ISSN Number: 2454-2024(Online)

International Journal of Technical Research & Science

MONETARY, REAL & FISCAL FACTORS AND VOLATILITY OF SOVEREIGN BOND YIELDS: EVIDENCE FROM INDIA

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Abstract- This study evaluates the volatility behavior of sovereign bond yields of India and impact of macroeconomic factors on their yield volatility. The researcher categorized macroeconomic variables into three categories viz. Monetary, Real and Fiscal factors, and then applied Principal Component Analysis to extract variables, which are loading maximum information or act as proxy of Monetary, Real and Fiscal factors. The results in the study inferred that there is inner volatility and yield effect in sovereign bond across all maturities. The study also inferred those macroeconomic variables impact volatility of sovereign bond yields differently, based on their maturity. Monetary factors impact the volatility of both short term (1-, 2 year) and medium term (3-, 5 year) sovereign bond yields, Real factors impact the volatility of bond yields across all maturities, Fiscal factors impact volatility of long term (10-, 15- and 30 year) sovereign bond yields in India. The implications of this study are that Reserve Bank of India and other policy makers can use monetary policies to stabilize the yield fluctuations of short term and medium-term sovereign bonds, Real activities can be used to stabilize the fluctuation across all maturities of sovereign bond yields and Fiscal policies can be used to stabilize the fluctuations of long-term sovereign bond yields in India.

Keywords: Sovereign Bond Yields, Monetary, Real and Fiscal factors, GARCH (1, 1).

1. INTRODUCTION

Volatility is a vital factor in any investment analysis be it asset pricing, security pricing or risk management. Likewise, the impartment issue related to sovereign bond markets is the macroeconomic variables that are affecting the volatility of yields, price and risk. Viceira (2007), finds that interest rates forecast bond volatility. Ederington and Lee (1993) find the impact of monthly macroeconomic announcements on Treasury bond return volatility is much higher between 0830 and 0855 Eastern Standard Time. Fleming and Remolona (1997, 1999) find significant effects of macroeconomic announcements on the return volatility of US 5 year Treasury note. Balduzzi et al.(1999), Elton, and Green (2001), finds impact of macroeconomic news on the volatility of returns of short term and long term US treasury interest instruments. Jones et al. (1998), Christiansen (2000), and Goeij and Marquering (2006), also finds that macroeconomic announcements affect the volatility of bond returns. They also find that releases of employment and producer price index data effects the volatility of medium- and long-term bonds while monetary factors effect the volatility of short-term bond returns. Carlo Altavilla et al. (2013), found that macroeconomic data release significantly explain the bond returns. This increases with holding period, ranging from 10% to 40% for daily to one year holding period respectively. Jones et al. (1998) found that new information coming from release of macroeconomic announcements is immediately incorporated in bond prices. Andersen et al. (2003, 2007) investigated the reactions of stock, bond and foreign exchange markets and found that macroeconomic news causes conditional mean jump. Suk-Joong Kim et al. (2003) found that markets do not respond to the news announcements; rather it is news content of these announcements, which makes markets to react. Suk-Joong Kim, Jeffrey Sheen (2000), found that future prices falls in response to the news of higher current account deficit, GDP, inflation and retail prices than their expected, where as future prices rises due to unexpected unemployment.

Don Bredin et al (2010), found that excess bond returns primarily react to domestic news announcements rather than foreign news announcements.

However, some studies like Ludvigson and Ng (2009) have studied whether macroeconomic variables themselves can predict the bond volatility and find that macroeconomic variables greatly affect bond returns and bond risk premia. Now the question arises whether the volatility in sovereign bond yields in India is due to their inner shocks or it is caused by external forces (macroeconomic factors). This study is a humble attempt to answer this question.

2. LITERATURE REVIEW

Tim Bollerslev et al. (2000) investigated the impact of macroeconomic announcements on return volatility of US Treasury bond futures contracts using a daily data from 1994 to 1997. The variables used in the study were: dependent variable, US treasury bond futures contracts and independent variables were: Humphrey–Hawkins testimony, Employment reports , PPI , Employment costs , Retail sales , NAPM survey , FOMC meetings , CPI , Treasury note auction results , Beige book , Industrial production ,Housing starts, GDP, Consumer confidence, New single-family home sales , Durable goods orders, Trade balance Business inventory, Existing home sales, Construction spending, Personal income and Productivity and costs. The main objective of the study was to find out intraday patterns in the volatility of US Treasury bond futures contracts. The methodology used in this study is ARCH and GARCH models. The major findings were that out of all announcements only the Humphrey–Hawkins testimony, the employment report, the producer price index (PPI), the employment cost, retail sales, and the NAPM survey were having the greatest impact on return volatility of US Treasury bond futures contracts. They also found that there exist two spikes in the intraday volatility at 0830 and 1000 Eastern Standard Time respectively. Volatility reveals U-shaped pattern across all the day.

Jingzhi Huang and Lei Lu (2008) studied the impact of macroeconomic variables on the volatility of Treasury bond returns. The dependent variables used in study were 1-, 2-, 5-, 7-, 20- and 30 year US treasury bond returns and independent variables were macroeconomic variables viz. index of Help Wanted Advertising in Newspaper, National Association of Production Management Index, Federal funds rates, Non borrowed reserves.. The frequency of data was monthly spanning from 1961 to 2008, covering a period of 48 years. Real and Monetary factors were extracted by using Principle Component analysis. The objective of the study was to investigate the impact of macro variables on the volatility of US Treasury bond returns. The methodology used in the study was regression analysis. They found that both real and monetary factors significantly impact the volatility of US treasury returns. But real factors affect the volatility of US treasury returns across all maturities. While monetary variables affect the volatility of short and medium US treasury returns. Their results and findings were consisting with those of Evan and Marshall (1998). Who found that monetary policy shocks induces a positive responsive in short term interest rates and has very less impact on medium term rates and almost no impact on long term rates. Goeij and Marquering (2006) who found that monetary policy announcement affect volatility of only short term bonds.

Simon et al. (2011) they investigated the evolving relationship in the volatility of sovereign bond yields in the European Economic and Monetary Union (EMU). For that purpose, they studied the behavior of daily sovereign bond yields of 11 EMU countries. The data used in the study were daily data of 10 year sovereign bond yields from 26th march 201 to 31 December 2010 was taken from Thomson Reuters Data stream for the EMU-11 countries: Austria,

Belgium, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal and Spain. The main purpose of this study was to investigate the volatility behavior of sovereign bond yields in different euro zone countries. In order achieve the objective they applied Lee (1999)′s component-GARCH model. The methodology used in the study to decompose volatility in permanent and transitory components were Engel and Lee (1999)′s component-GARCH model and their results shows that transitory shifts in debt market sentiment tend to be less significant determinants of bond-yield volatility than volatility to the underlying fundamentals. Secondly they developed a correlation and causality analysis and found that the existence of two different groups of countries viz. core EMU countries and peripheral EMU countries. They found that there are relatively strong correlations of over 0.75 among Austria, Belgium, Finland, France, Germany, Italy and The Netherlands, which indicates the existence of some degree of commonality between them. They also found very strong and significant correlation among the permanent volatilities of Portugal and Greece, Belgium and Spain, and Spain and Ireland. Correlations of lesser but still notable magnitude also are detected between Spain and Austria, Finland, France, Germany, Netherlands and Portugal; and between Italy and Ireland.

Luis M. Viceira (2012), studied the time variation bond risk, measured in terms of co variation of bond with equity returns, consumption growth and in the volatility of bond returns. The variables used in the study were bond returns and equity returns, The main objective of the study was to investigate whether the quantity of the bond risk is time varying or not and whether this time variation is correlated with the variables which are explaining time variation in excess bond returns. The findings shows that there is positive relationship among short term nominal interest rate, bond risk and volatility, which supports the hypothesis of Glosten et al. (1993), that short term interest rates forecasts stock market volatility, because there is inflation uncertainty, which can be correlated with overall economic uncertainty. If it is possible to proxied short term interest rates for both inflation uncertainty and overall economic uncertainty, one can easily use it to forecast bond yield volatility and also covariance of both stocks and bonds. The results also reveals that the yield spread forecast of the bond stock returns covariance positively at both short and long run and suggests that yields can forecast bond excess not only to variation in overall risk aversion but also variations in bond risk itself, which is in contrast to the effects of short term interest rate. The yield spread beta of the bond return volatility seems to be stable over passage of time.

Belen Nieto et al. (2013), studied the relationship between the volatility of corporate bond returns and standard financial and macroeconomic indicators. They used daily returns of US corporate bond from 31 December 1996 to 31 January 2012, collected from Bank of America. The main objective of the study was to understand the behavior of corporate bond volatilities. The methodology used in the study is GARCG-MIDAS model. The major findings reveals that Macroeconomic factors like industrial production, aggregate consumption, and employment growth, and financial indicators like the term structure slope, the default premium and the VIX volatility index are key determinants of the long-run component of volatility for corporate bonds across all rating categories, while inflation, and market-wide illiquidity shocks are also important for low credit rating bonds and particularly, for junk-bonds

Yogendra Singh Rajavat (2013) the author investigated the impact of volatility of foreign bond market returns on the volatility of Indian bond market returns. The variables used in the study were Indian bond market return Indian stock returns, USA bond market returns, UK bond market returns. The period of study is of three years from 1 July 2010 to 1 July 2013. The methodology applied ADF test, Max Eigen value and Cointegration rank (Trace) test. The objective of the study is to analyze volatility in Indian bond returns and factors affecting it. The findings and conclusion suggest that USA bond returns, UK bond returns and BSE returns have positive impact on Indian bond returns.

This study is contributing the existing literature in three ways. First, in contrast to piecemeal approach, this study is taking a wide range of sovereign bond indices of 1-, 2-, 3-, 5-, 10-, 15- and 30 years, categorized into Short term, Medium term and long-term bond indices and macroeconomic variables are classified into monetary, real and fiscal factors. Second in previous studies like Jingzhi Huang and lei Lu (2008), the macroeconomic factors used were monetary and real, but this study is using three categories viz. Monetary, Real and Fiscal factors and more over the macroeconomic variables used in this study are entirely different from those used in Jingzhi Huang and lei Lu (2008). Third they (Jingzhi Huang and lei Lu) have examined the impact of monetary and real factors on the volatilities of bond returns by using regression analysis. But this study is evaluating the volatility behavior of sovereign bond yields of India and impact of monetary, real and fiscal factors on their yield volatility by applying GARCH (1, 1) model. This model was applied to know whether sovereign bond yields of India are volatile or not, if yes whether volatility is due to inner shocks or external shocks.

The main objective of this study is to investigate the volatility behavior of sovereign bond yields in India and impact of Monetary, Real and Fiscal factors on their yield volatility.

3. DATA AND METHODOLOGY

The frequency of data used in the study is monthly and comprised of sovereign bond yields of 1-, 2-, 3-, 5-, 10-, 15- and 30 years as dependent variables and macroeconomic variables viz. interest rate, exchange rate, oil price under monetary variables, gross domestic product, index of industrial product and consumer price index under real variables and deficit finance and domestic debt under fiscal variables of India covering a sample period of 17 years from 2000 to 2016, comprising of 204 observations of each variable. Monthly data has been used because in case of GDP, deficit finance and domestic debt higher frequency data like weekly, daily is not available. So the researcher used monthly data of all variables in order to bring uniformity in data set. The data related to sovereign bond yields were collected from Bombay stock exchange and macroeconomic variables were collected from Reserve bank of India and bloom berg data base. The excess yields of sovereign bonds are calculated by using over and above average of sovereign bond yields. The model applied is GARCH (1, 1), the reason of applying GARCH (1,1) model, because GARCH (1, 1) includes both ARCH and GARCH terms, which shows the both volatility and yield effects respectively. In other words it indicates whether volatility is due to inner shocks or it is caused by external factors.

The results in the table reveals that mean values across all the maturities of sovereign bond yields does not vary significantly and ranges from 6.75 basis points of one year bond yields to 8.72 basis points for two year bond yields. The values of standard deviation also does not vary significantly across all maturities except 30 year bond yields Which indicates that standard deviation 30 year bond yield is very low as compared to short term and medium term sovereign bond yields and ranges 1.057 % for fifteen year bond yields to 1.638 % for three year bond yields. The time series data should be approximately normal for further analysis. The values of skewness and kurtosis across all maturities of sovereign bond yields are within plus-minus one which indicates that data used in the study is approximately normally distributed and can be used for further analysis.

Table-3.1 Exhibits the descriptive statistics of excess of average bond yields

Sovereign bond yields	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std.Error	Statistic	Std.Error
one year	204	6.75	1.390	-.044	.170	-.754	.339
two year	204	8.72	1.638	-.457	.170	-.590	.339
three year	204	7.30	1.334	.308	.170	-.006	.339
five year	204	7.58	1.305	.098	.170	.281	.339
ten year	204	7.81	1.363	.401	.170	.037	.339
fifteen year	204	7.98	1.057	-.027	.170	.357	.339
thirty year	204	8.32	.588	-.068	.170	.579	.339

3.1 Extraction of variables by using Principal Component Analysis

The Principal Component Analysis are used to extract variables which will load maximum information about a particular group of variables as used by Jingzhi Huang and Lei Lu (2008). The Monetary variables viz. interest rate, exchange rate, oil prices, Real activities viz. Gross Domestic Product, Index of Industrial Product and Consumer Price Index and Fiscal variables viz. Deficit finance and Domestic Debt are used as macroeconomic variables. The variables extracted under monetary variables are Interest rate, exchange rate; Gross domestic product and deficit finance each are identified as Real and Fiscal factors respectively.

Table-3.2 Exhibits the variable extracted from various macroeconomic variables under three categories

Categories	Factors extracted	KMO and Bartlett's Test	Sig.	% of Variance extracted
Monetary	Int. rate, exc. rate	.500	.000	83.529
Real	GDP	.500	.000	95.618
Fiscal	Deficit finance	.500	.000	57.771

The table shows the result of Principal component analysis, which reveals that KMO and Bartlett's Test, is equal to 0.5 and are significant in all the three groups, which indicates the adequate sample, has been used in the study. The results further exhibit that monetary variables viz. interest rate and exchange rate accounts 83.529 % of the variance of monetary variables. These two variables load a significant amount of information about the monetary factors and can be used as a proxy to measure the monetary factors. Similarly among Real activities, gross domestic product (GDP) is extracted which accounts for 95.618 % of the variance of real activities and is loading maximum information, hence it can be used as proxy of real activities. In the same way in fiscal variables, deficit finance is extracted which accounts 57.77% of the variance of fiscal factors and loads significant amount of information and hence it can be used as a proxy of fiscal variables.

Table-3.3 Exhibits Stationarity of Sovereign bond yields over the excess of average yields of sovereign bond yields

Variable	ADF Test		PP Test		KP- SS Test	
	Level	1st diff.	Level	1st diff.	level	1st diff.
01 year	0.0360	0.0000	0.0228	0.0000	0.789652	0.758147
02 year	0.6544	0.0000	0.6044	0.0000	0.739134	0.714790
03 year	0.1954	0.0000	0.1954	0.0000	0.235149	0.123169
05 year	0.1411	0.0000	0.1097	0.0000	0.218709	0.174235
10 year	0.1407	0.0000	0.1167	0.0000	0.160067	0.175213
15 year	0.0360	0.0000	0.0228	0.0000	0.220770	0.089344
30 year	0.0005	0.0000	0.0036	0.0000	0.159165	0.084663
Int. rate	0.7483	0.0000	0.8112	0.0000	0.367713	0.199650
Exc. rate	0.9635	0.0000	0.9770	0.0000	0.130429	0.107679
GDP	0.9446	0.0000	0.9889	0.0000	0.502967	0.242636
Def. finance	0.7066	0.0000	0.7000	0.0000	0.670669	0.151738

The table exhibits that all the variables are not stationary or having unit root at level except 1-, 15- and 30 year bond yields in both tests i.e. Augmented Dickey Fuller test, Phillips Perron tests but after converting them into first difference the whole data set becomes stationary in ADF and PP test, but the results in Kwiatkowski-Phillips-Schmidt-Shin test are in contrary to the former two tests i.e. Augmented Dickey Fuller test, Phillips Perron tests. This also signifies that the data set used in the study is valid for using further analysis. So the researcher has used the data only after converting the variables into first difference. Here it is important to mention that only those variables are converted into first differences which are not stationary at level.

Hypothesis

1. **H0**: there is no volatility in sovereign bond yields of India.
2. **H0**: Monetary, Real and Fiscal do not have any impact on their yield volatility.

4. ANALYSIS AND GRAPHICAL REPRESENTATION

Table-4.1 Exhibits the results of GARCH (1, 1) model

Maturity	Short term sovereign bond yields			
	One-year sovereign bond yield		Two-year sovereign bond yield	
Variables	Coefficient	(P. Value)	Coefficient	(P. Value)
ARCH (1)	0.149077	0.0000	0.104184	0.0000
GARCH (1)	0.596927	0.0000	0.467357	0.0000
Exchange rate	-0.133582	0.0000	0.129101	0.0022
Interest rate	-7.35E-05	0.0000	-0.161773	0.0000
GDP	-6.67E-05	0.0000	-0.252735	0.0000
Deficit finance	-0.001256	0.4513	0.001749	0.9697

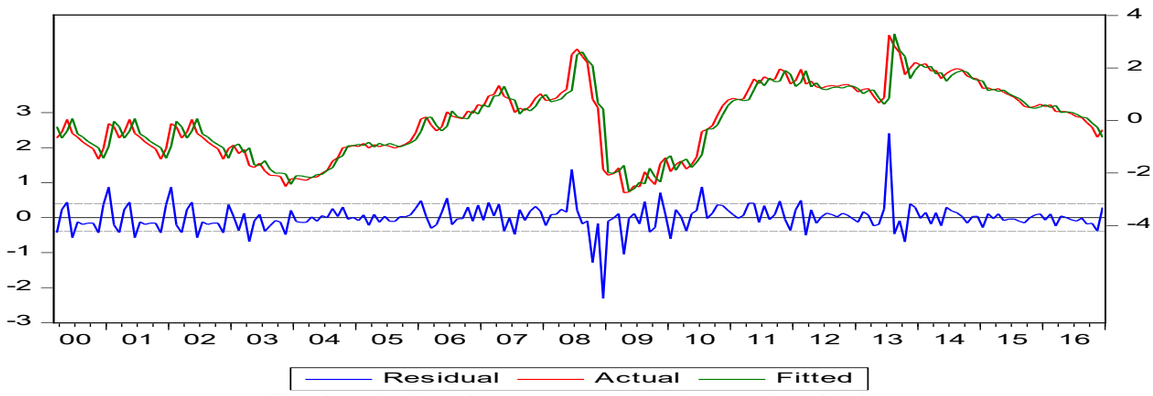

Fig. 4.1 volatility of one-year sovereign bond yields of India

The graph of one year sovereign bond yields shows three lines of three different colours, Blue colour indicates yields over and above average yields and their volatility, red colour lines shows actual yields and green colour line shows fitted line. The residuals or blue line infers that there is prolonged low volatility during entire study period. The volatility increases in 2008 due to global financial crises and its impact on Indian economy and higher inflation rate in India in 2013-14. From the graph one can infer that sovereign bond yield in India are also impacted by global shocks

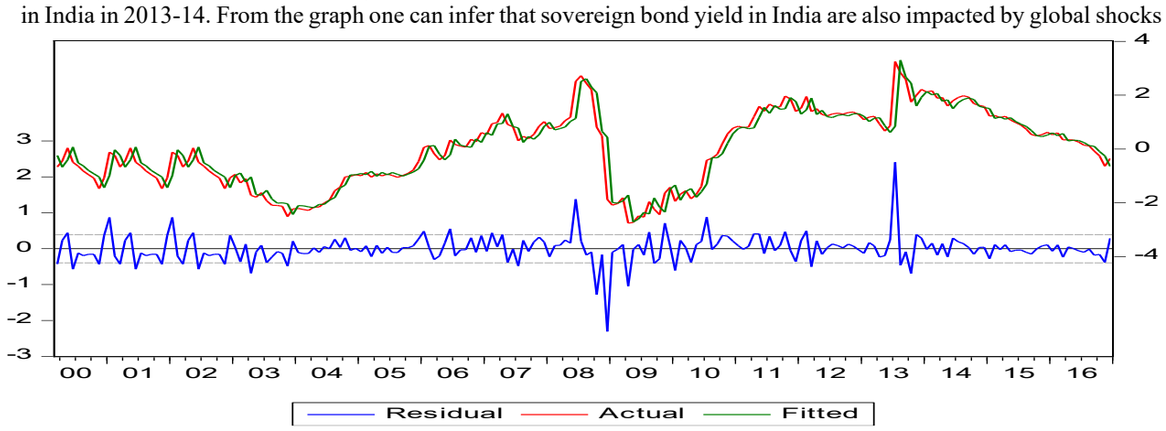

Fig. 4.2 Volatility of two-year sovereign bond yields of India

The graph of two year bond yield of India shows that there is volatility throughout study period. The volatility enhances during 2008 due to financial crises and 2013- 14 due to higher rate of inflation rate in India. Both the graphs of short term bond yields i.e. one year and two year resembles with each other because macroeconomic variables viz. monetary variables are equally impacting the short term bond yields in India.

Table-4.2 Medium term sovereign bond yields

Maturity	Medium term sovereign bond yields			
	Three year bond yields		Five year bond yields	
Variables	Coefficient	(P. Value)	Coefficient	(P.value)
ARCH (1)	0.259361	0.0000	0.206825	0.0000
GARCH (1)	0.560424	0.0000	0.662544	0.0000
Exchange rate	0.355348	0.0000	0.232407	0.0000
Interest rate	-0.033271	0.0004	0.212643	0.0000
GDP	-7.84E-06	0.0055	-4.65E-06	0.0011
Deficit finance	-0.010107	0.7828	-0.002107	0.4198

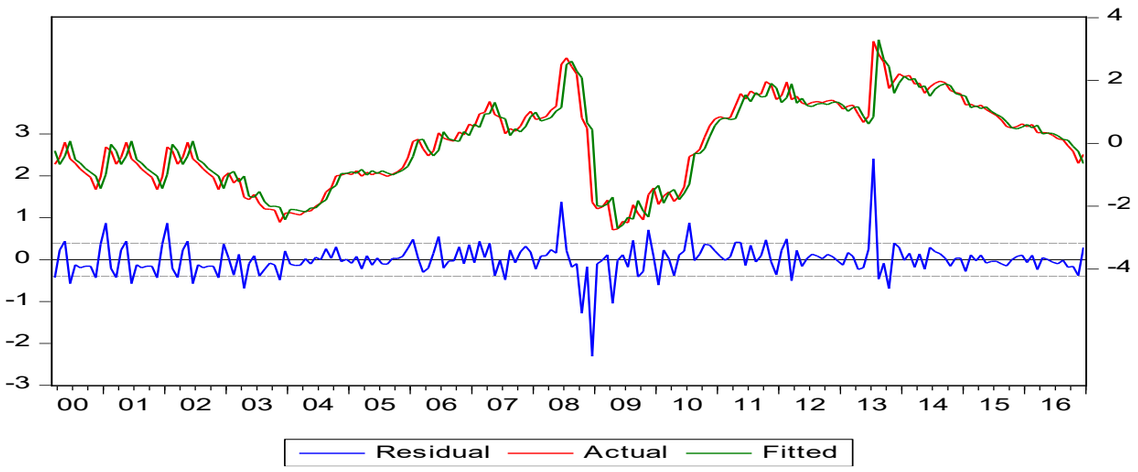

Fig. 4.3 Volatility of three-year sovereign bond yields of India

The graph of three-year bond yield of India shows that there is volatility throughout study period. The volatility increases during 2008 due to financial crises and 2013- 14 due to higher inflation rate in India. The graphs of three year bond yields resembles with short term bond yields because macroeconomic variables viz. monetary factors are equally impacting the short term and medium term sovereign bond yields.

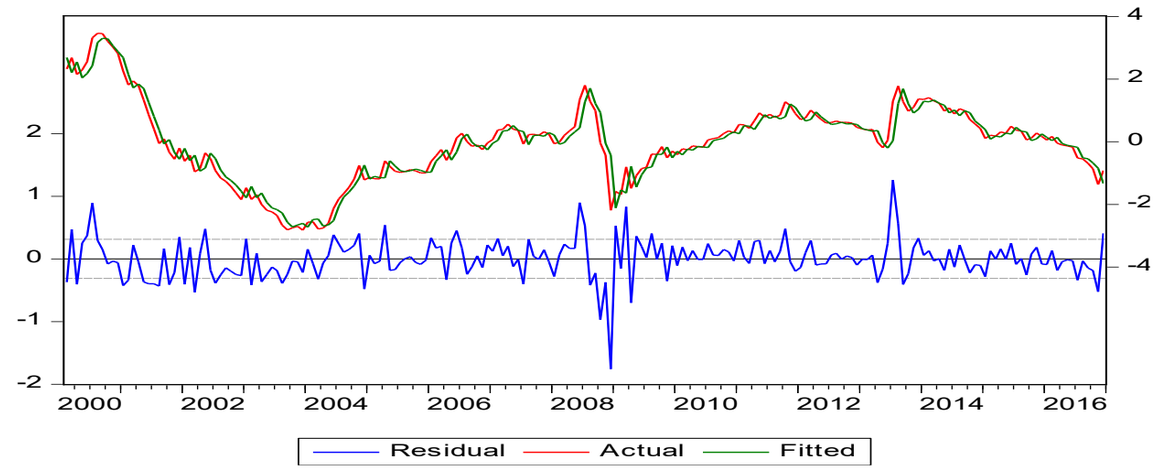

Fig. 4.4 Volatility of five-year sovereign bond yields of India

The graph of five year sovereign bond yields is showing prolonged low volatility during entire study period. The graph of short term and medium term sovereign bond yields resembles with each other, because monetary policies and real activities are impacting both the short term and medium term sovereign bond yields. The graphs clearly conveys whenever there is change in monetary policies or real activities. It equally impact short term and medium term sovereign bond yields.

Table-4.3 Long term sovereign bond yields

Maturity	**Long term sovereign bond yields**					
	10-year bond yields		**15-year bond yields**		**30-year bond yields**	
Variables	**Coefficient**	**(P.value)**	**Coefficient**	**(P.value)**	**Coefficient**	**(P.value)**
ARCH (1)	0.230090	0.0000	0.146569	0.0000	0.149766	0.0000
GARCH (1)	0.643363	0.0000	0.579919	0.0000	0.598418	0.0000
Exchange rate	0.002107	0.1851	0.046411	0.2184	0.031515	0.3361
Interest rate	0.014683	0.6608	-0.056145	0.4320	-0.064005	0.9993
GDP	-3.53E-06	0.0314	-1.44E-05	0.0002	-2.32E-05	0.0087
Def. finance	-1.58E-07	0.0058	-4.88E-07	0.0047	-8.80E-07	0.0042

The results in the above table exhibits that the sovereign bond yields of India are volatile during entire study period. The coefficients and corresponding p values of GARCH (1, 1) model are highly significant. This indicates that sovereign bond yields are volatile and volatility is due to their inner shocks. I.e. ARCH effect and GARCH effect. In other words, volatility of previous month yields affects the volatility of current month yields and yields of previous month affect the yields of current months, which together is known as inner shocks. So we can reject null hypothesis rather we accept research hypothesis, means that there is volatility in sovereign bond yields across all maturities in India. Meanwhile "Monetary", "Real" and "Fiscal" factors have different impacts on the volatility of sovereign bond yields of India. Because Monetary factors influence volatility of short term (1-, 2 year) and medium term (3-, 5 year) sovereign bond yields. Real factors influence the volatility of bond yields across all maturities. But fiscal factors affect volatility of only long term (10-, 15- and 30 year) sovereign bond yields. Our results are in consonance with existing studies of Jingzhi Huang & Lei Lu (2008), Goeij and Marquering (2006). The implication of the above analysis is that the Reserve Bank of India can use monetary variables like interest rate, exchange rate and other monetary variables or policies to stabilize the short term and medium-term sovereign bond yields in India. Similarly, policy makers in India can real activities like GDP and other real activities to stabilize sovereign bond yields across all maturities in India and in the same way policy makers can use fiscal variables or policies to stabilize the long-term sovereign bond yields in India. Our results and findings are extending and contributing the existed literature in two ways. First we found that not only monetary and real factors but also fiscal factors can be used to stabilize the sovereign bond yields

especially long term sovereign bond yields in India. Second we found that macroeconomic variables or monetary variables, real activities and fiscal variables or policies are no way different from developed economies, because macroeconomic variables are showing similar impact on sovereign bond yields in India as they show impact on sovereign bond yields in developed economies like US and other European economies.

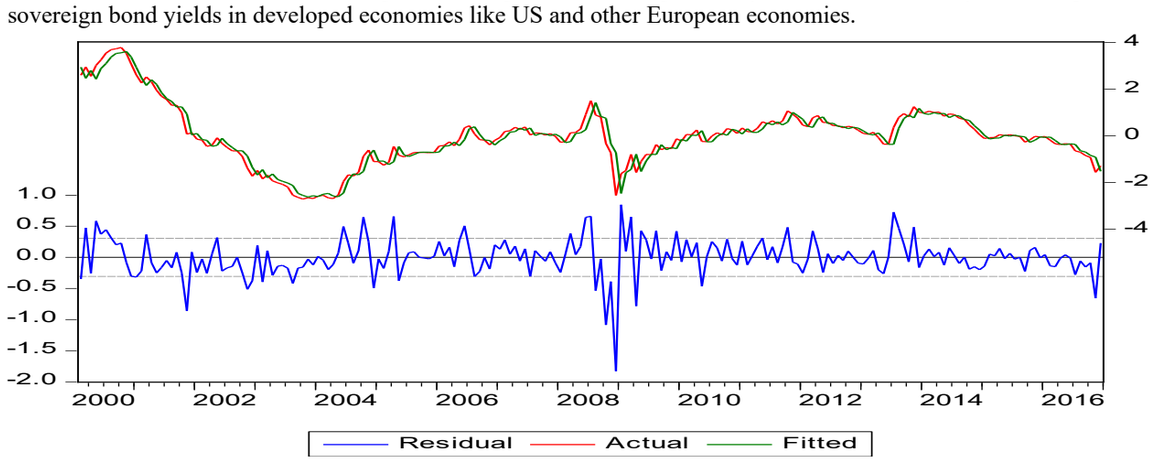

Fig. 4.5 Volatility of ten-year sovereign bond yields of India

The graph of ten year sovereign bond yield shows that there is prolonged low volatility during entire study period; the graph clears shows that there is high volatility only during 2008, due to financial and 2013-14, there is less variation in volatility long term sovereign bond yield in 2013-14. These variations may be due to rate of GDP and graph clearly indicates that monetary factors do not impact volatility of long term sovereign bond yields.

Fig. 4.6 Volatility of Fifteen-year sovereign bond yields of India

The graph of fifteen-year sovereign bond yields shows that there is prolonged low volatility during entire study period; the graph clears shows that there is high volatility only during 2008, due to financial and 2013-14, there is less variation in volatility long term sovereign bond yield in 2013-14. These variations may be due to rate of GDP and graph clearly indicates that monetary factors do not impact volatility of long term sovereign bond yields.

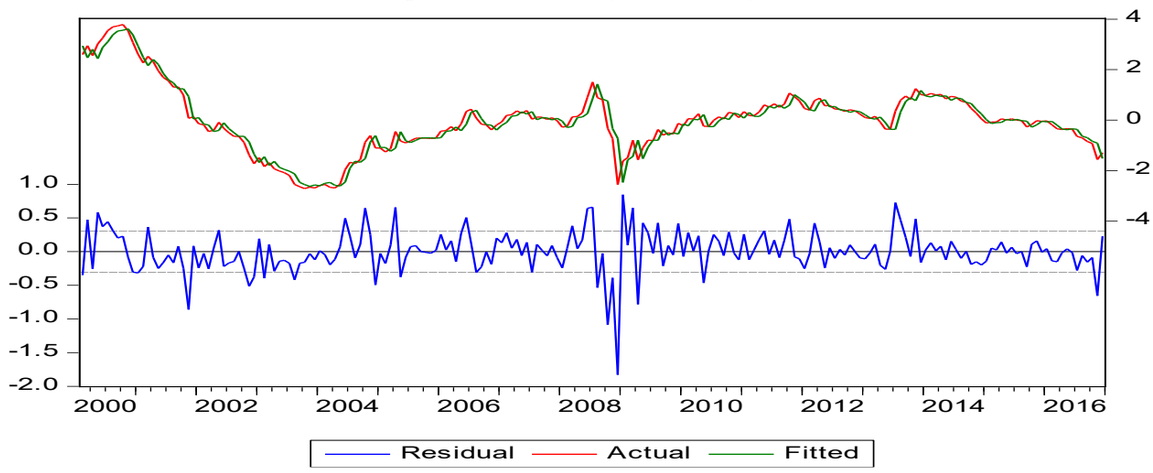

Fig. 4.7 Volatility of Thirty-year sovereign bond yields of India

The graphs of long term sovereign bond yields viz. ten year, fifteen year and 30 year bond yields resembles with each other and indicates that volatility of long term sovereign bond are influenced by fiscal factors. Because in 2008 there were financial crises due to which the gap in fiscal deficit might have widened**.** This has affected the volatility of long term bond in India.

CONCLUSION AND FINDINGS

This study investigated volatility behavior of sovereign bond yields of India and the impact of macroeconomic variables on their yield volatility. Sovereign bond yields are divided into three categories based on their maturity, short term (1-, 2 year), medium term (3-, 5 year) and long term (10-, 15-, and 30 year) and macroeconomic variables are classified into three groups' viz. Monetary, Real and Fiscal factors. The study found that sovereign bond yields in India are volatile, and this volatility is due to their inner shocks as well as external shocks caused by macroeconomic

variables. The study also found that macroeconomic variables impact volatility of sovereign bond yields differently, based on their maturity. Monetary factors impact the volatility of short term (1-, 2 year) and medium term (3-, 5 year) sovereign bond yields, Real factors impact the volatility of bond yields across all maturities. But fiscal factors effects volatility of only long term (10-, 15- and 30 year) sovereign bond yields of India. The implications of this study are that monetary policies can be used to stabilize the yield fluctuations of short term and medium-term sovereign bonds, Real activities can be used to stabilize the fluctuation across all maturities of sovereign bond yields and Fiscal policies can be used to stabilize the fluctuations of long-term sovereign bond yields in India.

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