



## Factors causing movements of yield curve in India



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### ABSTRACT

The article identifies principal reasons underlying the movements of yield curve for government debt market in India for the period Jul '97 to Dec '11. The study finds that though statistically Svensson's (SV) (1994) model outperforms Nelson and Siegel's (NS) (1987) model in yield curve estimation, 99% of the movements in yield curves in India are explained by three factors which are 'level' (long-term factor), 'Slope' (short-term factor) and 'Curvature' (medium-term factor) with 'level' contributing more than 90% of its variations. This implies that in more than 90% of cases, the yield curves move parallel either in upward or in downward direction bringing similar effects to all maturity spectrums. This means that yield curve movements in India mainly reflect the monetary policy changes of central bank. Hence, NS's three parameter model is probably more than sufficient to capture all possible shapes of yield curves in India. This finding also suggests that a simple 'duration and convexity' hedging strategy should be appropriate to cover maximum risk exposure of government debt market investors in India.

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### 1. Introduction

The Indian debt markets are relatively less developed compared to its equity markets. Government debt market is mostly restricted to the trading in government securities only. Bonds and other fixed income instruments issued by the public sector units, financial institutions and corporate are the main trading instruments in the non-government (NG) debt market. Government debt market in India has developed much faster over the course of time in terms of liquidity, transparency and volume of transactions as compared to NG debt market after the deregulation of financial markets since 1991. As of 2005, about 91% of all debt securities accounts to the government, 7–8% to financial institutions, and less than 2% to corporate debt. The government debt market stands at 25% of GDP while the corporate debt to GDP is 5% as of 2009. The total market loans of central government securities in 2003 was Rs 6.8 billion as opposed to Rs 1.4 billion in 1996. The outstanding loan for 2009 was Rs 13.6 billion.

The estimation of term structure of interest rates or a benchmark zero coupon yield curve for government debt market has been possible after the liberalisation of the Indian financial market. In the pre-reform days, administered interest rates had been the dominant feature of the Indian market. Yield curve estimation and factors underlying its movements were not meaningful until late nineties due to the gradual course of financial deregulation in India. A 'zero coupon yield curve' (ZCYC) or 'the term structure of interest rate' gives the relationship among the market interest rates with different

maturities at a particular time period. This has been used as a benchmark for evaluating investment strategies in the local and global financial markets for more than a decade. Central Banks often use it as an indicator of future inflation. The credibility, sustainability, and the conduct of monetary policy strategies can be assessed through the yield curve developments. The estimate can be used to price all non-sovereign fixed income instruments with an addition of an appropriate credit spread. Principal drivers or determinants of the yield curve help investors to develop hedging strategies for debt instruments. This also helps to assess the maturity and independent functioning of government debt market.

This study aims at identifying key factors underlying the movements of yield curve in government debt market in India in order to provide a guideline to the risk-averse debt market investors and to see if the yield curve movements reflect market expectations. The article begins with estimation of term structure of interest rates for government debt market in India post the financial deregulation in 1990–91 for Indian debt market using parsimonious families of models like Nelson and Siegel (1987) and Svensson (1994) to capture all possible variations of yield curves during the period Jul '97 to Feb '04. The study then moves on to examine the justification of the choice of number of parameters used in the parsimonious model by extracting the unobserved factors underlying the movements of term structure of interest rates or yield curves with no prior assumptions of exact relationship between factors and the changes in bond price for the period Jul '97 to Feb '04 and Mar '04 to Dec '11. Instead of estimating monthly yield curve by 3 or 4 parameter-based parsimonious models (NS or SV), the study extends the extraction of key determinants of yield curve movements for the period Mar '04 to Dec '11 to see if the structural policy changes in government debt market in the past 5–7 years have changed

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the composition of key factors driving the yield curve movements as eventually the article shows the latter justifies the former.

This article is organised as follows: [Section 2](#) provides a brief overview of Indian debt market. [Section 3](#) has literature survey, [Section 4](#) gives data description. [Section 5](#) explains econometric methodology. Estimation results are discussed in [Section 6](#). [Section 7](#) concludes the study.

## 2. Overview: Indian debt market

Indian debt market was very thin in terms of breadth and depth before 1990s. Interest rates were administered. Coupon rates were artificially low to reduce the cost of borrowing of the government. It was a captive market dominated by banks, insurance companies, provident funds and other financial institutions. The risk-free government debt market has grown much faster as compared to non-government debt market since the financial deregulation started in the year 1991–92 (July–June). A series of reform initiatives that eventually helped to develop the government debt market is worth mentioning.

The abolition of automatic monetisation through ‘ad hoc’ Treasury Bills and the introduction of a system of Ways and Means Advances for the Central Government are some of the major steps in this direction. RBI has introduced the system of primary dealers (PDs) on March 29, 1995. Subsidiary General Ledger (SGL) account was opened up to disseminate market information on daily trading of government securities in Sep '94. Coupon rates were increased gradually. Foreign institutional investors were allowed to invest in government securities markets starting January 30, 1997. Gradual reduction of reserve requirements both in SLR (Statutory Liquidity Ratios) and CRR (Cash Reserve Ratios) and the introduction of liquidity adjustment facility (LAF) on June 2000 are some of the major achievements towards reform. In February 2002, Negotiated Dealing System (NDS) was operationalised. Securities with call and put option were introduced in July 2002. Interest rate derivatives have been introduced in June 2003. STRIPS or zero coupon bonds are also introduced for trading in secondary market recently.

These gradual phases of reform measures have a profound impact in the improvement of market depth and liquidity over time as reflected in various parameters shown in [Table 1](#). The outstanding stock of central government securities has gone up from Rs 769 billion in 1992 to Rs 13,589 billion in 2009, an increase of 190%. As a proportion of GDP, it has increased substantially from 15% in 1992 to 26% in 2009. The average maturity of securities issued during the year has elongated from around 6 years in 1996 to 15 years in 2003. The weighted average cost of securities has declined from 14% in 1996 to 8% in 2009.

[Table 3](#) shows the bond holding pattern of some of the dominant players in the government debt market. RBI, Life Insurance Corporation (LIC), banks, and provident funds have been the dominant players in government debt market. As seen in [Table 3](#), the stake of other players like mutual funds, and foreign investors have increased to 22% in 2007 as compared to 13% in 2001, a 70% jump. The investor base for Federal securities in the US has been banks, financial institutions, provident funds (PFs), insurance and pension funds. The Major owners are International official Entities and Investors along with the Federal Reserve System. Some of the major investors in the US debt can be listed as Goldman Sachs, Citigroup Companies, Merrill Lynch, Bank of America and AIG. The maturity distribution of dated central Government securities transactions in the secondary market as shown in [Fig. 10a,b,c](#) and [d](#) from 2008–09 to 2011–12 suggests the buyers' preference of holding long-term securities. As seen in the pie diagrams in [Fig. 10a](#) to [d](#), securities in the maturity range of 7–10 years and above 10 years account for 80 to 90% of the trading activity. The securities in the maturity range of 7–10 years represent the highest share of trading at 54.0% in 2008–09 and 56% in the year 2011–12. [Fig. 11](#) also suggests that the RBI does not carry out open market operations with Treasury Bills. In June 2012, the RBI has infused Rs 12,000-crore into the market via Open Market Operations (OMOs) to relax the liquidity situation by purchasing the government securities 8.19% bonds maturing in 2020, 8.79% bonds

**Table 1**

Sources: RBI, Report on Currency and Finance, Various Issues.

|   | 1992  | 1996  | 2002   | 2003   | 2009   |
|---|-------|-------|--------|--------|--------|
| 1. Outstanding Stock (Rs in billions)                                       | 769   | 1375  | 5363   | 6739   | 13,589 |
| 2. Outstanding Stock as ratio of GDP (percent)                              | 14.68 | 14.2  | 27.89  | 27.29  | 25.54  |
| 3. Turnover/GDP (percent)   | –     | 34.21 | 157.68 | 202.88 | 332.61 |
| 4. Average maturity of the securities issued during the year (in years)     | –     | 5.7   | 14.9   | 15.32  | 13.81  |
| 5. Weighted average cost of the securities issued during the year (percent) | 11.78 | 13.77 | 9.44   | 7.34   | 7.69   |
| 6. Minimum and maximum maturities of stock issued during the year (years)   | –     | 2–10  | 5–25   | 7–30   | 4–30   |
| 7. PDs' share in the turnover   |       |       |        |        |        |
| A. Primary market   | –     | –     | 70.46  | 65.06  | 45.4   |
| B. Secondary market   | –     | –     | 22.04  | 21.72  | 18.77  |
| 8. Transactions on CCIL (face value Rs in billions)                         | –     | –     | 548    | 15,323 | 62,545 |

Note: Outstanding Stock represents the total market loans of Central Government.

Turnover is the total of outright and repo turnover in G-secs. Outright turnover and repo turnover are calculated as twice and four times the transactions volume respectively.

Data includes development but include MSS and Non-competitive Bids.

maturing in 2021, 8.08% bonds maturing in 2022 and 7.35% bonds maturing in 2024. [Table 2](#) provides a comparative picture of bond market capitalization as a percentage of GDP for Indian bond market in the global setting in terms of public versus private ownership. As observed, similar to other developing nations like China, Brazil, and Indonesia India's bond market is dominated by the public sector participation.

## 3. Literature survey

The history of empirical literature of estimation of term structure of interest rates is very vast. Empirical studies in this direction started in the late 20s with [Guthmann's \(1929\)](#) work in developed countries. [Fisher \(1966\)](#) and [Cohen et al. \(1996\)](#) investigate yield curve fitting using functional forms which can be estimated by the Ordinary Least Square (OLS) regression. However, a seminal work in this field is done by [McCulloch \(1971, 1975\)](#). [McCulloch \(1971\)](#) in his yield curve analysis constrained the cash flows from different bonds of same maturity rates or due at the same time to be discounted at the same rate of return and estimated a discount function from which a term structure can be derived. There has been a significant development in the literature contributed by [Schaefer \(1977, 1981\)](#), [Vasicek and Fong \(1982\)](#), [Shea \(1985\)](#), [Nelson and Siegel \(1987\)](#), [Svensson \(1994\)](#), and [Fisher et al. \(1995\)](#) since then. [Schaefer \(1981\)](#) uses

**Table 2**

Public versus private bond market (percent of GDP).

Source: World Bank.

| Country        | Private bond market |       |       | Public bond market |      |       |
|----------------|---------------------|-------|-------|--------------------|------|-------|
|                | 1991                | 2001  | 2007  | 1991               | 2001 | 2007  |
| Argentina      | 0.1                 | 5.0   | 5.6   | 5.6                | 10.8 | 23.7  |
| Brazil         | 0.0                 | 9.4   | 16.9  | 0.0                | 48.7 | 46.1  |
| China          | 3.1                 | 7.5   | 14.5  | 2.4                | 9.3  | 29.4  |
| Indonesia      | 0.1                 | 1.4   | 2.0   | 0.0                | 31.0 | 17.0  |
| India          | 0.7                 | 0.4   | 2.7   | 20.6               | 25.3 | 31.0  |
| Mexico         | 1.6                 | 9.7   | 17.1  | 17.2               | 14.3 | 20.3  |
| Korea          | 30.2                | 60.0  | 58.8  | 13.0               | 25.5 | 48.1  |
| Australia      | 14.1                | 28.7  | 57.4  | 22.1               | 18.1 | 13.1  |
| Canada         | 12.9                | 27.3  | 29.6  | 69.3               | 60.0 | 51.3  |
| Germany        | 38.6                | 54.1  | 34.5  | 20.2               | 31.9 | 39.9  |
| France         | 55.4                | 39.8  | 48.5  | 22.8               | 44.9 | 51.4  |
| United Kingdom | 14.0                | 18.3  | 15.8  | 24.8               | 29.5 | 32.1  |
| Italy          | 28.0                | 34.3  | 54.8  | 80.8               | 86.2 | 79.1  |
| Japan          | 40.4                | 48.5  | 38.8  | 44.0               | 89.4 | 159.9 |
| United States  | 72.3                | 105.7 | 125.1 | 55.8               | –    | –     |

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