Government Bonds and Stock Market : Volatility Spillover Effect

Muhammadriyaj Faniband [1]
Taranum Faniband [2]

Abstract

A new data set of government bond prices, that is, the Clearing Corporation of India Limited's Broad Total Return Index (BTRI) was introduced in this paper. The Total Returns Index (TRI) provides the change due to both the price movements and accrued interest. TRI reflects the change in the index due to market capitalized weighted price movement and accrued interest. This paper investigated volatility spillovers between government bonds and the stock market in India by following the GARCH (1, 1). By using a broad weekly data set during 2004 – 2019, with a total of 835 observations, this paper addressed a key research question : Does the effect of volatility spillover exist between government bonds and Nifty ? Does causality exist between government bonds and Nifty ? The results of Granger causality indicated that BTRI did not Granger cause Nifty. Further, the reverse was also not true, meaning that there existed no lead-lag relationship between BTRI and Nifty. The squared residuals' coefficient of Nifty had a positive sign but was insignificant, showing that there was no effect of volatility spillover from the Nifty to the BTRI. Hence, the volatility in Nifty did not influence volatility in the BTRI but vice versa, this statement is also not true. This research is mainly useful to those investors who invest in both government bond market and stock market.

Keywords : **broad return index, Clearing Corporation of India Limited, government bond prices, India, Nifty, stock market, total return index**

JEL Classification : C1, C58, G11, G12

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The interest in stock and government bonds is not a new phenomenon. A sizable research work is done on the association between stock and bond markets. In security pricing, investment analysis, and risk management, the key variable is volatility. Connolly et al. (2005), Ilmanen (2003), and Nieto et al. (2015) pointed out the correlation between the stock market and government bonds. There is always an inverse relationship between stock and bond prices, that is, if bond prices go up, then the stock price decreases and vice-versa. Consumers tend to buy more commodities when the economy is growing. In such a situation, companies report profit because of increase in demand and investors invest in the stock market to get good returns when they have an idea that the stock market is riskier than the bonds market. On the other hand, consumers spend less when the economy is in a slowdown because of less money in their hands. In this case, corporate earnings decrease because of a fall in the aggregate demand. This is the state when the price of bonds increases as investors would want to invest in a safe place with assured returns. However, this is not the absolute case. There are times when both the bonds and the stock market go up together. This happens when there is too much liquidity

[1] *Assistant Professor (Corresponding Author),* Department of Commerce, Christ Academy Institute for Advanced Studies, Bengaluru- 560 083, Karnataka. (Email : riyajfaniband@gmail.com) ; ORCID iD : 0000-0001-6775-3582
[2] *Independent Researcher,* Bengaluru, Karnataka. (Email : taranumfaniband@gmail.com) ;
ORCID iD : 0000-0001-5117-595X

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or money in the economy. There is also a possibility when both these markets together suffer from a downfall. A good example of the same is the COVID-19 pandemic.

The government bonds are considered to be the backbone of the fixed income securities and also the main source of funding for the government. The government securities markets in a singular manner dominate the transactions in the fixed income market in India. The Indian bond market has gained in an exponential manner and holds the fourth rank concerning outstanding government debt in Asian markets after Japan, China, and South Korea.

Although there is a growing theoretical and empirical literature on the relationship between stock and bond markets, there is no clear answer to several important questions. First of all, no study considers the Clearing Corporation of India Limited (CCIL) Broad Total Return Index (BTRI) for Indian bond markets to study the volatility spillover between government bonds (i.e., CCIL broad and liquid index) and the stock market in India. Therefore, this paper addresses the following unanswered questions. Does the volatility spillover effect exist between government bonds and Nifty ? Does causality exist between government bonds and Nifty ? This paper addresses these issues by identifying whether volatility in stock prices has an impact on the volatility in government bond prices using GARCH (1, 1) model. The causality test is also applied to the data covering the period from January 2004 – December 2019. The empirical results provide no evidence of volatility spillover from the Nifty to the BTRI.

The main contribution of this paper is that this is the first study that uses CCIL's BTRI data for the first time to study the volatility spillover effect between government bonds and the stock market in India to the best of our knowledge.

Review of Literature

Dean et al. (2010) noticed that the return shocks in equity and bond markets cause volatility between bond and equity. McMillan (2020) stated that inflation, stock returns, consumer sentiment, and purchasing managers' index exhibited consistent significance. Ilmanen (2003) asserted that low correlations should prevail between stock market returns and bond markets when inflation rates are low.

The research specifically focusing on government bonds included Akram and Das (2019), who showed that the key driver of the long-term government bond yield is the short-term interest rate in India. Altavilla et al. (2017) found that only one-tenth of the daily variation in bond yields was explained by macroeconomic surprises. Francová (2017) concluded that international arbitrage pricing theory determines the relationship between factors and the price of bonds.

Kumar and Khanna (2018) detected that the Chinese market suffered the greatest fluctuation while the Indian financial market was found to be the most stable market. Chellaswamy et al. (2021b) analyzed the effect of reforms made in stock market on the performance of stock market. Faniband and Karthigai Prakasam (2019) found that differential voting rights shares and ordinary shares did not react equally to the stock market and volatility and economic policy uncertainty of the US and India. Sulistiawan and Rudiawarni (2020) suggested that moving average trading rules can be applied by investors in the Indonesia stock market. Shabarisha and Madegowda (2020) found the existence of information asymmetries in return volatility. Chellaswamy et al. (2020) analyzed the impact of Chinese macroeconomic factors on the Chinese and Indian stock markets. Faniband and Marulkar (2019, 2020) observed that share prices of 30 companies of S&P BSE SENSEX did not get influenced by total income, net profit, and EPS on the date of announcement. Chellaswamy et al. (2021a) focused on the stock market linkages and interdependencies between China and India. Al-Tarawneh and Al-Assaf (2018) and Panwar and Nidugala (2019) studied how the macroeconomic indicators caused the stock market development in India and Jordan, respectively. Aggarwal (2017) concluded that the market mood index and VIX index was positively and negatively related to stock returns, respectively. Brooks and

Ragunathan (2003) confirmed that there were spillovers in both directions from 'A' and 'B' shares in China. However, there was no spillover in volatility from 'A' to 'B' share prices or vice-versa. Lee and Rui (2002) pointed out that trading volume did not Granger-cause stock market returns.

Data and Variables

This paper examines the volatility spillover between government bonds and stock market in India during January 2004 – December 2019. For the analysis, the total number of observations is 835. The log weekly returns of the closing prices of both BTRI and Nifty are used for this research. The BTRI and Nifty index data were collected from CCIL and Yahoo Finance websites, respectively.

For the bond markets, CCIL Broad is the index that serves as performance benchmarks against which the performance of bond markets can be measured. CCIL Broad Index includes the top 20 traded bonds. The Total Returns Index (TRI) provides the change due to both the price movements and accrued interest. TRI reflects the change in the index due to market capitalized weighted price movement and accrued interest.

Methodology

Generalized Autoregressive Conditional Heteroskedasticity [GARCH (1, 1)] Model

The volatility transmission between the government bonds (BTRI) and stock market (Nifty) is tested using the GARCH (1, 1) model. There is a capability that existing volatility in Nifty may cause volatility in BTRI via lead-lag or lag-lead association because of the existence of the causal relationship. The Granger causality test is used to test the causal association between both the markets. Then squared residuals of the return series are produced from the specific volatility procedures, and these are used as a proxy for the shocks in the other market.

$$R_t = \mu + \varepsilon_t \text{; Mean Equation} \quad \text{..... (1)}$$

Here, R_t is the daily return of both the indices at time t, μ is intercept, and ε_t is white noise error term.

$$\sigma^2_t = \gamma + \mu\,\varepsilon^2_{t-1} + \beta\sigma^2_{t-1} + \varphi\in^2_t \text{; Variance Equation} \quad \text{..... (2)}$$

Here, $\gamma > 0$, $\alpha \geq 0$, $\beta \geq 0$. σ^2_t is the conditional variance for the BTRI daily return series. ε^2_{t-1} is the lagged ARCH term and $\beta\sigma^2_{t-1}$ is lagged GARCH term for BTRI. Φ indicates the coefficient of the squared residuals of the Nifty. α is the ARCH parameter and β is the GARCH parameter.

Analysis and Results

The results of BTRI and Nifty are shown in this section. The changes in the closing prices of the BTRI and Nifty are captured in Figure 1. It can be clearly observed that both the indices have moved together with a lot of volatility. Figure 2 and Figure 3 indicate that the BTRI and Nifty weekly return series have a lot of volatility and appear to be stationary. The periods of high volatility continued for a longer period followed by the periods of sustained low volatility, indicating volatility clustering. Though variances are oscillating, both the markets' return series are fluctuating around mean. Figure 4 shows weekly return of BTRI and Nifty together.

Table 1 presents the calculation of summary statistics that helps in understanding the properties of both BTRI and Nifty. The mean value for Nifty is higher compared to the mean value of the BTRI. Therefore, these variables appear to be skewed to the right. The value of skewness has a negative sign, and the kurtosis value is greater than

Figure 1. ***BTRI and Nifty Closing Prices***

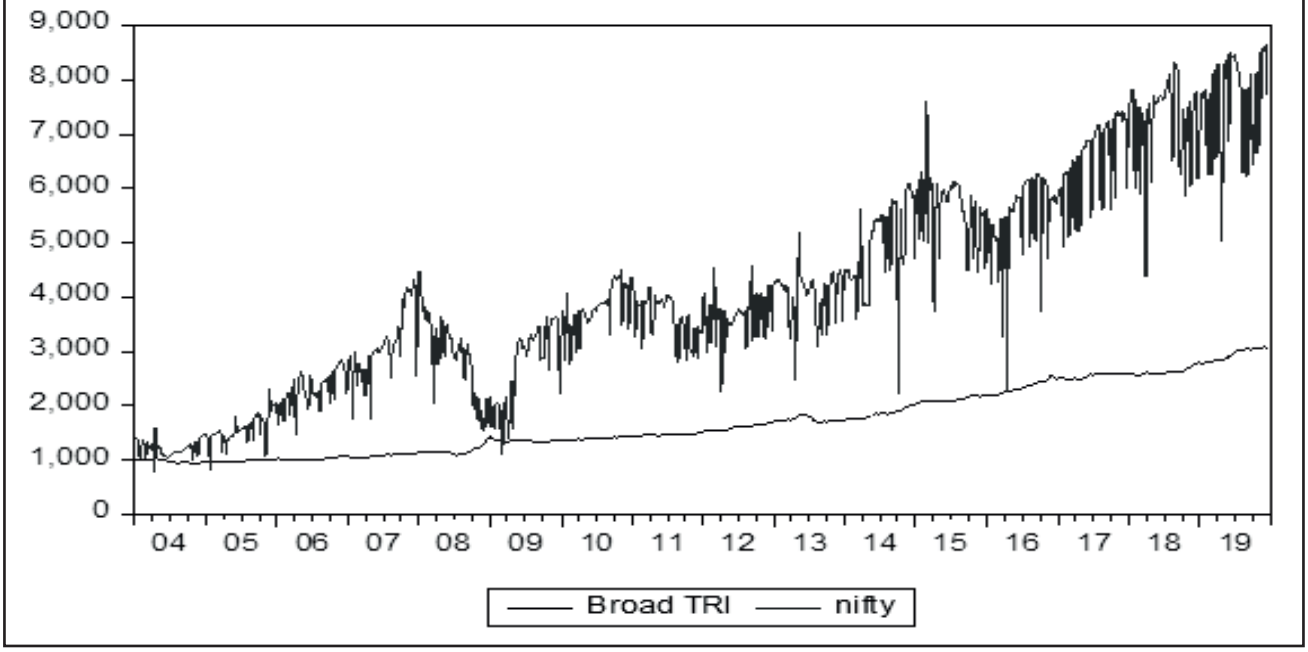
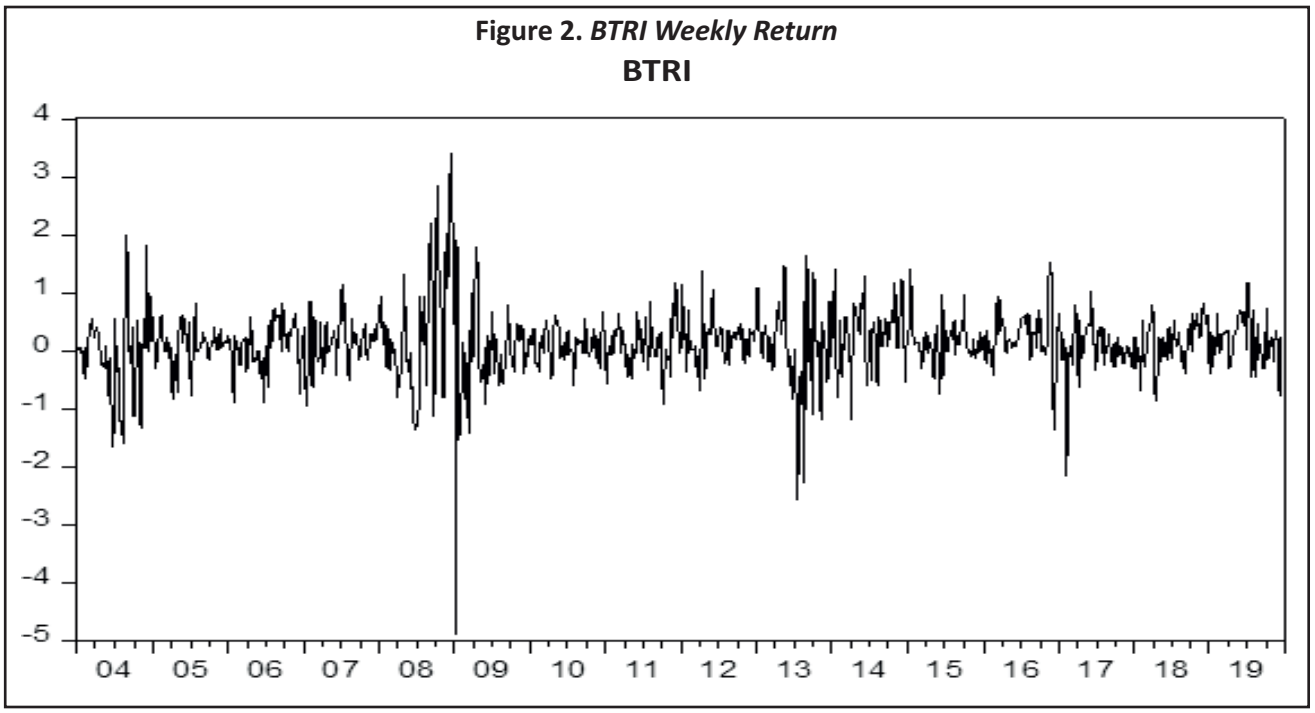


Figure 2. ***BTRI Weekly Return***



the reference value, that is, three for both BTRI and Nifty, indicating that both the return series are not normally distributed. It indicates that the distributions of both the indices are long left tail and leptokurtic. It is observed that both BTRI and Nifty returns are not normally distributed as per the Jarque – Bera test. The Quantile - Quantile plot

Figure 3. ***Nifty Weekly Return***

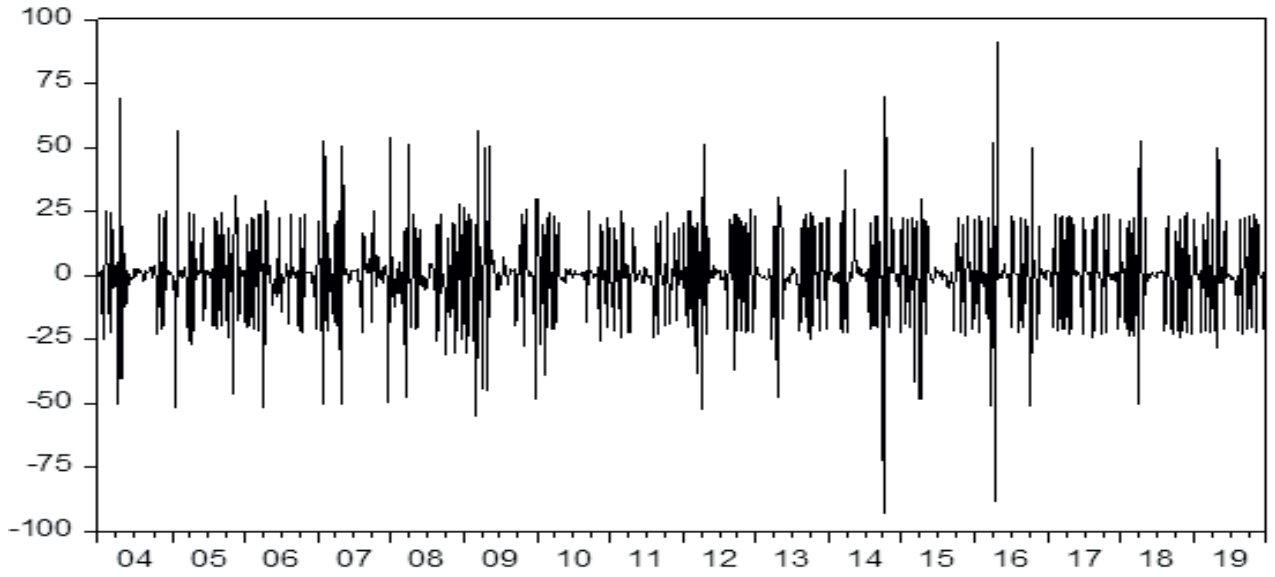
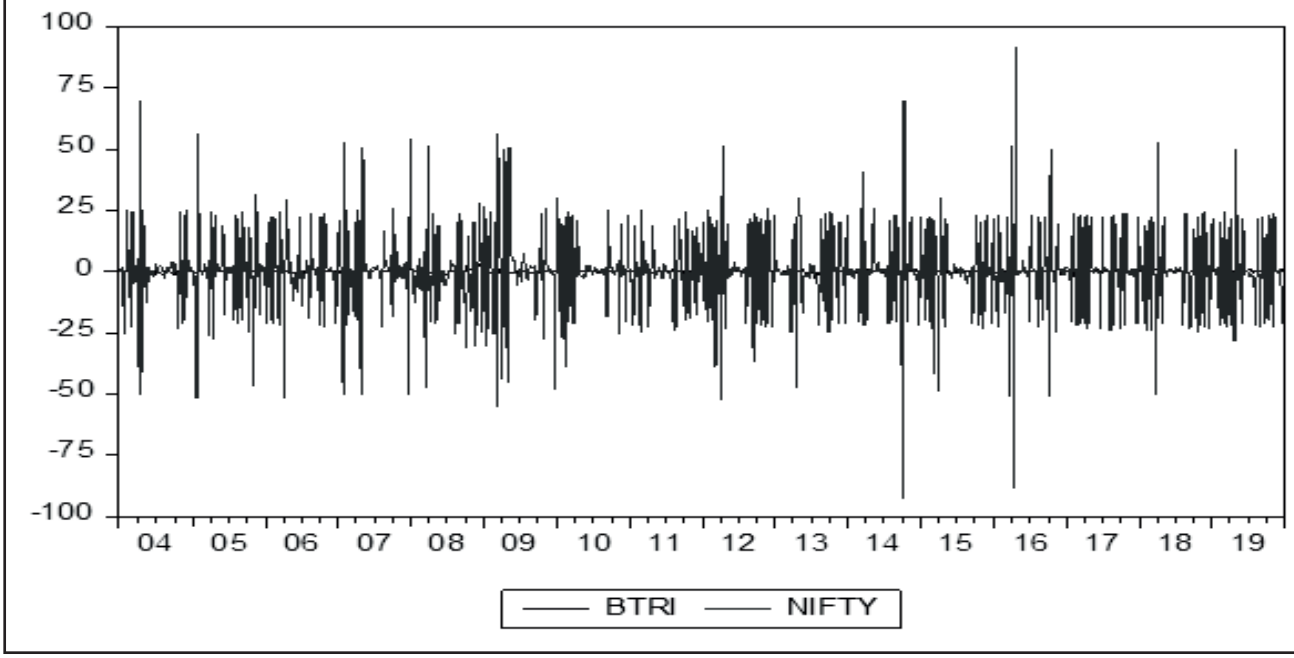


Figure 4. ***BTRI and Nifty Weekly Return Series***



shown in Figure 5 also confirms that both BTRI and Nifty returns are not normally distributed because the thick black lines are not along the straight line but represent an 'S' shape (Adesina, 2013). The results of the unit root test for BTRI and Nifty are shown in Table 2. The results show that both BTRI and Nifty have no unit root.

Figure 5. ***Quantile – Quantile Plot for BTRI and Nifty Return Series***

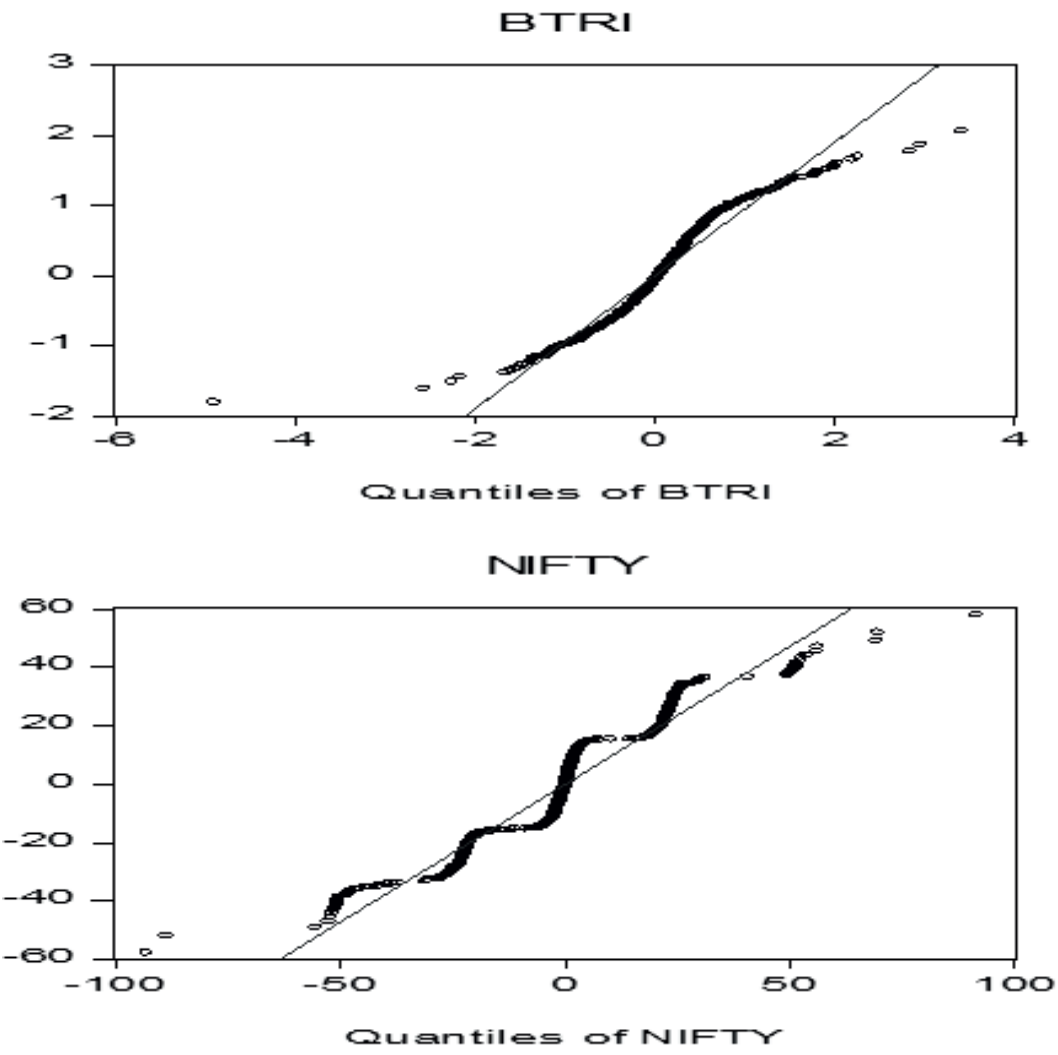


Table 1. ***Descriptive Statistics***

	BTRI Return	Nifty Return
Mean	0.134717	0.178121
Median	0.145460	0.501614
Maximum	3.423185	91.71830
Minimum	–4.897089	–92.92600
Std. Dev.	0.597168	17.85148
Skewness	–0.360454	–0.106757
Kurtosis	12.32785	6.503322
Jarque – Bera	3045.261	428.5935
Observations	835	835

Table 2. ***Unit Root Tests***

Return Series	ADF	PP
BTRI	–15.5622***	–22.6578***
	(0.0000)	(0.0000)
Nifty	–23.8025***	–117.556***
	(0.0001)	(0.0001)

Note. ***, ** indicate level of significance at 1% and 5%, respectively.

Table 3. ***Heteroscedasticity Test – ARCH-LM***

BTRI	*F*-statistic	105.6623	Prob. *F*(1,832)	0.0000
	Obs**R*-squared	93.98087	Prob. Chi-Square(1)	0.0000
Nifty	*F*-statistic	148.8516	Prob. *F*(1,832)	0.0000
	Obs**R*-squared	126.5657	Prob. Chi-Square(1)	0.0000

ARCH Effects - Test Results

The existence of heteroscedasticity in the residuals needs to be tested to analyze the volatility of the return series in the markets. Table 3 shows the results of the Lagrange multiplier test for the residuals. The regression of the conditional mean equation is run to obtain the residuals for BTRI and Nifty. The null hypothesis of no ARCH effects is rejected, meaning that ARCH effects are present for both BTRI and Nifty return series.

Granger - Causality Test

The results of the Granger causality test are summarized in Table 4. Therefore, it is concluded that BTRI does not Granger cause Nifty. Moreover, the reverse is also not true, meaning that there exists no lead-lag relationship between BTRI and Nifty. However, these results are handy as the volatility spillover effect from Nifty to BTRI can be understood for further analysis. This result is not consistent with the findings of Ilmanen (2003), who found that the causality from bond prices to stock prices was positive and vice versa.

To test the volatility spillover effect from the Nifty weekly return to BTRI, the GARCH (1, 1) model is estimated. The results shown in Table 5 indicate that all the coefficients are found to be significant except 'φ'. Figure 6 depicts the correlogram of squared residuals. It can be seen that the GARCH coefficient value is more than the ARCH coefficient, signaling that the volatility in Nifty is affected largely by the previous periods' volatilities than the volatility from the previous periods. Although the sum of the GARCH and ARCH coefficients is less than one but close to one, it specifies that shocks may crumble over some time, but slowly. The coefficient of the squared residuals of Nifty has a positive sign but is insignificant, indicating that there is no volatility spillover from the Nifty to the BTRI. Hence, the volatility in Nifty does not influence volatility in the BTRI but vice versa, this statement is also not true.

Table 4. ***Pairwise Granger Causality Test***

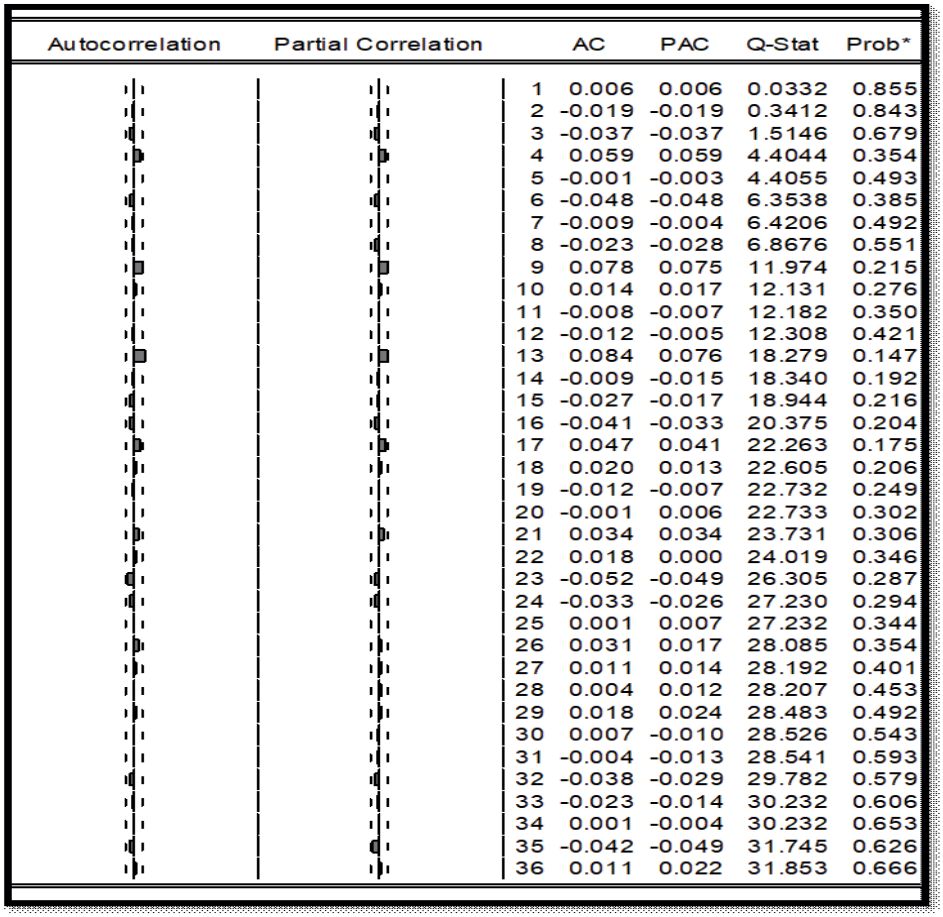
Null Hypothesis :	Obs	*F*-Statistic	Prob.
BTRI does not Granger cause NIFTY.	833	2.47146	0.0851
NIFTY does not Granger cause BTRI.		0.82326	0.4394

Table 5. ***GARCH (1, 1) Results***

Variable	Coefficient	Std. Error	*z*-Statistic	Prob.
μ	0.137951***	0.020789	6.635795	0.0000
AR(1)	0.292991***	0.034103	8.591394	0.0000
		Variance Equation		
γ	0.011814***	0.002341	5.047547	0.0000
α (ARCH Effect)	0.176144***	0.024857	7.086358	0.0000
β (GARCH Effect)	0.785138***	0.022163	35.42518	0.0000
α + β	0.961282			
ϕ (Spillover Effect)	6.28E-06	0.000388	0.016204	0.9871
R-squared	0.071361	Mean dependent var		0.134879
Adjusted *R*-squared	0.069126	*S.D.* dependent var		0.597508
S.E. of regression	0.576487	Akaike info criterion		1.272786
Sum squared resid	276.1722	Schwarz criterion		1.312454
Log likelihood	–523.7517	Hannan–Quinn criter.		1.287995
Durbin–Watson stat	2.117118			
Inverted AR Roots	.29			

Note. ***, ** indicate level of significance at 1% and 5%, respectively.

Figure 6. ***Correlogram of Squared Residuals GARCH (1, 1)***



	AC	PAC	Q-Stat	Prob*
1	0.006	0.006	0.0332	0.855
2	-0.019	-0.019	0.3412	0.843
3	-0.037	-0.037	1.5146	0.679
4	0.059	0.059	4.4044	0.354
5	-0.001	-0.003	4.4055	0.493
6	-0.048	-0.048	6.3538	0.385
7	-0.009	-0.004	6.4206	0.492
8	-0.023	-0.028	6.8676	0.551
9	0.078	0.075	11.974	0.215
10	0.014	0.017	12.131	0.276
11	-0.008	-0.007	12.182	0.350
12	-0.012	-0.005	12.308	0.421
13	0.084	0.076	18.279	0.147
14	-0.009	-0.015	18.340	0.192
15	-0.027	-0.017	18.944	0.216
16	-0.041	-0.033	20.375	0.204
17	0.047	0.041	22.263	0.175
18	0.020	0.013	22.605	0.206
19	-0.012	-0.007	22.732	0.249
20	-0.001	0.006	22.733	0.302
21	0.034	0.034	23.731	0.306
22	0.018	0.000	24.019	0.346
23	-0.052	-0.049	26.305	0.287
24	-0.033	-0.026	27.230	0.294
25	0.001	0.007	27.232	0.344
26	0.031	0.017	28.085	0.354
27	0.011	0.014	28.192	0.401
28	0.004	0.012	28.207	0.453
29	0.018	0.024	28.483	0.492
30	0.007	-0.010	28.526	0.543
31	-0.004	-0.013	28.541	0.593
32	-0.038	-0.029	29.782	0.579
33	-0.023	-0.014	30.232	0.606
34	0.001	-0.004	30.232	0.653
35	-0.042	-0.049	31.745	0.626
36	0.011	0.022	31.853	0.666

Conclusion and Implications

This paper studies the volatility spillover effect between government bonds and stock market in India using the GARCH (1, 1) model. In this study, the following important findings are obtained. First, both the indices have moved together during the study period with a lot of volatility. The periods of high volatility continued for a longer period followed by the periods of sustained low volatility indicating volatility clustering. Second, BTRI does not Granger cause Nifty. There exists no lead-lag relationship between BTRI and Nifty. Third, the volatility in Nifty does not influence volatility in the BTRI, but vice versa, this statement is also not true. This research is mainly useful to those investors who invest in both government bond market and stock market.

Limitations of the Study and Scope for Further Research

This is the first study that uses CCIL BTRI data to find volatility spillover effect between government bond and stock market in India. However, this study can be further extended to the analysis of the volatility spillover between CCIL BTRI and commodity prices. Further research can also be undertaken on CCIL BTRI and crude and gold prices.

Authors' Contribution

The conception or design of the work, analysis and interpretation of the data, drafting and critical revision of the paper were done by Muhammadriyaj Faniband. Taranum Faniband extracted the research articles with high repute and filtered these based on the study design. She also collected the necessary data.

Conflict of Interest

The authors certify that they have no affiliations with or involvement in any organization or entity with any financial interest, or non-financial interest in the subject matter, or materials discussed in this manuscript.

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About the Authors

Muhammadriyaj Faniband holds MPhil and MCom in commerce. He is also pursuing PhD in finance. He has published research papers in reputed Scopus indexed and ABDC listed journals. He is also the reviewer of several journals published by Springer Nature, Wiley, Inderscience, and other reputed publishing houses. He has completed a research project on Avishkar Research Fellowship funded by the University of Pune on behalf of the Governor Office of Maharashtra. The 'Avishkar Research Fellowship' is given to the top two research works across the commerce, management, and law disciplines in Maharashtra state each year. He has interests in the areas of empirical asset pricing, corporate finance, advanced econometrics, and analytics and banking.

Taranum Faniband is a commerce graduate and has completed MCom from Shivaji University, Kolhapur, Maharashtra. She has experience of teaching commerce subjects at the graduate level. She has also participated in national conferences. Her areas of interest include accounting, finance, financial markets, and banking.