# Fiscal Dominance and Public Debt Management

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**Abstract**

We assemble a novel granular level dataset on Indian public debt consisting of central government security level data from 1999 to 2022 to study the debt dynamics and the impact of the COVID-19 pandemic on the same. Our study uses about 8000 central government marketable dated securities from 1999 to 2022 and provides a snapshot of the debt dynamics with regard to the maturity structure of debt and the interest cost burden using Hall and Sargent's (1997,2011) methodology. Our calculations show that the average maturity of debt has been declining and most of the centre's debt is below 15 years. From the yield-to-maturity data, we find that there are periods when the spread between the interest rates declined and a clear level effect on the yield-to-maturity schedule before and after the pandemic. In light of such findings, our paper focuses on (i) the government's debt management strategy in terms of the issuance of securities of different maturities and how that affects the interest burden and the debt (ii) the extension of the Hall-Sargent framework to explicitly account for the term premium by decomposing the nominal interest payouts into a short rate and term premium, (iii) how fiscal dominance plays a role in the evolving maturity structure of debt. Our preliminary analysis from a counterfactual exercise for the debt management strategy shows that "bills only" and "bonds only" policies could have led to a lower interest cost burden and a lower marketable debt if the government issued only long-term securities.

Key Words: Public Debt, Debt Decomposition, Fiscal Dominance, Term premia, Debt Management, Indian Economy
JEL Codes: : E62, E65, E52, E4, G12, G28, H63

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# 1 Introduction

Like many countries around the world, India too faced a surge in sovereign debt post-COVID-19. As per IMF estimates whereas India's debt-GDP was about 74% it rose to 90% during 2020. High debt-GDP ratios were not uncommon, especially among those involved in the World Wars or post-Great Financial Crisis. However, what makes the surge in Indian sovereign debt important is the fact that it is still an emerging nation with weak fundamentals.

Earlier studies show that post-2000, inflation and growth rate played important roles in affecting the debt-GDP ratio (Das and Ghate (2022)). Macroeconomic reform policies like the FRBM Act of 2003 that put a cap on the deficit for the Centre and State helped keep the debt burden low. India adopted an inflation targeting framework in 2016 whereby inflation was kept under check since.

From the government budget constraint, there are four factors that affect the change in the debt-GDP ratio between any two time periods- *nominal interest rate, economic growth, inflation and primary deficit/surplus*. Whereas,ceteris paribus, nominal interest rate and primary deficit add to the debt-GDP ratio, growth rate, inflation and primary surplus help reduce it. In India there is a cap on inflation and deficit, due to inflation targeting and FRBM Act. Therefore, in the Indian context, the role played by the nominal interest rate become important when considering the factors that affect debt. Since the maturity structure of debt is directly associated with the interest rate, it, therefore, becomes an important factor driving the debt dynamics.

The large rise in the government debt level also raises numerous concerns regarding the conduct of monetary policy and in particular its ability to control inflation. Since it is questionable that the government will be able to provide the sizable surpluses needed to service this surge in debt, the fiscal authority may find themselves with little choice but to turn to inflation. If such a scenario occurs, monetary policy will cede (at least in part) control of inflation to fiscal policy, which will then become subservient to it. In that context, the maturity structure of debt becomes a key variable when the monetary authority reacts to inflation and the appropriate maturity of debt can restore the efficacy of monetary policy in controlling inflation. We, therefore, consider how the maturity structure of the debt plays a role in ascertaining whether there is any scope for fiscal dominance in the Indian context.

In this paper we analyze the term premia or more generally excess returns associated with the government securities that have a direct bearing on the interest cost. By looking at the average maturity structure of the securities which we calculate by looking at how much outstanding payments are due in any year for the government, as opposed to the conventional method of quantifying the maturity, we try to comprehend whether the maturity structure of debt gives us evidence of fiscal dominance, given that the Central Bank also acts as the debt management officer for the government in India.

Government debt in India consists of debt issued by the centre and the states and is mostly nominal in nature, unlike the US or UK where a certain percentage of debt is inflation-indexed. The Reserve Bank of India (RBI, henceforth) is the Central Bank that conducts the auctions/transactions related to the securities at the directive of the centre and state governments. The state governments in India currently have a cap on their market borrowings (20% of GDP as per FRBM Act) and are allowed to borrow only domestically.

We assemble a novel granular level dataset on Indian public debt consisting of central government security level data from 1999 to 2022 to study the debt dynamics and the impact of the COVID-19 pandemic on the same. Our study uses about 7000 central government marketable dated securities issued from 1999 to 2022 and traces each security from the date of issuance till the latest amount outstanding. We use this security-level debt data for the centre for our analysis. Aggregate debt consists of securities of various maturities and therefore calculation of interest rates is difficult from such aggregate-level data. Thus we consider *security level* debt data that helps in calculating returns on the securities of different maturities.

We provide a snapshot of the debt dynamics in India with a particular focus on two major economic disruptions - the 2008 Global Financial Crisis (GFC) and the 2020 COVID-19 pandemic (COVID-19). Using the Hall and Sargent (Hall and Sargent (1997, 2011)) (HS, henceforth) methodology we look at each of the dated securities as a series of zero coupon bondsone for each date at which the coupon or principal is due.

We find that the average maturity of central securities has fallen to around seven years during both the GFC and pandemic even though the government issued longer-dated securities to finance its expenditure during the pandemic. The average nominal return as a function of maturity is observed to have an inflection point at the 19th-year mark and longer maturities have more volatile risk and returns that are similar to the pattern found in other advanced economies (Hall and Sargent (2011)). Also, a clear reduction can also be seen for the mean returns at the 20th, 25th, and 30th-year mark attributable to an investor's preferences for "on-the-roof securities".

The central government securities' yield curve pre- and post-pandemic displays an apparent level effect with the yield curve falling in the post-pandemic period. This highlights the fact that the short end of the curve has fallen in the post-pandemic period. Also, the steady increase in the spreads between the benchmark 10 years and 1-year securities post-pandemic accentuates the fact that there was a hardening of the 10-year yield. This shows more reliance on short-term debt to finance expenditures.

From our decomposition exercise, we find that nominal interest and inflation play a substantial role in driving the evolution of the debt-GDP ratio. When we decomposed the nominal rate into the short rate and the term premium, we find that its the short rate component that made a substantial contribution to increasing the debt-GDP ratio throughout our total sample period. What is more surprising is that when we break the total sample period into various sub-periods, then we get a negative term premia/excess returns, which points out the fact that in these sub-periods the preferences of the investors flipped giving rise to episodes of negative term premia.

The debt management strategy of the government in terms of the issuance of securities of different maturities plays an important role in affecting the interest cost burden and the overall debt. To that end, we undertake a counterfactual exercise, following Hall and Sargent (1997) and ask: "What would be the effect on the cost of funds if the government issued only 1-year securities ("bills only"), 2-10 years' securities ("notes only") or only 10+ years' securities ("bonds only") as a debt management strategy?" Our preliminary analysis shows that a "bills only" and "bonds only" strategy would have led to lower cost of funds and the government could have smoothed its expenses had it followed a strategy of issuing only securities with maturities more than 10 years.

We also propose to extend our model to take into account that the government and the central bank can have two different balance sheets and hence extend the decomposition of the consolidated balance sheet to a two-budget constraint analysis to account for the fact that if there is a dominance of one particular regime or the fact that the Central Bank has to follow an interest-on-reserve payment policy to the government. This might change the dynamics of the public debt, as the traditional setting that looks only at interest payments reported by the government, does not capture this aspect.

## 2 Related Literature

Our work relates to the work of Buiter and Patel (1992) and Rangarajan and Srivastava (2003) also undertake a debt decomposition using aggregate Indian government debt data. Rangarajan and Srivastava (2003) however do not cover the inflation targeting period and neither they take into account security level analysis. Moharir (2022) conducts an accounting decomposition for India using aggregate debt data for the time period 1981 to 2017 but doesn't consider a security level analysis. Ali Abbas et al. (2011) compile a large comprehensive data set on gross government-debt GDP ratios covering nearly the entire IMF membership (of 178 countries). Their analysis reveals a pattern of asymmetric contributions from the components in the government budget constraint to changes in public debt. However, these authors do not do a security-level analysis. Das and Ghate (2022) assemble a novel security level data-set, and apply the approach of Hall and Sargent (2011, 1997)to assess Indian public debt sustainability. Our paper builds on the work of Das and Ghate (2022) and extends the decomposition analysis of Hall and Sargent (2011) to include the time period before and after COVID-19. Since COVID-19 forced governments all around the world to increase expenditure across the segments for various social welfare schemes and also to bring the economy back on track, looking at the evolution of the debt-to-GDP is an important task to undertake.

Earlier works by Fama and Bliss (1987) and Campbell and Shiller (1991) show the failure of the Expectation Hypothesis, which is the basis for deciphering the term premium but consider it as time-invariant, and instead, they forecast excess returns. Stambaugh (1988), Piazzesi and Swanson (2008) and Cochrane and Piazzesi (2005) also document time varying term premium for the US. Mehra and Sinha (2016) examined the term structure of interest rates in India and showed the failure of the expectation hypothesis for India. They also found that the volatility puzzle documented by Shiller on US data is not observed in Indian bond returns. To the best of our knowledge, our paper is the first paper that explicitly breaks the excess return/term premium security-wise for all the Central Government securities going back to 2000 using the HS methodology. In that respect, unlike the earlier work which looks at term premium, we take into account excess return from the perspective of the amount of outstanding debt of the fiscal authority and not merely the issuance of bonds. It is important to note that we measure term premium purely from an accounting perspective since we are interested in the evolution of the observed debt-to-GDP over the years using historical data.

Several papers have studied the interactions between monetary and fiscal policies using the fiscal theory or price level (Leeper (1991), Leeper and Leith (2016), Cochrane (2001), Cochrane (2018), Bianchi and Melosi (2017), Bianchi and Ilut (2017), Bhattarai et al. (2014), Sims (2011)). One of the main conclusions of this literature is that conventional methods of responding to shocks (such as lowering interest rates in response to a contraction in demand) will not work when monetary policy becomes subservient to fiscal policy because shocks filtered through the government's budget can affect inflation. However, the literature has abstracted so far from looking at another potential channel via the maturity structure of debt which can also point out the scope for fiscal dominance. The Hall and Sargent (2011) framework allows us to capture the maturity structure of debt directly in our calculations of decomposition of the government budget constraint and by thereby giving us a sense of how the maturity profile of debt has a role to play in ascertaining aby scope.

# 3 Accounting Decomposition

This section gives an overview of the (Hall and Sargent (2011)) Methodology to decompose the central government debt into components that can be tractable. We then extend the decomposition framework to explicitly include the term premia component in that and see how the presence of term premia leads to the evolution of the debt-GDP ratio. We also provide a simple exposition of our framework with just 2 types of bonds to get a clear picture of the decomposition.

## 3.1 Accounting Framework

We start by writing the government budget constraint, which is given as

$$\frac{B_t}{Y_t} = (r_{t-1,t} - \pi_{t-1,t} - g_{t-1,t})\frac{B_{t-1}}{Y_{t-1}} + \frac{def_t}{Y_t} + \frac{B_{t-1}}{Y_{t-1}} \tag{1}$$

where $Y_t$ is the real GDP at time t, $B_t$ is the real value of securities issued by the fiscal authority. $r_{t-1,t}, \pi_{t-1,t}, g_{t-1,t}$ are the nominal interest rate, inflation rate, and the growth rate of real GDP from period t-1 to period t. $\frac{def_t}{Y_t}$ is the ratio of primary deficit to real GDP. Equation (1) says that the value of debt-to-GDP in time period t is equal to the sum of the nominal interest rate payments net of growth and inflation (the first term on the RHS) and the deficit-to-GDP ratio of this time period and the debt-to-GDP ratio of the previous time period (second and third terms respectively).

To bring some of the consequences of interest rate risk and the maturity structure of the debt for the evolution of the Debt-GDP ratio, the budget constraint is redefined.

Let $\tilde{B}^j_{t-1}$ be real values of nominal zero-coupon bonds of maturity *j at t-1*.

$\tilde{r}^j_{t-1,t}$ is the net nominal holding period return betweent *t-1 and t* on nominal zero-coupon bonds of maturity *j*.

Then using these definitions the new redefined budget constraint is given as

$$\begin{aligned}\frac{\tilde{B}_t}{Y_t} &= \sum_{j=1}^{n} \tilde{r}^j_{t-1,t}\frac{\tilde{B}^j_{t-1}}{Y_{t-1}} - (\pi_{t-1,t} + g_{t-1,t})\frac{\tilde{B}_{t-1}}{Y_{t-1}} \\ &\quad + \frac{def_t}{Y_t} + \frac{\tilde{B}_{t-1}}{Y_{t-1}}\end{aligned} \tag{2}$$

The above equation distinguishes contributions to the growth of the debt-GDP ratio that depend on debt maturity j from those that don't.

## 3.2 Decomposition

To proceed further, we follow Hall and Sargent (2011) and thus denote at each date, t, compute the number of rupees the government has promised to pay at each date t+j. Then the coupons are stripped from the coupon bonds and they are valued as a weighted sum of zeroes as any coupon bond can be decomposed into zero coupon bonds with varying maturity.

Let $s^t_{t+j}$ is the number of time t+j rupees that the government has at time t promised to deliver while $q^t_{t+j}$ be the number of time t dollars that it takes to buy a dollar at time t+j, so this is like the price of a bond. $q^t_{t+j}$ is given by

$$q^t_{t+j} = \frac{1}{(1+\rho_{jt})^j}$$

where $\rho_{jt}$ the time $t$ yield to maturity(YTM) on bonds with $j$ periods to maturity.

To convert t dollars to goods, use $v_t = 1/p_t$, with $p_t$ being the price level in base year. Thus, we get the total real value of government debt outstanding in period t equals

$$v_t \sum_{j=1}^{n} q^t_{t+j} s^t_{t+j}$$

Hence, we can write the redefined time t budget constraint as

$$v_t \sum_{j=1}^{n} q^t_{t+j} s^t_{t+j} = v_t \sum_{j=1}^{n} q^t_{t+j-1} s^{t-1}_{t+j-1} + def_t \tag{3}$$

Equation (3) denotes the real value of the government budget constraint taking into account the different tranches of the maturity structure of the debt that the government has issued. So in a way weighting the budget constraint with the maturity tranches. The real value of the interest-bearing debt at the end of period t is represented on the left-hand side of equation (3), while the real value of the primary deficit and the real value of the government's outstanding debt at the beginning of the period are combined on the right-hand side.

In order to draw the analogy to between equation (3) and the initial government budget constraint, given by equation (2), divide equation (3) by $Y_t$ on both sides to get

$$\frac{v_t \sum_{j=1}^{n} q^t_{t+j} s^t_{t+j}}{Y_t} = \frac{v_t \sum_{j=1}^{n} q^t_{t+j-1} s^{t-1}_{t+j-1}}{Y_t} + \frac{def_t}{Y_t}$$

Doing the algebraic manipulations and rearranging, details of which can be found in the appendix, we will get

$$\frac{v_t \sum_{j=1}^{n} q_{t+j}^{t} s_{t+j}^{t}}{Y_t} = \sum_{j=1}^{n} \left( \frac{v_t}{v_{t-1}} \frac{q_{t+j-1}^{t}}{q_{t+j-1}^{t-1}} \frac{Y_{t-1}}{Y_t} - 1 \right) \frac{v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1}}{Y_{t-1}} + \frac{def_t}{Y_t} + \frac{v_{t-1} \sum_{j=1}^{n} q_{t+j-1}^{t} s_{t+j-1}^{t-1}}{Y_{t-1}} \tag{4}$$

Recognizing the terms in equation (4), we have
$v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1} = \tilde{B}_{t-1}^{j}$, which is the value of the debt of maturity j in time period t-1. Summing over all maturities we will get the value of debt in period t-1

$$\tilde{B}_{t-1} = \sum_{j=1}^{n} \tilde{B}_{t-1}^{j}$$

Now since $v_t = 1/p_t$, thus we will have

$$\left( \frac{v_t}{v_{t-1}} \frac{q_{t+j-1}^{t}}{q_{t+j-1}^{t-1}} \frac{Y_{t-1}}{Y_t} - 1 \right) = \tilde{r}_{t-1,t}^{j} - \pi_{t-1,t} - g_{t-1,t} \tag{5}$$

Thus combining all these and plugging that into equation (4) will give us equation (2).

For the purpose of illustration, Appendix B provides a simple example with just two types of bonds ( 1 year and 2 years) and a finite discrete time frame to bring home the fact as to how equation (4) can be used to write the budget constraint in this simple exposition.

## 3.3 Introducing Term Premium

Now according to the given definitions, $q_{t+j}^{t}$ is the number of time t rupees that it takes to buy a rupee at time t+j, so this is like the price of a zero coupon bond with maturity j.

By definition, the net nominal holding period return between time *t-1 and t* on nominal zero-coupon bonds of maturity *j* is given as

$$\tilde{r}_{t-1,t}^{j} = \frac{q_{t+j-1}^{t}}{q_{t+j-1}^{t-1}} + 1$$

The above equation which is the holding period return between *t-1* and *t* on nominal zero-coupon bonds of maturity *j* can be interpreted as buying a *j* period bond at time *t-1* and selling it as a *j-1* year bond at time *t* can be decomposed into the short rate and the excess returns/term premium as follows

$$\tilde{r}_{t-1,t}^{j} = \rho_{1t} + \tilde{rx}_{t-1,t}^{j} \tag{6}$$

where

$\rho_{1t}$: Short rate or the date $t$ yield to maturity on an 1-period bond

$\tilde{rx}^{j}_{t-1,t}$: excess return holding the $j$ period bond from date $t$ to date *t+1*

This measure of *excess return* is our *term premium*.

With this decomposition, we will have equation (5) as

$$\left(\frac{v_t}{v_{t-1}}\frac{q^{t}_{t+j-1}}{q^{t-1}_{t+j-1}}\frac{Y_{t-1}}{Y_t}-1\right) \approx (\rho_{1t}+\tilde{rx}^{j}_{t-1,t})-\pi_{t-1,t}-g_{t-1,t} \tag{7}$$

By this decomposition of the one-period holding period return into the short rate and the excess return premia, we can capture the dynamics that the term premia plays.

## 3.4 Contributions of inflation, growth and term premium for debt decomposition

To take into account the role played by inflation, growth, and nominal returns (which has now an additional term in the form of excess returns/term premium, we will start with equation (2), which depicts the evolution of the debt to GDP ratio and now with the decomposition of the nominal return as in equation (6), can be written as

$$\begin{aligned}\frac{\tilde{B}_t}{Y_t} =& \sum_{j=1}^{n}(\rho_{1t}+\tilde{rx}^{j}_{t-1,t})\frac{\tilde{B}^{j}_{t-1}}{Y_{t-1}}-(\pi_{t-1,t}+g_{t-1,t})\frac{\tilde{B}_{t-1}}{Y_{t-1}}\\ &+\frac{def_t}{Y_t}+\frac{\tilde{B}_{t-1}}{Y_{t-1}}\end{aligned} \tag{8}$$

To see the role played by the various factors in the evolution of debt-to-GDP ratio in various episodes over time, we can take the next step by taking $\frac{\tilde{B}_{t-\tau}}{Y_{t-\tau}}$ as an initial condition at time $t-\tau$.

Then iterating on equation (8), we can get the following equation for the evolution of the debt-to-GDP ratio as

$$\begin{aligned}\frac{\tilde{B}_t}{Y_t}-\frac{\tilde{B}_{t-\tau}}{Y_{t-\tau}} =& \sum_{s=0}^{\tau-1}\Bigg[\sum_{j=1}^{n}(\rho_{1t-s-1}+\tilde{rx}^{j}_{t-s-1,t-s}-\pi_{t-s-1,t-s}-g_{t-s-1,t-s})\frac{\tilde{B}^{j}_{t-s-1}}{Y_{t-s-1}}\\ &+\frac{def_{t-s}}{Y_{t-s}}\Bigg]\end{aligned} \tag{9}$$

The above equation shows that starting from an initial time period, we can characterize the evolution in the debt-to-GDP ratio as the decomposition of the following terms in the RHS of equation (9). Note that the terms on the right side of the equation are actually weighted by the debt-to-GDP ratio of the various maturity tranches and this leads to the case that the factors which are playing a role in the evolution of the debt-to-GDP, namely nominal return (which is a combination of term premium and short rate) net of inflation and the growth rate are weighted by the issuance of debt-to-GDP for that maturity in that given year tranche. To get a much clearer picture, Appendix A gives an example of the decomposition equation taking into account a particular time period and shows how the change in the debt-to-GDP ratio can be decomposed. Appendix B provides how the term premium will be used for the example with 2 types of bonds.

We take equation (9) to the data for Central securities and note the role of the various factors in the change of the debt-to-GDP ratio.

# 4 Data & Stylized Facts

On the aggregate debt data, we assemble a new and consistently defined annual time series of aggregate government debt between 1951 and 2022 and its components. These components are the nominal interest rate, inflation, the real GDP growth rate, and the primary deficit/surplus. At the security level, we assembled our data from the Status Papers issued by the Ministry of Finance, Government of India, that document the total amount outstanding for Central government securities for a particular year and the details about new issuances in that financial year. We broke the securities into a series of zero-coupon bonds by stripping the coupons from the same. Then we computed separate matrices for the principal payments and the coupon payments. To this end, we consider securities outstanding and issued by the Central government from 1999 to 2022 and we track about 8000 such securities.

The yield data for the Subsidiary General Ledger (SGL) transactions in government-dated securities for various maturities are obtained from the Reserve Bank of India (RBI). Using the yield curve data Reserve Bank of India-RBI we then calculate prices and the market value of the debt and subsequently undertake the debt decomposition along the lines of Hall and Sargent (2011).

Data for other variables used for decomposition like GDP is obtained from the Economic Survey, CPI inflation is obtained from OECD and the data for primary deficit/surplus is obtained from RBI. Detailed methodology for the creation of the dataset is given in Appendix C of the paper.

Using the Hall-Sargent (HS) methodology we calculated the nominal debt that is due as a share of GDP for different maturity tranches between 2000-2021 for centre securities. This is shown in Figure 1 and it is observed that between 2000–2021 much of center's debt is due within 15 years of maturity, though as of 2020 there is a small percentage of debt is due between 20–25 years. Post-2010 there was a gradual decline in the maturity of the debt that was due, and there seems to be a break away from that trend as of 2020 most likely due to the pandemic.

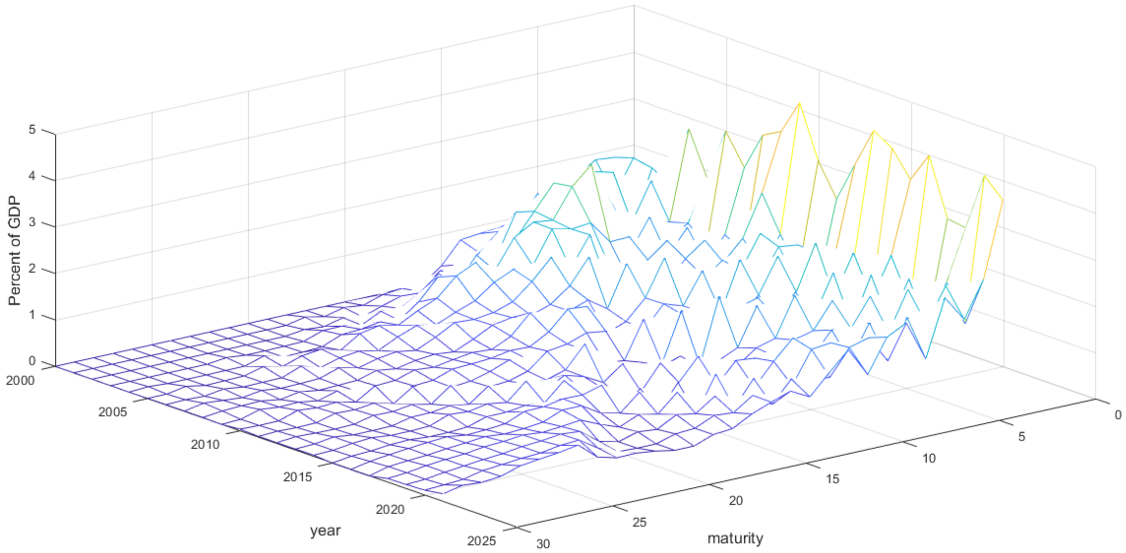


Figure 1: Decomposition exercise: Nominal payouts as a share of GDP for centre securities: 2000–2021

The mean and standard deviation of the nominal returns calculated for the outstanding securities from 1999 until 2021 is shown in figure 3. We find that the mean returns on central government debt have a clear digression at the 19th-year mark and that longer maturities have more volatile risk and returns that are similar to the pattern found in other advanced economies (Hall and Sargent (2011, 2022)). A clear dip can be seen for the mean returns at the 20th, 25th, and 30th-year mark which can be partially attributed to the investor's preferences for the "on the roof securities" as observed in figure 2.

Figures 4 and 5 shows the yield spread between 10 years and 1-year-old security and the yield to maturity for centre securities between 2018–2021, respectively. Comparing the yield curves pre and post-pandemic, we find a clear level effect with the levels falling post-pandemic highlighting the fact that the short end of the curve has fallen post-pandemic. The steady increase in the spreads between the benchmark 10-year and 1-year securities post-pandemic accentuates the fact that there was the hardening of the 10-year yield and thus showing more reliance on short-term debt to finance expenditures, which maps the fall in average maturity that we found during the pandemic.

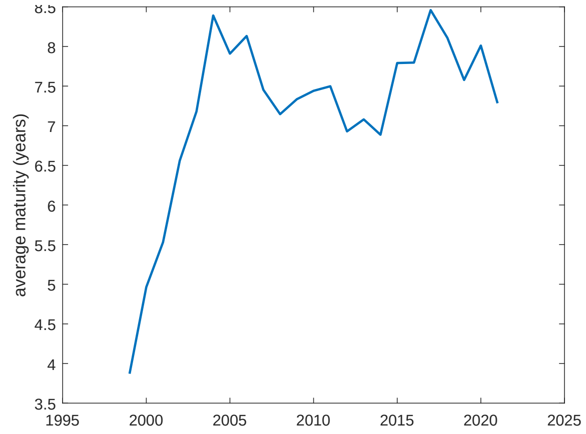


Figure 2: Average Maturity for Centre Securities: 2000–2021

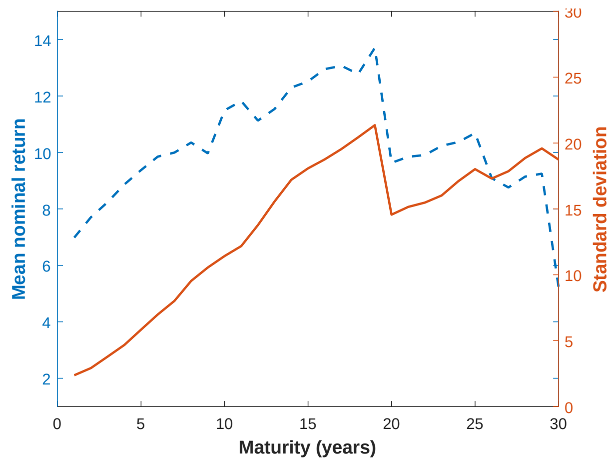


Figure 3: Mean and St. Dev. of Nominal returns against maturity: 2000–2021

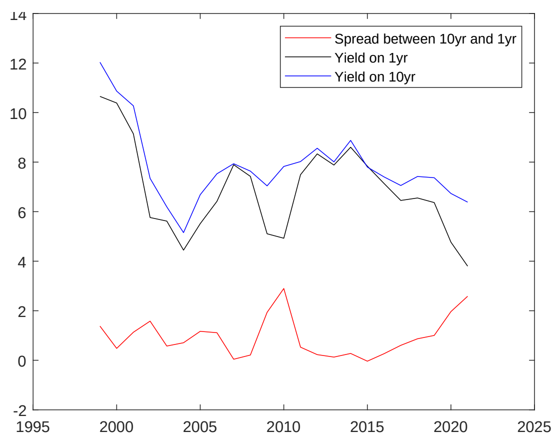


Figure 4: Yield to Maturity Spread for Centre Securities:2000–2021

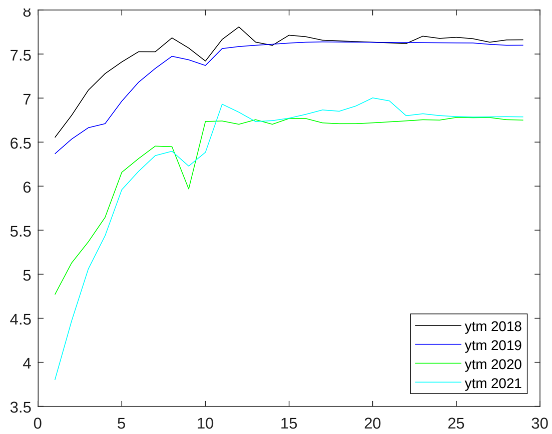


Figure 5: Yield to Maturity Pre and Post Pandemic years:Centre

## 4.1 Counterfactual Exercise

Assuming that the post-2000 interest rates had remained unchanged, how would the government's interest expenses have been affected if it had followed a different debt management policy? We performed a counterfactual exercise, following Hall and Sargent (1997) by asking the question-"What would be the effect on the cost of funds and the marketable debt if the government issued only 1-year securities ("Bills only"), only 2-10 years' securities ("Notes only") or only 10+ years' securities ("Bonds only") as a debt management strategy? The results of the counterfactual exercise are shown in figure 6.

We find that using a "Bills only" strategy would have been much less volatile and the cost of funds would have been lower in absolute terms as well. As the first graph of the left panel of the figure shows that using the "Bills only" strategy would have given a lower cost of funds, mainly during the period from 2003 to 2010. In fact, the government could smooth its expenses had it followed a strategy of issuing only securities with maturities of more than 10 years. However, when we see the right panel, which plots the counterfactual exercise for the amount of marketable debt, we find that using the debt with "Bills only" strategy would have increased the debt quite substantially which is completely valid as the more short-term debt that the government will issue, the sooner the payments will be due. In terms of the marketable debt (as a percent of GDP) shows that to keep the total debt at the same level, the government could have done that by issuing more long-term securities which would have been less both in terms of volatility and as a percentage of GDP. The last figure on the left panel shows that the total real value of the marketable debt would have been substantially lower under the longs only than under the actual policy and it remains low for the whole sample that we considered.

These results indicate that debt-management policies weighted toward longer maturities would have led to lower interest costs and less accumulation of debt over the period from 2000 to 2020. After 2000 debt-management policies weighted toward shorter maturities would have generally lowered interest costs but a higher accumulation of debt. However, if the debt management office would have taken policies that weighed towards long-term debt then not only the cost of funds would have been lower (last figure of the left panel of 6) but the total marketable debt would also have been lower(last figure of the right panel of 6).

However, the evaluation of the results of the counterfactual exercise should be interpreted with caution. Given that interest rates are not completely deterministic in nature and same goes for the result of following a given strategy as well. Thus the role played by inflation should also be considered in the analysis. When the government issues nominal securities, it exposes the public to a risky investment whose real return is dependent on the inflation rate during the bond's lifespan.

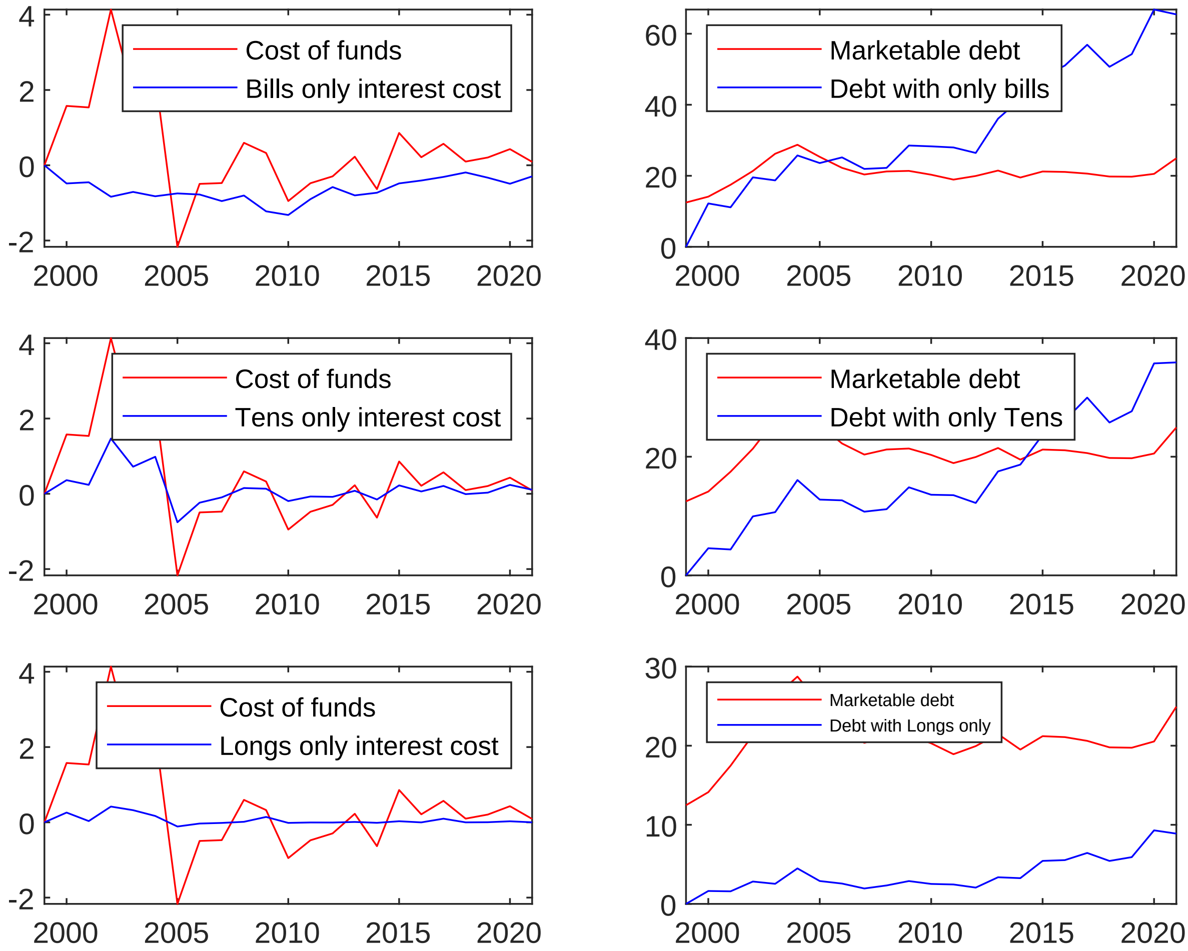


Figure 6: Counterfactual exercise: Yield to Maturity Pre and Post Pandemic years: Centre

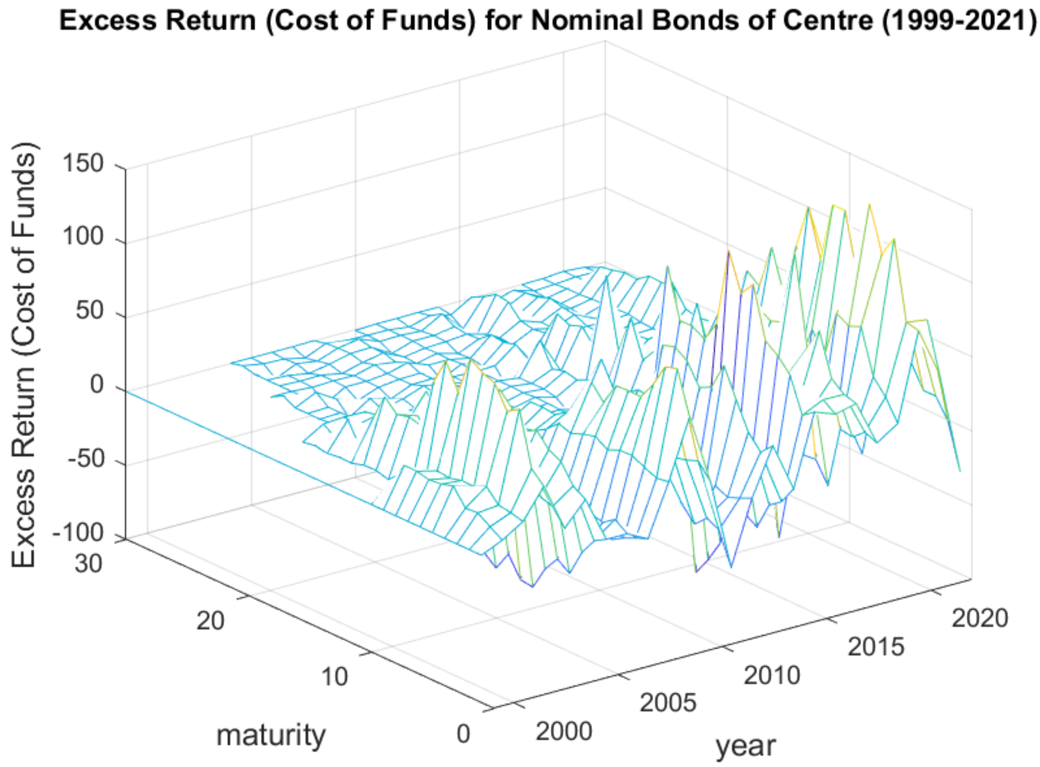


Figure 7: Evolution of Excess Return for Nominal Securities over maturities and years

## 4.2 Evolution of Term premia for Central Securities

Figure 7 shows the complete picture of the evolution of the excess returns/term premium on the nominal securities for the full period of 2000 to 2022. We have episodes of varying excess returns over the said time period as can be seen from the figure. As can be seen from figure 7, the excess returns are much more volatile for securities with maturities between 5 to 20 years, which is not very surprising for India given the fact that the 10-year paper is the mostly traded paper in the domestic bond market.

For the specific years between 2004 to 2007, till the run-up to the great financial crisis of 2008, and then again from 2011 to 2014, just before the change in the monetary policy framework by RBI, excess returns/ term premium have actually become negative which clearly shows the fact that apart from the debt management policy of the fiscal authority, macroeconomic sentiments, as well as inflationary expectations, were playing a huge role in making the term premium negative. In principle, the term premium can be negative, given the way we have decomposed, primarily because of 2 reasons: the short rate (1 year YTM) is higher than the nominal HPR for that bond of a given maturity in a year or that the nominal HPR is itself negative, to begin with. Appendix B gives a small illustration as to how the second case can happen, which we also see in the data for the period 2004-2007, and we can have negative nominal returns. This can be possible, as Appendix B also mentions, due to the change in the price of bonds which can be explained by the specific demand and supply of funds in the line of the loanable funds theory.

From the decomposition results below we show that the term premium factor indeed plays a role in explaining the evolution of debt for India, however, the magnitude of the total proportion is not very large as compared to the short rate, which has a much larger proportion. This can be due to the fact that the overall maturity of debt that the government issues, from the standpoint of our calculations, is approximately around 7 years (see figure 2) and since the excess returns play a much stronger role for longer-dated securities, thus for the overall period, the role that term premium plays in driving nominal returns is less relative to the short rate which changes much more promptly with changes in the monetary policy rates and other factors which hit the short end of the yield curve faster.

# 5 Debt Decomposition Results

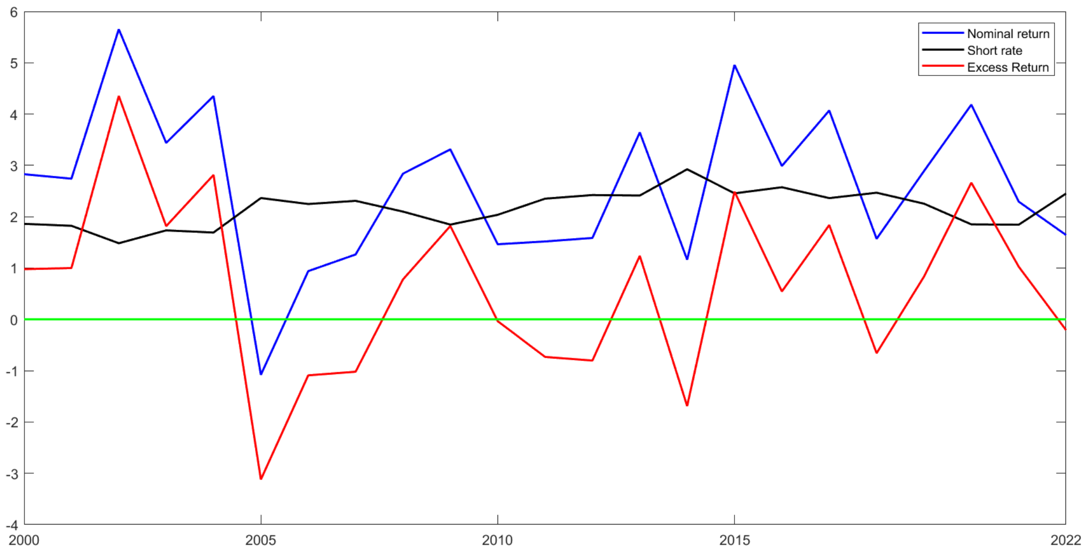


Figure 8: Caption

# 6 Term Premium and Fiscal Dominance

## 6.1 What is Fiscal Dominance?

The wide-ranging accommodation in monetary policy rates and the expansion of central bank balance sheets to contain the financial and monetary effect of the COVID-19 pandemic has brought questions on the practice of monetary policy vis-à-vis fiscal policy. Post the Global Financial Crisis (GFC) of 2008-09 and more so after the COVID-19 crisis, there has been a large increase in general government debt worldwide. Due to

| | | Period | | | | | |
|---|---|---|---|---|---|---|---|
| **Start** | | **2000-** | **2000-** | **2005-** | **2009-** | **2014-** | **2018-** |
| **End** | | **2022** | **2005** | **2009** | **2014** | **2018** | **2022** |
| **Debt-GDP** | | | | | | | |
| | Start | 19.70 | 19.70 | 35.60 | 34.90 | 34.70 | 37.30 |
| | End | 47.70 | 35.60 | 34.90 | 34.70 | 37.30 | 47.70 |
| | Change | 28.00 | 15.90 | -0.7 | -0.2 | 2.60 | 10.30 |
| **Marketable debt** | | | | | | | |
| | Nominal return | 57.40 | 15.10 | 8.40 | 9.40 | 13.60 | 11.00 |
| | Safe-rate | 48.00 | 9.10 | 8.50 | 12.10 | 9.90 | 8.40 |
| | Ex_Return(TP) | 9.40 | 6.00 | -0.1 | -2.8 | 3.70 | 2.60 |
| | Inflation | -43.4 | -5.6 | -7.7 | -15.7 | -6.4 | -8 |
| | Real return | 13.60 | 9.10 | 0.60 | -5.7 | 6.80 | 2.80 |
| | Growth rate | -36.8 | -8.9 | -9.00 | -7 | -8.10 | -3.80 |
| **Non-marketable debt** | | | | | | | |
| | Nominal return | 29.80 | 13.30 | 7.40 | 4.10 | 3.10 | 1.90 |
| | Inflation | -5.9 | -0.4 | -1.10 | -2.1 | -0.7 | -1.60 |
| | Growth rate | -4.8 | -0.8 | -1.30 | -0.9 | -0.9 | -0.80 |
| **Primary Deficit/GDP** | | 29.40 | 3.40 | 1.90 | 10.80 | 2.30 | 11.00 |

Table 1: Security level debt decomposition for centre securities.

| | | | Period | | | | | |
|---|---|---|---|---|---|---|---|---|
| **Start**<br>**End** | | | **2000-**<br>**2022** | **2000-**<br>**2005** | **2005-**<br>**2009** | **2009-**<br>**2014** | **2014-**<br>**2018** | **2018-**<br>**2022** |
| **Debt-GDP** | | | | | | | | |
| | **Start** | | 19.70 | 19.70 | 35.60 | 34.90 | 34.70 | 37.30 |
| | **End** | | 47.70 | 35.60 | 34.90 | 34.70 | 37.30 | 47.70 |
| | **Change** | | 28.00 | 15.90 | -0.7 | -0.2 | 2.60 | 10.30 |
| **Marketable debt** | | | | | | | | |
| | **Nominal return** | | 57.40 | 15.10 | 8.40 | 9.40 | 13.60 | 11.00 |
| | | **1-2 years** | 14.30 | 3.00 | 2.60 | 3.20 | 3.10 | 2.40 |
| | | **TP(1-2 Years)** | 1.50 | 0.60 | 0.30 | -0.2 | 0.40 | 0.40 |
| | | **2 -10 years** | 31.00 | 8.80 | 4.40 | 5.00 | 6.90 | 5.90 |
| | | **TP(2-10 yrs)** | 8.20 | 4.40 | 0.40 | -1.1 | 2.00 | 2.50 |
| | | **10+ years** | 12.20 | 3.30 | 1.30 | 1.20 | 3.60 | 2.80 |
| | | **TP(10+ yrs)** | 4.10 | 1.90 | -0.20 | -0.7 | 1.70 | 1.40 |
| | **Inflation** | | -43.4 | -5.6 | -7.7 | -15.7 | -6.4 | -8 |
| | | **1-2 years** | -12.9 | -1.6 | -2.4 | -4.7 | -1.9 | -2.3 |
| | | **2 -10 years** | -22.6 | -3.1 | -3.9 | -8.3 | -3.3 | -4 |
| | | **10+ years** | -7.9 | -1 | -1.4 | -2.6 | -1.2 | -1.7 |
| | **Growth rate** | | -36.8 | -8.9 | -9 | -7 | -8.1 | -3.8 |
| | | **1-2 years** | -10.4 | -2.4 | -2.6 | -2 | -2.3 | -1.1 |
| | | **2 -10 years** | -19.2 | -4.8 | -4.6 | -3.8 | -4.2 | -1.9 |
| | | **10+ years** | -7.2 | -1.8 | -1.8 | -1.2 | -1.6 | -0.8 |
| **Non-marketable debt** | | | | | | | | |
| | **Nominal return** | | 29.80 | 13.30 | 7.40 | 4.10 | 3.10 | 1.90 |
| | **Inflation** | | -5.9 | -0.4 | -1.1 | -2.1 | -0.7 | -1.6 |
| | **Growth rate** | | -4.8 | -0.8 | -1.3 | -0.9 | -0.9 | -0.8 |
| | **Primary Deficit to GDP** | | 29.40 | 3.40 | 1.90 | 10.80 | 2.30 | 11.00 |

Table 2: Security level debt decomposition for centre securities by maturity.

the persistence of fiscal deficit in many countries and high public debt-to-GDP ratios for many years, challenges have aroused for both the central banks and public debt managers worldwide. Evidently, accommodative monetary policy may come at a cost, and this is especially true when it comes to unconventional monetary practices like the asset purchases made by central banks (CBs) during the epidemic. Risks could increase if central banks' asset purchase programs (APPs) are particularly extensive and unrestricted. Concerns about fiscal dominance may surface, the central bank's reputation is in jeopardy, and pressures on capital outflows, particularly for emerging nations with weaker macroeconomic performance, are increasing.

All these factors gives rise to the phenomena of fiscal dominance. Fiscal dominance can be seen as occurring most frequently at times when easy money conditions are combined with expansionary fiscal measures in order to reduce the debt burden. It is also believed that fiscal dominance occurs when CBs utilise their policy instruments to support the prices of government securities and maintain low interest rates to lower the cost of servicing the government's debt.

# 7 Future Work

We propose to extend our model to take into account that the government and the central bank can have two different balance sheets. Thereby extending the decomposition of the consolidated balance sheet to a two-budget constraint analysis to account for the fact that there is the dominance of one particular regime or the fact that the central bank has to follow an interest-on-reserve payment policy to the government. This might change the dynamics of public debt, as the traditional way of looking only at interest payments reported by the government, does not capture this aspect. Looking at the balance sheet of the central bank is important given the fact that the channel via which we are thinking of fiscal dominance to play a role is related to yield control by the central bank.

Given the level of granularity of our assembled dataset, we plan to look at the various episodes where we can get a sense of fiscal dominance, if not for the full sample period. By using a simple theoretical model framework, we wish to see how does the central bank, under the purview of possible fiscal dominance, reacts to higher government debt levels since the yield curve control that it will employ will have a bearing on the payouts of the government and thereby leading to ultimately the topic of sustainability of debt.

# 8 Conclusion and Discussion

In this paper, we assembled a novel dataset of about 7000 Central securities and using the Hall and Sargent (2011) methodology decompose various attributes of the evolution of the debt-GDP ratio- nominal interest payments, inflation, GDP growth, and the primary deficit- and bifurcate them with the maturity structure of debt. We found that over the complete time period of our study, from 1999 to 2022, nominal interest rates and primary deficit played a huge role in the increase in the debt-GDP ratio, while inflation helped in washing away debt quite substantially. We find that the term premium also plays an important role in driving the evolution but there have been episodes of negative term premium which points to the fact that due to certain specific reasons the investors were willing to purchase longer-dated securities without any extra premium. Some of the reasons could be how inflationary expectations or preferences of investors shape up during these periods (namely 2004 to 2007 and 2011 to 2014). We also find from our decomposition of the nominal rate that the short rate(1 year YTM) actually explains a much larger proportion of the total change in the debt-GDP ratio and remains substantially high even in the sub-periods.

This feature of the short rate explains quite a significant portion of the evolution and contributes to the growth of the debt-GDP ratio of the fiscal authority pointing out the possibility of scope for fiscal dominance. Though we typically think of fiscal dominance via inflation here we point out another prominent channel that is scantly discussed in the literature i.e. via the maturity structure of debt. The fact that the short rate is responsible for close to 48% of the total increase in the debt-GDP ratio which is even more than how much inflation drives down debt-GDP (-43.6%) for the full sample period, points to the fact that the evidence for fiscal dominance in India is a mixed one and therefore requires further scrutiny. Our counterfactual exercise shows that the government could have faced a lower cost of funds if it would have issued debt larger than 10 years in maturity but the fact that it has not happened shows the possibility that the debt management office is more inclined to roll over the debt by issuing shorter-dated maturities.

In the next phase of our work, we wish to scrutinize what is driving the case of fiscal dominance for India using the novel methodology by Hall and Sargent (2011) as it allows us to look through the maturity structure of the securities. Unlike the case of examining only the budget constraint of the central government, we also need to look at the budget constraint of the Central Bank as well and look at both budget constraints in unison because if there is a scope for fiscal dominance, then it should be reflected, in an aggregate sense, in the budget constraints of the government as well as the Central Bank.

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# Appendix A: Technical Appendix

In this appendix, we derive equation (4) of the paper detailing all the steps in the process.

We start by writing the government budget constraint, which is given as

$$\frac{B_t}{Y_t} = (r_{t-1,t} - \pi_{t-1,t} - g_{t-1,t})\frac{B_{t-1}}{Y_{t-1}} + \frac{def_t}{Y_t} + \frac{B_{t-1}}{Y_{t-1}} \tag{10}$$

To bring some some of the consequences of interest rate risk and the maturity structure of the debt for evolution of Debt-GDP ratio, the budget constraint is redefined.

Let $\tilde{B}^j_{t-1}$ be real values of nominal zero-coupon bonds of maturity *j at t-1*.

$\tilde{r}^j_{t-1,t}$ is the net nominal holding period return betweent *t-1 and t* on nominal zero-coupon bonds of maturity *j*.

Then using these definitions the new redefined budget constraint is given as

$$\begin{aligned} \frac{\tilde{B}_t}{Y_t} &= \sum_{j=1}^{n} \tilde{r}^j_{t-1,t}\frac{\tilde{B}^j_{t-1}}{Y_{t-1}} - (\pi_{t-1,t} + g_{t-1,t})\frac{\tilde{B}_{t-1}}{Y_{t-1}} \\ &+ \frac{def_t}{Y_t} + \frac{\tilde{B}_{t-1}}{Y_{t-1}} \end{aligned} \tag{11}$$

The above equation distinguishes contributions to the growth of the debt-GDP ratio that depend on debt maturity j from those that don't.

## Accounting Details

To Carry out the accounting details, At each date, t, compute the number of rupees the government has promised to pay at each date t+j. The coupons are stripped from the coupon bonds and they are vallued as weighted sum of zeroes as any coupon bond can be decomposed into zero coupon bonds with varying maturity.

$s^t_{t+j}$ is the number of time t+j dollars that the government has at time t promised to deliver.

$q^t_{t+j}$ be the number of time t dollars that it takes to buy a dollar at time t+j, so this is like the price of a bond.

$$q^t_{t+j} = \frac{1}{(1+\rho_{jt})^j}$$

where $\rho_{jt}$ the time $t$ yield to maturity on bonds with $j$ periods to maturity.
To convert t dollars to goods, use $v_t = 1/p_t$, with $p_t$ being the price level in base year.

The total real value of government debt outstanding in period t equals

$$v_t \sum_{j=1}^{n} q^t_{t+j} s^t_{t+j}$$

Thus now we can define the time t budget constraint as

$$v_t \sum_{j=1}^{n} q_{t+j}^{t} s_{t+j}^{t} = v_t \sum_{j=1}^{n} q_{t+j-1}^{t} s_{t+j-1}^{t-1} + def_t \tag{12}$$

The left-hand side of equation (2) is the real value of the interest bearing debt at the end of period t. The right-hand side of equation (2) is the sum of the real value of the primary deficit and the real value of the outstanding debt that the government owes at the beginning of the period.

Now to attain the government budget constraint that we have in (**??**),we will proceed as follows. Using equation (2),

$$v_t \sum_{j=1}^{n} q_{t+j}^{t} s_{t+j}^{t} = v_t \sum_{j=1}^{n} q_{t+j-1}^{t} s_{t+j-1}^{t-1} + def_t$$

Divide by $Y_t$ on both sides to get

$$\frac{v_t \sum_{j=1}^{n} q_{t+j}^{t} s_{t+j}^{t}}{Y_t} = \frac{v_t \sum_{j=1}^{n} q_{t+j-1}^{t} s_{t+j-1}^{t-1}}{Y_t} + \frac{def_t}{Y_t}$$

Now add and subtract $\frac{\sum_{j=1}^{n} v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1}}{Y_{t-1}}$ on the RHS of the above equation, we get

$$\begin{aligned}\frac{v_t \sum_{j=1}^{n} q_{t+j}^{t} s_{t+j}^{t}}{Y_t} =& \frac{\sum_{j=1}^{n} v_t q_{t+j-1}^{t} s_{t+j-1}^{t-1}}{Y_t} - \frac{\sum_{j=1}^{n} v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1}}{Y_{t-1}} \\ &+ \frac{def_t}{Y_t} + \frac{\sum_{j=1}^{n} v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1}}{Y_{t-1}}\end{aligned}$$

$$\begin{aligned}\frac{v_t \sum_{j=1}^{n} q_{t+j}^{t} s_{t+j}^{t}}{Y_t} + =& \left( \frac{\frac{\sum_{j=1}^{n} v_t q_{t+j-1}^{t} s_{t+j-1}^{t-1}}{Y_t}}{\frac{\sum_{j=1}^{n} v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1}}{Y_{t-1}}} - 1 \right) \frac{\sum_{j=1}^{n} v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1}}{Y_{t-1}} \\ &+ \frac{\sum_{j=1}^{n} v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1}}{Y_{t-1}} + \frac{def_t}{Y_t}\end{aligned}$$

Cancelling the terms and rearranging, we get

$$\begin{aligned}\frac{v_t \sum_{j=1}^{n} q_{t+j}^{t} s_{t+j}^{t}}{Y_t} =& \sum_{j=1}^{n} \left( \frac{v_t}{v_{t-1}} \frac{q_{t+j-1}^{t}}{q_{t+j-1}^{t-1}} \frac{Y_{t-1}}{Y_t} - 1 \right) \frac{v_{t-1} q_{t+j-1}^{t-1} s_{t+j-1}^{t-1}}{Y_{t-1}} \\ &+ \frac{def_t}{Y_t} + \frac{v_{t-1} \sum_{j=1}^{n} q_{t+j-1}^{t} s_{t+j-1}^{t-1}}{Y_{t-1}}\end{aligned} \tag{13}$$

To recognize the terms in the above equation and see the analogy with equation number (2),we see that

$$v_{t-1}q^{t-1}_{t+j-1}s^{t-1}_{t+j-1} = \tilde{B}^{j}_{t-1}$$

$$\tilde{B}_{t-1} = \sum_{j=1}^{n} \tilde{B}^{j}_{t-1}$$

Now since $v_t = 1/p_t$, thus we will have

$$\left( \frac{v_t}{v_{t-1}} \frac{q^{t}_{t+j-1}}{q^{t-1}_{t+j-1}} \frac{Y_{t-1}}{Y_t} - 1 \right) = \tilde{r}^{j}_{t-1,t} - \pi_{t-1,t} - g_{t-1,t} \tag{14}$$

## Deciphering the term premium

Now according to the given definitions, $q^{t}_{t+j}$ is the number of time t dollars that it takes to buy a dollar at time t+j, so this is like the price of a zero coupon bond with maturity j.

Thus we can define the return on a *j* period bond one period later is given as $\tilde{r}^{j}_{t-1,t}$, which is the net nominal holding period return between time *t-1 and t* on nominal zero-coupon bonds of maturity *j*.

$$\tilde{r}^{j}_{t-1,t} = \frac{q^{t}_{t+j-1}}{q^{t-1}_{t+j-1}} + 1$$

The above equation which is the holding period return between *t-1* and *t* on nominal zero-coupon bonds of maturity *j* can be interpreted as buying a *j* period bond at time *t-1* and selling it as a *j-1* year bond at time *t*.

We can decompose the log return on an *j-period* bond one period later as

$$\tilde{r}^{j}_{t-1,t} = \rho_{1t} + \tilde{rx}^{j}_{t-1,t} \tag{15}$$

where

$\rho_{1t}$: Short rate or the date *t* yield to maturity on an 1-period bond

$\tilde{rx}^{j}_{t-1,t}$: excess return holding the *j* period bond from date *t* to date *t+1*

This measure of *excess return* in our *term premium*.

With this decomposition, we will have

$$\left( \frac{v_t}{v_{t-1}} \frac{q^{t}_{t+j-1}}{q^{t-1}_{t+j-1}} \frac{Y_{t-1}}{Y_t} - 1 \right) \approx (\rho_{1t} + \tilde{rx}^{j}_{t-1,t}) - \pi_{t-1,t} - g_{t-1,t} \tag{16}$$

For the excess return which is simply

$$\tilde{rx}^{j}_{t-1,t} = \tilde{r}^{j}_{t-1,t} - \rho_{1t}$$

we can calculate it for all the maturity of bonds that are being issued by the government. So can define a vector across maturity (without the $j$ superscript) as consisting of

$$\mathbf{r x_{\tilde{t-1,t}}} = [\tilde{rx}^2_{t-1,t}, \tilde{rx}^3_{t-1,t}, \tilde{rx}^4_{t-1,t} ...]^T$$

By this decomposition of the one period holding priod return into the short rate and the excess return premia, we can capture the dynamics that the term premia plays.

## Contributions of inflation, growth and term premia for debt decomposition

Equation (2) in this model, which depicts the evolution of the debt to GDP ratio can now be written to get the term premia explicitly as

$$\begin{aligned}\frac{\tilde{B}_t}{Y_t} &= \sum_{j=1}^{n} (\rho_{1t} + \tilde{rx}^j_{t-1,t}) \frac{\tilde{B}^j_{t-1}}{Y_{t-1}} - (\pi_{t-1,t} + g_{t-1,t}) \frac{\tilde{B}_{t-1}}{Y_{t-1}} \\ &+ \frac{def_t}{Y_t} + \frac{\tilde{B}_{t-1}}{Y_{t-1}} \end{aligned} \tag{17}$$

As a next step take $\frac{\tilde{B}_{t-\tau}}{Y_{t-\tau}}$ as an initial condition at time $t-\tau$.
Iterate on equation (10), we can write

$$\begin{aligned}\frac{\tilde{B}_{t-1}}{Y_t} &= \sum_{j=1}^{n} (\rho_{1t-1} + \tilde{rx}^j_{t-2,t-1}) \frac{\tilde{B}^j_{t-2}}{Y_{t-2}} - (\pi_{t-2,t-1} + g_{t-2,t-1}) \frac{\tilde{B}_{t-2}}{Y_{t-2}} \\ &+ \frac{def_{t-1}}{Y_{t-1}} + \frac{\tilde{B}_{t-2}}{Y_{t-2}} \end{aligned} \tag{18}$$

Plugging (10) into (9) and arranging, we have

$$\begin{aligned}\frac{\tilde{B}_t}{Y_t} &= \sum_{j=1}^{n} \left[ (\rho_{1t} + \tilde{rx}^j_{t-1,t}) \frac{\tilde{B}^j_{t-1}}{Y_{t-1}} + (\rho_{1t-1} + \tilde{rx}^j_{t-2,t-1}) \frac{\tilde{B}^j_{t-2}}{Y_{t-2}} \right] \\ &- (\pi_{t-1,t} + g_{t-1,t}) \frac{\tilde{B}_{t-1}}{Y_{t-1}} - (\pi_{t-2,t-1} + g_{t-2,t-1}) \frac{\tilde{B}_{t-2}}{Y_{t-2}} \\ &+ \frac{def_t}{Y_t} + \frac{def_{t-1}}{Y_{t-1}} + \frac{\tilde{B}_{t-1}}{Y_{t-1}} + \frac{\tilde{B}_{t-2}}{Y_{t-2}} \end{aligned} \tag{19}$$

Thus by iterating and collecting terms, we will reach the following decomposition equation as

$$\frac{\tilde{B}_t}{Y_t} - \frac{\tilde{B}_{t-\tau}}{Y_{t-\tau}} = \sum_{s=0}^{\tau-1} \left[ \sum_{j=1}^{n} (\rho_{1t-s-1} + \tilde{rx}^j_{t-s-1,t-s} - \pi_{t-s-1,t-s} - g_{t-s-1,t-s}) \frac{\tilde{B}^j_{t-s-1}}{Y_{t-s-1}} + \frac{def_{t-s}}{Y_{t-s}} \right] \tag{20}$$

Equation (22) is the key equation that will be used for the decomposition.

## An example

To see things in a much more simpler way and to see an example of how equation 22 will be implemented, let's take a concrete example.

Suppose we want to see how the debt to GDP ratio evolved during the time period 2005-09. For this purpose the appropriate values of $t$ and $\tau$ will be 2009 and 04 respectively as we are measuring the change in the Debt-GDP for 4 years. We will have $n = 30$ as the maximum maturity period bond available to us was for 30 years.

Thus with this formulation, equation 23 will become

$$\frac{\tilde{B}_{2009}}{Y_{2009}} - \frac{\tilde{B}_{2005}}{Y_{2005}} = \sum_{s=0}^{3} \left[ \sum_{j=1}^{30} (\rho_{1,2009-s} + \tilde{rx}^j_{2009-s-1,t-s} - \pi_{2009-s-1,2009-s} - g_{2009-s-1,2009-s}) \frac{\tilde{B}^j_{2009-s-1}}{Y_{2009-s-1}} + \frac{def_{2009-s}}{Y_{2009-s}} \right] \tag{21}$$

Now opening the outer summation of the RHS of the above equation to see the impact of each year, we will have

$$\begin{aligned} \frac{\tilde{B}_{2009}}{Y_{2009}} - \frac{\tilde{B}_{2005}}{Y_{2005}} = & \left[ \sum_{j=1}^{30} (\rho_{1,2008} + \tilde{rx}^j_{2008,2009} - \pi_{2008,2009} - g_{2008,2009}) \frac{\tilde{B}^j_{2008}}{Y_{2008}} \right. \\ & \left. + \frac{def_{2009}}{Y_{2009}} \right] + \left[ \sum_{j=1}^{30} (\rho_{1,2007} + \tilde{rx}^j_{2007,2008} - \pi_{2007,2008} - g_{2007,2008}) \frac{\tilde{B}^j_{2007}}{Y_{2007}} \right. \\ & \left. + \frac{def_{2008}}{Y_{2008}} \right] + \left[ \sum_{j=1}^{30} (\rho_{1,2006} + \tilde{rx}^j_{2006,2007} - \pi_{2006,2007} - g_{2006,2007}) \frac{\tilde{B}^j_{2006}}{Y_{2006}} \right. \\ & \left. + \frac{def_{2007}}{Y_{2007}} \right] + \left[ \sum_{j=1}^{30} (\rho_{1,2005} + \tilde{rx}^j_{2005,2006} - \pi_{2005,2006} - g_{2005,2006}) \frac{\tilde{B}^j_{2005}}{Y_{2005}} \right. \\ & \left. + \frac{def_{2006}}{Y_{2006}} \right] \end{aligned} \tag{22}$$

So equation 24 gives decomposes the total change in the debt to GDP between the period 2005 to 2009 into the individual changes pertaining to each year.

## 8.1 Note on how average maturity of debt is calculated

Since average maturity plays an important role in our discussion, it's quite pertinent to give a brief discussion as to how it is calculated in our framework. The way Hall and Sargent (2011) calculates the average maturity or duration of the bonds is different from how the government calculates duration. The framework that Hall and Sargent (2011) proposes and we adopt is that we look at what is the per period average maturity of the debt that is outstanding in a given year taking into account that the maturity of a bond already issued changes every period and thus the payment outstanding also changes. We first show how the government calculates the average maturity and then show how we are doing this and what are the key differences between these two methodologies and how the method we are using is capturing more information into account.

Government securities in India are available in a wide range of maturities from 91 days to as long as 40 years to suit the duration of varied liability structures of various institutions.

# Appendix B: Simple Example of the decomposition: 2 types of bonds example

In order to get a concise picture of our accounting decomposition, we provide a simple example consisting of 2 types of bonds with maturities in 1 and 2 time periods. Working with this example will help to see the decomposition in a much more tractable way.

Suppose we are in time period $t = 1$ and there are bonds of two types of maturities. The maturity profile of the bond is $j = 1, 2$, so we have a short-duration bond that matures in 1 time period forward and another bond that will mature in time periods.

Thus we have $t = 0, 1, 2, 3$ and $j = 1, 2$.

So the consolidated budget constraint of the government in period 1 is given as

$$\frac{B_1}{Y_1} = (r_{0,1} - \pi_{0,1} - g_{0,1})\frac{B_0}{Y_0} + \frac{def_1}{Y_1} + \frac{B_0}{Y_0} \tag{23}$$

For sake of simplicity we assume that there are only nominal zero coupon bonds and not inflation-indexed. So let $\tilde{B}_0^j$ be real values of nominal zero-coupon bonds of maturity $j$ at time *0*.

If we denote the holding period return (HPR) between time *0 and 1* by $\tilde{r}_{0,1}^j$, then we can write the new budget constraint at time $t = 1$ as

$$\frac{\tilde{B}_1}{Y_t} = \left(\tilde{r}_{0,1}^1\frac{\tilde{B}_0^1}{Y_0} + \tilde{r}_{0,1}^2\frac{\tilde{B}_0^2}{Y_0}\right) - (\pi_{0,1} - g_{0,1})\frac{\tilde{B}_0}{Y_0} + \frac{def_1}{Y_1} + \frac{\tilde{B}_0}{Y_0} \tag{24}$$

Again to carry out the decomposition, we have taken the same route as before and thus we can write the total real value of outstanding debt in period 1 as

$$v_1(q_2^1 s_2^1 + q_3^1 s_3^1)$$

where $s_2^1$ and $s_3^1$ are the number of time 2 and time 3 dollars that the government has at *time 1* promised to deliver.

$q_2^1$ and $q_3^1$ are the number of time 1 dollar that it takes to buy a dollar at time 2 and time 3 respectively, akin to price of a bond and thus

$$q_2^1 = \frac{1}{1 + \rho_{11}}$$

$$q_3^1 = \frac{1}{(1 + \rho_{21})^2}$$

where $\rho_{11}$ and $\rho_{21}$ are the YTM at time 1 for bonds maturing with 1 and 2 periods to maturity.

$v_1$ is simply to convert time 1 dollars into goods, so $v_1 = 1/p_1$.

Thus now we can define the time 1 budget constraint as

$$v_1(q_2^1 s_2^1 + q_3^1 s_3^1) = v_1(q_1^1 s_1^0 + q_2^1 s_2^0) + def_1 \tag{25}$$

Note that from equation 3, we will have $q_1^1 = 1$ as the number of time 1 dollar required to buy a dollar in time 1 is simply 1 itself.

To arrive at the equation, that we have in the paper, divide by $Y_1$ on both sides of equation 3.

$$\frac{v_1(q_2^1 s_2^1 + q_3^1 s_3^1)}{Y_1} = \frac{v_1(q_1^1 s_1^0 + q_2^1 s_2^0)}{Y_1} + \frac{def_1}{Y_1}$$

After doing the similar manipulation like we have done in the paper, we will arrive at the following equation which is given as

$$\frac{v_1(q_2^1 s_2^1 + q_3^1 s_3^1)}{Y_1} = \left(\frac{v_1}{v_0}\frac{q_1^1}{q_1^0}\frac{Y_0}{Y_1} - 1\right)\frac{v_0 q_1^0 s_1^0}{Y_0} + \left(\frac{v_1}{v_0}\frac{q_2^1}{q_2^0}\frac{Y_0}{Y_1} - 1\right)\frac{v_0 q_2^0 s_2^0}{Y_0} + \frac{def_1}{Y_1} + \frac{v_0(q_1^0 s_1^0 + q_2^0 s_2^0)}{Y_0} \tag{26}$$

Now to recognize the terms and see the analogy, we have

$$v_0 q_1^0 s_1^0 = \tilde{B}_0^1$$
$$v_0 q_2^0 s_2^0 = \tilde{B}_0^2$$
$$\tilde{B}_0 = \tilde{B}_0^1 + \tilde{B}_0^2$$

Also, by taking the relevant approximations,

$$\left(\frac{v_1}{v_0}\frac{q_1^1}{q_1^0}\frac{Y_0}{Y_1} - 1\right) \approx \tilde{r}_{0,1}^1 - \pi_{0,1} - g_{0,1}$$

$$\left(\frac{v_1}{v_0}\frac{q_2^1}{q_2^0}\frac{Y_0}{Y_1} - 1\right) \approx \tilde{r}_{0,1}^2 - \pi_{0,1} - g_{0,1}$$

Since by definition, $\tilde{r}_{0,1}^1$ is the net nominal holding period return of a 1 period to maturity bond between periods 0 and 1, hence it is actually nothing but $\tilde{r}_{0,1}^1 = \rho_{10}$, where $\rho_{10}$ is the YTM of a one period to maturity bond at time 0.

In order to decompose the term premia (excess return) component from the nominal returns, we need to keep in mind the fact that by definition , term premium or excess return is the excess holding period return on holding a zero coupon bond for different maturities. To be more precise, it is the excess return of a long bond over a short bond.

In our case, we will have

$$\tilde{r}_{0,1}^1 = \rho_{10}$$
$$\tilde{r}_{0,1}^2 = \rho_{10} + \tilde{rx}_{0,1}^2 \tag{27}$$

where $\tilde{rx}^2_{0,1}$ is the excess return of holding a 2 period to maturity bond from periods 0 to 1.

Excess returns or Term Premium is in general the compensation demanded by investors for holding duration risk. So it's the compensation demanded for holding the longer duration asset as against rolling the investment with short term instruments.

Note that $\tilde{r}^1_{0,1}$ will have no excess return as its the HPR of a 1 period to maturity bond between time 0 and 1.

Thus, from equation 6 we have

$$\tilde{rx}^2_{0,1} = \tilde{r}^2_{0,1} - \rho_{10}$$

As can be seen from this equation that the excess returns or term premium can be negative or positive depending upon the preference of the investors and other market information like monetary policy, inflation expectations, macro scenario-like any shock or the supply side dynamics of the bond market to name some.
In principle the excess returns or term premium can be negative as well if suppose the investor prefer to secure a fixed return for long period (say for institutional pension funds), then the investor may be willing to accept a negative term premium than taking over the rolling over risk.

Now plugging all these into equation 5, we will have

$$\begin{aligned}\frac{v_1(q^1_2 s^1_2 + q^1_3 s^1_3)}{Y_1} &= \left(\frac{v_1}{v_0}\frac{q^1_1}{q^0_1}\frac{Y_0}{Y_1} - 1\right)\frac{v_0 q^0_1 s^0_1}{Y_0} + \left(\frac{v_1}{v_0}\frac{q^1_2}{q^0_2}\frac{Y_0}{Y_1} - 1\right)\frac{v_0 q^0_2 s^0_2}{Y_0} \\ &+ \frac{def_1}{Y_1} + \frac{v_0(q^0_1 s^0_1 + q^0_2 s^0_2)}{Y_0}\end{aligned}$$

$$\implies \frac{\tilde{B}_1}{Y_1} = \left(\tilde{r}^1_{0,1} - \pi_{0,1} - g_{0,1}\right)\frac{\tilde{B}^1_0}{Y_0} + \left(\tilde{r}^2_{0,1} - \pi_{0,1} - g_{0,1}\right)\frac{\tilde{B}^2_0}{Y_0} + \frac{def_1}{Y_1} + \frac{\tilde{B}_0}{Y_0}$$

$$\implies \frac{\tilde{B}_1}{Y_1} - \frac{\tilde{B}_0}{Y_0} = (\tilde{r}^1_{0,1})\frac{\tilde{B}^1_0}{Y_0} + (\tilde{r}^2_{0,1})\frac{\tilde{B}^2_0}{Y_0} - (\pi_{0,1} + g_{0,1})\left(\frac{\tilde{B}^1_0}{Y_0} + \frac{\tilde{B}^2_0}{Y_0}\right) + \frac{def_1}{Y_1}$$

$$\implies \frac{\tilde{B}_1}{Y_1} - \frac{\tilde{B}_0}{Y_0} = (\rho_{10})\frac{\tilde{B}^1_0}{Y_0} + (\rho_{10} + \tilde{rx}^2_{0,1})\frac{\tilde{B}^2_0}{Y_0} - (\pi_{0,1} + g_{0,1})\left(\frac{\tilde{B}_0}{Y_0}\right) + \frac{def_1}{Y_1} \tag{28}$$

Equation 30 is the decomposition equation, which is actually taking into account the fact that we have a term premium term explicitly floating in it.

## Example of Negative Excess Returns

Now, it can be quite possible to have the term premium/ excess returns to be negative.

Recall, by definition, the excess returns in this framework is given as

$$\tilde{rx}^2_{0,1} = \tilde{r}^2_{0,1} - \rho_{10}$$

There can be two possible ways for the excess return to be negative:

1. When the short rate ,$\rho_{10}$, is greater than the HPR of a 2 periods to maturity bond between time 0 and 1, $\tilde{r}^2_{0,1}$.
2. The nominal returns, $\tilde{r}^2_{0,1}$, is itself negative to begin with.

Let's see an instance when the second case is possible, as we have episodes in our dataset where the nomial returns themselve become negative.

Remember that y definition

$$\tilde{r}^2_{0,1} = \frac{q^1_2}{q^0_2} - 1$$

where $q^1_2$is the number of time 1 rupee that it takes to buy a rupees at time 2 and $q^0_2$ is the number of time 0 rupee required to buy a rupees at time 2. Therefore

$$\begin{aligned} \tilde{r}^2_{0,1} =& \frac{q^1_2}{q^0_2} - 1 \\ =& \frac{\frac{1}{(1+\rho_{11})}}{\frac{1}{(1+\rho_{20})^2}} - 1 \end{aligned} \tag{29}$$

For example take the case that

$$\rho_{11} = 0.05$$
$$\rho_{20} = 0.02$$

then our calculations will yield

$$\tilde{r}^2_{0,1} = \frac{\frac{1}{(1.05)}}{\frac{1}{(1.04)^2}} - 1$$

$$\implies \tilde{r}^2_{0,1} = \frac{0.9523}{0.9611} - 1$$
$$\implies \tilde{r}^2_{0,1} = -0.009$$

So as the YTM increases, as we can clearly see from the example, the price of the security falls and thus it can be possible to have negative returns.

# Appendix C: Data

## Steps of preparing the dataset for decomposition

In this section, we provide the complete steps as to how we assembled the data and the subsequent process to make it usable for the accounting decomposition.

- We assembled the data for all the Central government securities issued by the government from 1999 on wards from the Status Paper of government debt, issued by the Ministry of Finance.

- The RBI on the behalf of the Ministry of Finance resorts to issue the securities and act as the debt manager for the government, the next section in this appendix gives some details as to how does RBI carry out the task.

- Since a coupon bond is a stream of promised coupons plus an ultimate principal payment. We regard such a bond as a bundle of zero-coupon bonds of different maturities and price it by unbundling it into the underlying component zero-coupon bonds, one for each date at which a coupon or principal is due, valuing each promised payment separately.

- In this way we can get the **C** matrix, which gives the coupon payments for all the securities over all the years for all the maturities and the **P** matrix, which is the principal matrix that gives the principal payments for all the years over the whole maturity horizon.

- So in a way we have stripped the coupons from each bond and price a bond as a weighted sum of zero-coupon bonds of maturities.

- By adding these two matrices, namely the P matrix and the C matrix, we can get the total payments outstanding for the central government as a weighted sum, with weights being given by the various maturity tranches.

- From the yield to maturity (YTM) data for the Subsidiary General Ledger (SGL) transactions in government dated securities for various maturities, we obtained the "price" of each security, which in our description is defined as the number of time t rupees that it takes to buy a rupee at time t + j. In this respect note that all the securities under our consideration are rupee denominated securities.

- We also calculate the value of currency measured in goods per rupee as the inverse of the price in the base year(this becomes our $v_t$.

- By multiplying $q^t_{t+j}$ with $v_t$ and $s^t_{t+j}$, we get the real value of the marketable bond in year t. Then by summing them over all the maturities, we get the total real value of government debt outstanding in period t.

- We combined this data with other variables used for decomposition like GDP that is obtained from the Economic Survey, CPI inflation which is obtained from OECD and the data for primary deficit/surplus is obtained from RBI.

- The schematic chart below gives a snapshot as to how the real value of the marketable debt is calculated.

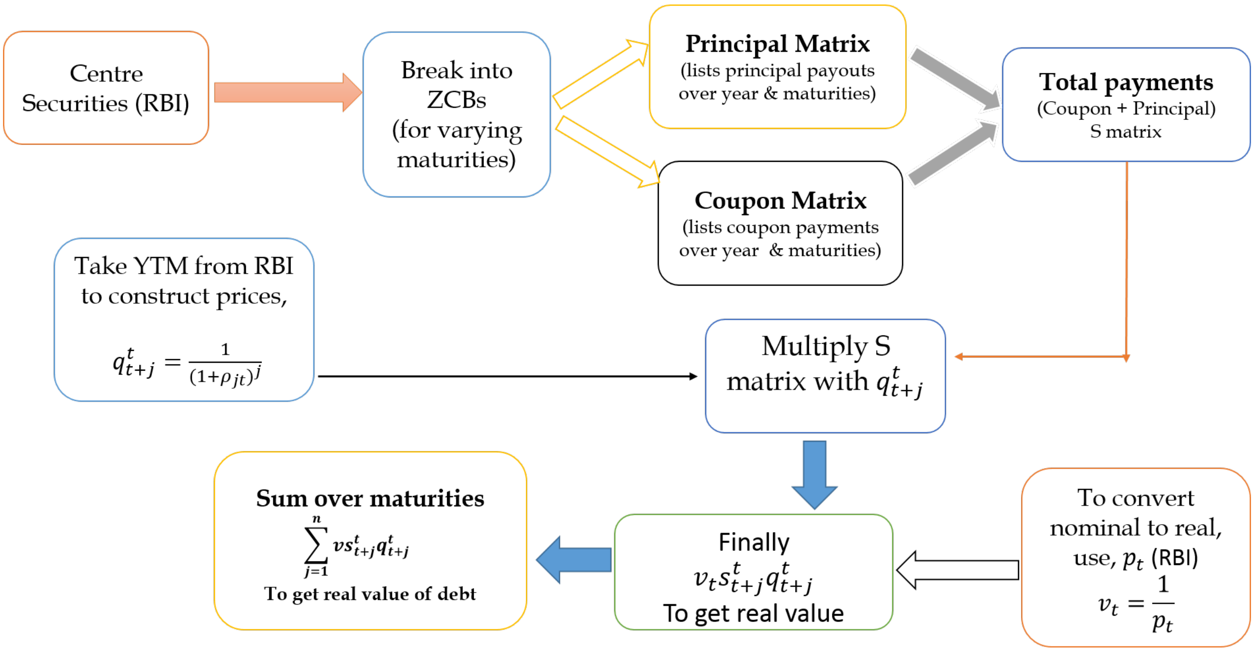


Figure 9: Schematic Flow Chart showing calculation of real value of government debt

## How does the RBI issues securities?

Here we look at how the Reserve Bank of India (RBI) issues the central government securities[1].

The RBI acts as the banker and the debt manager to the government. A Government Security (G-Sec) is a tradable instrument issued by the Central Government or the State Governments acknowledging the obligation of the government's debt.

In India, the Central Government issues both, treasury bills and bonds or dated securities while the State Governments issue only bonds or dated securities, which are called the State Development Loans (SDLs).

The *Public Debt Office (PDO)* of the Reserve Bank of India acts as the registry / depository of G-Secs and deals with the issue, interest payment and repayment of principal at maturity. Most of the *dated securities* are **fixed coupon** securities.

Types of bonds issued

- Most Government bonds in India are issued as fixed rate bonds.

[1] Details can be found here

- Floating rate bonds (FRBs) were first issued in September 1995 in India and have a variable coupon and can carry the coupon, which will have a base rate plus a fixed spread, to be decided by way of auction mechanism.
- Government had last issued a zero coupon bond in 1996.
- Inflation Indexed Bonds (IIBs) - IIBs are bonds wherein both coupon flows and Principal amounts are protected against inflation.
- STRIPS: they are essentially zero coupon bonds and they are created out of existing securities only and unlike other securities, are not issued through auctions.

Besides banks, insurance companies and other large investors, smaller investors like Co-operative banks, Regional Rural Banks, Provident Funds are also required to statutory hold G-Secs.

## How are G-Secs issued

- G-Secs are issued through auctions conducted by RBI on its electronic platform.
- Participants include Commercial banks, scheduled UCBs, Primary Dealers, insurance companies and provident funds, who maintain funds account (current account) and securities accounts (Subsidiary General Ledger (SGL) account) with RBI.
- All non members including non-scheduled UCBs can participate in the primary auction through scheduled commercial banks or PDs.
- The RBI, in consultation with the Government of India, issues an indicative half-yearly auction calendar which contains information.
- Auction for *dated securitie*s is conducted on Friday for settlement on T+1 basis (i.e. securities are issued on next working day i.e. Monday).
- The Reserve Bank of India conducts auctions usually every Wednesday to issue T-bills of 91day, 182 day and 364 day tenors. Settlement for the *T-bills* auctioned is made on T+1 day.
- An auction may either be yield based or price based
  - A **yield-based auction** is generally conducted when a **new** G-Sec is issued. Investors bid in yield terms up to two decimal places. Bids are arranged in ascending order and the cut-off yield is arrived at the yield corresponding to the notified amount of the auction and the cut-off yield is then fixed as the coupon rate for the security.Bids which are higher than the cut-off yield are *rejected*.

- A **price based auction** is conducted when Government of India **re-issues securities** which have already been issued earlier. Bidders quote in terms of price per '100 of face value of the security. Bids are arranged in *descending order* of price offered and the successful bidders are those who have bid at or above the cut-off price.
- Depending upon the method of allocation to successful bidders, auction may be conducted on Uniform Price basis or Multiple Price basis.
- In a **competitive bidding**, an investor bids at a specific price / yield and is allotted securities if the price / yield quoted is within the cut-off price / yield and are undertaken by well-informed institutional investors such as banks, financial institutions, PDs, mutual funds, and insurance companies.

How does one get information about the price of a G-Sec?

The return on a security is a combination of two elements (i) coupon income and (ii) the gain / loss on the security due to price changes.

Information on traded prices of securities is available on the RBI website here and also in the FBIL website.

The Clearing Corporation of India Limited (CCIL) is the clearing agency for G-Secs. In effect, during settlement, the CCP becomes the seller to the buyer and buyer to the seller of the actual transaction.CCIL also guarantees settlement of all trades in G-Secs.