ISSN Number: 2454-2024(Online)

International Journal of Technical Research & Science

# INTERNAL AND EXTERNAL SHOCKS IN SOVEREIGN BOND YIELDS OF INDIA AND CHINA: EVIDENCE FROM GARCH (1, 1) MODEL

**Shariq Ahmad Bhat, Singh Ashwini Shivkumar**
**Department of Commerce, Pondicherry University, Pondicherry, India**
**E-Mail Id: bhatshariq01@gmail.com, ashsingh5896@gmail.com**

**Abstract-** This study examined Internal & external shocks in sovereign bond yields of India & China with the help of GARCH (1 1) model and its different variants over a period of 17 years from January 2006 to December 2022 and the frequency data is monthly. The volatility of sovereign bond yields of India and China was examined by applying different variants of ARCH family, such as ARCH, GARCH (1, 1), E-GARCH and T-GARCH. The results show that sovereign bond yields were volatile and this volatility was due to their internal shocks as well as external shocks. However, the impact of external shocks varies with the maturity of sovereign bond yields in both countries. The monetary variables affect the volatility of short term and medium term, fiscal variables affect the volatility of long term and real variables affect the volatility across all maturities of sovereign bond yields of India and China.

**Keywords:** Internal & external shocks, sovereign bond yields, volatility, India & China.

## 1. INTRODUCTION

The capital markets were exhibiting substantial movements due to the fluctuations in macroeconomic variables; all financial asset prices appear volatile. These facts were studied vigorously and are being under scrutiny to examine the reasons behind these dramatic changes in financial asset prices like *"LeRoy and Porter, (1981); Shiller, (1981); Zhong et al., (2003)"* have different opinions about the reasons for volatility. According to one school of thought, the movements of markets are caused entirely by the information provided to it. They tried to explain the above phenomenon by putting forth the theories and tried to predict the future variations of financial asset prices based on these theories. The reasons they were giving to prove their theories are, efficient market hypothesis holds that it is information that affect the prices of financial assets. They also said that the volatility of financial market fluctuates due to the arrival of new information in the market. The other school of thought has argued that volatility is entirely based on investor's reactions, according to their social, political, and psychological beliefs. They also argue that volatility has nothing to do with external information provided to market. The issue of volatility in the yields of both stock as well as bonds have enticed a considerable attention in the recent past. This enormous attention has mainly emanated for it being used as a measure of uncertainty or risk. In addition to this, volatility has crucial implications for the process of predicting and forecasting stock and bond yields. There were several episodes of market turbulence in past, which caused extreme fluctuations in bond yields and increased worries of policy makers, investors, portfolio managers, traders etc. These episodes of higher fluctuations raised questions whether markets have become too much powerful or due to some other forces that led the occurrence of such higher fluctuations.

However, there were enormous studies conducted on volatility of stock markets as well as bond markets, but still very little is known about the driving forces behind these higher fluctuations and volatility. Therefore, the current study focuses on the internal and external shocks in sovereign bond yields across different maturities of India and China with respect to the impact of macroeconomic variables on their shocks (volatility).

## 2. REVIEW OF LITERATURE

The following paragraph discuss about the studies related to the bond market and its volatility conducted in different bond markets at global level.

*Charles M. Jones et al. (1998)* investigated the Treasury bond yields of US and their reactions to the release of macroeconomic news or their announcements. The sample period of the study was taken from 1979 to 1995 covering a period of 16 years. The daily returns of 5-, 10-, and 30 years were taken over the excess of three months Treasury bill yields. The main objective of the study was to investigate whether this non-auto correlated announcements of employment rate and producer price index give rise to auto correlated volatilities of treasury yields of US.

The model applied in this study was ARCH, GARCH (1, 1) and OLS models given by *Engle(1982).*The study found that US quarterly inflation has auto correlated volatility. The main reason why they have taken employment rate and producer price index as independent variables because they were independently released on periodic, preannounced dates and they are not clustered in time and most important they were known to be the cause of substantial volatility of bond markets**.** *McQueen and Roley (1993); Ederington and Lee (1993)* they suggested that the fact bond yields or asset prices, which respond all news announcements of producer price

index, and employment rate were evidenced against strong form of market efficiency. They further concluded that if markets will reflect entire private information then the announcements made by government would not act as news at all. The major findings were that shocks to volatility that occurs due to announcement of news have subsequent impact on daily volatility. They also found that the risk that bond yields bear during announcement days should be compensated with higher expected excess returns. They found that release of information or announcements of news do not generate any auto-correlated volatility that isthe reason why markets or bond yields quickly incorporate announcements or information into prices. Their results were consistent with the findings of *Ederington and Lee (1993)*, which indicates that the volatility during coming days would not be in a position to generate any public or government news shocks.

*Tim Bollerslev et al. (2000)* investigated the impact of macroeconomic announcements on yield volatility of Treasury bond futures contracts of US by using a daily data from 1994 to 1997. The main purpose of their study was to examine the intraday patterns in the volatility of US Treasury bond future contracts. The methodology used in this study is ARCH and GARCH models. The major findings of the study were that out of all announcements only the employment report, the producer price index and Humphrey–Hawkins testimony were affecting the volatility of US Treasury bond returns. 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 and1000 Eastern Standard Time respectively. Volatility reveals U-shaped pattern across all the day. Therefore, it can be claimed that in US, the employment report and producer price index were more sensitive with the US bond market.

*Peter de Goeij & Wessel (2006)* examined the effects of macroeconomic news announcements on conditional volatility of different maturities of 1-, 3-, 5- and 10-year Treasury bond yields of US and two corporate indices. The study period is from January 1982 to September 2004covers a period of 22 years and providing 5682 observations. This study contributed the existed literature by generalizing the GJR specifications in such a way that macroeconomic news announcements were accounted for as given by of *Glosten et al. (1993).* Bond returns were calculated in the same way as calculated by *Jones et al. (1998)* and *Christiansen (2000).* The bond returns used in the study were over the excess of three months risk free returns of Treasury bill. The main purpose of the study was to examine the impact of macroeconomic announcement shocks on conditional volatility of bond returns of US and to examine whether news announcements differ from non-news announcements and to check whether the asymmetric volatility is explained by macroeconomic announcements or not, if yes to what extent, asymmetric volatility is explained by these macroeconomic announcements. They found that market volatility is extended to great extent by pre-announcements of macroeconomic news and raises the conditional bond volatility. They also found that macroeconomic news announcement shocks were lesser persistent than regular macroeconomic news shocks. They also observed that macroeconomic impact volatility of long-term bond returns while as monetary policies announcement impact volatility of short-term bond returns.

*The Bhat, S. A. (2018),* evaluated the informational efficiency of sovereign bond markets of India and China by using Toda & Yamamoto Granger causality. He found that both the markets are informationally inefficient and there is unidirectional causality running from selected macroeconomic variables such as interest rate, exchange rate, gross domestic product and fiscal deficit to sovereign bond yields in India and China.

*The Bhat, S.A. & Dar, Q.F. Decision (2019),* evaluated the volatility persistence of 10-yearsovereign bond yields in India and China. For that purpose, the researcher has evaluated the behaviour of daily yields of 10-year sovereign bonds of India and China during June 2010 to December 2017. Engle and lee (1999)'s component-GARCH model was used to decompose the volatility in permanent and transitory components.

*Simon Sosvilla-Rivero et al. (2012)* they tried to investigate the relationship in the volatility of sovereign bond yields in the European Economic and Monetary Union (EMU). For that purpose, they tried to evaluate the behaviour of daily sovereign bond yields of 11 EMU economies. The objective of the study was to investigate the volatility behaviour of sovereign bond yields in different euro zone countries. In order to achieve the objective they applied Lee(1999) ´s component-GARCH model. They first decomposed the volatility in permanent and transitory components by applying Engel and Lee (1999) component-GARCH model and the results showed that transitory shifts in debt market tends to be lesser significant determinants of bond-yield volatility than volatility to the underlying fundamentals. Secondly, they developed a correlation and causality analysis to found that the existence of two different groups of countries viz. core EMU countries and peripheral EMU countries.

*Belen Nieto et al. (2015)* studied the nexus between the volatility of corporate bond yields andstandard financial macroeconomic indicators. The main objective of the study was to evaluatethe volatility behaviour of corporate bond yields. The methodology used in the study is GARCG-MIDAS model. The major findings reveal 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 tried to investigate the impact of volatility of foreign bond market yields on the volatility of Indian bond yields. The methodology applied ADF test, Max Eigen value and Co-integration rank (Trace) test. The objective of the study is to analyse 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.
It was found that most of the studies have evaluated the impact of macroeconomic news announcements rather than real macroeconomic variables on the volatility of Treasury bond yield in US and other European countries. However, it was found that, there is dearth of literature related to sovereign bond markets of India and China The contribution of the present study to the existing literature can be explained in following points. Firstly, the macroeconomic variables used in the present study are entirely different from existed studies. Secondly, the current study has used real macroeconomic variables rather than their announcements to evaluate internal volatility of sovereign bond yields in India and China and impact of macroeconomic variables on their volatility. Thirdly, the study evaluates the impact of previous period volatility on current period volatility by taking four control variables such as interest rate, exchange rate, GDP and fiscal deficit.
*Antonio Afonso et. al (2014)* this study tried to evaluate the effect of announcements by credit rating agencies such as Moody's, Standard & Poor's, and Fitch, (upgrades and downgrades) on the volatility of equity and bond returns in twenty-one European Union countries. viz. "Austria, Belgium, Bulgaria, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Netherlands, Poland, Portugal, Romania, Spain, Sweden, and United Kingdom".
The remaining portion of the study is organized as follows data and sample description is followed by methodology in the fourth section, followed by empirical analysis in the fifth section. Results and discussions are given in the sixth section followed by comparison and implication in seventh and eight section and finally conclusion is given in ninth section of the study.

## 3. DATA AND SAMPLE DESCRIPTION

The data used in the study is over the excess of average yields of sovereign bonds across different maturities as dependent variables. While four macroeconomic variables such as interest rate, exchange rate, gross domestic product and fiscal deficit are independent variables. The study covers the period of 17 years from January 2005 to December 2021 and the frequency of data is monthly. It has been collected from National stock exchange and Shanghai stock exchange of India and China respectively. The sovereign bond yields are divided into three categories based on their maturity period like short term, medium term and long term. The data of macroeconomic variables was collected from Bloomberg, Reserve Bank of India and International Financial Statistics.

## 4. METHODOLOGY

The econometric model used for the analysis in this study is a GARCH (1, 1) model. The
GARCH (1, 1) model has been applied because it includes both ARCH term and GARCH term. The ARCH term of the GARCH (1, 1) model represents the effect of previous period(here period is month) volatility on current period volatility. Whereas the GARCH term of GARCH (1, 1) represents the effect of previous period yield effect on current period yield.
To examine Internal & external shocks in sovereign bond yields across different maturities in India and China with respect to macroeconomic variables. The methodology followed in the current study is the replication of methodology of prominent empirical studies, like *Forbes and Rigobon(2002), Bekaert, Harvey and Lumsdaine (2002 a, b), Edwards (2000), Aggarwal, Inclan andLeal (1999), Richards (1996), Levine and Zervos (1995).*
Different models have been developed to examine the volatility of asset prices throughout the world. Like *Engle (1982),* has developed an Auto Regressive Conditional Heteroscedasticity (ARCH) model. While, *Bollerslev & Taylor (1986)* developed the model called Generalize Auto Regressive Conditional Heteroscedasticity (GARCH). The models such as ARCH and GARCH and their improved variants such as E-GARCH and T-GARCH etc. are widely used across the world to model the volatility in finance and economics.
Prior to modelling the volatility of time series data of sovereign bond yields and macroeconomic variables in India and China, data needs to be stationary, once the stationarity of data is ascertained, it is followed by ascertaining the Heteroscedasticity. The results of Heteroscedasticity are shown in table no. II for India and China. Since homoscedasticity model cannot be used to examine volatility, therefore the presence or absence of ARCH effect in residual series of sovereign bond yields in India & China can be tested with the help of Lagrange Multiplier (LM) test developed by Engel (1982). In this pursuit, first, the residuals are extracted by applying an autoregressive and moving average (ARMA) test that was used by *Box, G. E., & Pierce, D. A. (1970)* and then same data was used again to examine the presence or absence of ARCH effect at different lags.

### 4.1 GARCH (1, 1) Model

In the GARCH model, the conditional variance is dependent upon its own previous lags. Bollerslev & Taylor first developed the GARCH model in 1986. The mostsimple model specification of the Garch (1, 1) is mentioned below.

$$\sigma^2_t = \alpha_0 + \alpha_1 u^2_{t-1} + \beta \sigma^2_{t-1} \quad \text{..... (3.1)}$$

Where $\sigma^2 t$ is conditional variance which is forecasted by one period ahead from past information; $\alpha 0$ is the constant term; $\alpha_1 u^2 t-1$ (ARCH term), is the news about the volatility from the previous period, measured as lag

of the squared residuals from the mean equation and $\beta\sigma^2 t-1$ (the GARCH term), is the last period forecast variance.

**4.2 Exponential GARCH (EGARCH) Model**

The main limitation of TGARCH model was it is confining parameters to make variance positive. Therefore, in order to overcome this limitation, *Nelson (1991)* developed the E-GARCH model, which has the feature to make the conditionalvariance positive by using logarithm to $\sigma_t^2$ in the specification. The simplest model specification of E-GARCH model is as follows.

$$\log \sigma_t^2 = \omega + \alpha_1 \left\{ \frac{\varepsilon t-1}{\sigma t-1} \sqrt{\frac{2}{\pi}} \right\} + \beta_1 \log \sigma^2{}_{t-1} + \gamma \left[ \frac{\varepsilon 2t-1}{\sigma t-1} \right] \quad \text{..... (3.2)}$$

Where, $\gamma$ is the coefficient of leverage effect and log $\sigma_t^2$ is one period ahead of forecast variance based on past information by using logarithm. Other terms are same as for basic GARCH model. This asymmetric effect is test if $\gamma$ is not equal to Zero, then it can be concluded that past volatility has the impact on future conditional variance, that is called presence of asymmetric effect.

**4.3 Threshold GARCH (T-GARCH) Model**

The limitation of basic GARCH model is that it is not taking into account the leverage effect of an asset price. Therefore, in order to estimate the leverage effect of an asset price of time series data, Glosten et al. (1993) and Zakoian, J. M. (1994) developed T-GARCH model. The simple specification of TGARCH model is mentioned below.

$$\sigma_t^2 = \omega + \alpha_1 \varepsilon^3{}_{t-1} + \gamma d_{t-1} \varepsilon^2{}_{t-1} + \beta_1 \sigma^2{}_{t-1} \text{.....(3.3)}$$

Where, $\gamma$ is the coefficient of leverage term, dt-1 is the dummy variable, dt-1=1, if $\varepsilon$ t-1<0 (bad news) and dt-1 = 0 (good news) have different effects on conditional variance. However, when $\gamma$ is not equal to zero, it can be concluded that the news impact is asymmetric and there is presence of leverage effects. If the effect is existing and $\alpha + \beta + (\gamma/2)$ is <1, then the conditional variance is said to stationary.

## 5. EMPIRICAL ANALYSIS “

Since the data used in the study is time series data, at first instance the stationarity of data is to be evaluated prior to its use for analysis, which is mentioned by *D.N Gujarati (2003).* The data should be stationary. *Granger & Newbold (1974)* again argues that by using nonstationary data, the results of the regression would be spurious and will lead to nonsensical conclusions. Therefore, prior to do any empirical analysis of time series data, it is mandatory for a researcher to check the stationarity of data. The two very important and popular tests to check the stationarity of time series data are Augmented Dickey-Fuller test (ADF) and Philip-Perron (PP) test. The researcher has used the both tests to examine the stationarity of data. The results of both the tests were shown in table no. 1 for India and China.

**Table-5.1 Results of Augmented Dickey-Fuller Test and Phillip-Perron Test of Sovereign Bond Yields over the Excess of Average Yields and Macroeconomic Variables**

| | INDIA | | | | CHINA | | | |
|---|---|---|---|---|---|---|---|---|
| | ADF | | Phillips-Perron | | ADF | | Phillips-Perron | |
| Variable | Level | 1stdiff. | Level | 1stdiff. | Level | 1stdiff. | Level | 1stdiff. |
| 1year bond yields | 0.2565 | 0.0000 | 0.1815 | 0.0000 | 0.0045 | 0.0000 | 0.0244 | 0.0000 |
| 2year bond yields | 0.2750 | 0.0000 | 0.1993 | 0.0000 | 0.0143 | 0.0000 | 0.0381 | 0.0000 |
| 3year bond yields | 0.1954 | 0.0000 | 0.1834 | 0.0000 | 0.0120 | 0.0000 | 0.0193 | 0.0000 |
| 5year bond yields | 0.1411 | 0.0000 | 0.1097 | 0.0000 | 0.0018 | 0.0000 | 0.0168 | 0.0000 |
| 10year bond yields | 0.1407 | 0.0000 | 0.1167 | 0.0000 | 0.0069 | 0.0000 | 0.0185 | 0.0000 |
| 15year bond yields | 0.1228 | 0.0000 | 0.1360 | 0.0000 | 0.0106 | 0.0000 | 0.0039 | 0.0000 |
| 30year bond yields | 0.1015 | 0.0000 | 0.07036 | 0.0000 | 0.0470 | 0.0000 | 0.0444 | 0.0000 |
| Interestrate | 0.7483 | 0.0000 | 0.8112 | 0.0000 | 0.6330 | 0.0000 | 0.5672 | 0.0000 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| Exchangerate | 0.9143 | 0.0000 | 0.9770 | 0.0000 | 0.5498 | 0.0000 | 0.6314 | 0.0000 |
| GDP | 0.9446 | 0.0049 | 0.9889 | 0.0098 | 0.0199 | 0.0000 | 0.0400 | 0.0000 |
| FiscalDeficit | 0.7066 | 0.0000 | 0.6750 | 0.0000 | 0.8556 | 0.0000 | 0.5498 | 0.0000 |

This table provides results of Augmented Dickey-Fuller Test and Phillip-Perron Test of Sovereign Bond Yields over the excess of average yields and Macroeconomic Variables of India and China.

Theresultrevealsthatmostofthevariablesarehavingunitrootatlevel.However, at first difference all the variables become stationary. Therefore, the maximal order of integration of all the variables is I (1).

After satisfying the assumption of stationarity of data, the researcher is required to examine the presence or absence of ARCH effects in the time series data. In order to examine the presence or absence of ARCH effects, the study makes the use of ARCH-LM test and its results are given in the table below.

**Table-5.2 The results of ARCH-LM test of sovereign bond yields of India and China**

| Term to maturity of India | | | | | | | |
|---|---|---|---|---|---|---|---|
| Statistic | 1year | 2year | 3year | 5year | 10year | 15year | 30year |
| Fstatistics (p.value) | 0.446*** (0.000) | 0.680*** (0.000) | 2.363*** (0.000) | 4.571*** (0.000) | 3.651*** (0.000) | 0.197*** (0.000) | 2.106*** (0.000) |
| LMstatistics (P.value) | 0.912*** (0.000) | 0.912*** (0.000) | 4.732*** (0.000) | 8.959*** (0.000) | 7.082*** (0.000) | 0.404*** (0.000) | 4.230*** (0.000) |
| Term to maturity of China | | | | | | | |
| Fstatistics (p.value) | 4.661*** (0.000) | 4.158** (0.0170) | 3.094** (0.047) | 3.946** (0.020) | 7.038*** (0.001) | 4.791** (0.009) | 1.533** (0.019) |
| LMstatistics (P.value) | 9.127*** (0.000) | 8.183** (0.016) | 6.152** (0.046) | 7.781** (0.020) | 13.47*** (0.001) | 9.369** (0.009) | 3.097** (0.019) |

***Note:*,**,***means significant@10%,5%,and1%respectively***

The results had shown in the above II table's presents the Heteroscedasticity test of Lagrange Multiplier (LM) to examine the absence or presence of ARCH effect in residual series of sovereign bond yields over the excess of average yields of India and China. The results in the table clearly show that F statistics and LM statistics are highly significant at one percentage and five-percentage level. The significant value in all cases indicates that there is presence of ARCH effect in both time series data of India and China. Therefore, researcher can examine the volatility behaviour of sovereign bond yields of India and China with respect to the macroeconomic variables by applying different models of GARCH (1,1) model.

The study has made use of the GARCH (1, 1) model, which comprises of both ARCH as well as GARCH terms. The ARCH term helps to evaluate the effect of previous period (month) volatility on current period volatility. Similarly, GARCH term aids in evaluating the effect of previous period yield on current period yield. The presence of both ARCH term and GARCH term are known as internal shocks or internal volatility. In addition to this, it also enables researcher to evaluate the effect of external shocks on the volatility of sovereign bond yields.

**Table-5.3 GARCH (1,1) Model of Sovereign Bond Yields across different Maturities of India**

| Maturity | Short term bond yields | | Medium term bond yields | | Long term bond yields | | |
|---|---|---|---|---|---|---|---|
| Variables | 1 year bond index | 2 year bond index | 3 year bond index | 5year bond index | 10 year bond index | 15 year bond index | 30 year bond index |
| ARCH(1) | 0.149077*** | 0.104184*** | 0.259361*** | 0.206825*** | 0.230090*** | 0.146569*** | 0.149766*** |
| GARCH(1) | 0.396927*** | 0.267357*** | 0.360424*** | 0.262544*** | 0.243363*** | 0.279919*** | 0.298418*** |
| Int. rate | 1.155-05*** | 0.161773*** | 0.033271*** | 0.212643** | 0.014683 | 0.056145 | 0.064005 |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| Ex. rate | 0.133582*** | 0.129101*** | 0.155348** | 0.132407*** | 0.002107 | 0.046411 | 0.031515 |
| GDP | 2.172425*** | 0.252735*** | 1.143206** | 1.190523** | 3.235206*** | 1.242545*** | 3.224215** |
| Fis. Deficit. | 0.001256 | 0.001749 | -0.010107 | -0.002107 | 1.283207** | 4.185417** | 8.303427** |
| This table presents the estimated results of GARCH(1,1) model of short, medium term and long term sovereign bond yields of India. The specification of GARCH(1,1 ) model is as follows:$\sigma^2=\alpha0+\alpha1u^2-1+Q\sigma^2-1$,.Where $\sigma^2t$ is conditional variance which is forecasted by one period ahead from past information;α0 is the constant term; $\alpha1u^2t-1$(ARCH term) ,is the news about the volatility from the previous period, measured as lag of the squared residuals from the mean equation and $Q\sigma^2t-1$(the GARCH term),is the last period forecast variance.. | | | | | | | |

***Note:*,**,***means significant@10%,5%,and1%respectively***

**Table-5.4 Results of GARCH (1,1) Model of Sovereign Bond yields across different Maturities of China**

| Maturity | Short term bond yields | | Medium term bond yields | | Long term bond yields | | |
|---|---|---|---|---|---|---|---|
| Variables | 1 year bond index | 2 year bond index | 3 year bond index | 5 year bond index | 10 year bond index | 15 year bond index | 30 year bond index |
| ARCH(1) | 0.238127*** | 0.153133*** | 0.126083*** | 1.292008** | 0.140371** | 0.319019*** | 0.169427*** |
| GARCH(1) | 0.371799*** | 0.359846** | 0.396636** | 0.164148*** | 0.394622*** | 0.236986*** | 0.590326*** |
| Int. rate | 0.231504*** | 0.214726*** | 0.218596*** | 0.197978** | 0.053721 | 0.003665 | 0.002884 |
| Ex. rate | 0.136063*** | 0.126063*** | 0.110741*** | 0.129442*** | 0.021563 | 0.000939 | 0.007758 |
| GDP | 0.122412*** | 0.152242*** | 0.132242** | 0.201571 ** | 0.231481*** | 0.241272*** | 0.012801** |
| Fis. Deficit | 1.45E-05 | 8.42E-05 | 4.36E-05 | 0.000316 | 0.134156*** | 4.134525*** | 2.143525*** |
| This table presents the estimated results of GARCH(1,1) model of short, medium term and long term sovereign bond yields of India. The specification of GARCH(1,1 ) model is as follows:$\sigma^2=\alpha0+\alpha1u^2-1+Q\sigma^2-1$,.Where $\sigma^2t$ is conditional variance which is forecasted by one period ahead from past information;α0 is the constant term; $\alpha1u^2t-1$(ARCH term) ,is the news about the volatility from the previous period, measured as lag of the squared residuals from the mean equation and $Q\sigma^2t-1$(the GARCH term),is the last period forecast variance. | | | | | | | |

***Note:*,**,***means significant@10%,5%,and1%respectively***

The result in the table 5.4 exhibits that the short, medium, and long-term sovereign bond yields of India and China are exhibiting volatile behaviour during entire study period. The corresponding coefficient values of ARCH (1) and GARCH (1) models are significant at one percentage. Which indicates that sovereign bonds are volatile and this volatility of sovereign bonds was due to their internal shocks, because ARCH (1) and GARCH (1) both represents the internal shock or volatility that means previous month volatility as well as previous month yield are both effecting the current month volatility and current month yield of sovereign bonds of India and China. Therefore, we can reject null hypothesis rather accept alternate hypothesis, means previous period volatility has an effect on current period volatility in sovereign bonds across maturities of short term, medium and long term. The results also reveals that external forces such as interest rate, exchange, gross domestic product and fiscal deficit effects the volatility of sovereign bond yields of India and China. However, their effect varies with the maturity period of sovereign bond as well as the category of macroeconomic variables. As monetary variables such as interest rate, exchange rate, affect the volatility of both short and medium term bond yields and shows no sign of effect on long-term sovereign bond volatility. However, real variable such as GDP is affecting volatility of sovereign bonds across all maturities and fiscal variable such as fiscal deficit is affecting the volatility of long-term sovereign bonds only and show no connection with the volatility of either short term or medium term sovereign bond yields of India and China. Therefore, it can be concluded that monetary variables are affecting volatility of short-term and medium bonds only, fiscal variables are affecting volatility of long-term bonds only and real variables are affecting volatility across all maturities of sovereign bonds of India and China.

## 6. EXTERNAL VOLATILITY OR EXTERNAL SHOCK

The results reveals that the volatility of sovereign bonds in both economies are affected by macroeconomic variables categorised into monetary variables consists of interest rate, exchange rate, real variables consists of gross domestic product and fiscal variables consists of fiscal deficit. However, the effect of these macroeconomic variables varies with the maturities of sovereign bonds. Like monetary variables affect the volatility of short term (1-, 2 year), medium term (3-, 5 year) bond indices. Real variables effect the volatility of sovereign bonds across all maturities i.e. short term (1-, 2 year), medium term (3-, 5 year) and long term (10-,

15- 30 year) bond indices and fiscal variables effect only the volatility of long term (10-, 15- 30 year) bond indices. Therefore, it can be conclude that sovereign bonds in two different economies were showing similar behaviour as far as their volatility behaviour is concerned. The findings of this study are consistent with the findings of *Jingzhi Huang and Lei Lu (2011),Ludvigson & Ng (2009), Goeij and Marquering (2006).* They found that sovereign bonds of US were volatile and monetary variables were affecting the volatility of US short term and medium term bonds and real variables were affecting volatility of US bond across all maturities. It is interesting to note that in both sovereign bond markets of India and China the fiscal deficit do not any impact on short term and medium terms sovereign bond yields. Therefore, both sovereign bond markets were exhibiting similar behaviour regarding the volatility of sovereign bonds and effect of external factors on their volatility.

**Table-6.1 Result of E-GARCH and T-GARCH for Sovereign Bond Yields of India and China**

| Variables | E-GARCH | | T-GARCH | |
|---|---|---|---|---|
| | Coefficient | Prob. | Coefficient | Prob. |
| 1 year bond yields | 0.036918 | 0.8301 | 0.126495 | 0.8195 |
| 2 year bond yields | -0.257312 | 0.1485 | 0.323217 | 0.3156 |
| 3 year bond yields | -0.137322 | 0.4902 | 0.226145 | 0.7071 |
| 5 year bond yields | -0.149801 | 0.3444 | 0.215220 | 0.5980 |
| 10 year bond yields | -0.071876 | 0.6454 | 0.191724 | 0.6452 |
| 15 year bond yields | -0.229224 | 0.1523 | 0.570711 | 0.2191 |
| 30 year bond yields | -0.035038 | 0.8463 | 0.169494 | 0.6848 |

"This table presents the estimated results of EGARCH $\sigma_t^2 = \omega + \alpha_1 \varepsilon^3{}_{t-1} + \gamma d_{t-1} \varepsilon^2{}_{t-1} + \beta_1 \sigma^2{}_{t-1}$ and TGARCH $\log \sigma_t^2 = \omega + \alpha_1 \left\{ \frac{\varepsilon t-1}{\sigma t-1} \sqrt{\frac{2}{\pi}} \right\} + \beta_1 \log \sigma^2{}_{t-1} + \gamma \left[ \frac{\varepsilon 2t-1}{\sigma t-1} \right]$ .Where, $\gamma$ is the coefficient of leverage effect and log $\sigma_t^2$ is one period ahead of forecast variance based on past information by using logarithm. Other terms are same as for basic GARCH model. This asymmetric effect is test if $\gamma$ is not equal to Zero, then it can be concluded that past volatility has impact on future conditional variance, that is called presence of asymmetric effect"

And for TGARCH

"Where, $\gamma$ is the coefficient of leverage term, dt-1 is the dummy variable, dt-1=1, if $\varepsilon$ t-1<0 (bad news) and dt-1 = 0 (good news) have different effects on conditional variance. However, when $\gamma$ is not equal to zero, it can be concluded that the news impact is asymmetric and there is presence of leverage effects. If the effect is existing and $\alpha + \beta + (\gamma/2)$ is <1, then the conditional variance is said to stationary."

The results in the table V indicates that coefficients and corresponding prob. values of both E-GARCH and T-GARCH are insignificant, which signifies that there is no leverage effect in sovereign bonds of India & China. The sovereign of bonds of the both countries does not quickly react to any macroeconomic news item or announcement as stock markets does. From above discussion, it clearly indicates that sovereign bonds of India & China takes more time to react to any news item either good or bad news than the stock markets take. The evaluation of leverage effect of sovereign bonds of India & China enables the researcher to convey the message to the risk aversion investors that investment in sovereign bonds of India &China quite safer vis-a-vis any other investments.

## CONCLUSION AND FINDINGS

The study examined Internal & external shocks in sovereign bond yields of India & China with the help of GARCH (1 1) model and its different variants. The volatility of sovereign bond yields in India and China was examined by applying different variant models of ARCH family, such as ARCH, GARCH(1,1),E-GARCH and T-GARCH. The study found that in both India and China, the sovereign bond yields are volatile during the entire study period and the level of volatility is almost similar in both cases because internal volatility or ARCH

and GARCH effect were significant at one percentage and five percentages for sovereign bond yields in both India and China. Similarly, the effect of macroeconomic variables on the volatility of sovereign bonds or external volatility were having same effect on sovereign bonds in both India and China The interest rate, exchange rate and GDP were significant at one percentage in both markets in case of short term and medium term sovereign bonds. Like short term and medium term sovereign bonds, the level of volatility is similar in long term sovereign bonds in both India and China as GDP and fiscal deficit are significant at one and five percentage in both cases which implies that the results are equally true in both India and China.

The study also reveals that macroeconomic variables effects the volatility of sovereign bond yields varies according to the maturity periods. The macroeconomic variables such as interest rate and exchange rate affect the volatility of short-term and medium-term sovereign bond yields. Similarly, macroeconomic variables such as fiscal deficit affect the volatility of long-term sovereign bond yields and it does not have any impact on short term and medium term sovereign bond volatility. Macroeconomic variables such as GDP affect the volatility of sovereign bond yields across all maturities. The study further shows that there is no leverage effect found in both sovereign bond yields of India and China.

The policy makers of India and China can make use of different macroeconomic variables to stabilize the fluctuations or volatility of yields of sovereign bond indices across different maturities. Further, it can be suggested that macroeconomic variables such as interest rate and exchange rate can be used to stabilize short-term and medium-term sovereign bonds yields in both the sovereign bond markets of India and China. However, they cannot be used for long-term sovereign bonds. Whereas macroeconomic variables such as fiscal deficit can be used to stabilize the fluctuations or volatility of long-term sovereign bond yields, and macroeconomic variable such as gross domestic product can be used to stabilize fluctuations across all maturities of sovereign bond yields in India and China.

## REFERENCES

[1] Afonso, A., Gomes, P. &Taamouti, A. (2014). Sovereign credit ratings, market volatility, and financial gains.ComputationalStatistics&DataAnalysis,76,20-33.

[2] Aggarwal, R., Inclan, C., & Leal, R. (1999). Volatility in emerging stock markets. Journal of Bailey, W., Li, H., Mao, C.X., &Zhong, R.(2003).Regulation fair disclosure and earnings information: Market, analyst, and corporate responses. The Journal of Finance, 58(6),2487-2514.

[3] Bekaert, G., Harvey, C.R., &Lumsdaine, R. L. (2002). Dating the integration of world equity markets. Journal of Financial Economics, 65(2),203-247.

[4] Bhat, S. A., & Dar, Q. F. (2019). Behaviour of volatility persistence in 10-year sovereign bond yields of India and China: evidence from component-GARCH model of Engle and Lee (1999). Decision, 46(3), 233-237.

[5] Bhat, S. A. (2018). Informational efficiency of sovereign bond markets of India and China: evidence from Toda and Yamamoto Granger causality (1995). Decision, 45(4), 313-323.

[6] Box, G.E., Pierce, D. A. (1970). Distribution of residual auto correlations in autoregressive-integrated moving average time-series models. Journal of the American statisticalAssociation,65(332),1509-1526

[7] Christiansen, C. (2000). Macroeconomic announcement effects on the covariance structure of government bond returns. Journal of Empirical Finance, 7(5), 479-507

[8] De Goeij, P., & Marquering, W. (2006). Macroeconomic announcements and asymmetric volatility in bond returns. Journal of Banking & Finance, 30(10), 2659-2680.

[9] Ederington, L., Lee, J., 1993. How markets process information: news releases and volatility. Journal of Finance 48, 1161–1191.

[10] Edwards, S., & Susmel, R. (2000). Interest rate volatility and contagion in emerging markets: evidencefromthe1990s (No. w7813). National bureau of economic research.

[11] Engle, R. F., & Bollerslev, T. (1986). Modelling the persistence of conditional variances. Econometric reviews, 5(1),1-50. Engle RF, Lee G (1999) A long run and short-run component model of stock return volatility. In: Engle RF, Lee G (eds) Cointegration, causality, and forecasting: a Festschrift in honour of Clive WJ Granger. Oxford University Press, Oxford, pp 475–497.

[12] Engle, R. F. (1982). Auto regressive conditional heteroscedasticity with estimates of the variance of United Kingdom inflation. Econometrica: Journal of the Econometric Society,987-1007.Financial andQuantitativeAnalysis,34(1),33-55.

[13] Forbes, K. J., & Rigobon, R. (2002). Nocontagion, only interdependence: measuring stock market comovements. The journal of Finance, 57 (5), 2223-2261.

[14] Glosten, Lawrence R., Ravi Jagannathan, and David E. Runkle, 1993, on the relation between the expected value and the volatility of the nominal excess return on stocks, Journal of Finance 48, 1779-1801.

[15] Glosten, L. R., Jagannathan, R., & Runkle, D. E. (1993). On the relation between the expected value and the volatility nominal excess return on stocks. The journal of finance,48(5),1779-1801.

[16] Gómez-Puig, M., Sosvilla-Rivero, S., & Del Carmen Ramos Herrera, M. (2014). Anupdateon EMU sovereign yield spread drivers in times of crisis: A panel data analysis. The North American Journal of

Economics and Finance, 30,133-153.
[17] Granger, C. W., & Newbold, P. (1974). Spurious regressions in econometrics. Journal of econometrics,2(2),111-120.
[18] Gujarati, D. N. 2003, basic Econometrics. NewYork: McGraw Hill Book Co. Huang, J. Z., Lu, L., & Wu, B. (2011). Macro factors and volatility of Treasury bond returns.
[19] Jane, T. D., & Ding, C. G. (2009). On the multivariate EGARCH model. Applied Economics Letters, 16(17), 1757-1761.
[20] Jones Charles M., Owen Lamont and Robin L. Lumsdaine (1998). "Macroeconomic News and Bond Market Volatility" Journal of Financial Economics, 47 (1998), pp.315-337.19
[21] Lee, G. G., & Engle, R. F. (1993). A permanent and transitory component model of stock return volatility. Available at SSRN 5848.
[22] LeRoy, S. F., & Porter, R. D. (1981). The present-value relation: Tests based on implied variance bounds. Econometrica: Journal of the Econometric Society, 555-574.
[23] Levine, R., & Zervos, S. (1995). Stock markets, banks, and economic growth. American economic review,537-558.
[24] Ludvigson, S. C., & Ng, S. (2009). Macro factors in bond risk premia. The Review of Financial Studies, 22(12), 5027-5067.
[25] McQueen, G., & Roley, V. V. (1993). Stock prices, news, and business conditions. The review of financial studies, 6(3), 683-707.
[26] Nieto, B., Novales, A., & Rubio, G. (2015). Macro-economic and Financial Determinants of the Volatility of Corporate Bond Returns. Quarterly Journal of Finance, 5(04),1550021.
[27] Rajavat, Y. S. (2013). Long Term Cointegration of Stocks Traded with Dollar And GBP. International Journal of Research in Management & Social Science,28.
[28] Richards, A. J. (1996). Volatility and predictability in national stock markets: how do emerging and mature markets differ? Staff Papers,43(3), 461-501.
[29] Shiller, R. J. (1981). The use of volatility measures in assessing market efficiency. The Journal of Finance, 36(2), 291-304.
[30] Zakoian, J. M. (1994). Threshold heteroskedastic models. Journal of Economic Dynamics and control, 18(5), 931-955.