

Yield Curve Forecasting And Strategies

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ABSTRACT

This paper shows that yield curve (YC) is dynamic and in order to earn active returns in fixed income market, investors need to forecast YC. Vector Autoregression (VAR) modeling is employed in the paper to forecast shape of YC. Various YC strategies are suggested to earn active returns in fixed income market. Investment in Long Term Bonds (LTB) is suggested if YC is stable and slope of the YC is expected to decrease. In the same way, investment in Short Term Bonds (STB) and Medium Term Bonds (MTB) is suggested if curvature of the YC is expected to be more humped shaped and vice versa. Also, in case of expectations of increase (decrease) in interest rates, invest in low (high) duration bonds and if volatility of the YC is expected to increase (decrease) invest in bonds or portfolio of bonds with higher (lower) convexity.

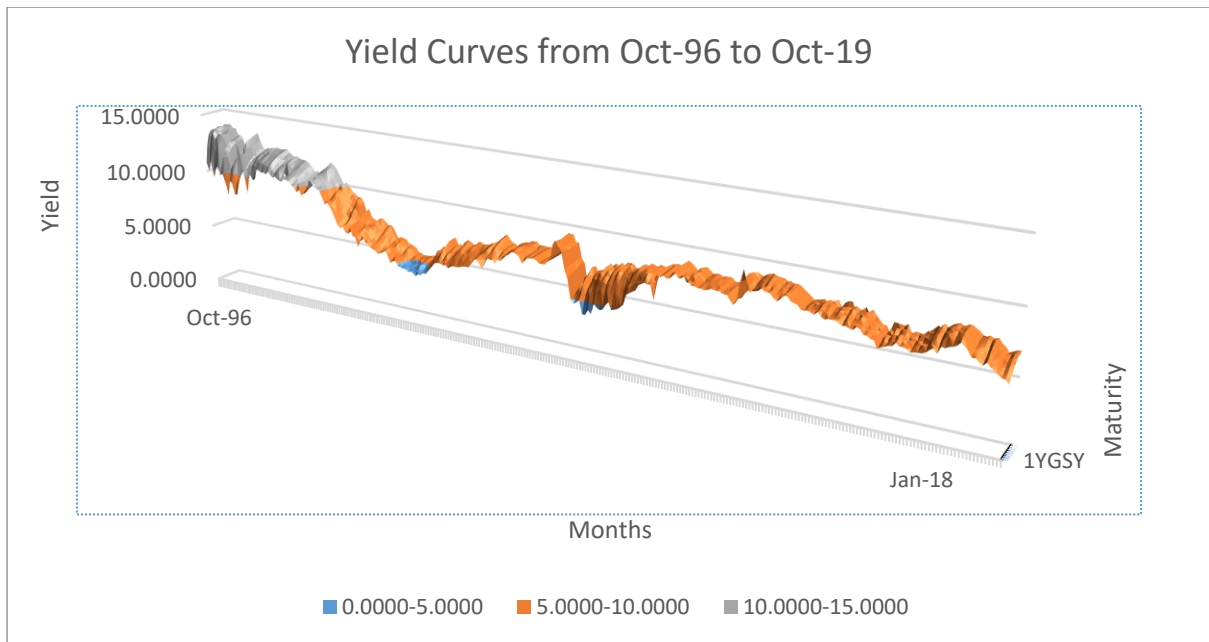
Keywords: Yield Curve, Shape of Yield Curve, Duration, Convexity, Vector Autoregression.

I. INTRODUCTION:

For investment in fixed income market understanding yield curve (YC) dynamics is most important for all fixed income market participants like central bankers, insurance companies, bankers and other fixed income market participants. YC is relationship between maturity of default risk free bonds (government securities) and their zero coupon yield. Zero coupon yields are generally calculated using bootstrapping methodology (Fabozzi & Steven, 2012). Reserve Bank of India (RBI), issues government securities having maturity ranging from fifteen days to thirty years. Yield of these maturities are used in construction of the YC. YC is the basis of valuation for all securities in fixed income market.

YC is dynamic in all economies and India is not an exception. YC in the Indian fixed income market from October 1996 to October 2019 is shown in figure 1.1. The figure shows that Indian YC is dynamic and keeps on changing. This change in YC is captured with the help of three parameters: level, slope and curvature. As considered by studies namely Bekaert et. al. (2010) and Sensarmaa and Bhattacharyya, (2016), level of YC is average of the short, medium and long term yield; slope is difference between long and short term yield and curvature is measured by adding long and short yield and subtracting two time medium term yield. Level, slope and curvature of the YC are shown with the help of figure 1.2, 1.3 and 1.4 respectively.

Figure 1.1: YC from Oct-96 to Oct-19



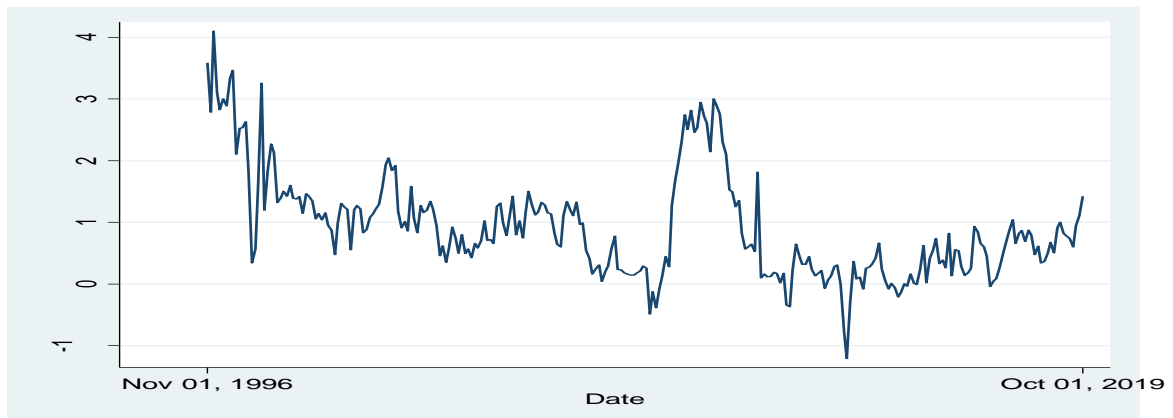
Source of Data: RBI DBIE

Figure 1.2: Level of the YC



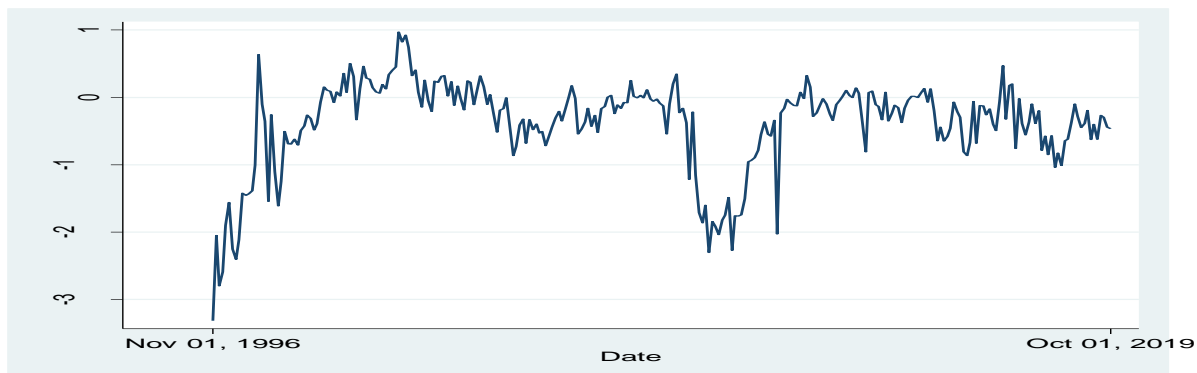
Source of Data: RBI DBIE

Figure 1.3: Slope of the YC



Source of Data: RBI DBIE

Figure 1.3: Curvature of YC



Source of Data: RBI DBIE

Market participants in fixed income market have to build some strategies to earn active return and reduce risk particularly YC risk. YC risk is fluctuations in the YC which effect price of bonds in fixed income market. Beside YC risk there are other risks involved in fixed income investment like interest rate risk, default risk, political risk, exchange rate risk, downgrade risk etc.

1.1 Objectives:

Following are the objectives of this paper:

- to build a model to forecast the parameters of YC,
- to explain various YC strategies used for investment in fixed income market.

The paper proceeds as follows; section II builds a model to forecast slope, level and curvature of the YC, section III explains various YC strategies for investment in fixed income market and last section concludes the paper.

II. FORECASTING THE YC:

In order to explain the YC dynamics, various term structure theories have been developed in the finance literature. Fisher (1896) and Keynes (1930) argued that short term and long term interest rates are related to each other.. Expectation hypothesis was developed by Roll (1970, 1971), John R. Hicks (1946) and Friedrich A. Lutz (1940). This hypothesis states that future short term rates can be predicted by forward rates. And STB and LTB are perfect substitutes of each other. Liquidity preference theory (Hicks, 1946) suggests that liquidity inverters prefer STB over LTB due to which the slope of YC is positive. Culbertson (1957) also supported liquidity preference theory. Modigliani and Sutch (1966) developed theory of preferred habitats also called as market segmentation theory. They argued that investors prefer bonds as per their requirement not as per liquidity, which is also claimed by Hicks. This means that every investor has preferred habitat which effect demand and supply of bonds in that habitat. This demand and supply of bonds effects shape of YC.

Different models to forecast parameters of the YC have been developed in finance literature. Sensarmaa and Bhattacharyya (2016) employed SVAR (structural vector autoregression) to

model the shape of YC along with other macroeconomic variables. Oskooee and Mitra (2010) also used VAR (vector autoregression). They used slope, level and curvature of the YC along with other variables for analysis. Bhattarai and Arpita (2015), Bernard and Gerlach (1998) and Kapur et. Al. (2018) also used VAR for predicting shape of YC. Therefore, to forecast parameters of the YC, VAR is used in this paper.

2.1 Vector Autoregression (VAR): In VAR we do not have to specify which variable is endogenous and which is exogenous. In this study, VAR is estimated by adding slope, level and curvature in estimation equation without specifying which variable is endogenous. Slope (SLOPE), level (LEVEL) and curvature (CURVATURE) are already defined above. First difference are represented by DSLOPE, DLEVEL and DCURVATURE respectively.

2.2 VAR Model Equations:

$$\text{Slope}_t = C_{1,1} * \text{Slope}_{t-1} + C_{1,2} * \text{Slope}_{t-2} + C_{1,3} * \text{DLevel}_{t-1} + C_{1,4} * \text{DLevel}_{t-2} + C_{1,5} * \text{Curvature}_{t-1} + C_{1,6} * \text{Curvature}_{t-2} + C_{1,7}$$

$$\text{DLevel}_t = C_{2,1} * \text{Slope}_{t-1} + C_{2,2} * \text{Slope}_{t-2} + C_{2,3} * \text{DLevel}_{t-1} + C_{2,4} * \text{DLevel}_{t-2} + C_{2,5} * \text{Curvature}_{t-1} + C_{2,6} * \text{Curvature}_{t-2} + C_{2,7}$$

$$\text{Curvature}_t = C_{3,1} * \text{Slope}_{t-1} + C_{3,2} * \text{Slope}_{t-2} + C_{3,3} * \text{DLevel}_{t-1} + C_{3,4} * \text{DLevel}_{t-2} + C_{3,5} * \text{Curvature}_{t-1} + C_{3,6} * \text{Curvature}_{t-2} + C_{3,7}$$

C_{1,1} Coefficient 1 of equation 1 of slope with first lag, similarly other coefficients.

2.3 Data: Monthly data of government securities (one, five and ten year) yield ranges from October 1996 to October 2019, downloaded from RBI database on Indian economy (RBI, 2019), is used for analysis, data prior to 1996 is not available.

Variables used in VAR required to be stationary, if not stationary than after first difference, in most of cases, time series variables become stationary. Augmented Dickey-Fuller (ADF) is employed for testing stationarity. Akaike Information Criteria (AIC) is used for deciding optimum lag length in ADF test. Table I shows stationarity of variables. Slope and curvature are stationary without first difference and level become stationary after first difference.

Table I: Stationarity of Variables

Variables	Level/First Difference	Lag Length: AIC	ADF test statistic		Decision
			t-Statistic	Prob.*	
Slope	Level (SLOPE)	3	-3.41451	0.01130	

	First Difference (DSLOPE)				Stationary without first difference
Level	Level (LEVEL)	4	- 2.54031	0.10710	Stationary after first difference
	First Difference (DLEVEL)	3	- 7.92051	0.00000	
Curvature	Level (CURVATURE)	3	- 4.13586	0.00100	Stationary without first difference
	First Difference (DCURVATURE)				

Source: Author's Calculations

2.4 VAR Lag Order Selection Criteria: For VAR we require to determine the optimum lag length. Hannan-Quinn information (HQ) order selection criteria is used for selecting the optimum lag length and two lags are selected for estimating VAR.

2.5 Vector Autoregression (VAR) Estimates: Table II shows that slope with own lag is most persistent component effecting slope of YC. Beside this curvature and level also effect slope. Curvature effect level after first lag and curvature is effected by itself with lags. Following VAR estimation equations are used for prediction of slope, level and curvature.

Table II: VAR Estimates:

Standard errors in () & t-statistics in []			
	SLOPE	DLEVEL	CURVATURE
SLOPE(-1)	0.725554 (0.07379) [9.83208]	-0.089440 (0.07112) [-1.25765]	-0.039208 (0.06655) [-0.58913]
SLOPE(-2)	0.150529 (0.07207) [2.08858]	0.077666 (0.06946) [1.11817]	-0.001895 (0.06500) [-0.02916]
DLEVEL(-1)	-0.141169 (0.07006) [-2.01485]	0.037322 (0.06752) [0.55274]	0.063474 (0.06319) [1.00452]
DLEVEL(-2)	0.125548 (0.06308) [1.99026]	-0.056721 (0.06079) [-0.93303]	-0.090642 (0.05689) [-1.59325]

CURVATURE(-1)	0.109978	-0.192986	0.522090
	(0.07500)	(0.07228)	(0.06764)
	[1.46644]	[-2.67012]	[7.71893]
CURVATURE(-2)	-0.149037	0.100857	0.302193
	(0.07414)	(0.07145)	(0.06687)
	[-2.01012]	[1.41151]	[4.51926]
C	0.089459	-0.047619	-0.020367
	(0.03443)	(0.03318)	(0.03105)
	[2.59833]	[-1.43517]	[-0.65592]

2.6 VAR Model

$$\begin{aligned} \text{Slope}_t &= 0.726 * \text{Slope}_{t-1} + 0.151 * \text{Slope}_{t-2} - 0.141 * \text{DLevel}_{t-1} + 0.126 \\ &\quad * \text{DLevel}_{t-2} + 0.11 * \text{Curvature}_{t-1} - 0.15 * \text{Curvature}_{t-2} + 0.089 \\ \text{DLevel}_t &= -0.089 * \text{Slope}_{t-1} + 0.078 * \text{Slope}_{t-2} + 0.037 * \text{DLevel}_{t-1} - 0.057 \\ &\quad * \text{DLevel}_{t-2} - 0.193 * \text{Curvature}_{t-1} + 0.101 * \text{Curvature}_{t-2} - 0.048 \\ \text{Curvature}_t &= -0.039 * \text{Slope}_{t-1} - 0.002 * \text{Slope}_{t-2} + 0.063 * \text{DLevel}_{t-1} - 0.091 \\ &\quad * \text{DLevel}_{t-2} + 0.522 * \text{Curvature}_{t-1} + 0.302 * \text{Curvature}_{t-2} - 0.020 \end{aligned}$$

VAR is one of the model suggested by literature which is used for forecasting shape of the YC. We have used only latent variables for forecasting but other macroeconomic variables can also be used by econometricians. So, VAR is just a simple model, other econometric models can also be used for forecasting. Advance models for predicting of shape of YC is beyond the scope of this research paper.

III. YC STRATEGIES:

In this study, YC strategies for earning active returns are categorized on the basis of assumption of future changes in YC. Some of these strategies are also suggested by David and Ludwig (2005), Steven et. al. (1997), Martin et.al. (2019) and Takao et. al. (2003). There are following two possibilities:

- I. YC is stable
- II. YC is dynamic i.e. change in shape of the YC.

Stable YC means shape of the YC remains same during investment horizon. If YC is stable and positive, invest in LTB to earn active returns. As bond moves towards maturity the price of bond increases due to decrease in yield, this is also called riding the YC with the help of which investor can earn capital gain beside coupon on bonds.

If level of YC is expected to increase it is better to invest in short and medium end of the YC by investing in STB and MTB and if level is expected to decrease invest in LTB. With decrease (increase) in level of the YC value of LTB increase (decrease) more than STB and MTB.

If slope of the YC is expected to increase it is again better to invest in STB and MTB because value of LTB decrease more than STB and MTB, and in case of expectation of decrease in slope invest in LTB because value of LTB increase more than STB and MTB.

If curvature is expected to increase i.e. YC becomes more humped, then it is better to invest in STB and LTB because price of MTB decreases and LTB and STB increases and if curvature is expected to decrease than vice versa. Further for investment in bonds and portfolio of bonds, YC strategies are divided into three categories:

3.1 Long Short Positions: In this strategy buy (short) bonds in which yield is expected to decrease (increase). This means in case of increase (decrease) in slope of the YC buy (short) STB and short (buy) LTB. If curvature of the YC is expected to be more (less) humped, short (buy) MTB and buy (short) STB and LTB. This strategy is similar to buying at lower rate and invest at higher rate.

3.2 Management of Bond Duration: Duration is change in value of bond with one percentage change in interest rate with parallel shift in YC. Higher the duration higher is the interest rate risk. If yield (interest rate) is expected to decrease lengthen the portfolio duration by investing LTB and if the yield (interest rate) is expected to increase shorten the portfolio duration by investing in STB.

3.3 Management of Bond Convexity: Duration shows the linear relationship between price of bond and interest rate. Convexity is the second order effect which shows deviation of price of bond calculated by using duration due to change in interest rate. With positive convexity of bonds or portfolio of bonds, increase in price due to decrease in interest rates is higher than calculated by duration and decrease in price due to increase in interest rates is less than calculated by duration. So positive convexity is valuable for investors.

Also convexity is valuable in high volatile interest rate environment. If interest rates are expected to be more (less) volatile buy (sell) bonds at long (short) end of the YC because convexity of bonds at long end of the YC is high. Effectiveness of strategy depends upon effectiveness of forecast. If forecast, go wrong investor may incur losses.

IV. CONCLUSION:

YC is dynamic, in order to earn active return, we need to forecast three parameters of YC namely slope, level and curvature. VAR model is used in this study to forecast these parameters of the YC. Beside VAR, other models in consultation with econometricians can also be used for forecasting. Different strategies are suggested in the study to earn active return. If slope, level and curvature is expected to increase invest in STB and MTB. Also manage duration and convexity of bond portfolio as per expectation of change in the YC. Invest in long (short) duration bonds if interest rates are expected to decrease (increase). Invest in bonds with higher (lower) convexity i.e. long (short) end of YC, if YC is expected to be more (less) volatile.

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