Are Liquidity and Credit Risk Key Determinants of Corporate Credit Spreads (CCS) in India?

Lithin B. M. [1]
Suman Chakraborty [2]
Nikhil M. N. [3]

Abstract

Purpose : The crumble of the financial markets through the recent crises wobbled precariousness in the corporate credit spreads (CCS) critical for risk management and bond pricing. Against this backdrop, this study investigated the role of liquidity and credit risk on CCS.

Methodology : The study applied three models using a battery of 392 active corporate bonds in India: pooled OLS, fixed effect, and IV-GMM. Data for the research were collected from Bloomberg and analyzed using Stata.

Findings : First, while credit risk did have a role in determining CCS, liquidity holds greater significance as a determining factor. Specifically, there was a 0.9560427 basis point increase in CCS for every basis point increase in bid-ask spread (liquidity). In contrast, CCS increased by 0.3460369 for every basis point increase in credit risk. Second, a negative coefficient for the interaction term between bid-ask spread and credit risk suggested that credit risk was a moderating variable that weakened the relationship between bid-ask spread and CCS.

Practical Implications : The managers should augment their risk management practices to manage liquidity risk better and maintain a higher credit quality to reduce the negative impact of liquidity risk on CCS. Moreover, the findings affirmed that the better the firm's credibility, the lesser the CCS would be, implying that firms should try to improve their credit ratings.

Originality : The results remained consistent across various regression models, and they held significant implications for the literature concerning the modeling of corporate bond prices.

Keywords : **bond pricing, risk management, corporate bonds, GMM, bid-ask spread, emerging market, panel regression**

JEL Classification Codes : C230, G10, G11, G12

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Liquidity and credit risk are critical determinants of corporate credit spreads (CCS), making them core issues in finance, especially during financial distress (Ledwani et al., 2022). While credit risk models, such as the structural and reduced form, have been the traditional theoretical foundations for understanding

[1] *Doctoral Scholar,* Department of Commerce, Manipal Academy of Higher Education, Manipal - 576 104, Karnataka. (Email : lithin.bm@learner.manipal.edu) ; ORCID iD : https://orcid.org/0000-0001-9332-7202
[2] *Professor (Corresponding Author),* Department of Business Administration, Manipal University, Jaipur - 303 007, Rajasthan. (Email : suman.chakraborty@jaipur.manipal.edu) ; ORCID iD : https://orcid.org/0000-0002-3999-7181
[3] *Doctoral Scholar,* Department of Commerce, Manipal Academy of Higher Education, Manipal - 576 104, Karnataka. (Email : nikhil.n7@learner.manipal.edu) ; ORCID iD : https://orcid.org/0000-0002-6760-2669

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CCS, empirical studies suggest that these models fail to explain the levels or changes in CCS (Chen et al., 2007). This has led to an increasing focus on understanding the impact of other variables, such as liquidity, firm-specific factors, and macroeconomic conditions, on CCS (Chang et al., 2021; Helwege et al., 2014). In particular, the theory of liquidity preference has been suggested to account for the importance of liquidity in explaining CCS. This theory suggests that investors strictly prefer liquidity and require a greater return for holding less liquid, longer-term bonds. While the role of liquidity in CCS is increasingly recognized, it is important to note that credit risk also plays a crucial role. In fact, liquidity and credit risk are often examined together and require equal importance (Ericsson & Renault, 2006; Zheng, 2006). Moreover, the increasing corporate accounting frauds, specifically in the Indian context, increase corporate risk, adding ingredients to the determinants of bond performance (Kumar, 2014).

Relevant to this discussion, as stated by T. Rabi Sankar in 2022:

> Reassuring trends can be seen in CCS variations. These spreads have broadened during times of stress and volatility, whether they be domestic or international, demonstrating the maturity of the corporate bond market in pricing. Therefore, understanding the evolution and resiliency of the corporate bond market requires an awareness of the previously described components and the factors that determine CCS, especially liquidity and credit risk.[1]

Therefore, this research endeavor proposes to address the following research problems: Are liquidity and credit risk significant determinants of CCS (after accounting for controls)? Does credit risk moderate the relationship between liquidity and CCS (interaction)?

The Indian capital market, a critical component of the country's financial system, has experienced significant growth and transformation in recent years (Faniband, 2020). Notably, the most appropriate studies established for developed markets are not necessarily applicable to emerging markets due to numerous market imperfections inherited in the Indian economy (Venugopalan & Vij, 2014). Therefore, understanding the sensitivity of CCS to both liquidity and credit risk is essential for effective credit risk management and predicting economic growth, particularly in emerging markets like India. Thus, the current research, motivated by this problem, employs a battery of 392 corporate bonds to empirically assess the impact of liquidity and credit risk on CCS.

Literature Review

Theoretical Background

The theoretical models have laid the foundation for pricing credit risky securities, and the most valuable insights can be drawn from the theoretical structural and reduced-form models. Black and Scholes (1973) developed a model for pricing options on common stock. However, the application of their option pricing model was later extended to corporate bond pricing by Merton (1974). As the research reviews, what is now referred to as Black-Scholes-Merton (BSM hereafter) model has many simplifying assumptions. Although some assumptions in the BSM model remain unrealistic, the BSM model was extended to include default before maturity (Black & Cox, 1976). The studies that have extended the BSM model by relaxing the assumptions are referred to as structural models. Structural models allow a bond portfolio manager to examine how the credit risk of corporate debt is a function of the issuer's leverage and asset volatility from a theoretical standpoint. As a result, the impact of

[1] Speech by Mr. T. Rabi Sankar, Deputy Governor of the Reserve Bank of India, at the Business Standard Summit, Mumbai, 21 December 2022.

a new stock or bond issue on a corporation's capital structure may be examined. While structural models are superior, they are criticized for being difficult to calibrate and computationally intensive. Unlike structural models where default is endogenous, reduced-form models are known for modeling the credit risk exogenously.[2] As it implies, the determination of default exogenously, as is applied in reduced-form models, proposes to endow with a simple framework for credit risk modeling and estimating the CCS. The proposition is that the reduced form model does not look at what causes default but considers the default event. The default time, the recovery rate process, and the risk-free interest rate are the primary factors that these models outline. The main framework for reduced-form models is the Poisson process, a traditional stochastic process. Duffie and Singleton (1999) and Jarrow and Turnbull (1995) developed the most well-known reduced-form models.

Overall, both classes of models contribute considerably to credit risk modeling. However, theoretical models have failed to explain the CCS in the literature. As a result, empirical studies have emerged as an improvement to mitigate the potential failure of theoretical models (Chen et al., 2007; Thakur et al., 2018). Therefore, the review expounds on various determinants of CCS that have become a point of interest for practitioners and scholars alike as a new and time-relevant research focus.

Empirical Evidence

Standard key performance indicators for liquidity, credit risk, and other corporate and macroeconomic factors need to be measured consistently worldwide to determine the progress of the bond markets' market depth and any initiatives taken to develop the bond market. In this context, assessing the explanatory power of liquidity and credit risk can help to evaluate the corporate bond markets' progress.

Credit Risk

Longstaff et al. (2005) empirically found that the default component might vary between 51% – 56% across different rating categories in Investment Grade bonds and 71% of spreads for Speculative-Grade bonds due to credit risk. Chen et al. (2007) indicated that neither the level nor the dynamic of CCS of corporate bonds over treasury bills could be fully captured by credit risk, which was in line with the results of Huang and Huang (2012). Demirovic et al. (2015) showed that equity volatility and credit risk (Merton's distance-to-default) outperformed the various identified accounting variables in the study in explaining the CCS. Further, Maalaoui Chun et al. (2014) empirically investigated the determinants within multiple regimes and found that default, liquidity, and market factors had significant power to explain CCS. Helwege et al. (2014) documented that liquidity and credit risk accounted for a significant portion of the variation in CCS. However, when testing the liquidity measures, proxies for liquidity poorly explained the variation in CCS. The evidence also undermined the explanation for a significant part of the spreads variation, indicating that an unidentified factor could be responsible for this variation.

Over the last two decades, CDS (credit default swap) has hit the mainstream. CDS are derivative contracts in which the contract seller may compensate contract purchasers in the corporate default event. Because it represents credit risk, the CDS will serve as a straightforward gauge for determining the default component in CCS (Longstaff et al., 2005).

[2] The value of any endogenous variable is determined within the model. The value is dependent on the other variables in the model. In contrast, exogenous variable's value is determined independent of the variables within the economic model.

Liquidity

The concept of a liquidity premium required by investors for illiquid securities dates back to Amihud and Mendelson (1986). Lo et al. (2004) further postulated that liquidity costs limit trading frequency. Chen et al. (2011) referred to this trading ability of security as trading liquidity or external liquidity, which indicated a security's ability to be rapidly exchanged in significant quantities at a minimal cost and without substantially changing the price. Lou and Sadka (2011) empirically disentangled the impact of external liquidity on the performance of securities. External liquidity could explain a significant fraction of CCS in the wake of assessing the performance of securities. A broad range of studies has accentuated the role of liquidity measures (Díaz & Escribano, 2020).

Amihud (2002) was the most insightful and straightforward to implement. This was particularly useful for ascertaining whether price impacted trading. The Amihud measure (ILLIQ) was the average ratio of the absolute return in a corporate bond to its traded volume during a given period. Roll (1984) developed a measure demonstrating that the effective bid-ask spreads were the first-order serial negative covariance of the price changes in adjacent trades. However, this measure has been extended in the extant literature to make allowances for adjusted idiosyncratic price changes and average prices to measure the covariance (Díaz & Escribano, 2020; Fong et al., 2017; Holden, 2009). Bao et al. (2008) investigated the liquidity of corporate bonds. An illiquidity measure was established by gauging the extent of price reversals in corporate bonds through transaction-level data. It can be concluded that the degree of illiquidity present in corporate bonds is significant, surpassing what can be attributed to bid-ask bounce alone.

The definition of illiquidity and its measurement remains unclear in the absence of a theory. Illiquidity, on the other hand, has two distinct features. First, it is caused by market frictions such as transaction costs and restrictions on trade and capital flows; second, its influence on the market is only temporary. However, starting from the popular Roll (1984) measure, which is based on subsequent price changes, several models or proxies for estimating intraday spread utilizing low-frequency data are proposed (Abdi & Ranaldo, 2017; Chung & Zhang, 2014; Cobandag Guloglu & Ekinci, 2022; Corwin & Schultz, 2012; Fong et al., 2017; Holden, 2009; Lesmond et al., 1999). Additionally, various studies have tested their performance and reported that the performance of these proxies is mostly unsatisfactory (Chung & Zhang, 2014; Cobandag Guloglu & Ekinci, 2022; Corwin & Schultz, 2012; Fong et al., 2017; Lesmond et al., 1999). Furthermore, because these proxies are engineered to measure liquidity regularly, their efficacy at higher frequencies is limited.

The lack of a theoretical framework makes defining and measuring illiquidity unclear. However, illiquidity is characterized by temporary market influence caused by market frictions such as transaction costs and restrictions on trade and capital flows. Several models or proxies for measuring intraday spread utilizing low-frequency data have been proposed, including Roll's (1984) measure (Abdi & Ranaldo, 2017; Chung & Zhang, 2014; Cobandag Guloglu & Ekinci, 2022; Corwin & Schultz, 2012; Fong et al., 2017; Holden, 2009; Lesmond et al., 1999). However, various studies have reported that the performance of these proxies is generally unsatisfactory and limited at higher frequencies (Chung & Zhang, 2014; Cobandag Guloglu & Ekinci, 2022; Corwin & Schultz, 2012; Fong et al., 2017; Lesmond et al., 1999). Notably, Amihud and Mendelson (1986) established a positive correlation between expected returns and the bid-ask spread, which was used as a measure of illiquidity, while investigating the impact of the bid-ask spread on asset pricing.

Other Determinants

Although liquidity and credit risk are the primary drivers of CCS, general factors such as macroeconomic and market-wide (Chen et al., 2007; Darwin et al., 2012; Helwege et al., 2014; Smaoui et al., 2017; Thakur et al., 2018)

bond specific and firm-specific factors including accounting variables (Darwin et al., 2012; Febi et al., 2018; Kim & Stock, 2014) play a significant role in explaining the CCS. Market-wide variables tend to explain a large portion of CCS (Darwin et al., 2012). However, when re-examined, Tang and Yan (2010) found that firm-specific determinants had a sizeable explanatory power for credit risk.

Hypotheses Development

Based on the literature review, the study identifies three key variables: Liquidity, credit risk, and CCS. First, as documented in the extant literature, market participants demand a higher CCS for less liquid securities to compensate for the increased risk of being unable to sell the security quickly at a fair price. Thus, as the bid-ask spread increases, CCS will increase (Chen et al., 2007). Consequently, the following hypothesis has been developed.

- **$H0_1$:** There is no relationship between liquidity (bid-ask) and CCS.

Second, the review suggests that market participants demand a higher CCS for securities with higher credit risk to compensate for the increased likelihood of default (Chen et al., 2007). As a result, the following hypothesis has been formulated.

- **$H0_2$:** There is no relationship between credit risk and CCS.

Finally, evidence documented in the literature suggests that the relationship between liquidity and CCS may vary depending on the credit risk of the security (Ericsson & Renault, 2006; Zheng, 2006). Market participants may demand a higher CCS for securities with low liquidity and high credit risk to compensate for the increased risk of holding such securities. Hence, the following hypothesis has been postulated.

- **$H0_3$:** Credit risk does not moderate the relationship between liquidity and CCS.

Research Objectives

- To examine the relationship between liquidity (bid-ask) and CCS.
- To investigate the relationship between credit risk and CCS.
- To analyze the moderating effect of credit risk on the relationship between liquidity and CCS.

Research Methodology

Sample and Data

The research method for this article was quantitative research. Therefore, the financial data utilized in this study were obtained from the Bloomberg database. In addition, data pertaining to all active bonds were collected up to September 30, 2022. The entire corporate bond sample was carefully scrutinized to ensure the reliability of the results, and those samples lacking actual market transactions or with incomplete data on pertinent variables were removed from the analysis.

To ensure a robust analysis, we included only corporate bonds with at least two years remaining to maturity in the sample. This was done because bonds with longer maturities are less susceptible to trading near their maturity

date, as established by Warga (1992). In addition, bonds with embedded options were not included in the sample due to their tendency to impact bond prices (Thakur et al., 2018). These criteria were essential for the study, as previously noted in the literature (Thakur et al., 2018; Warga, 1992). The final sample comprised 392 bonds that met the aforementioned criteria, most holding AAA, AA+, and AA credit ratings.

Variables

This study measured the dependent variable, corporate credit spreads (CCS), using the yield difference between corporate bonds and sovereign securities, as commonly done in previous studies (e.g., Chen et al., 2007). The primary focus of the current research was to investigate the impact of liquidity and credit risk on CCS. Liquidity was measured as the average of the bid-ask spread, as shown in Equation 1, while credit risk was measured using credit ratings. Following Chen et al. (2007), a cardinal rating was assigned to each credit rating to measure credit risk.

The study included both liquidity and credit risk as independent variables. Additionally, the study controlled for several variables commonly used in the literature, including operating income to sales, leverage, size, time to maturity (TTM), level, slope, market return, and GDP (refer to Table 1 for the operational definition of the variables).

$$Average\ Bid-Ask\ Spread_t = \frac{Ask_t - Bid_t}{\frac{Ask_t + Bid_t}{2}} \qquad (1)$$

Ask_t and Bid_t are the "closing quotes on quarter t."

To enhance the efficiency of estimators, all data in this study were collected quarterly to form a panel structure. This approach provided benefits in estimation by increasing the number of observations available for analysis. In addition, panel data analysis was particularly advantageous because it controlled for unobserved time-invariant

Table 1. ***Description of Variables***

Variable	Operational Definition (Construct)
Panel A : Dependent Variable	
Corporate Credit Spreads (CCS)	The yield spread between a corporate bond and treasury security with a comparable maturity.
Panel B : Independent Variable	
Liquidity	Average bid-ask spread.
Credit Risk	The creditworthiness of bonds is assessed using a cardinal scale that spans from 1–22, with one indicating the highest rating for AAA bonds and 22 representing the lowest rating for D-rated bonds.
Panel C : Control Variables	
Operating Income to Sales	The ratio of operating income to sales.
Size	Natural log of total assets.
Leverage	The ratio of total debt to total assets.
Time to Maturity	Time remaining to maturity in months.
Level	3-month treasury rate.
Slope	Difference between 10-year benchmark bond yield and 2-year benchmark bond yield.
Market Return	Percentage Nifty 50 index quarterly return.
Gross Domestic Product (GDP)	Percentage growth in GDP rate.

heterogeneity, resulting in more accurate estimates. In summary, using panel data analysis in this study improved the quality and reliability of the results (Chang et al., 2021; Grandes et al., 2017; Tran & Pham, 2022; Mathad & Kumar, 2019).

Regression Models

The following regression model was employed to measure the impact of liquidity and credit risk on CCS in India.

$$CCS_{it} = \alpha_0 + \beta_1 Liq_{it} + \beta_2 CR_{it} + \beta_3 Op_{it} + \beta_4 Siz_{it} + \beta_5 Lev_{it} + \beta_6 TTM_{it} + \beta_7 Levl_{it} + \beta_8 Slop_{it} + \beta_9 Nif_{it} + \beta_{10} GDP_{it} + \varepsilon_{it} \quad (2)$$

where, *CCS* is the dependent variable corporate credit spreads; *Liq* represents liquidity; *CR* represents credit risk; *Siz* represents the total size of the firms; *Lev* indicates leverage ratio; *TTM* represents the time to maturity; *Levl* represents level; *Slop* represents slope; *Nif* and *GDP* being macro-economic indicators shows Nifty returns and GDP rate, respectively (refer to Table 1 for variables description); β_1, β_2, β_3, β_4, β_5, β_6, β_7, β_8, β_9, and β_{10} are the regression coefficients to be estimated for firm *i* at time *t*, and the error or unexplained portion in the regression model will be captured by ε.

This study initially examined the relationship between CCS and liquidity using pooled OLS and fixed effects models. However, evidence of endogeneity and reverse causality between these variables was observed. The instrumental variables generalized method of moments (IV-GMM) was used to address this concern to estimate the model's parameters. This ensured that the estimates of the parameters were consistent, even when endogeneity was present. If the goal is to estimate the parameters of a single equation, and there are valid instrumental variables available to address endogeneity, then IV-GMM may be the appropriate choice. Moreover, valid instrumental variables that satisfy the relevant criteria were identified rigorously and used in the study. All the analysis pertaining to the study was carried out using STATA software.

Analysis and Results

Summary Statistics

Table 2 exhibits the descriptive statistics of the variables under examination. The results indicate that the mean

Table 2. ***Summary Statistics***

	Corporate Credit Spread	*Credit Risk*	*Operating Income to Sales*	*GDP*	*Size*	*Leverage*	*Time to Maturity*	*Slope*	*Market Return*	*Level*
Mean	0.33	3.64	0.84	17.35	13.39	0.69	98.69	1.01	0.01	7.14
Median	0.50	1.49	0.91	17.38	13.69	0.77	95.00	0.92	0.01	7.08
Maximum	17.12	466.49	1.95	17.52	16.29	1.00	239.00	2.03	0.11	9.61
Minimum	–4.78	–10.27	–2.88	16.97	9.05	0.22	26.00	–0.12	–0.23	3.07
Std. Dev.	1.51	21.05	0.26	0.12	1.61	0.19	41.69	0.63	0.06	1.45
Skewness	0.24	18.27	–3.34	–0.77	–0.62	–0.67	0.72	–0.02	–2.12	–0.66
Kurtosis	7.81	379.94	37.38	3.08	2.30	2.27	3.32	1.60	9.21	3.42
Jarque-Bera	6238.5	38321962.0	233669.8	642.8	537.3	292.7	580.7	520.9	15118.5	510.4

Probability	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Sum	2134.3	23318.1	3837.1	111167.7	85854.1	2110.9	632901.0	6490.9	25.4	45800.3
Observations	6413	6413	4573	6408	6413	3042	6413	6431	6408	6413

values for CCS and credit risk are 0.33 and 3.64, respectively. These findings suggest that, on average, corporate bonds in the Indian corporate bond market trade at a higher yield than government bonds. Additionally, a high credit risk deviation reveals a significant diversity across the bonds studied. The control variables, including operating income to sales, size, leverage, TTM, slope, level, GDP, and market return, have means of 0.84, 13.39, 0.69, 98.69, 1.01, 7.14, 17.35, and 0.01, respectively. The wide variation in these independent variables suggests that the sample is diverse and suitable for analysis.

The normality of the data is checked using the Jarque-Bera test, which tests the hypothesis that the data are normally distributed. The test yielded a non-significant *p*-value at the 5% significance level, indicating that the data is not normally distributed.

Correlation Analysis

The correlation results reported in Table 3 show that liquidity (bid-ask) is positively associated with CCS, as evidenced by a reported correlation coefficient of 0.13. Similarly, credit risk is positively related to CCS, as indicated by a coefficient of 0.35. These findings are in agreement with the documented findings in the extant literature. The pairwise correlation among the variables is examined in the study to assess the potential collinearity issue among the independent variables. The results indicate that the correlation coefficients among liquidity, credit risk, operating income to sales, leverage, TTM, level, slope, market return, GDP, and the dependent variable CCS are all below 0.75. This suggests no significant collinearity problem in the research, as each independent variable is not highly correlated with any other variable.

Table 3. *Correlation Matrix*

	Corporate Credit Spread	Liquidity	Credit Risk	Operating Income to Sales	Size	Leverage	Time to Maturity	Level	Slope	Market Return	GDP
Corporate Credit Spread	1.00										
Liquidity	0.13	1.00									
Credit Risk	0.35	0.14	1.00								
Operating Income to Sales	–0.06	–0.14	–0.20	1.00							
Size	–0.30	–0.03	–0.46	0.20	1.00						
Leverage	0.04	0.01	–0.06	0.31	0.09	1.00					
Time to Maturity	–0.05	–0.01	–0.19	0.15	0.17	–0.06	1.00				
Level	–0.23	0.00	0.10	–0.09	0.00	0.03	–0.61	1.00			
Slope	–0.19	0.01	0.08	–0.11	0.00	0.04	–0.52	0.73	1.00		
Market Return	–0.03	0.01	0.01	–0.02	–0.01	0.00	–0.01	0.00	0.24	1.00	
GDP	–0.13	–0.01	0.09	–0.06	–0.01	0.06	–0.47	0.66	0.46	–0.17	1.00

Table 4. ***Variance Inflation Index (VIF) Analysis***

Variable	*VIF Coefficients*
Liquidity	1.050
Credit Risk	1.197
Operating Income to Sales	1.206
Size	1.1390
Leverage	1.321
Time to Maturity	1.755
Level	3.024
Slope	2.436
Market Return	1.278
GDP	1.842

Moreover, the variance inflation factor (VIF) tests collinearity among the variables. The VIF values, reported in Table 4, obtained for each variable are less than 5, indicating a low level of collinearity. Therefore, the results show that the research model is robust and reliable, and the independent variables are unaffected by significant collinearity issues.

Test for Stationarity

Table 5 presents the results of the ADF test for the variables used in the study. The test statistics of all the variables are significant at a 5% significance level, indicating that the null hypothesis of non-stationarity is rejected. This implies that the data of the variables selected in the study are stationary at the level. Therefore, the time series data used in the study is suitable for analysis using panel data techniques.

Table 5. ***Augmented Dicky - Fuller Test for Stationarity***

Variable	*Statistic*	*Probability*
Corporate Credit Spread	1820.87	0.00
Liquidity	953.5	0.00
Credit Risk	2514.35	0.00
Operating Income to Sales	1327.11	0.00
Size	3549.82	0.00
Leverage	624.2	0.00
Time to Maturity	644.08	0.00
Level	1311.0	0.00
Slope	1472.69	0.00
Market Return	2520.77	0.00
GDP	1112.12	0.00

Table 6. ***Estimates of Panel Data Using OLS and Fixed-Effects***

	Regression Models			
Variables	**OLS1**	**OLS 2**	**Fixed1**	**Fixed 2**
Liquidity	1.837348**	2.175976	1.57052***	2.572927***
Credit Risk	0.00365***	0.0032476***	0.00132***	0.0021081***
Operating Income to Sales	–0.10832***	–0.1073503***	0.01662	–0.0079518
Leverage	0.002118	0.0017143	0.104876***	0.1046184***
Size	–0.17392	–0.1737339***	0.026316	0.0258703
Time to Maturity	–0.00802***	–0.0080083***	0.005405***	0.0054675***
Level	–0.34672***	–0.3460506***	–0.33968***	–0.3397506***
Slope	–0.0929***	–0.092804***	–0.13079***	–0.1328612***
Market Return	–0.70172	–0.6989548	–0.64888***	–0.6489507***
GDP	–0.58989***	–0.5839453***	–0.6619***	–0.6675531***
Constant	16.25737	16.14369	12.88515	13.0178
Interaction		–0.0580092*		–0.1141245**
***R*-Squared**	0.137	0.1382	0.3707	0.3767

Note. *, **, *** are statistically significant at the 10%, 5%, and 1% level of significance, respectively.

Analysis of the Findings

In this section, the study presents a systematic approach to illustrate how the IV-GMM provides more reliable estimates compared to OLS and fixed-effects estimates. It commences by conducting an OLS analysis and subsequently implements a fixed-effects model, which proves inadequate in capturing endogeneity concerns. To overcome these issues, a rigorous GMM process to obtain accurate estimates is employed in the study. This step-by-step procedure effectively addresses endogeneity concerns and ensures the production of valid estimates.

Due to the widespread utilization of OLS in previous research, an OLS analysis is used to assess the direct impact of selected independent variables, namely liquidity and credit risk, on the dependent variable, CCS. The findings from this analysis are presented in Table 6. However, as suggested by Bielen and Marneffe (2018) and Ullah et al. (2021), the endogenous variable is identified before interpreting the results from the OLS to confirm whether the results obtained from the OLS model are consistent. Primary outcomes from the OLS model indicate that bid-ask spread (liquidity) positively impacts CCS with a coefficient of 1.837348, allowing us to reject the study's first hypothesis ($H0_1$). The results confirm the significant association between liquidity and CCS and are consistent with recent research by Chen et al. (2007). Similarly, credit risk is positively associated with CCS, implying that every 1 basis point increase in credit risk can increase the CCS by 0.00365 basis points, and thus, the study's second hypothesis, that is, $H0_2$ is rejected. The above findings align with the studies of Chen et al. (2007) and Mukherjee (2019).

In Model (1), it is observed that most control variables, such as TTM, level, slope, and GDP, negatively impact CCS. This suggests that the firm-specific and market-wide performance mechanisms can decrease the CCS, as shown in agency theory. Therefore, internal factors are likely to affect firm performance (Beiner et al., 2006).

Based on the consistent results in model (1), the study continues to test the third hypothesis ($H0_3$) in the Model (2), wherein we examined the moderating role of credit risk on the association between liquidity and CCS. The results indicate that the interaction terms are significant (–0.0580092), implying that credit risk plays a crucial

role in the impact of liquidity ($H0_3$ is rejected). In the context of the relationship between bid-ask spread, credit risk, and CCS, a negative coefficient will indicate that the effect of bid-ask spread on CCS is weaker (i.e., less positive or more negative) when credit risk is higher. In a market with low credit risk, where most bonds are considered relatively safe, bid-ask spreads may be narrower and have less impact on CCS. In this case, credit risk acts as a moderating variable because it influences the strength of the relationship between bid-ask spread and CCS.

The use of a simple pooled OLS regression method does not account for time-specific or firm-specific effects. The fixed effect model (FEM) and random effect model (REM) are commonly used to address this limitation. A Hausman test is performed to determine the most suitable model, following recommendations from Thakur et al. (2018). Results from the Hausman test suggest that FEM is the better model. The fixed effect panel regression analysis, presented in Table 6, is consistent with the OLS results reported earlier. Specifically, the results in FEM Models (1) and (2) reveal a significant positive relationship between CCS and liquidity, implying that an increase in bid-ask leads to an increase in CCS. The relationship between CCS and credit risk is also significant and positive, consistent with the OLS results. The coefficient on CCS in these models is positive and statistically significant at the 99% confidence level. The results for other variables, such as TTM, level, slope, and GDP, are consistent with existing literature. Interestingly, unlike the OLS results, the empirical evidence suggests a significantly positive relationship between CCS and leverage, indicating that higher levels of debt lead to an expansion of CCS.

A few studies, such as those conducted by Chen et al. (2007) and He and Milbradt (2014), identified endogeneity as a potential issue when examining the relationship between liquidity and CCS. Consequently, using OLS or fixed-effects models may result in inconsistent estimators (Bielen & Marneffe, 2018; Ullah et al., 2021). Furthermore, the use of fixed-effects models alone is also inadequate in addressing this issue. Thus, liquidity is treated as an endogenous variable to address the problem of endogeneity (Chen et al., 2007).

This study employs the IV-GMM (general method of moments) estimator, proposed by Arellano and Bond (1991), to account for the potential reverse causality between liquidity and CCS. GMM estimation has become increasingly popular among researchers, as it can provide better results than traditional 2SLS approaches. GMM estimation is particularly efficient in the presence of heteroscedasticity (Baum et al., 2003), avoids loss of observations when utilizing lags of internal instruments (Roodman, 2009), and does not necessitate the identification of exogenous instruments. Despite its advantages and widespread use in other research domains, the Arellano-Bond estimator is yet to be employed to address endogeneity concerns between liquidity and CCS.

The IV-GMM results reported in Table 7 demonstrate a negative and statistically significant effect of liquidity on CCS. The results show that a 1 unit increase in bid-ask spread, on average, leads to an increasing CCS by 0.9560427. Furthermore, the most significant impact is found for credit risk, such that a 1 unit increase in the credit risk increases the CCS by 0.3460369. For the entire sample, the impact of liquidity on CCS moderated by credit

Table 7. ***Estimates of Panel Data Using IV-GMM***

	Regression Models	
Variables	**GMM 1**	**GMM 2**
Liquidity	0.648783***	0.9560427***
Credit Risk	0.3428886 ***	0.3460369***
Operating Income to Sales	0.1117685	0.056089
Leverage	–0.0395134***	–0.0388795***
Size	0.0677987**	0.0764254**

Time to Maturity	–0.0080648***	–0.0080491***
Level	–0.2006779***	–0.2013006***
Slope	–0.3616219***	–0.3616498***
Market Return	–0.5585996	–0.564247
GDP	–1.197703***	–1.205714***
Constant	22.04042***	22.09626***
Interaction		–0.0516677***
Hansen over-id. test (*p*-value)	0.192	0.210
AR (2) Arellano-Bond test (*p*-value)	0.342	0.318

Note. *, **, ***: Statistically significant at the 10%, 5%, and 1% level of significance, respectively.

risk is negative and statistically significant, as expected, implying that higher credit risk accompanies higher liquidity risk. In IV-GMM, the significance of the coefficient for each variable is considered to have improved compared to other estimation methods.

For the entire sample, the impact of leverage is positive and statistically significant, as expected, implying that higher debt level results in increased CCS. Furthermore, size, TTM, level, slope market return, and GDP show significant results at a 1% significance level. The results, however, are consistent with those of OLS and fixed-effect regressions indicating the robustness and reliability of regression results. The consistency of the GMM estimator is assessed using the Arellano-Bond test and Hansen test. The results reported in Table 6 suggest that the internal instruments used in the analysis are valid.

Discussion

In the current economic landscape, measuring the impact of various determinants of CCS is crucial, especially in emerging markets where CCS is acknowledged as a key element for predicting economic growth. CCS is expected to provide insights into the magnitude of a corporate bond's risk, predict future uncertainty, and assess a bond's marketability.

The results indicate that liquidity risk has a positive and significant impact on CCS, which is consistent with previous studies by Chen et al. (2007), Landschoot (2008), Linnenluecke et al. (2020), Min et al. (2003), Rodríguez et al. (2019), and Thakur et al. (2018). Furthermore, the bondholders expect higher yields on the securities with either a higher risk of liquidity or lower liquidity (Chen et al., 2007). This relationship between CCS and liquidity is consistent across OLS, fixed-effect, and IV-GMM. The theoretical prior is that liquidity is expected to be priced in CCS, as less liquid bonds trade less frequently, realize lower prices, and exhibit higher CCS.

Further, evidence of a positive relationship between credit risk and CCS is observed in the study. This relationship is supported by a significant body of literature (Longstaff et al., 2005; Rodríguez et al., 2019). For example, Longstaff et al. (2005) demonstrate that credit risk accounts for more than half of credit spreads, and the default component may vary across different rating categories in investment-grade and speculative-grade bonds. However, credit risk cannot fully capture the level or dynamics of CCS of corporate bonds over treasury securities, which is consistent with the findings of Huang and Huang (2012).

The results suggest that credit risk and liquidity interact to influence CCS, a commonly used measure of the credit risk premium, as suggested by Ericsson and Renault (2006) and Zheng (2006). The study finds that highly rated bonds with lower credit risk tend to be more liquid and have lower CCS. However, the impact of liquidity on

CCS is more pronounced for bonds with higher credit risk, as Ericsson and Renault (2006) demonstrated. This is likely because bonds with higher credit risk may be more illiquid, which can eventually increase transaction costs resulting in higher CCS. Additionally, one company's default can significantly impact the connected financial world (Shah, 2022).

Although liquidity and credit risk are the primary drivers of CCS, other factors, such as macroeconomic and market-wide variables (Chen et al., 2007; Darwin et al., 2012; Helwege et al., 2014; Smaoui et al., 2017; Thakur et al., 2018), bond-specific, and firm-specific factors including accounting variables (Darwin et al., 2012; Febi et al., 2018; Kim & Stock, 2014), the influence of spillover effects on bond market (Patel et al., 2023), also play a significant role in explaining CCS. Market-wide variables explain a large portion of CCS (Darwin et al., 2012). However, firm-specific determinants can also have a sizeable explanatory power for credit risk (Tang & Yan, 2010). Moreover, results suggest that CCS declines as the level and slope of the default-free term structure grow. This negative relationship is consistent with previous studies by Chen et al. (2007), Campbell and Taksler (2003), Landschoot et al. (2008), and Longstaff (2002). When interest rates rise, the asset's expected growth rate increases, lowering the risk of default and narrowing the CCS. The yield curve's slope indicates the market's predictions for future economic prospects, and CCS is anticipated to narrow down. Changes in level, slope, and curvature or shape are all major yield curve risk factors, and Azad et al. (2018) offer evidence for a negative relationship between level and CCS. Overall, the findings highlight the importance of considering credit risk and liquidity when analyzing the credit risk premium in fixed-income markets. By understanding how these factors interact, investors can make more informed investment decisions and better manage portfolio risk.

Implications and Conclusion

This study aims to examine the impact of liquidity and credit risk on CCS in India using a unique dataset covering 392 active corporate bonds. Specifically, results demonstrate that a comprehensive understanding of CCS in emerging bond markets should account for liquidity and credit risk. As a result, pooled OLS and fixed effects to control unobserved heterogeneity in panel data are used in this study. However, later GMM is employed due to the presence of endogeneity. Hence, GMM estimates the model's parameters in the presence of endogeneity, improving the results' robustness.

The results show that liquidity and credit risk are both significant determinants of CCS in India, with more liquid securities and securities with lower credit risk tending to have narrower spreads. Furthermore, the results support the view that liquidity and credit risk interact to influence CCS in emerging bond markets, indicating that future studies in emerging markets should account for both factors. Further, the combined effects of liquidity and credit risk are highly significant, as securities with high credit risk and low liquidity tend to have wider CCS. In contrast, securities with low credit risk and high liquidity tend to have narrow CCS. Therefore, the results highlight the importance of considering the interplay between liquidity and credit risk in understanding the determinants of CCS in emerging markets.

The practical implications of the findings of this study are significant, as they provide a more refined understanding of the factors driving the variability of CCS across rated categories for corporate bonds. The study's findings highlight the relevance of maintaining the liquidity level to mitigate the influence of liquidity risk on CCS. The study concludes that managers should augment their risk management practices to manage liquidity risk better and maintain a higher credit quality to reduce the negative impact of liquidity risk on CCS. Moreover, the findings affirm that the better the firm's credibility, the lesser the CCS will be, implying that firms should try to improve their credit ratings.

Theoretical and Managerial Implications

This study has important management implications for bond market practitioners. Managers, marketers, and other professionals may make better-informed decisions about risk management, portfolio creation, and funding strategies by disentangling the impacts of external and internal liquidity on CCS. The distinction between investment-grade and speculative-grade bonds emphasizes the importance of carefully assessing creditworthiness and liquidity conditions, especially for speculative-grade issuers. This study advances the theoretical understanding of liquidity and CCS by offering a complete picture of liquidity risk and its influence on bond pricing. The distinction between external and internal liquidity, as well as the separation between bond segments, enriches the current literature and improves our knowledge of liquidity dynamics in the fixed-income market.

Limitations of the Study and Scope for Future Research

Though the study's findings have managerial implications, it has a few limitations that can be considered in further studies.

- The study's sample includes only Plain Vanilla bonds due to the existing disparity among different types of bonds in terms of behavioral changes. In addition, the literature is scarce on complex securities like option-embedded and green bonds; further studies may consider such unexplored areas.

- The country coverage adopted in this study is limited to India, which could limit the generalizability of the results. Future research could extend the scope of this analysis to include more countries and categorize bonds into investment grade and speculative grade.

- The factors, such as market sentiment and political risk, may also impact pricing dynamics in emerging markets. Therefore, future studies could explore the combined effects of these factors on CCS to provide a more comprehensive picture of pricing dynamics in emerging market bonds.

Authors' Contribution

Lithin B. M. and Nikhil M. N. conceived the idea and developed a quantitative design to undertake the empirical study. Lithin B. M., Dr. Suman Chakraborty, and Nikhil M. N. extracted research papers with high reputations, filtered these based on keywords, and generated concepts and codes relevant to the study design. Dr. Suman Chakraborty verified the analytical methods and supervised the study. The data curation, data analysis, software handling, interpretation, and writing the original draft of the paper have been carried out by Lithin B. M. and Nikhil M. N. Dr. Suman Chakraborty carried out the editing of the manuscript, checking the validity of results, and two rounds of reviews.

Conflict of Interest

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

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About the Authors

Lithin B. M. is a UGC-SRF pursuing a Ph.D. in the field of the corporate bond market at the Manipal Academy of Higher Education. Mr. Lithin's research achievements are noteworthy, with several publications in leading journals indexed in Scopus and Web of Science and listed in the ABDC (Australian Business Deans Council) journal quality list.

Dr. Suman Chakraborty (Corresponding Author) has more than 20 years of experience in teaching, training, research, and academic administration and is presently working as a Professor at the Department of Business Administration, Manipal University Jaipur. His research interests revolve around the links between fundamental parameters, which are used as a valuation metric for corporates, valuation of financial assets, and financial markets, along with macroeconomics and international finance.

Nikhil M. N. is an accomplished academic and researcher specializing in finance. Nikhil pursued an MBA in finance and marketing specialization from Justice K S Hegde Institute of Management, Nitte. Nikhil is pursuing his Ph.D. in finance from the Department of Commerce, MAHE, Manipal, Karnataka, India. Nikhil has actively contributed to the academic community through publications in Scopus, Web of Science, and ABDC (Australian Business Deans Council) listed journals.