Empirical analysis of the effect of bond characteristics on volatility of different bond categories – A study of Indian Bond market

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ABSTRACT
The present paper investigate the probable effect of bond characteristics on bond volatility in Indian context. The research covered the ten years beginning in 2013 and ending in 2022. Bond Grading, Interest rate and term to maturity of bonds are taken as independent variables. The results reveal that term to maturity is the only bond characteristic that has significant impact on the bond volatility. The findings reveal that with 1 percent change in term to maturity of bond, the bond volatility for both secured and unsecured bonds increases. The other two characteristics i.e. interest rate and grading has non-significant impact on the bond volatility in Indian capital market.

Key words: Bond volatility, Bond’s term to maturity, Interest rate, Bond grading, India

Introduction
Researchers, regulators, and practitioners are becoming increasingly concerned about the volatility of government bonds as a result of the outbreak of the sovereign debt crisis that is raging throughout the globe. It would appear that liquidity circumstances play a significant part in the process of estimating and projecting the intraday volatility of equities that are not traded as frequently. A significant amount of attention and interest is currently being directed toward an investigation into how the bond market reacts to the recent instability that has been seen in the financial markets. This inquiry focuses on how the fixed income market responds to the recent instability that has been seen in the financial markets. Investors in the bond market are susceptible to the risk that the issuing company may be unable to fulfil its obligations, which include paying the coupon and refunding the principal amount of the bond. Understanding the complexity of the market for corporate debt, such as the bond volatility and the reasons that are driving it, is therefore vitally necessary. Examples of these complications include the bond volatility and the reasons that are driving it. Investors who are unwilling to take needless risks are more inclined to put their money into well-established businesses that have a track record of making profits at a rate that is relatively constant throughout their existence. Bonds are given their ratings after being assessed by credit rating organisations, who decide whether or not the bonds are creditworthy and based on their findings, the bonds are either rated highly or not rated at all. When it comes to the management of risk, having a solid understanding of bond volatility is far more beneficial than having a solid understanding of any other subject that can be researched. The vast majority of the authors who have made a contribution to the body of information that is now available have investigated the volatility of bonds and drawn
parallels between the volatility of stocks and bonds. To the best of our knowledge, an incredibly limited number of research have been conducted on the topic of monthly volatility of convertible and non-convertible bonds. However, we were unable to find any research that particularly evaluated these factors in relation to the volatility of bond prices. The grade of bonds, the length of the bond, and the interest rate all appear to play a role in the volatility of bonds; however, none of the studies that was discovered focused on these aspects of bonds.

The current study focuses on 52 Indian bonds that were active between 2013 and 2022. In the past, conventional methods for approximating bond profiles included using the bond’s term to maturity, rating, and interest rate as stand-ins. Here’s how the rest of the paper is laid out: Current research on bond volatility is presented in Section 2. In Chapter 3, we spoke about how to set up a study. The examination of the data is described in Section 4. In Section 5, the findings are discussed in detail. This paper’s conclusions and their ramifications are discussed in Section 6.

**Literature Review**

Kim et al. (2021) looked into how different factors, such as interest rate and stock market volatility, and credit ratings, were related to the volatility of the yield spread on corporate bonds. We used the same resources as Kim and Stock (2014) did to compile this information. The research will examine the volatility of yield spreads on corporate bonds using a number of different GARCH methodologies. The research found that when the best-fitting models were used, a few explanatory factors were found to be statistically significant at the 1% level. The relationship between macro-risk factors and the credit spread in India’s debt market was uncovered by Gupta (2021). The term “credit spread” refers to the differential in yields between bonds issued by corporations and those issued by governments of the same maturity. There are a number of elements that have an impact, either directly or indirectly, on the spread. In this particular manuscript, it was discovered that there is a connection between these aspects, and it was also investigated as to which elements are responsible for credit spread. Specifically, the study looks at the relationship between credit spread and interest rates. Market risk variables, such as GDP growth and inflation, as well as liquidity factors, such as the repo rate, are among the metrics that are being taken into consideration. Trinh et al. (2020) conducted research in the developing nation of Vietnam to investigate the connection between fiscal and financial macroeconomic parameters and the variation in the cost of borrowing money for the government through bonds. A sample of government bonds with maturities of one year, three years, and five years was used throughout the collection and analysis of monthly data beginning in July 2006 and continuing through December 2019. The results of this study can be used by those who make policies about the macroeconomy as well as investors to improve their ability to forecast the volatility of bond yields. According to the research conducted by Bauer and Rudebusch (2019), the yield curve is primarily determined by pattern expansion in addition to the equilibrium genuine loan cost. Nevertheless, observational models of the term structure of loan fees assume, in the vast majority of cases, that these fundamentals will continue to be the same. They show that representing time variation in these fundamental run patterns that have been around for quite some time is essential for understanding the components of Treasury yields and forecasting the returns on abundance securities. This is because time variation is
one of the most important factors that affects returns on abundance securities. They present a new exchange-free model that captures the essential role that run patterns have played in determining loan fees for a considerable amount of time now. This role has been essential for quite some time. The model also provides precise out-of-test yield estimates in addition to more recent valuations of the term premium that are more consistent with reality. Kalimipalli and Nayak (2012) used data from the bond market to calculate the correlation between equities volatility and bond liquidity, two factors that affect the spreads on corporations' bonds. Further conditional analysis shows that both distressed bonds and distress regimes are linked to significantly increased impact of volatility and liquidity shocks.

**Research Design**

The main objective is to measure the effect of variables pertaining to the profile of bonds on volatility of fixed income securities i.e. bonds. The current study utilised data from fifty-two different companies for its primary source material. The research covered the eleven years beginning in 2013 and ending in 2022. The data has been extracted from the BSE-listed companies.

**Sample Selection and Data Collection**

In order to increase the level of confidence that may be placed in the findings of the study, the years 2013-2022 were selected as the time period to be analysed. The Capitaline database was consulted in order to acquire this information. To be fair, the primary reason we are looking at numbers from that year is because the financial crisis that started in 2008 is the reason, we are looking at them. The remaining companies were divided into two groups: those that did not have a consistent pattern in their financial statements and those that did. Because of this, the information will cover all that can be found in the cosmos. After considering all of these restrictions, the data from fifty two companies was considered.

**Dependent variables**

Bond volatility has been chosen as dependent variable. In this particular study, the conditional volatility and the unconditional volatility were both considered to be dependent variables. The volatility of a random variable is said to be conditional when additional information is taken into consideration. Unconditional volatility, on the other hand, refers to the overall volatility of a random variable when there is no additional information to take into account. In contrast, the volatility of a random variable is said to be unconditional if and only if it demonstrates this level of volatility when no other information is present.

**Independent variables**

Grading of bond is considered to be the key independent variable. The grades are given to a bond by a rating administration that shows its credit quality. The various grades have been assigned to various categories of bonds by the rating agencies: AAA, AA, BBB, BB, B, CCC, CC, C and D. Term to maturity of bond is expressed in the form of the number of years and measures a bond’s sensitivity to change the interest rates.

\[
D = \frac{\sum_{t=1}^{n} \frac{\text{CF}_t}{(1+r)^t}}{P_B}
\]

Where

- \(P_B\) = Bond Price
- \(\text{CF}\) = Cash flow
- \(r\) = Rate of interest
- \(t\) = Time period till maturity

The interest rate paid on a bond by the bond's guarantor over the course of its tenure is known as the interest rate. Interest rates on bonds are established at the time of issuance and never change; bondholders receive interest payments at regular intervals.
Statistical Model
The GARCH model was used to examine the conditional volatility. It is popularly used for modelling and forecasting time series data in measuring volatility, stock prices etc. (Bai & Lam, 2019). The GARCH Model (Generalized Autoregressive Conditional Heteroskedasticity) is the one that is used to measure the volatility of bond prices. GARCH is a statistical model developed by Erdem et al. in 2005 that has multiple applications in the research of economic and financial time series data (Arabi, 2009).

\[ \sigma_t^2 = \sum_{i=1}^{\alpha_1} \gamma^2_{i-1} + \sum_{i=1}^{\beta_1} \lambda^2_{\gamma_{i-1}} + \epsilon \]

\[ \sigma^2_t = \text{Current day volatility} \]

\[ \epsilon = \text{Constant} \]

\[ \gamma^2_{i-1} = \text{ARCH Term.} \]

\[ \lambda^2_{\gamma_{i-1}} = \text{GARCH Term} \]

The variance was used in the calculation of the unconditional volatility. It is the standard by which bond volatility proxies are judged, hence its importance cannot be overstated.
Empirical Results
The following section demonstrates the statistical output and their interpretation.

Table I - Descriptive Statistics

<table>
<thead>
<tr>
<th>Bond Types</th>
<th>Statistics</th>
<th>Bond Characteristics</th>
<th>Term to Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Secured Bonds</td>
<td>N</td>
<td>2</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Mean</td>
<td>2.876</td>
<td>10.879</td>
</tr>
<tr>
<td>Unsecured Bonds</td>
<td>N</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>σ</td>
<td>0.3343</td>
<td>3.693</td>
</tr>
</tbody>
</table>

Source: Author compilation for SPSS Outcome

The statistics for secured bonds show that the volatility of secured bonds changed significantly as a result of the change in the bond profile. The change in the bond profile is the root cause of the newfound lack of volatility. The results show that there is a distinction between secured bonds with interest rates of 4-6, 6-8, and 8-10 in terms of their conditional volatility. The results support the validity of this classification. All interest rates have been shown to have positive average values. A common trend has emerged over the past few years in the various categories of bond 'term to maturity and bond grading. For a considerable period of time, this trend has been constant. It's possible to find a positive mean in each and every one of them. Research using descriptive statistics on risky bonds, According to the results, the highest mean interest rate was 9.287, with a range of 10-12. About half of all bonds can be found in this price range. Sixty-six percent of bonds are rated AA, the highest possible rating. Over sixty percent of the bonds in the sample have a term to maturity of less than two years. Every single category's mean value is also positive, and that holds true for every single bond profile parameter as well. It proves that bond price volatility follows the same patterns as bond price profiles.
The results of an analysis of variance test that was performed on data derived from secured bonds are presented in the table II that can be found above. It has been determined through the use of statistical analysis that the interest rate has a Levene p-value that is lower than 0.05. As a consequence of this, the null hypothesis cannot be accepted. According to the findings, it would appear that the interest rate has very little to no influence on the conditioned volatility of secured bonds. The results of the Levene’s test were analysed with the analysis of variance (ANOVA), and the results of that analysis were then used to assign grades to the cases. An analysis of variance carried out at a significance level of five percent yielded no results that could be considered statistically significant. It is a clear illustration of the significant impact that the term to maturity of a bond has on the conditioned volatility of secured bonds. When it comes to the interest rates on secured bonds’ interest (coupon) payments, the Levene statistic is lower than 0.05. This indicates that the alternative hypothesis is not a viable option for us. The results of Levene’s test were used as a basis for conducting an analysis of variance (ANOVA) to investigate the degree to which case grading is correlated with other variables. An analysis of variance (ANOVA) carried out with a significance level of five percent produced inconclusive results. When it comes to longevity, as determined by the Levene scale. It has been demonstrated that the term to maturity of a bond has a significant impact on the conditional volatility of secured bonds. When considering unsecured bonds, p is lower than 0.05 for each of the three different types of bonds (interest rate, bond grade, and term to maturity). According to these findings, it would appear that the interest rate does not play a significant role in the conditional volatility of unsecured bonds. On the other hand, it was discovered that the opposite was true regarding longevity. Due to the fact that the p value for the ANOVA test was greater than 0.05, the results cannot be utilised in the grading process. It has been shown that bond grades have no impact whatsoever on the conditional volatility of bonds.

Table II - Relationship between Bond Characteristics and Conditional Volatility of Bonds

<table>
<thead>
<tr>
<th>Type of Bond</th>
<th>Statistics</th>
<th>Bond Characteristics</th>
<th>Interest Rate</th>
<th>Bond Grading</th>
<th>Term to Maturity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Levene’s</td>
<td>ANOVA</td>
<td></td>
</tr>
<tr>
<td>Secured Bonds</td>
<td>Levene’s</td>
<td>[4.987]*</td>
<td>[2.567] (0.235)</td>
<td>[7.456]* (0.023)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ANOVA</td>
<td>[2.567] (0.278)</td>
<td>[1.678] (0.349)</td>
<td>[3.529]* (0.000)</td>
<td></td>
</tr>
<tr>
<td>Unsecured Bonds</td>
<td>Levene’s</td>
<td>[3.556]*</td>
<td>[5.234]* (0.021)</td>
<td>[1.567] (0.874)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>ANOVA</td>
<td>[2.456] (0.896)</td>
<td>[4.678]* (0.045)</td>
<td>[6.456]* (0.00)</td>
<td></td>
</tr>
</tbody>
</table>

Source: Author compilation from SPSS Output

*significant at five percent level
The outcomes of the Games-Howel test for each of the four distinct types of bonds are presented in the table III that can be found above. More specifically, the findings indicate that there is a significant gap, in terms of the conditional volatility of convertible bonds, between the 0-3 and 3-5 term to maturity bands. The period of time between 0 and 3 years has the lowest volatility, whereas the period of time between 3 and 5 years has the highest volatility. Volatility also varies with time. The findings indicate that the mean differences in bond maturities of 0-3 and 3-5 as well as 0-3 and > 5 are statistically significant, with the significant value for the former being less than 0.05 and the significant value for the latter being greater than 3. These findings pertain to non-convertible bonds. Because of this, the level of risk that is connected to unsecured bonds varies depending on their tenure, which can range anywhere from 0-3 years to 3.5 years or 0-3 years to more than 5 years.

Findings and Implications
The current paper estimates the impact of bond characteristics on the bond volatility in Indian capital market. The only aspect of bonds, regardless of their type, that has any bearing on their level of volatility is their term to maturity. Higher term to maturity is associated with greater degree of volatility. Due to the fact that bond term to maturity and volatility are directly tied to interest rates, a bond’s volatility will increase as its length increases. The research indicates that a one percent change in length results in a three and a half percent rise in the conditional volatility of bonds for secured bonds and a four and a half percent increase for unsecured bonds. According to the findings, the sensitivity of unsecured bonds to changes in bond term to maturity is significantly higher than that of secured bonds. Therefore, potential bond investors can research the term to maturity of the bond before making an investment. When it comes to unsecured bonds, the interest rate has the most significant impact on the bonds' level of volatility. The price of the bond goes up when the interest rate is lower than the interest rate that is currently being offered by the market, and it goes down when the interest rate is higher than the interest rate that is currently being offered by the market. The stock markets and their market regulator (SEBI) need to take a number of steps to increase confidence in implied volatility forecasts in bonds.

The returns on futures contracts are compared to the returns on bonds, which allows researchers in the future to make predictions about the Indian market. On the basis of these findings, researchers might suggest a new classification system for bonds that takes into account alternative time horizons and the possibility of

<table>
<thead>
<tr>
<th>Term to maturity, i</th>
<th>Term to maturity, j</th>
<th>Secured Bonds</th>
<th>Unsecured Bonds</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean Difference (I- J)</td>
<td>Sig.</td>
<td>Mean Difference (I- J)</td>
</tr>
<tr>
<td>0-3</td>
<td>3-5</td>
<td>5.7896*</td>
<td>0.00</td>
</tr>
<tr>
<td>&gt;5</td>
<td>0-3</td>
<td>7.4667*</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>&gt;5</td>
<td>5.8946</td>
<td>0.01</td>
</tr>
<tr>
<td></td>
<td>3-5</td>
<td>1.5567</td>
<td>0.25</td>
</tr>
<tr>
<td>&gt;5</td>
<td>0-3</td>
<td>-8.3556*</td>
<td>0.00</td>
</tr>
<tr>
<td></td>
<td>3-5</td>
<td>-4.7895</td>
<td>0.24</td>
</tr>
</tbody>
</table>

Source: SPSS results  *significance at five percent level
a reorganisation of the economy on a global scale. Additional research can be done on bond volatility as well as the seasonality effect. How can the strategic use of hedging help reduce the volatility of bond prices in certain circumstances? In the future, we will be able to investigate the correlation between the news about the macroeconomy and its impact on the implied volatility of bond prices. The volatility of both the Indian and international bond markets can be studied to determine whether or not they move in sync with one another.

**References**


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