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Demystifying Yield Spread on Corporate Bonds Trades in India

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Abstract
This paper aims to study the dynamics of corporate bond yield spread in India, and attempted to identify the possible determinants: bonds' liquidity, credit quality and therefore their yield spreads. A large sample of daily corporate bond trade data over a period of 6 years (2011–2016), classified into Issuers Segment-wise and Rating-wise, are analyzed within a basic statistical framework and using panel regression model. Default risk, as captured by the credit rating, is found to significantly affect the yield spread, for all types of securities. Even if the summary statistics and panel regression results broadly support the relationship between bond liquidity, captured through various bond characteristics and trade statistics, and yield spread, use of better liquidity proxy measure may improve the said relationship. Movements in equity market also affect corporate bond yield spread in India.

Keywords Corporate bond · Yield spread · Credit spread · Determinants · Liquidity · Panel regression

JEL Classification C13 · C23 · G10 · G12

1 Introduction

1.1 Corporate Bond Market in India

Being an important segment of the financial market, in particular, and of the financial system as a whole, of an economy, the presence of a vibrant, deep and robust corporate bond market is very crucial for its overall growth. A developed and robust corporate bond market contribute to: (i) Stabilize the financial system of a country; (ii) offer new, attractive, and liquid investment opportunities; (iii) enable borrowers

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to consider market borrowing, expected to be cheaper than bank borrowing, and contribute to the GDP growth of the domestic economy; (iv) allow financial institutions to raise debt (e.g. Tier II capital) to support their business activities and to meet the Regulatory Requirements, such as higher capital requirement for commercial banks under Basel III norms; (v) allow banks to reduce their lending exposures to large and mid-corporates, reduce credit concentration risk, and therefore undertake healthy business with manageable level of NPAs; and finally (vi) reduce the possibility of future financial crises, through distributing the counterparty default risk by offloading the same from the books of few financial institutions to a wide range of lenders and investors, including retail players.

Even if India may claim to have a world-class equity market, its bond market segment is still underdeveloped and is dominated by mostly the government securities, capturing roughly 35% (for Marketable Central Govt. securities) of GDP during 2016-17. On the other hand, even if the domestic credit to private sector in India is around 50% (as a percentage of GDP) during 2016, the ratio of outstanding corporate bond to country's GDP is even less than 15%. These figures clearly indicate the slow growth in the corporate bond market in India, especially in comparison with the corporate bond market in other developed economies like USA, Japan, Korea, etc. But at the same time, India is experiencing a significant growth in this segment, at least in comparison with the previous years. Both the stock exchanges (NSE and BSE) together has recorded a significant growth of roughly 37% (from 13 lakh crores in 2016 to 17.72 lakh crores in 2017) in the transaction of corporate debt securities in India. The possible factors behind such growth include: significant decline in the interest rate, making the market borrowing more cost-effective; regulators' initiatives to strengthen the rules to lend to large corporates, and motivating them to borrow from the market; necessary regulatory amendments to allow banks and other financial institutions to actively participate in the corporate bond market, offering greater innovation in instruments, structures; widening issuers and investors (including retail investors) base to access bond markets, etc.

One important feature of Indian corporate bond market is the dominance of securities with high credit quality, at least within the *investment grade* (AAA to BBB). Even if *speculative-grade* (below BBB) bonds offer an attractive return, there is insufficient demand for such securities, may be due to the nature of the investors. Since Indian corporate bond market is mostly dominated by risk-sensitive institutional investors, there may not be sufficient focus to maximize the portfolio yield, but to minimize the risk. This lack of sufficient demand for speculative-grade bonds also creates a hurdle for the relatively poor creditworthy corporate borrowers to tap the bond market to meet their financing requirement and therefore left the only option of bank borrowing. Rating-wise distribution of trades in non-govt. securities in India over last few years, given in Table 1 may be seen to gauge the liquidity of securities with various rating classes. The table clearly exhibits the fact that securities of higher credit rating are much more liquid than securities of a poor rating. Not only that, there is a declining trend in the liquidity of low rated bonds over the years, at least till 2015, showing investors increasing concern towards the counterparty and liquidity risk.

Table 1 Rating-wise distribution of corporate bond trades in India. *Source*: SEBI Handbook of Statistics 2016

Ratings assigned to corporate debt securities												
Year	Investment grade								Speculative grade		Total	
	Highest safety (AAA)		High safety (AA)		Adequate safety (A)		Moderate safety (BBB)		(Below BBB)			
	No.	Amount (Cr.)	No.	Amount (Cr.)	No.	Amount (Cr.)	No.	Amount (Cr.)	No.	Amount (Cr.)	No.	Amount (Cr.)
2010–2011	244	5,11,583	267	1,82,584	249	90,445	579	69,283	1843	42,704	3199	9,07,685
2011–2012	256	5,36,245	380	2,38,381	267	88,534	710	53,401	2793	56,239	4406	8,63,548
2012–2013	204	7,98,560	449	2,46,970	313	86,799	648	47,193	2558	54,090	4172	12,33,613
2013–2014	169	7,58,737	303	2,01,516	187	79,790	422	81,244	1351	38,475	2432	11,59,763
2014–2015	201	7,14,360	354	2,53,555	246	52,227	292	28,655	703	30,711	1796	10,79,508
2015–2016	178	10,31,140	309	1,93,074	214	40,889	151	6180	100	8,886	896	12,82,233
Apr 15–Dec. 15	125	8,75,277	229	1,35,410	142	26,872	81	4490	60	6,746	637	10,50,915
Apr 16–Dec. 16	185	9,77,765	275	2,12,906	194	45,884	139	7845	97	11,462	890	12,53,997

Difference between the yields offered by non-govt. securities of various maturities, issued by various sectors and with different credit ratings, and the risk-free yield on securities issued by the central govt. of similar maturity is commonly known as the credit spread. Even though this spread is known as the credit spread, the difference between the yield on non-govt. security and the risk-free yield of similar tenor need not be exclusively due to the credit risk, applicable to the non-govt. security. Such difference in the yield may be due to other important factors, like liquidity. Non-govt. securities of exactly similar tenor, credit rating, and issued by the same sector, even by the same entity/corporate, may get traded at different yield, and therefore at different yield spread, which may be only due to a difference in liquidity. Security with higher liquidity attracts lower spread and vice versa.

Average of the traded yield and yield spread on a sample of more than 60,000 actual trades in non-govt. securities in India, issued by various sectors (Bank-PSU-FIs, NBFC, Corporates, as per FIMMDA classification) and of different rating grades (AAA, AA, and A), for various residual maturities, in a range of 1–10 years, are summarized in Table 2.

The *swap spread,* sometimes used as an alternative to credit spread, is the yield difference between the swap curve and Treasury yield curve. Since the swap rates for any tenor are expected to be higher than the respective risk-free rates, the swap curve is expected to lie above the risk-free yield curve, and the swap spreads for any tenor, and at any point of time, are expected to be positive. There may be some instances when the swap spread is negative, maybe for all tenors, and the swap curve lies below the risk-free yield curve, as may be the case in the Indian market. On the other hand, the difference between the yield on corporate bond (especially of AA rating) and the swap rate of similar tenor, represented by the gap between the Non-Gsec. Yield curve and the Swap curve is known as the Spread over Swap. This spread measure may be used as an alternative to the corporate bond yield spread (yield on non-govt. security minus the risk-free rate).

1.2 Research Questions and Objectives

Yield spread, varying among securities issued by different sectors, of various maturities and of different rating grades, is the most important factor, capturing the market perception towards risk and return on investment in a specific non-govt. security. From the viewpoint of a trader/investor, a higher spread denotes higher return, but along with a higher level of risk (counterparty risk and/or liquidity risk). Since a prudent investor/trader need to analyze both the risk and return, before taking an investment/trading decision, what becomes more important is to demystify or analyze the yield spread on non-govt. securities. This concern may lead to frame the following questions which can be researched on:

- What are the dynamics of corporate bond yield spread in India?

Table 2 Average yield and yield spread on bond trades for various range of residual maturities under various segments and rating grades

Res. maturity	GOI yield (%)	Avg. traded yield			Avg. traded yield spread		
		A (%)	AA (%)	AAA (%)	A (%)	AA (%)	AAA (%)
Panel A: Bank-PSU-FI segment							
< 1 Year	7.948	9.191	8.814	8.388	0.604	0.955	0.479
1–2 Year	8.143	9.191	9.761	8.751	0.604	1.383	0.587
2–3 Year	8.044	9.159	9.364	8.680	0.649	1.151	0.631
3–4 Year	7.979	9.460	9.636	8.609	1.638	2.056	0.590
4–5 Year	8.219	9.725	9.556	8.878	1.931	1.808	0.589
5–6 Year	8.118	10.486	8.557	8.655	1.796	0.729	0.533
6–7 Year	8.076	9.632	8.431	8.549	0.857	0.256	0.476
7–8 Year	8.270	9.912	9.015	8.629	1.614	0.948	0.371
8–9 Year	8.109	9.745	9.344	8.425	1.504	1.432	0.399
9–10 Year	8.139	9.682	9.136	8.738	1.472	1.032	0.555
10–15 Year	8.320	9.404	8.677	8.469	0.911	0.296	0.175
Panel B: NBFC segment							
< 1 Year	7.948	10.138	9.032	8.807	2.819	1.090	0.809
1–2	8.143	11.607	9.603	9.128	3.659	1.523	0.972
2–3 Year	8.044	11.990	9.600	9.124	3.785	1.571	1.076
3–4 Year	7.979	10.655	9.762	8.819	3.042	1.684	0.916
4–5 Year	8.219	11.704	9.781	9.157	3.363	1.571	0.943
5–6 Year	8.118	12.630	10.608	9.577	4.342	2.454	1.366
6–7 Year	8.076	11.617	9.953	9.427	3.136	1.812	1.695
7–8 Year	8.270	11.617	9.574	8.827	3.136	1.493	0.724
8–9Year	8.109	9.884	9.665	8.868	1.232	1.502	0.741
9–10 Year	8.139	9.908	9.634	8.899	1.605	1.507	0.949
10–15 Year	8.320	9.835	9.633	8.242	1.834	1.209	− 0.337
Panel C: Corporate segment							
< 1 Year	7.948	10.005	9.133	9.294	2.321	1.354	1.230
1–2 Year	8.143	10.416	9.785	9.134	2.322	1.739	1.048
2–3 Year	8.044	10.555	9.500	8.596	2.633	1.467	1.003
3–4 Year	7.979	12.583	9.642	9.084	3.846	1.550	1.112
4–5 Year	8.219	11.592	9.524	8.719	3.186	1.542	0.925
5–6 Year	8.118	10.888	9.587	9.723	2.096	1.719	1.595
6–7 Year	8.076	10.888	9.748	9.156	2.096	1.604	1.179
7–8 Year	8.270	11.191	9.730	9.457	3.955	1.285	1.067
8–9 Year	8.109	11.299	9.757	9.315	3.739	1.067	1.093
9–10 Year	8.139	11.160	9.264	9.799	3.037	1.212	1.413
10–15 Year	8.320	10.712	9.057	9.124	2.535	0.472	1.130

- Is it possible to capture the movement of yield spread from the history of actual trades?
- Credit/default risk, liquidity, movements in other markets: How these factors attribute to the movement of corporate bond yield spread in India?
- Does these relationships between Yield Spread and its Major Determinants, in the Indian market, deviates from whatever suggested in the existing literature? If yes, what could be the possible explanation/justification?

In light of the above research problems/questions, an empirical study has been conducted with the following Research Objectives:

- To understand the movement of yield on non-govt. securities of various issuers segments, different rating classes, and over the years in India
- To capture the dynamics of yield spread movements
- To quantify the relative contribution of Liquidity, Credit Risk, and other market variables in the movement of yield spreads, using daily trade inputs
- To verify the consistency in the impact of statistically significant variables under different scenarios/circumstances.

In short, the broader objective of this research is to study the market dynamics of corporate bond yield spread in India and to identify the possible factors/determinants affecting bonds' liquidity and credit quality and therefore the yield spreads. To the best of my knowledge, this may be the first attempt to test the aforesaid research objectives considering a significantly large sample of daily trades, in Indian context.

1.3 Structure of the Paper

The remainder of the research paper is organized as follows. The second section brief the existing literature focused on the similar research questions worldwide. Detail description of the complete set of data used to conduct this study and the methodologies followed to empirically test the research questions are given in Sect. 3. Summary statistics and major research findings are analyzed in the next section, followed by concluding remarks in Sect. 5.

2 Review of Literature

There is a wide range of literature capturing the movement of yield spread on trades in corporate bonds worldwide, and the possible factors/determinants affecting such spread, under different circumstances, and at different point of time. Based on the broader types of such determinants, highlighted in the existing literature, this review section is divided into three parts: (i) bonds' liquidity and yield spread; (ii) bonds' credit risk and yield spread; and (iii) other market factors and yield spread. Literature highlighting these aspects in their respective studies are briefed in the following paragraphs.

2.1 Bonds' Liquidity and Yield Spread

Even after controlling for common bond-specific, firm-specific, and macroeconomic variables, more illiquid bonds are found to earn higher yield spreads, and any improvement in liquidity causes a significant reduction in spread component. Liquidity is found to be the key determinant in yield spreads, explaining as much as half of the cross-sectional variation in yield spread levels and as much as twice the cross-sectional variation in yield spread changes than is explained by rating effects alone (Chen et al. 2007).

Liquidity effects, captured through different bond characteristics (e.g. Issued Amount, Listing Status, Residual Tenor, Bond Age, bid-Ask Spread, Trading Volume, Number Of Trades, Missing Prices, Yield Volatility, etc.) account for a significant portion of the market-wide yield spread changes (Houweling et al. 2005; Chen et al. 2007; Chakravarty and Sarkar 1999; Bao et al. 2008; Bao et al. 2011). Liquidity premium, a part of the yield spread, and captured by various measures, varies differently between investment grade and speculative-grade bonds. Total estimated liquidity risk premium in speculative-grade bonds, having higher exposures to the liquidity factors, is almost two and half times higher than the liquidity premium attached to long-maturity investment grade bonds (Houweling et al. 2005; Jong and Driessen 2006). Such effect is found to be even more pronounced in periods of financial crises when *"flight-to-quality"* is confined only to bonds with the highest level of safety (Bao et al. 2008). Possibility for an increase in the yield spread is slow and persistent for investment grade bonds, whereas the effect is stronger but more short-lived for speculative-grade bonds (Dick-Nielsen et al. 2012). It is also evidenced that during stress periods, liquidity risk becomes a significant factor affecting bond prices, especially of low-rated bonds (Acharya et al. 2010; Friewald et al. 2012).

Even if it may be perceived that securities with larger primary issues have greater liquidity, securities issued by the same issuer but with different issue size are found to be the close substitute to each other in terms of their secondary market liquidity and therefore the yield spread (Crabbe and Turner 1995).

Even if changes in market-level illiquidity explain a substantial part of the time variation in yield spreads of bonds with higher level of credit rating, overriding the credit risk component, the bond-level illiquidity measure explains individual bond yield spreads, in its cross-sectional variation, with large economic significance (Bao et al. 2011)

Several research attempts are made to separate the impact of two important sources of risk (liquidity and default risk) on the corporate bond yield spreads. Even if a downward sloping term structure of yield spreads for investment grade bonds has been observed, contradicting the theory of "*crisis at maturity*", a positive relationship between yield spread and residual maturity is established, once the effect of liquidity and other factors on the yield spread are removed (Diaz and Navarro 2002).

Non-default component in corporate bond yield spreads, expected to be time-varying and mean reverts rapidly, is found to be strongly related to bond-specific liquidity measures (bid-ask spread, outstanding principal amount), measures of treasury richness (on-the-run/off-the-run Treasury yield spread), overall liquidity in fixed income markets, etc. (Longstaff et al. 2004).

In response to a long debate "Do bond investors demand credit quality or liquidity", a comprehensive answer given is "both, but at different times and for different reasons". Even if credit quality matters for bond valuation, but at times of market stress, investors chase liquidity, not credit quality (Beber et al. 2009).

Besides bond characteristics, and other trade statistics, there are some well-established liquidity proxies used to capture bond liquidity. Few of them includes Amihud Measure (Amihud 2002), Price Dispersion Measure (Jankowitsch et al. 2011), Roll Measure (Roll 1984). A larger Amihud measure implies greater price movement and a higher absolute return for a given trading volume, indicating a lower liquidity and therefore a higher yield spread. A lower dispersion indicates the possibility for the security to be traded at a price close to its fair value, and therefore indicate a higher liquidity, and a lower yield spread. Greater the value of the Roll measure, higher would be the negative covariance between consecutive returns, leading to a lower liquidity and higher yield spread. There are a good number of studies (Dick-Nielsen et al. 2012; Friewald et al. 2012) capturing the movement of corporate bond yield spread, using either or all of these proxy measures to represent liquidity in bond trades.

2.2 Bonds' Credit Risk and Yield Spread

A Significant Portion of the Yield Spread on corporate bonds, with all rating classes, is due to their respective default risk (Longstaff et al. 2004; Elton et al. 2001). Credit risk component is a more influential determinant of yield spreads than liquidity, especially after the onset of the crisis (Shah and Kebewar 2012*)*. Impact of credit risk, finally affecting bond's liquidity, on the yield spread may be even more for low rated or Speculative Grade/Junk Bonds (Friewald et al. 2012; Jing-zhi and Huang 2002).

Even if liquidity and credit risk are two important factors to decide the yield spread on corporate bonds, liquidity spreads are found to be positively correlated with credit risk and which further is a decreasing function of time to maturity. As the default possibility increases, the movement of bond yield spreads attributable to liquidity also increases (Ericsson and Renault 2006).

In case of very short-term corporate yield spread, even if liquidity plays a role in the determination of the spread, credit quality may play a stronger role in determining the yield spread, even for a maturity less than a month (Covitz and Downing 2007).

2.3 Other Market Factors and Yield Spread:

Differential Taxes on corporate bonds account for a larger portion of the yield spread than do expected losses due to default risk. It is observed that generalized model with taxes does a better job than the traditional models in identifying the components of corporate bond yield spreads. (*Lin* et al. 2008; Elton et al. 2001).

A very significant portion of the yield spread is found to be a compensation for systematic risk and is affected by the same influences that affect systematic risks in the stock market. Growth in the equity market, as captured through broader Equity

Index (value) and Liquidity in the equity market, has a significant impact on corporate bond yield (Jong and Driessen 2006; Pape and Schlecker 2007; Bao et al. 2008). Equity volatility (firm level) can explain as much cross-sectional variation in corporate bond yields and yield spread as can credit ratings. Idiosyncratic equity volatility helps to explain not only recent movements in corporate yield spreads but also their longer-term upward trends (Campbell and Taksler 2003).

Even though several macroeconomic or financial variables and bond specific factors are considered as proxies to define the yield spread on corporate bonds, most of the factors are found to have limited explanatory power. Aggregate factors appear much more important than firm-specific factors in determining credit spread changes. As suggested by Principal Component Analysis, monthly credit spread changes are principally driven by local supply/demand shocks that are independent of both credit-risk factors and standard proxies for liquidity (*Collin*-Dufresne et al. 2001).

3 Data and Research Methodology

3.1 Description of Data Used

The present research is based on Daily data on every single trades in corporate bonds through two major exchanges (NSE and BSE) in India, for a period of 6 years (February 2011 to December 2016), obtained from the Fixed Income Money Market and Derivatives Association (FIMMDA). Such trade data contain details on the basic features of corporate bonds (e.g. Maturity Date, Issue Data, Coupon Rate, Credit Rating, Issuer's Segment), security-wise traded yield and price (Volume Weighted Average), Trade Statistics (Volume and Number of Trades), Base/Risk-free yield of similar tenor as on the Deal Date, and the Yield Spreads. These deal-wise details are supplemented by details on other market variables (e.g. equity index: value and turnover, FX rate, risk-free benchmark rates, market average credit spread, etc.).

Even if a comprehensive database on corporate bond trades should contain regular and consistent trade data on various securities, issued by different sectors/issuer, and with various rating classes (AAA to C), the same may not be applicable to a developing market like in India. The corporate bond market in India is growing over the period but is still immature in terms of consistent and regular secondary market trading in securities issued by all possible sectors and with all possible credit ratings. The main problem in conducting an empirical research on Indian corporate bond market is this infrequent and irregular trades, that also on securities issued by few sectors (like Banks, PSUs, FIs), and with better credit ratings (like AAA and AA). There is hardly any trades on securities issued by private corporates, and securities with a credit rating of less than AA. This makes the sample *unintentionally biased*, which may have some impact on the findings derived from such empirical research. Details towards the issuer segment-wise, rating-wise, and year-wise composition of the overall sample, before and after the necessary cleaning, is presented in Table 3.

As the above table indicates, I have started with the first round sample of 94637 daily trades in 5750 (approximate) securities, represented by their ISIN numbers,

Table 3 Composition of sample of corporate bond trades

Total data, cross sectional and time unit		Segment and rating-wise trades (after cleaning)				
Unfiltered/initial traded points	94636	Segment	AAA	AA	A	BBB and Bellow
Total Traded Points (cleaned)	63008	Bank-PSU-FI	34258	2961	1650	52
No. of ISIN (N)_Cleaned	3973	NBFC	12501	4864	245	38
No. of Days Traded (T)	1423	Corporates	2864	3360	181	34
		Total	49623	11185	2076	124

Year-wise corporate bond trades (cleaned) under different rating class

Year	AAA	AA	A	BBB and below
2011	2879	488	83	3
2012	6451	1193	186	5
2013	10380	2494	495	29
2014	10047	2242	591	69
2015	11266	3061	426	14
2016	8600	1707	295	4
Total	49623	11185	2076	124

during the sample period of 6 years (1-Feb-2011 to 30-Dec-2016). But due to several reasons like, errors, missing numbers and repeated values in the source files, presence of outliers in some of the parameter values (either happened naturally or may be due to error in data entry in the source file), missing data in other market variables with respect to the daily corporate bond trade data, etc., the first round sample need to undergo a thorough cleaning process. After cleaning for any missing values and outliers in any of the series/parameters, by deleting all the values for that particular trade on that particular date, I have arrived at the final sample. The final sample consisted of a total of 63008 trades, in 3973 securities (ISIN), over a total of 1423 trading days (roughly equals to 250 trading days per year for a period of 6 years).

The sample is not only inconsistent in terms of regular trades, but also in terms of sector-wise and rating-wise trades. As exhibited from the above table, trades in corporate bond in India is mostly concentrated towards bonds issued by Banks/PSUs/FIs, and also for bonds with the highest level of safety (i.e. with credit rating of AAA, and at most AA), the yield spread of which are not expected to vary much, unless there is a significant difference in their liquidity. To summarize, the data used in this study is a Panel Data, with 'N' number (here 3973) of cross-sectional units and 'T' number (here 1423) time series units. But unlike a standard panel, with a balanced set of data, having "$N \times T$" number of total units, our panel is extremely unbalanced where the time series unit (T) varies for every cross-sectional units (N), resulting in a very small overall sample size, much smaller than "$N \times T$".

Complete set of corporate bond trade data is taken from the Fixed Income Money Market and Derivatives Association of India (FIMMDA), supplemented by the

National Stock Exchange of India (NSE), and Reserve Bank of India (RBI). Other data sources include Clearing Corporation of India Ltd. (CCIL), Cogencis Data Base, etc. The present study is conducted using software like STATA (Version: 15.0), and MS-Excel.

3.2 Description of the Variables Used

In order to demystify the movement of yield spreads on corporate bonds trades, the dependent variable is nothing but the deal-wise yield spread, whereas the independent variables are the list of factors affecting the yield spread and its movements over various securities (cross-sectional unit) and over time (time series unit). Independent variables may be any factor, broadly affecting the bond's creditworthiness and its liquidity which finally affect the yield spread (level and change) of any non-govt. security. Accordingly, list of factors affecting both the important components (credit quality and liquidity) include *Bond Characteristics*, *Trade Statistics*, *Other Market Factors*, and obviously some *Control Variables*. The inclusion of the control variables in a model is very important so that the marginal contributions of the crucial independent variables in explaining the variation of the dependent variable are duly captured. A list of variables used in this study is given in Table 4.

As already stated, yield spread on a corporate bond is basically driven by two major factors: *Credit Quality/CreditWorthiness*, and *Liquidity*, which may further be captured through various alternative factors/measures/variables. Creditworthiness may be simply captured through the credit rating (issuer rating/issue rating), offered by the external rating agency. On the other hand, there may be a list of factors/variables that may possibly capture the liquidity status of a bond. Such factors may be some of the bond's characteristics (e.g. *Size of issue*, *Coupon*, *Residual Maturity*, *Bond Age*), or maybe some trade statistics (e.g. *Trading Volume*, *Number of Trades*, *Trading Interval,* etc.*)*, or maybe some proxy measures captured through some trade statistics (e.g. *Amihud Measure*, *Price Dispersion Measure*, *Roll Measure)*. A brief description of some of these variables, selected for the study, and their expected relationship with the yield spread and its changes are given in the following section.

3.2.1 Bond Credit Rating

Credit rating of a bond issuer (i.e. Issuer's rating) and/or the rating of a specific issue (i.e. Issue rating) can be used to capture the credit risk involved in a non-govt. security, and to decide the yield spread at which the security is likely to trade in the market. Securities based on their credit rating may be classified as "Investment Grade (AAA to BBB)" and "Speculative Grade (Below BBB)". Better the credit rating of a corporate bond, safer it would be for someone to invest/trade in that security, leading to a fall in the yield spread. Normally the rating varies from AAA to C, maybe with 19 different types (AAA+, AAA, AAA−, ……, BBB+, BBB, BBB−,…., B+, B, B−, and C). A value may be assigned to each rating in a range from 1 to 19 respectively for credit rating ranging from C to AAA+. Better the rating, higher would be the value, i.e. the value is 19 for AAA+, and 1 for C. Therefore, the relationship

Table 4 List of factors/variables used in the study

List of variables used			
Factors affecting credit worthiness	Factors affecting liquidity	Other market factors	Control variables
Credit rating (C to AAA+, coded from 1 to 19)	Coupon rate	Dummy variables (sector segmentation)	Movements of risk-free yield (level and slope)
	Residual maturity	Equity Index (value and turnover)	Movement of market (AA) term rates
	Bond's age	Foreign exchange rate (USD/INR)	Credit risk premium (market average)
	Trading volume and no. of trades		

between the credit rating, as represented by these assigned numbers, and the yield spread is expected to be *negative* (Houweling et al. 2005; Chen et al. 2007). These ratings are normally assigned by one or more external rating agencies. In case a bond issue, in our sample, is rated by more than one agency, and all the ratings are different from each other, the lowest rating is considered to assign the value, maybe with a conservative approach.

3.2.2 Coupon Rate

Coupons are expected to be higher in case of corporate bonds, especially to take care of the high level of credit risk. Therefore coupon may be used as a proxy for credit risk. But once the credit risk is duly captured through a reasonable proxy, say credit rating, the coupon rate may be used as a proxy for liquidity as well (Chen et al. 2007). Accordingly, corporate bonds with similar credit rating but with a different coupon will have different levels of liquidity. Higher the coupon of a bond lower would be the liquidity, and higher would be the yield spread, leading to a *positive* relationship between coupon and yield spread. Coupon rate may also be used as an explanatory variable[1] to test the effect of tax on the corporate bond yield spread (Elton et al. 2001), where a *positive* relationship is expected between coupon, measuring the tax effect, and yield spread.

3.2.3 Residual Maturity

Residual Maturity (the time difference between the deal date and maturity date) of a bond may also play some role in deciding its liquidity. Many institutions, like banks, insurance companies, etc., depending on their balance sheet structure, regulatory concerns, and difficulties to forecast the movements of very long-term interest rates in an uncertain interest rate regime, may prefer to avoid trading in long-term securities, causing insufficient liquidity in securities of longer maturities. Therefore, the longer the residual maturity of a bond, lower would be its acceptability in the secondary bond market, causing a poor liquidity, and higher yield spread. Alternatively, the relationship between residual maturity and yield spread is *positive* (Houweling et al. 2005; Chen et al. 2007; Chakravarty and Sarkar 1999; Bao et al. 2008). But the scenario in the corporate bond market in India may be slightly different, where the maximum liquidity lies, neither in the short-term nor in the long term, but in the medium term, like 8–12 years maybe because of availability of robust risk-free benchmark points in that maturity range. Therefore, there may not be any consistent pattern of such relationship (residual maturity versus liquidity/yield spread) over the short term, medium term and long term segment in Indian corporate bond market.

[1] Suppose, an investor with a marginal tax rate of X% would need to receive a pre-tax coupon of C/(1 − X%) to have an after-tax coupon of C. Therefore, the markup in the coupon to compensate for the concerned taxes incurred on the coupon income should be roughly proportional to the coupon rate of the bonds.

3.2.4 Bond Age

Age of a bond or the time passed since its issuance in the primary market till the deal date, may also play some role in the tradability of the bond, and therefore may affect its liquidity and the yield spread. The yield on bonds which are recently issued, known as *on-the-run* securities, may be very close to recent market expectations than similar bonds of relatively higher age, known as *off-the-run* securities. Therefore market may prefer to trade more on on-the-run bonds, at a lower spread, leading to a *positive* relationship between yield spread and bond age (Houweling et al. 2005; Chen et al. 2007; Chakravarty and Sarkar 1999; Bao et al. 2008).

3.2.5 Trade Statistics

Various statistics related to actual trades in bonds, like *trading volume* and *number of trades* in every single deal on a given deal date, may be used to capture the daily liquidity. Accordingly higher trading volume and number of trades indicate higher liquidity and therefore lower yield spread, indicating a *negative* relationship between the trading volume/number of trades and the yield spread. The logarithmic value[2] of the number of trades is used in our model (Chen et al. 2007). Even if there are several alternative measures available to capture bond liquidity better than the simple trade statistics, the same could not be used because of insufficient information available in an illiquid market like in India.

3.2.6 Equity Index: (Value and Turnover)

Because of strong inter-linkages between various segments of the financial markets in an economy, movements in the equity market is likely to affect the movement in the corporate bond market, especially when similar types of corporate entities have exposure in both the markets. A broad equity index (NSE NIFTY 500 Index), capturing more than 95% of the market capitalization of stocks listed on National Stock Exchange of India Ltd., is considered. Daily value and turnover of this equity index are used respectively to represent the growth and liquidity in Indian equity market. Higher the value of the equity index, capturing a wide range of companies, lower would be the expected risk of investment in those companies, and lower would be the expected yield spread from the bonds issued by them. Therefore, there is a *negative* relationship between the value of broad equity index and yield spread from corporate bonds (Jong and Driessen 2006; Pape and Schlecker 2007; Landschoot 2008). On the other hand, turnover in the concerned equity index, denoting the liquidity in the equity market, is expected to affect the liquidity in the corporate bond market. A significant rise in liquidity in one market is expected to reduce the liquidity in the

[2] Logarithmic Transformation of the trade statistics (Trading Volume, and/or Number of Trades) makes the variables stationary, a necessary precondition before setting a regression model. A variable is said to be *Stationary* whose statistical properties (e.g. Mean, Variance, Autocorrelation, etc.) are all constant over time.

other market. Therefore any rise in the equity market turnover may lead to reduce the liquidity and increase the yield spread in the corporate bond market, suggesting a *positive* relationship between equity market turnover and corporate bond yield spread. Log values of both NIFTY 500 Index and its Turnover are considered in this research.

3.2.7 Dummy Variable (Issuers' Segment)

Necessary dummy variables may be added in the list of independent variables, ensuring that it won't create the problem of multicollinearity. Since there are three broader issuers' segments (Bank-PSU-FI; NBFC, and Corporates), as given by FIMMDA, we have introduced two segment dummies, representing the first two segments (Bank-PSU-FI segment, NBFC segment), in our model. The dummy variable will take a value of 1 for bonds issued only by the concerned segment, otherwise 0. Such dummy variables will be present only in rating-wise sub-samples.

3.2.8 Control Variables

Any change in the benchmark risk-free rate and in its slope is expected to have a direct impact on the yield spread of non-govt. securities (Chen et al. 2007; Papageorgiou and Skinner 2006; Landschoot 2004). Normally, any rise in the risk-free interest rates may cause the yield spread to become narrow, leading to a *negative* relationship between the benchmark risk-free rates and the yield spread. I have used 10-Year GOI Par yield, from the FIMMDA base yield curve, to represent the benchmark risk-free rate in India. On the other hand, the difference between the long and short-term risk-free yield, represented as the *Slope* of the risk-free yield curve, may also have some impact on the corporate bond yield spread. Higher the difference, steeper would be the slope of the risk-free yield curve, and greater would be the market expectation for a future rise in the risk-free interest rates, leading to a fall in the yield spread, again suggesting a *negative* relationship. Difference between 10 years (long-term) and 2 years (short-term) risk-free GOI yield is considered to capture the slope of the risk-free term structure.

Any change in the average market spreads, for various segments of bond issuers, for various rating classes, and for various maturities, is expected to affect the yield spread on actual deals in the market, suggesting a *positive* relationship between the average market spread and the yield spread on individual trades. I have used the average market spread, published by FIMMDA on monthly/fortnightly basis (monthly basis till May 2016). Monthly/fortnightly spread matrix (from February 2011 to December 2016) are used to interpolate the average market spread for all individual trade with their respective residual tenor, mapping with the issuer segment and rating class. Same monthly/fortnightly matrix are used to interpolate the average spread data for all the trades happened within the same month/fortnight.

3.3 Description of Research Methods Applied

Methodologies used to test the research objectives of this study are broadly classified into two:

- Trade summaries and descriptive statistics; and
- Fixed or random effects panel regression model

Once the complete data sets on deal wise details and details of other markets factors and control variables are duly cleaned, the same is initially used to conduct a primary analysis towards dynamics of segment-wise, rating-wise, maturity-wise trades; movement of yield spreads across securities and time; an association between yield spread and other variables.

Once the data are primarily analyzed, the same is made available for the panel regression model. Econometric models generally used to analyze a panel data may broadly depend upon the presence of a significant cross-sectional and/or temporal/time effect. A panel data may possess either or both of the cross-sectional and temporal effect, or the data may not contain either of them. If neither cross-sectional nor temporal effect is expected to be present in the panel data, the entire data, over the cross-sectional units (N) and time series unit (T), may be simply *pooled*, and an ordinary least squares (OLS) regression model, with an intercept (α) and slope coefficients (βs), expected to be constant across the cross-sectional and time series units, may be formed. This type of OLS regression model is known as *pooled regression model*. Alternatively, in presence of either or both of the cross-sectional and temporal effect in the panel data set, where the intercept and/or the slope coefficients are not expected to be constant across the cross-sectional and time series units, a *panel regression model* (with *fixed effects* or with *random effects*) may be proposed, depending upon the nature (fixed or random) of the error terms.

3.3.1 Pooled Regression Model

A simple OLS pooled regression model, with Y as a dependent variable, and 'm' numbers of independent variables (X) can be represented as:

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_k X_{kit} + u_{it}; \quad i = 1, 2, \ldots ., N; t = 1, 2, \ldots, T; k = 1, 2, \ldots, m;$$

where 'α' and 'βs' are respectively the intercept and slope coefficients, expected to be constant across the cross-sectional and time series units, and 'μ' is the error term, capturing the unexplained variation in Y, and Independent and Identically distributed random variable with zero mean and constant variance, such that: $\mu_{it} \sim IID\left(0, \sigma_\mu^2\right)$.

3.3.2 Panel Regression Model (with Fixed or Random Effects)

The form of a simple panel regression equation, with 'N' number of Cross Section units (represented as 'i'), 'T' number of time series units (represented as 't'), and 'm' number of independent variables (represented as 'k') is such that:

$$Y_{it} = \alpha + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_k X_{kit} + u_{it}; \quad i = 1, 2, \ldots, N; t = 1, 2, \ldots, T; k = 1, 2, \ldots, m;$$

here 'u_{it}', is the error component, such that: $u_{it} = \mu_i + \lambda_t + \nu_{it}$.

Now, based on the assumption (*fixed* or *random*) of the error components, a required model need to be specified.

Assumption 1 μ_i and/or λ_t are fixed parameters to be estimated and the random error term, ν_{it}, is independent and identically distributed with zero mean and constant variance σ_ν^2 (i.e. homoscedastic), or $\nu_{it} \sim IID\left(0, \sigma_\nu^2\right)$.

Under this assumption of fixed μ_i and/or λ_t and $\nu_{it} \sim IID\left(0, \sigma_\nu^2\right)$, the structured panel model is known as *Fixed Effects Model*.

Assumption 2 Alternatively, μ_i and/or λ_t are assumed to be random just like the random error term (ν_{it}); or μ_i and/or λ_t and ν_{it}, all are assumed to be independent and identically distributed with zero mean and constant variance, such that:

$$\mu_i \sim IID\left(0, \sigma_\mu^2\right); \lambda_t \sim IID\left(0, \sigma_\lambda^2\right); \nu_{it} \sim IID\left(0, \sigma_\nu^2\right)$$

With this assumption of randomness in μ_i and/or λ_t and ν_{it}, supplemented with further assumptions that they are all independent of each other and also of the explanatory variable (s), the model can be treated as a *Random Effects Model*.

Fixed effects panel data models again may be formed with various assumption towards the slope coefficients and intercepts over cross-sectional and time unit. One such model, finally considered here, with the assumption of constant slope coefficients but different intercepts only over the cross-sectional units, is represented as:

$$Y_{it} = \mu_i + \beta_1 X_{1it} + \beta_2 X_{2it} + \cdots + \beta_k X_{kit} + \nu_{it}; \quad \nu_{it} \sim IID\left(0, \sigma_\nu^2\right);$$
$$i = 1, 2, \ldots, N; t = 1, 2, \ldots, T; k = 1, 2, \ldots, m;$$

Separate intercepts for all cross-sectional units can be estimated by including a separate *dummy variable* for each i-th units. Accordingly, μ_i in the above equation will be replaced with $\sum_{i=1}^{N} \mu_i D_i$; where D_i represents the dummy variable for the i-th unit. if the intercepts (μ_i) are found to be statistically significant, the model is said to be accounted for the cross-sectional heterogeneity. This fixed effects model with heterogeneous intercepts over cross-sectional units can also be estimated through OLS with dummy variable, and therefore is known as least square dummy variable (LSDV) model.

In order to test the suitability of the pooled regression model and the fixed effects model, a poolability test has been performed.

3.3.3 Poolability Test

This statistical test verify the assumption that neither the cross-sectional nor the temporal effect are significant, and the data may be simply pooled and an OLS regression model can be run with an intercept (α) and slope coefficients (βs), which are expected to be constant across cross-sectional and time series units. Therefore, a Restricted F-test may require being performed, such that:

$$F = \frac{\left(R^2_{UR} - R^2_R\right)/J}{\left(1 - R^2_{UR}\right)/(n-k)}$$

where R^2_{UR} and R^2_R are respectively the R^2 of the unrestricted regression (i.e. Fixed Effects Model) and the restricted regression (i.e. Pooled OLS). 'J' is the number of linear restrictions on the restricted model, 'k' represents the number of parameters used in the unrestricted model, and 'n' is the total number of observations (N × T).

Comparing this estimated F-value with the tabulated value of F ($F_{J, n-k}$), may be at 1% right tail significance level, the difference in the explanatory powers of both the models maybe captured, and if the estimated F-value is greater than the tabulated F-value, the null hypothesis (H_0: zero cross-sectional effect, and therefore constant intercepts) may be rejected, and the restricted regression (i.e. pooled regression) may conclude to be invalid, supporting the fixed effects panel regression model.

Once the poolability test, described above, suggest the suitability of the panel regression model for our sample of panel data, I have estimated both fixed-effects regression and random-effects GLS regression, with various sub-samples. Various sub-samples (e.g. *All Segments_All Ratings*; *All Segments_AAA Rating*, *All Segments_AA Rating*, *All Segments_A Rating*, *Bank-PSU-FI_All Ratings*, *NBFC_All Ratings*, *Corporates_All Ratings*) are created to understand the impact of various factors on the yield spread, for different rating classes and different sectors. Finally, the *Hausman test* is performed to make the suitable selection between fixed and random effect model. Results of the *Hausman* tests (H_0: The preferred model is random effects model), for all sub-samples, rejecting the null hypothesis at 1% level of significance, support in favor of the fixed effect model.

Accordingly, the final fixed effects model, with the final list of 13 independent variables selected, is structured, such that:

$$\begin{aligned} YS_{it} = {} & \alpha + \beta_1 C_{it} + \beta_2 RT_{it} + \beta_3 BA_{it} + \beta_4 CR_{it} + \beta_5 LN_{NOTit} + \beta_6 D\_BPF_{it} \\ & + \beta_7 D\_NBFC_{it} + \beta_8 LN\_NIFTY_{it} + \beta_9 LN\_NIFTY\_Turn_{it} \\ & + \beta_{10} \mathrm{Ret.\_}USD/INR_{it} + \beta_{11} GOI\_10Y_{it} + \beta_{12} GOI\_10Y2Y_{it} \\ & + \beta_{13} OIS\_1Y_{it} + u_{it}; \\ u_{it} = {} & \mu_i + \nu_{it}; \nu_{it} \sim IID\left(0, \sigma^2_\nu\right) \end{aligned}$$

where *YS* = traded yield spread; *C* = bond's coupon rate; *RT* = bond's residual tenor; *BA* = bond's age; *CR* = bond's credit rating; *LN_NOT* = log (Bond's No. of Trades); *D_BPF* = Dummy Variable (for Bank-PSU-FI Bonds); *D_NBFC* = Dummy

Table 5 Important summary statistics of segment-wise trades in corporate bond market in India

Summary of bond market data (Year: 2011–2016; all rating classes, different segment)									
Bond parameter	Bank-PSU-FI			NBFC			CORPORATES		
	Mean	S.D.	Range	Mean	S.D.	Range	Mean	S.D.	Range
Spread over G-Sec	0.57%	0.60%	7.69%	1.11%	0.68%	9.18%	1.38%	0.76%	11.34%
FIMMDA spread	0.68%	0.35%	3.51%	1.10%	0.46%	4.24%	1.05%	0.49%	4.21%
Traded yield	8.74%	0.79%	7.07%	9.19%	0.87%	10.15%	9.53%	0.93%	11.93%
Res. tenor (Yr)	8.19	9.43	88.75	4.90	6.70	88.15	9.01	14.82	88.76
Bond age	1.10	1.41	11.69	1.01	1.16	12.16	1.29	1.33	10.40
Coupon	8.98%	0.67%	5.90%	9.46%	0.80%	7.55%	9.70%	0.90%	8.50%
Trade Vol. (Cr)	53.05	108.78	5446.51	43.33	73.13	2038.00	45.90	75.04	1805.00
No of trades	3.40	5.14	253.00	2.22	2.23	65.00	2.53	3.21	49.00

Variable (for NBFC Bonds); *LN_NIFTY* = Log of NIFTY 500; *LN_NIFTY_Turn* = Log (NIFTY 500 Turnover); *Ret._USD/INR* = Return in USD/INR Exchange Rate; *GOI_10Y* = 10-Year GOI Yield; *GOI_10Y2Y* = 10Y GOI Yield minus 2Y GOI Yield; *OIS_1Y* = 1Y OIS Rate.

4 Analysis of Research Findings

This section is broadly divided into two sub-sections. The first sub-section summarizes the descriptive statistics of historical trades in corporate bonds (segment-wise, rating-wise) in India, along with the other market variables, followed by the association/co-movement between the variables. The results of the fixed effects panel regression model, capturing the factors/determinants affecting the corporate bond yield spreads in India are discussed in the subsequent sub-section.

The following two Tables 5, 6 summarize the average statistics and average variation in few selected parameters of all the daily trades, within the selected sample of roughly 63000 trades, in corporate bonds, issued by various segments of issuers, and also with different rating classes. The average traded yield spread, its daily average variation, and the range within which the yield spread varies, all are found to be the least in case of bonds issued by Banks/PSUs/FIs, as even being reflected from the average spread data suggested by the FIMMDA. In contrast to the FIMMDA consideration, where spread for NBFC bonds are more than bonds issued by corporates, the actual trade data reflect a different situation while comparing the average yield spread and its variation for bonds issued by NBFC and Corporates. The following table clearly demonstrates that the average traded yield spread and its average variation for bonds issued by NBFCs are not the highest, as expected, rather the bonds issued by corporate entities are found to be most risky, maybe due to a high level of counterparty risk or due to a lower level of liquidity.

If we look into the average residual tenor of all trades, bonds with residual maturity within a range of 8–10 years are more liquid and therefore attracts more trades,

Table 6 Important summary statistics of rating-wise trades in corporate bond market in India

Summary of bond market data (Year: 2011–2016; all segments, different rating classes)												
Bond parameter	AAA			AA			A			BBB and Below		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Spread over G-Sec	0.64%	0.54%	8.12%	1.38%	0.81%	7.73%	1.56%	1.24%	11.61%	1.77%	1.25%	5.62%
FIMMDA spread	0.71%	0.32%	2.51%	1.19%	0.42%	2.68%	1.82%	0.51%	3.56%	2.91%	0.63%	2.55%
Weighted avg. yield	8.79%	0.79%	8.44%	9.49%	0.89%	8.90%	9.82%	1.03%	12.92%	10.06%	1.22%	5.89%
Residual tenor (Yr)	6.42	5.35	88.59	11.01	18.85	88.78	9.95	10.14	88.71	6.42	3.83	9.70
Bond age	1.12	1.38	12.16	1.02	1.18	11.35	0.80	1.02	7.95	0.89	1.51	10.40
Coupon	9.04%	0.68%	6.95%	9.71%	0.84%	7.50%	9.93%	1.06%	6.00%	10.38%	1.21%	6.00%
Credit rating (No.)	18.00	0.10	2.00	15.32	0.77	2.00	12.23	0.60	2.00	8.23	1.55	5.00
Trade Vol. (Cr)	52.39	103.58	5446.51	38.98	65.72	1808.50	38.31	60.48	675.00	76.77	132.43	785.00
No of trades	3.08	4.66	253.00	2.51	2.83	65.00	3.19	3.49	32.00	3.63	4.50	24.00

Table 7 Association between bond and other market parameters and corporate bond yield and yield spread for various issuers' segments

Correlation between selected market parameters and traded yield and yield spread						
	Yield spread			Traded yield		
	Bank-PSU-FI (%)	NBFC (%)	Corporate (%)	Bank-PSU-FI (%)	NBFC (%)	Corporates (%)
Coupon	**57.93**	**59.99**	**62.66**	63.52	65.68	71.58
Res. tenor (Year)	12.74	7.29	21.69	14.22	9.52	33.79
Bond age	− 8.15	− 11.92	− 9.47	− 14.75	− 14.04	− 10.99
Credit rating (No.)	**− 36.74**	**− 44.04**	**− 33.92**	− 29.13	− 37.30	− 27.30
Trade volume	3.28	− 7.39	− 1.02	2.94	− 10.48	− 7.68
No. of trades	6.89	− 2.55	4.77	12.96	− 1.20	11.17
NIFTY 500	− 18.46	− 15.92	− 9.65	− 51.77	− 53.46	− 43.51
NIFTY turnover	− 11.14	− 10.60	− 7.40	− 31.35	− 31.20	− 27.92
USD/INR	− 0.66	− 0.60	− 2.60	0.73	0.20	− 2.41
FIMMDA GOI 10− Y	− 4.79	− 15.28	− 8.15	66.12	58.46	57.08
GOI10Y-2Y	− 1.41	0.13	1.82	− 1.44	− 9.83	2.15
OIS_1Y	− 2.42	− 12.35	− 10.37	64.31	− 30.29	52.06
FIMMDA spread	**50.67**	**53.29**	**44.56**	46.86	36.81	28.34

Bold values represent Moderate or Higher degree of correlation as per the general rule of thumb

especially for bonds issued by Bank/PSU/FI and Corporates. Since 10 year is the most important benchmark point in risk-free term structure in India, trades even in any non-govt. securities are expected to be concentrated near this point, but with a very high level of average variation, implying popularity of bonds with other maturity levels (Low and High) as well. On the other hand, if the average age of all the bonds traded is considered, the findings are in line with the existing literature, where bonds issued in recent periods and therefore with a lower age (1–1.5 years) are expected to be more liquid and therefore experience more trades. If the liquidity in bonds issued by different segments is taken into consideration, bonds issued by Banks/PSUs/FIs are found to be more liquid, as depicted by both the Average Volume and Number of Trades, but also with a higher level of variation.

Trade summaries in non-govt. securities, issued by all segments, but with different rating classes, given in Table 6, may also be analyzed to understand the trade dynamics in corporate bonds with different level of creditworthiness. As expected, the average yield spread, out of all the daily trades captured in the sample, and its average variation, both are found to be higher for trades with a lower level of credit rating. Trades in securities with the lowest credit rating (BBB and Below) attract the highest yield spread, with a higher level of variation among trades in similar securities. If the average market spread, given by FIMMDA, and the average trading spread, extracted from actual trades, are compared over various rating classes, the FIMMDA spread almost for all rating class (except for AA) are found to be higher than the average trading spread in securities of similar rating. This difference between FIMMDA spread and trading spread even widens for securities with

Table 8 Association between bond and other market parameters and corporate bond yield and yield spread for various rating classes

Correlation between selected market parameters and traded yield and yield spread						
	Yield spread			Traded yield		
	AAA (%)	AA (%)	A (%)	AAA (%)	AA (%)	A (%)
Coupon	**54.16**	**62.74**	**76.48**	61.49	67.24	83.11
Res. tenor (Year)	− 14.74	11.75	4.50	− 1.02	19.91	4.21
Bond age	− 9.66	− 3.09	13.98	− 14.15	− 8.37	16.70
Credit rating (No.)	7.37	− 20.43	25.39	4.24	− 20.46	24.15
Trade volume	2.23	− 1.96	− 7.48	0.78	− 5.41	− 12.20
No. of trades	3.04	− 4.57	− 2.48	9.58	2.02	− 8.21
NIFTY 500	**− 28.28**	5.96	15.23	− 60.53	− 29.33	− 13.79
NIFTY 500 turnover	− 17.68	2.52	12.77	− 36.82	− 17.12	− 5.16
USD/INR	− 0.88	− 0.90	12.54	0.46	− 0.31	− 0.24
FIMMDA GOI 10− Y	0.23	− 22.71	− 53.66	73.03	43.28	− 4.38
GOI10Y− 2Y	0.08	5.23	6.82	− 3.80	1.78	12.39
OIS_1Y	2.69	− 23.90	− 53.37	71.88	40.50	− 7.41
FIMMDA spread	**55.18**	**33.37**	**42.50**	41.82	20.19	26.63

Bold values represent Moderate or Higher degree of correlation as per the general rule of thumb

lower credit rating. This practice of suggesting a yield spread higher than the trading spread, and also widening such spread for low rated securities, simply denotes a conservative approach by the regulatory bodies in India to deal with non-govt. securities and their valuation. Higher average variation (S.D.) in the trading spread, almost for all rating classes, highlight the fact that the actual market is more volatile than the average market expectation. Statistics on residual tenor and age of securities traded indicate higher tradability for bonds with an average residual maturity of 6–10 years, and with an average age of 1–1.5 years. Liquidity parameters (average volume and number of trades) exhibit the fact that liquidity is more for safer bonds, and it narrows down once we move from better credit rating to poor rating.

In order to understand the dynamics of corporate bond trades and movement of yield spread on trades in securities under various issuers' segment and rating classes, it is also important to study the co-movement/association between traded yield/yield spread with other bond specific factors and other market parameters. The degree of correlation between selected parameters (bond specific and other market) and traded yield and yield spread, for trades in securities under various issuers' segments and various rating classes, are briefed in Tables 7, 8. The first table captures the correlation estimated for trades in securities issued by three different segments, whereas the similar estimate but for trades in securities under various rating classes are captured in the subsequent table.

The direction (positive or negative) of most of the associations are as per whatever is seen in the standard literature, except few exceptions. But the degree (strong or weak) of few of such association may contradict with the standard findings drawn in most of the existing literature, possibly due to immature corporate

bond market with inconsistent and infrequent trading in securities over various issuing sectors and/or rating classes.

Referring to Table 7, exhibiting the association between yield spread and other factors for trades in securities under various issuing sectors, a reasonable degree of correlation is established between yield spread and coupon and credit rating. There is also some expected but weak association between yield spread and few other bond parameters (residual tenor and bond age) and growth in the equity market (index value and its turnover). The nature of the association between yield spread and other factors for trades in securities under various rating classes, exhibited in Table 8, is slightly different. Unlike found for trades in securities of various issuers segments, there is no significant association between yield spread/yield and credit rating. The possible reason could be the segmentation of the sample based on three broad classes of credit rating, within which there may not be many variation in trades with various rating notches under the broader rating (e.g. AAA+, AAA, and AAA− within AAA rating class, and so on). The associations with other variables, even if found as expected (in terms of positive/negative), but not sufficiently strong, as suggested in the existing literature. Among the control variables, even if a strong association is established between deal-wise yield spread and the average market spread, the same is found to be as expected but weak for risk-free term structure.

Even if the nature of such association between yield spread or traded yield and the selected parameters are more or less same, the degree of association between traded yield and the selected parameters (bond specific and market-wide) are found to be stronger in this study, again exhibiting a strong relationship between trade in corporate bonds and the selected variables. A brief summary of expected and observed association between yield spread and other selected parameters are given in Table 9.

4.1 Results of Fixed Effects Panel Regression

After summarization of the market dynamics of all possible trades in different types of non-govt. securities in India, followed by capturing the association between yield spread and other variables, a further attempt is made to understand the possible determinants/factor affecting the yield spread on the panel of deals (deals across securities and across time) using the panel regression model. As suggested by the results of Hausman test, carried out for the selection of suitable model, between the fixed effects and random effects panel regression, the fixed effects model is invariably selected, for all the sub-samples (segment-wise and rating-wise). Therefore, the results of the fixed effect panel regression model, for all the six panels (Segment-wise: *Bank-PSU-FI Panel*, *NBFC Panel*, and *Corporates Panel*; Rating-wise: *AAA Panel*, *AA Panel*, and *A Panel*) are reported and analyzed in this section. It may be noted here that the segment dummies will be absent in all the three issuers segment-wise panels.

Table 9 Fundamental versus observed relation between yield spread and other parameters

Yield spread and other parameters: fundamental versus observed relation			
Selected parameters	Fundamental relation	Observed relation	Explanation
Coupon rate	Positive	Positive	High credit risk/tax/lower liquidity → higher coupon → higher spread
Residual maturity	Positive	Positive/negative	Higher maturity → lower (higher) liquidity → higher (lower) spread
Bond age	Positive	Negative	Higher age → lower liquidity → higher spread
Credit rating	Negative	Negative	Higher rating → lower spread
Trading vol. and no. of trades	Negative	Negative/positive	Higher liquidity → lower spread
Equity Index (value and turnover)	Negative/positive	Negative/positive	Higher value (turnover) in equity → lower (higher) yield spread
FX market (USD/INR)	Negative	Negative	Higher FX rate → higher risk-free rate → lower spread
Risk-free yield (level and slope)	Negative	Negative/positive	Higher risk-free rate/steeper risk-free YC → lower spread
Avg. market spread	Positive	Positive	Higher avg. market spread → higher spread

Table 10 Fixed effects panel regression results on factors affecting yield spread for bonds under various issuers' segments

FE panel regression results: comparison among various segments						
Regression variables and parameters	Bank-PSU-FI		NBFC		Corporates	
	Coef.	P > |t|	Coef.	P > |t|	Coef.	P > |t|
Coupon	0.04898	0.643	−0.44163	0.066	8.38184**	0.000
Residual tenor	−0.00004**	0.000	−0.00007**	0.002	0.00000	0.735
Bond age	−0.00040**	0.000	−0.00036**	0.000	−0.00043**	0.000
Credit rating no	−0.00011**	0.000	−0.00005	0.419	−0.00049**	0.000
LN (no. of trades)	0.00013**	0.000	0.00005	0.152	0.00009	0.191
BPF dummy						
NBFC dummy						
LN (NIFTY 500)	−0.00766**	0.000	−0.01286**	0.000	−0.00652**	0.000
LN (NIFTY 500 turnover)	0.00012*	0.029	0.00026*	0.013	0.00040	0.078
USD/INR change	−0.01828**	0.000	−0.01453**	0.000	−0.01182	0.202
GOI-10Y	−0.34203**	0.000	−0.44556**	0.000	−0.06418	0.074
GOI (10Y-2Y)	0.17195**	0.000	0.23483**	0.000	−0.13792**	0.001
OIS-1Y	0.10353**	0.000	0.13758**	0.000	−0.21777**	0.000
Constant	0.08793**	0.000	0.18774**	0.000	−0.71667**	0.000
R2 (within)	0.2582		0.329		0.1655	
R2 (between)	0.1381		0.2338		0.4847	
R2 (overall)	0.1316		0.0995		0.4025	
F-Stat	1183.99**	0.0000	700.5**	0.0000	105.2**	0.0000
Correlation (μi, Xb)	0.0885		−0.7339		−0.9977	
Poolability test (F test that all u_i = 0):	70.730**	0.000	16.760**	0.000	13.560**	0.000

Tables 10, 11 highlights the results of the fixed effect model, applied to the segment-wise panels and rating-wise panels. The results basically show the statistical significance of almost all the selected independent variable, with few exceptions, followed by the model's overall goodness of fit. Even if FIMMDA Spread, to capture the average market spread for various issuers segments and rating classes, was proposed to be included in the original fixed effect model, as a control variable, the same is dropped in the final model. Since the respective average FIMMDA spread broadly captures the credit risk component of the yield spread in all possible trades, inclusion of another rating variable in the model to capture the impact of credit risk may not make much sense, and therefore the rating variable in our model, almost for all the panels, was coming statistically insignificant and/or with unexpected association. Exclusion of the FIMMDA spread as a control variable, even if have some impact on the model's overall goodness of fit, the same is not found to affect the statistical significance and explanatory power of any other variable in the model. Based on the sign of all the coefficients and their respective probabilities (to reject the H_0: Coefficient is Zero and the concerned independent variable do not affect the

Table 11 Fixed effects panel regression results on factors affecting yield spread for bonds under various rating classes

FE panel regression results: comparison among various segments						
Regression variables and parameters	AAA		AA		A	
	Coef.	P > |t|	Coef.	P > |t|	Coef.	P > |t|
Coupon	−0.00551	0.956	0.05979	0.838	0.00000	
Residual tenor	0.00000	0.387	−0.00002**	0.001	0.00004**	0.008
Bond age	−0.00032**	0.000	−0.00001	0.932	−0.00019	0.481
Credit rating no	−0.00162**	0.000	−0.00104**	0.000	−0.00099*	0.014
LN (no. of trades)	0.00010**	0.000	0.00003	0.687	−0.00001	0.957
BPF dummy	−0.00816**	0.000	0.00345	0.170	−0.01417**	0.006
NBFC dummy	−0.00876**	0.000	0.00214	0.186	−0.00542	0.191
LN (NIFTY 500)	−0.00890**	0.000	−0.01073**	0.000	−0.00663**	0.000
LN (NIFTY 500 turnover)	0.00016**	0.000	0.00032	0.093	0.00018	0.676
USD/INR change	−0.02013**	0.000	−0.00711	0.363	0.02986	0.089
GOI-10Y	−0.33279**	0.000	−0.33784**	0.000	−0.50911**	0.000
GOI (10Y-2Y)	0.15532**	0.000	0.16480**	0.000	−0.13429	0.138
OIS-1Y	0.10797**	0.000	−0.01825	0.487	−0.31333**	0.000
Constant	0.13752**	0.000	0.14003**	0.000	0.16027**	0.000
R2 (within)	0.3276		0.1706		0.3789	
R2 (between)	0.097		0.1418		0.2963	
R2 (overall)	0.1386		0.0622		0.4409	
F-Stat	1770.6**	0.0000	152.73**	0.0000	94.03**	0.0000
Correlation (μi, Xb)	−0.1267		−0.0818		0.1518	
Poolability test (F test that all u_i = 0):	51.37**	0.000	9.71**	0.000	43.49**	0.000

dependent variable), supplemented by the values of R^2 and F-statistics, the impact of all the selected determinants/factors in capturing the movement of corporate bond yield spread may be summarized as follows:

4.1.1 Finding No. 1

Even if most of the factors are found to be statistically significant, marginal contribution of most of the variables in explaining the dependent variable (i.e. yield spread) are very small. Even if some variables are found to have a significant and expected relationship in some specific panel (issuers segment-wise and/or rating-wise), the same may not be true across the panels.

- Factors selected to capture the movements in the corporate bond yield spread are expected to be very important. But may be due to extremely infrequent and irregular trades in most of the non-govt. securities in India over the periods, mak-

ing the panel heavily unbalanced, strong relationship between the dependent and independent variables could not be established.
- A different relationship between the same pair of variables, but in different panels, as observed in the fixed effects results, are not something unexpected/abnormal. Market dynamics are not expected to be similar for securities of different types (different issuers segments, different rating classes). Therefore, whatever relation is standard and expected for trades in securities in one segment (e.g. Bank/PSU/FI or AAA rating), the same may not be valid for trades in other segments. This differences may be even stronger if the market is extremely heterogeneous in terms of trades in securities under various issuers segments and rating classes, which may be the case in an illiquid market like in India.

4.1.2 Finding No. 2

Unlike observed in the correlation statistics, no significant relationship between coupon rates and the yield spread is found, except for trades in securities issued by corporates.

- Coupon Rate, possibly expected to capture the credit/liquidity risk and/or tax effects, is found to be insignificant, may be due to the presence of credit rating to capture bonds' credit risk, and insignificant tax effect on the yield spread in the Indian market. Liquidity for securities issued by a particular segment and with higher credit rating may not again largely depend upon the coupon.

4.1.3 Finding No. 3

Longer the Residual Tenor of a bond, Higher (Lower) would be the credit and/or liquidity risk, and wider (narrower) would be the Yield Spread, exhibiting a positive (negative) relationship between them.

- Unlike whatever is observed through the correlation statistics, a mixed results is found in the fixed effect panel model. Even if residual tenor is found to have a significant impact on the yield spread for trades in securities issued by Bank/PSU/FI and NBFC, the same relationship do not support the standard expectation, as exhibited in the existing literature. Here, the possible explanation could be the dominance of medium term (8–12 years) risk-free yield that encourages the market also to trade in medium term corporate bonds, resulting to a negative relationship between residual maturity and yield spread.
- Even if a positive relationship is observed between residual tenor and yield spread in two out of three panels of different rating classes, the same is found to be significant only for bonds with 'A' rating. The relationship, even if positive, but found to be statistically insignificant for bonds with the highest level of safety (i.e. for AAA rated bonds), reflecting a fact that liquidity and therefore the yield spread of such security is not broadly driven by bonds' residual maturity.

4.1.4 Finding No. 4

Older the bond issue, higher is the liquidity, and lower is the yield spread, exhibiting a negative relationship, as also supported by the correlation statistics.

- Unlike found in the literature, where age of securities and yield spread are expected to be positively related, a negative relationship is observed in almost all possible panels. Possibly, securities which are issued and therefore available in the market for a longer period, maybe with a stable trading history, attracts more liquidity and lower yield spread, leading to a negative association.

4.1.5 Finding No. 5

Without any deviation from the literature, better the credit rating, lower the default risk, and lower would be the yield spread, exhibiting a negative relationship between credit rating (number) and yield spread almost in all the panels, also supported by the correlation statistics.

- Even if the rating coefficient is negative and significant for all the three panels representing the three rating classes, the explanatory power of the same variable is found to be maximum for trades in bonds with the highest level of safety (i.e. AAA rating class), followed by 'AA' and then 'A'. This clearly indicates that yield spreads in high rated securities are relatively more sensitive to change in credit quality even by one notch (e.g. AAA to AAA− or to AAA+).

4.1.6 Finding No. 6

Higher the Liquidity of a deal (as measured by No. of Trades), Larger is the Yield Spread, but statistically significant only for deals in Bank/PSU/FIs segment and for deals with the Highest rating class (i.e. AAA).

- Unlike found in the literature, our results exhibit a partly significant but unexpectedly positive relationship between the liquidity and yield spread, may be due to irregular trades in most of the securities throughout the sample period, and also due to insufficient liquidity information captured by the liquidity measure selected in this study. Use of a better liquidity measure maybe in a sample of more regular trades in securities, can establish a desired relationship between liquidity in non-govt. securities and their yield spread.

4.1.7 Finding No. 7

Higher the value of equity indices, lower would be the expected risk in investment in those listed corporates, narrower would be the yield spread, denoting a negative relationship between the value of equity index and corporate bond yield spread. On the other hand, higher the Turnover in the equity market, lower would be the bond investments, causing a fall in bonds' liquidity, and therefore rise in Spread,

suggesting a positive relationship between turnover in the equity market and bond yield spread.

- Even if the desired relationship between value of equity index and yield spread is observed, the relationship between equity market turnover and bond yield spread are found to be positive and significant only for deals in securities issued by the Bank/PSU/FIs and NBFC segments, and with the highest rating class (AAA Bonds). The possible reason for this partially significant results may be due to relatively more liquidity in trades under such segments and therefore strong linkages with the other financial market segment.

4.1.8 Finding No. 8

Issuing Sectors, represented by the Segment Dummies, significantly affect the corporate bond yield spread, at least for trades in High Rated Securities

- Segment dummies are not found to be statistically significant for trades in other two rating classes, may be possibly due to a fact that traders, interested to trade in low rated bonds, mostly consider the credit risk and liquidity, not the issuing sectors, of the securities. Alternatively, since AAA bonds have a very low level of credit risk and higher liquidity, traders may consider the issuing sector as a criterion to select a bond.

4.1.9 Finding No. 9

Significant role of Control Variables (i.e. Risk-free yield curve: Levels and Slope, OIS Rate representing the Term Lending/Borrowing Rate between AA rated entities) in capturing yield spread movements, for bonds with almost all sectors, and all rating classes.

4.1.10 Finding No. 10

Even if there is a mixed result in terms of the statistical significance of individual variables/factors, for different panels, the fixed effects results (R^2 and F-statistics) clearly indicate models' overall goodness of fit, for all the panels. Even if R^2 (Within) values are relatively small, the same may be considered reasonable looking at the unbalanced nature of the panel.

5 Concluding Remarks

Being an important segment of the financial market of a developing economy like in India, the presence of a vibrant, deep and robust corporate bond market is very crucial for its overall growth. The success of a corporate bond market further lies on widening the scope of market players (Bond Issuers, Investors, and Traders), high Level of trading activity, and therefore higher liquidity, for bonds issued by all

possible sectors, and for all rating classes. Appropriateness of the yield spreads at which non-govt. securities are expected to be priced and traded is one of the major concern for market players to enter into such segment. Therefore analysis of such spread, especially in developing markets, has become a much-researched topic. With this motivation, I have attempted to study the market dynamics of corporate bond yield spread in India, and have tried to identify the possible factors affecting bonds' liquidity, credit quality and therefore the yield spreads.

Daily corporate bond trade and spread data (more than 90,000 daily trades in roughly 4000 securities), over a period of 6 years, classified into various subsamples (Issuers Segment-wise, Rating-wise) are analyzed within a basic statistical framework and Fixed Effects Panel Regression Model. The model attempted to capture the impact of few selected variables (Coupon Rate, Residual Maturity, Bond Age, Credit Rating, Number of Bond Trades, Segment Dummies, NIFTY 500, NIFTY 500 Turnover) on corporate bond Yield Spread in India.

The average traded yield spread, its daily average variation, and the range, all are found to be the least in case of bonds issued by Banks/PSUs/FIs, which are further found to be mostly liquid in India. As expected, average yield spread and its average variation, both are found to be higher for trades in securities with a lower level of creditworthiness, which further found to be relatively illiquid. While comparing the average market (FIMMDA) spread and the average trading spread, over various rating classes, the FIMMDA spread almost for all rating class are found to be higher than the average trading spread in securities of similar rating. This difference between FIMMDA spread and trading spread even widens for securities with lower credit rating, denoting a conservative approach, proposed by the domestic regulator, to deal with non-govt. securities in India. Default risk is found to significantly affect the yield spread, for almost all possible types of securities. Even if the summary statistics and fixed effect results broadly support the relationship between bond liquidity and yield spread, use of better liquidity proxy measure may improve the said relationship. Movements in equity market also found to affect the corporate bond yield spread in India.

The above findings may help the market players and concerned stakeholders to understand the dynamics of Indian corporate bond market better, and also to gain insights towards the movement of the yield spread and its possible variation due to multiple factors, including liquidity, credit quality, other market movements, etc.

Even if a significantly large sample is used to address the research objective, infrequent and irregularity in daily trades in most of the securities throughout the sample period, leading to an unbalanced panel, may cause some of our major findings, not sufficiently strong or deviate from whatever is expected and supported by the existing literature.

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References

Acharya, V., Amihud, Y., & Bharath, S. (2010). Liquidity risk of corporate bond returns. Working Paper-16394, *National Bureau of Economic Research*. Source: https://core.ac.uk/download/pdf/66720 26.pdf.

Amihud, Y. (2002). Illiquidity and stock returns: Cross-section and time—series effects. *Journal of Financial Markets, 5,* 31–56.

Bao, J., Pan, J., & Wang, J. (2008). Liquidity of corporate bonds. *Working Paper*, MIT Sloan School of Management. Source: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1106852.

Bao, J., Pan, J., & Wang, J. (2011). The illiquidity of corporate bonds. *Journal of Finance, 66,* 911–946.

Beber, A., Brandt, M. W., & Kavajecz, K. A. (2009). Flight-to-quality or flight-to-liquidity? Evidence from the euro-area bond markets. *Review of Financial Studies, 22*(3), 925–957.

Campbell, J. Y., & Taksler, G. B. (2003). Equity volatility and corporate bond yields. *The Journal of Finance, LVIII*(6), 2321–2349.

Chakravarty, S., & Sarkar, A. (1999). Liquidity in US fixed income markets: a comparison of the bid-ask spread in corporate, government and municipal bond markets. *Working Paper*, Federal Reserve Bank of New York. Source: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.139.7322&rep=rep1&type=pdf.

Chen, L., Lesmond, D. A., & Wei, J. (2007). Corporate yield spreads and bond liquidity. *The Journal of Finance, LXII*(1), 119–149.

Collin-Dufresne, P., Goldstein, R. S., & Martin, J. S. (2001). The determinants of credit spread changes. *The Journal of Finance, LVI*(6), 2177–2207.

Covitz, D., & Downing, C. (2007). Liquidity or credit risk? The determinants of very short-term corporate yield spreads. *Journal of Finance, 62,* 2303–2328.

Crabbe, L. E., & Turner, C. M. (1995). Does the liquidity of a debt issue increase with its size? Evidence from the corporate bond and medium-term note markets. *The Journal of Finance, 50*(5), 1719–1734.

Diaz, A., & Navarro, E. (2002). Yield spread and term to maturity: Default vs. liquidity. *European Financial Management, 8*(4), 449–477.

Dick-Nielsen, J., Feldhutter, P., & Lando, D. (2012). Corporate bond liquidity before and after the onset of the subprime crisis. *Journal of Financial Economics, 103,* 471–492.

Elton, E. J., Gruber, M. J., Agrawal, D., & Mann, C. (2001). Explaining the rate spread on corporate bonds. *The Journal of Finance, LVI*(1), 247–277.

Ericsson, J., & Renault, O. (2006). Liquidity and credit risk. *The Journal of Finance, LXI*(5), 2219–2250.

Friewald, N., Jankowitsch, R., & Subrahmanyam, M. G. (2012). Illiquidity or credit deterioration: A study of liquidity in the US corporate bond market during financial crises. *Journal of Financial Economics, 105,* 18–36.

Houweling, P., Mentink, A., & Vorst, T. (2005). Comparing possible proxies of corporate bond liquidity. *Journal of Banking & Finance, 29,* 1331–1358.

Jankowitsch, R., Nashikkar, A., & Subrahmanyam, M. G. (2011). Price dispersion in otc markets: A new measure of liquidity. *Journal of Banking & Finance, 35*(2), 343–357.

Jing-zhi, H., & Huang, M. (2002). How much of the corporate-treasury yield spread is due to credit risk? *The Review of Asset Pricing Studies, 2,* 153–202.

Jong, F. D., & Driessen, J. (2006). Liquidity risk premia in corporate bond markets. *Working paper*, Tilburg University and University of Amsterdam. Source: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.487.927&rep=rep1&type=pdf.

Landschoot, A. V. (2004). Determinants of euro term structure of credit spreads. NBB Working Paper (No. 57), July 2004. Source: https://www.ecb.europa.eu/pub/pdf/scpwps/ecbwp397.pdf.

Landschoot, A. V. (2008). Determinants of yield spread dynamics: Euro versus US dollar corporate bonds. *Journal of Banking & Finance, 32*(12), 2597–2605.

Lin, H., Liu, S., & Wu, C. (2008). Non-default components of corporate yield spreads: taxes or liquidity? Working Paper. Source: http://ssrn.com/abstract=1105621.

Longstaff, F., Mithal, S., & Neis, E. (2004). Corporate yield spreads: default risk or liquidity? New evidence from the credit-default swap market. Working Paper, National Bureau of Economic Research. Source: (http://www.nber.org/papers/w10418).

Papageorgiou, N., & Skinner, F. S. (2006). Credit spreads and the treasury zero coupon spot curve. *Working Paper.* Source: http://ssrn.com/abstract=712361.

Pape, U., & Schlecker, M. (2007). Are credit spreads and interest rates co-integrated? Empirical analysis in the USD corporate bond market. ESCP-EAP Working Paper (No. 25), *European School of Management*. Source: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=998772.

Roll, R. (1984). A simple implicit measure of the effective bid–ask spread in an efficient market. *Journal of Finance, 39,* 1127–1139.

Shah, S. N., & Kebewar, M. (2012). US corporate bond yield spread a default risk debate. Working Paper, University of Orleans (France).

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