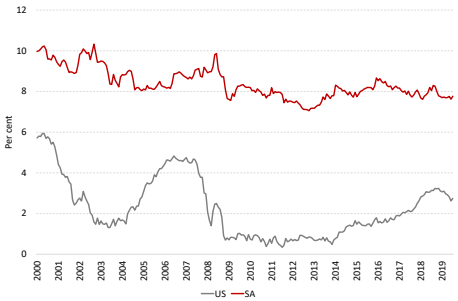
Short rate expectations (10 Year)



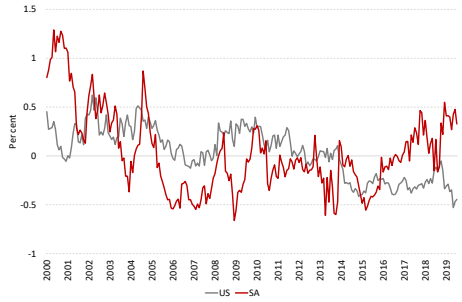
Term Premium (5 Year)



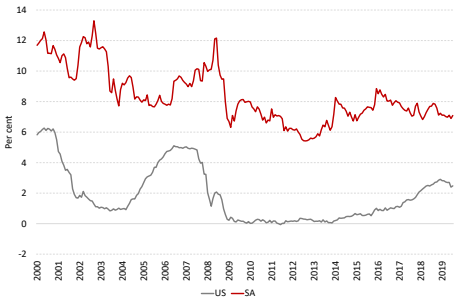
Short rate expectations (5 Year)



Term Premium (1 Year)



Short rate expectations (1 Year)



Source: Bloomberg, authors estimates.