Bond Short Selling and CDS Spread

Huu Nhan Duong
Monash Business School, Monash University
huu.duong@monash.edu

Petko S. Kalev
RoZetta Institute and La Trobe University
p.kalev@latrobe.edu.au

Madhu Kalimipalli
Lazaridis School of Business & Economics, Wilfrid Laurier University
mkalimipalli@wlu.ca

Saurabh Trivedi
RoZetta Institute and Macquarie University
saurabh.trivedi@hdr.mq.edu.au

Abstract

While extant literature provides evidence on the information role of CDS market for price formation in corporate bonds, we show that firm level bond short interest is positively related to the one-month ahead credit default swap (CDS) spreads. This finding is robust to alternative measurements or estimation methods and controlling for the influence of equity short interest and put options trading volume. The relationship between bond short interest and CDS spread is present mainly in the firms with higher short selling fees or where firm level CDS contracts are more liquid. Firms with higher bond short selling activities have higher credit risk profiles, as indicated by higher leverage, higher idiosyncratic volatility, lower firm performance, and higher financing costs. Overall, our paper shows the significance of the information provided by bond short sellers for cross-market assets such as CDSs.

JEL Classification: G10, G14, G23

Keywords: short selling, bond markets, credit default swaps

Bond Short Selling and CDS Spread

Abstract

While extant literature provides evidence on the information role of CDS market for price formation in corporate bonds, we show that firm level bond short interest is positively related to the one-month ahead credit default swap (CDS) spreads. This finding is robust to alternative measurements or estimation methods and controlling for the influence of equity short interest and put options trading volume. The relationship between bond short interest and CDS spread is present mainly in the firms with higher short selling fees or where firm level CDS contracts are more liquid. Firms with higher bond short selling activities have higher credit risk profiles, as indicated by higher leverage, higher idiosyncratic volatility, lower firm performance, and higher financing costs. Overall, our paper shows the significance of the information provided by bond short sellers for cross-market assets such as CDSs.

JEL Classification: G10, G14, G23

Keywords: short selling, bond markets, credit default swaps.

1 Introduction

The emerging research on short selling in the bond market indicates that bond short sellers may have access to valuable information that can aid in predicting bond prices (Hendershott, Kozhan, and Raman (2020). This information was not apparent during the time period examined in the research conducted by Asquith et al. (2013). However, Hendershott, Kozhan, and Raman (2020) suggest that the informational role of bond short sellers is limited to the bond market and finds no evidence regarding the impact of bond short sellers on cross-asset class prediction, especially in relation to future stock returns. In this paper, we present evidence of a cross-asset role for bond short selling, particularly in predicting the credit default swap (CDS) spreads.

Previous literature on information linkages between bond and CDS markets finds that CDS markets have leading information content for corporate bonds. For example, Hull, Predescu, and White (2004) study the information impact of CDS spreads on bond market ratings and find that credit spreads provide helpful information in estimating the probability of negative credit rating changes. Blanco, Brennan, and Marsh (2005) find that the CDS market leads the bond market in determining the price of credit risk. Baba and Inada (2009) find that the CDS spread plays a bigger role in price discovery than the bond spreads for Japanese banks. Norden and Wagner (2008) find that CDS spreads explain syndicated loan rates much better than spreads of similar-rated bonds. Forte and Pena (2009) study the long-run equilibrium relations between bond, CDS, and stock market implied spreads and find that stocks lead CDSs and bonds more frequently than the reverse and that the CDS market leads the bond market. Norden and Weber (2009) find that stock returns lead CDS and bond spread changes and that the CDS market contributes more to price discovery than the bond market.

This paper analyses the information flows from the short selling activity in the corporate bond market to the CDS market. The paper is related to the literature on bond short selling as well as on the price discovery in the CDS market on account of the information flows from the markets of other financial instruments of the underlying firms (Acharya and Johnson, 2007; Griffin, Hong, and Kim, 2016; Hilscher, Pollet, and Wilson, 2015; Kryzanowski, Perrakis, and Zhong, 2017; Marsh and Wagner, 2016). Specifically, we build upon the work of Griffin, Hong, and Kim (2016), who demonstrate the predictive role of short sellers in the equity market on CDS returns, by showing the predictive role of bond short sellers in influencing the CDS spreads. While the information content of CDS markets for underlying bonds is well understood, we provide evidence on how information generated by bond short selling is significantly related to subsequent period CDS spreads.

Short selling a bond or a synthetic short through a CDS are both methods that allow individuals to profit from the risk of default or decrease in the valuation of a corporate bond, as well as to hedge against credit risk exposure. These strategies require upfront costs, carry counterparty risks, and allow investors to express negative views about an issuer's creditworthiness. However, short selling a bond, in particular, is a relatively costly and time-consuming process compared to synthetic shorts through CDS, as stated by Czech (2021) and Sambalaibat (2022). According to Sambalaibat (2022), a search framework suggests that the total search cost of short selling a bond is considerably higher than that of synthetic shorts through CDS. Short selling requires multiple search stages, and in each stage, investors have to trade a bond in a potentially limited supply. Despite the arduous and expensive nature of bond short selling, the fact that short sellers are active in the bond market implies that there must be compelling reasons driving such behavior. The higher cost of directly shorting a bond compared to buying a CDS suggests that short sellers may have access to additional information regarding the credit issues of underlying bonds or firms. Consequently, investors in other related asset classes such as CDS investors may find information on bond short interest as value-relevant for them. This is the primary motivation for exploring the impact of bond short interest on the CDS spread.

The investigation is further motivated by the theoretical construct of Duffie and Lando (2001) model which suggests that the pricing of a CDS instrument depends on the likelihood and severity of firm default and the quality of the information available to CDS counterparties about firm value. Although CDS investors can exploit pricing inefficiencies and access privileged information through private communications with company managers (Acharya and Johnson, 2007), they may still benefit from incorporating short sellers' information in their assessment of credit risk. This was shown to be true in the case of equity short selling, as demonstrated by Griffin, Hong, and Kim (2016). Therefore, the next empirical question is whether bond short sellers convey any additional information in the CDS market. We conjecture that bond short interest can also provide information that can impact CDS spreads beyond what is conveyed by the equity short interest. If high or increasing short selling in the bond market is indicative of bad news about the firm beyond what is already conveyed by equity short sellers, then CDS investors are likely to factor this information into their evaluation of CDS spreads. We test this conjecture by examining the ability of firm level bond short interest to predict five-year *CDS* spreads in the next one month period.

Short sellers, whether in the equity or bond markets, generally indicate a belief in the downside risk associated with the underlying firm, making it pertinent to assess their impact on asset markets which are more concerned about the downside risk of the firm. Griffin, Hong, and Kim (2016) have already provided evidence on the role of equity short interest in predicting the future CDS return. Given that CDSs are an asset class that is highly relevant and specific to credit risk and default probabilities associated with a firm, it provides a more appropriate market setting for studying the effect of bond short sellers on CDS spreads. Therefore, it is the next logical step in exploring the impact of short selling on the credit market.

It is surprising that there is little literature on short selling in bond markets, considering that the bond market is much larger than the stock market globally. One of the main reasons for the lack of studies on bond short selling has been the lack of availability of data as the bond short selling is completely an over the counter (OTC) market and we understand that study of any OTC market is relatively difficult (Asquith et al., 2013). The importance of the research question is underscored by the significant size of the U.S. corporate bond market and CDS market,[1] the limited amount of existing research on corporate bond short selling, and expectations from *CDS* counterparties and market dealers, given their sophistication, to understand the role of bond short interest.

To answer our main research inquiry, we utilize data on bond short selling and 5-year *CDS* spreads from Markit. Our final sample includes 59,958 firm-month observations for 648 distinct firms covering the time period from February 2006 to December 2020. The key independent variable is firm level bond short interest which is the value-weighted (bond offering amount scaled by the sum of offering amounts of all the bonds issued by a firm) bond short interest quantity (quantity of bond short interest scaled by the bond offering amount) of all the bonds issued by a firm in a month. The key dependent variable is the level of spread of 5-year tenor CDS contract. We investigate the impact of bond short interest primarily on the 5-year benchmark CDS spreads of the firms as they are traded more frequently compared to the CDS of other maturities (Augustin and Izhakian, 2020; Das, Kalimipalli, and Nayak, 2014; Ericsson, Jacobs, and Oviedo, 2009).

First, we observe that the firm level bond short interest is positively and significantly related to the one month ahead 5-year *CDS* spread. These results remain strong after controlling several variables such as firm characteristics and macro-financial variables as well as firm and time fixed effects. The relationship between *CDS* spread and firm level bond short interest is

[1] As of June 2022, the total outstanding corporate bonds in the U.S. amounts to US$10.1 trillion (Source: https://www.sifma.org/resources/research/us-corporate-bonds-statistics/). As of June 2022, the global outstanding notional amount of CDS contracts is valued at US$9.3 trillion, with US counterparties holding positions in CDS contracts worth US$2.1 trillion (Source: https://stats.bis.org/statx/srs/table/d10.5?f=pdf).

also economically significant – a one-standard deviation increase in firm-level bond short interest increases the 5-year *CDS* spread by 19.21 basis points, which is 12% of the mean value of the 5-year *CDS* spread. The main baseline results are robust using alternative measures of CDS spreads and bond short selling. We further find that the influence of firm level bond short selling on the *CDS* spread is independent of the influence of equity short interest as well as put options volume. The baseline results are robust even after controlling for the persistence in CDS spread, or the stocks and bonds' return and risk variables.

We perform two additional analysis to mitigate the potential endogeneity concerns. We first use the propensity score matching approach to match firms with high bond short interest (above monthly median) to otherwise comparable firms but low bond short interest. We still find bond short interest to be positively related to future CDS spread for the matched sample. We also perform an internal instrumental variable analysis following the method of Lewbel (2012), in which the heterogeneity in the error term of the first stage regression is used to generate instruments from within the existing model. Our results show that the instrumented bond short interest still exerts a positive effect on future CDS spread.

Having documented a strong and robust relationship between bond short interest and one-month ahead CDS spread, we further examine the time-series and cross-sectional variation of this relation. In the first test, we consider how this relation varies following natural disaster periods versus other periods. We expect that large-scale disasters serve as exogenous shocks to the supply of bonds available for shorting. The decrease in bond ownership primarily arises from insurance companies liquidating their bond holdings to meet insurance claims, as they are naturally one of the largest lenders of the corporate bonds (Foley-Fisher, Gissler, and Verani, 2019). Consequently, the decreased availability of bonds for shorting should result in a decrease in bond short interest, indicating a reduction in the amount of information accessible within the shorting market. Supporting our conjectures, we find that both the supply of bonds available for shorting and bond short interest decline after natural disasters. More importantly, we show that the relationship between CDS spread and bond short interest is weaker during the disaster period.

In the second test, we analyze whether the borrowing cost i.e. fee of short selling a bond affects the impact of short selling on credit default swap spreads. Previous studies pertaining to stock short selling suggest that higher short selling fees improve the informational value of equity short interest and that equity loan fees are accurate predictors of stock market returns. Extending this reasoning to the bond market, we find that the relationship between CDS spread and bond short interest is present only in the high fee subsample.

Next, we assess the impact of CDS liquidity on the relationship between the bond short interest and CDS spread. We use Markit computed CDS depth score as the proxy for the liquidity of the CDS contracts of the underlying firms. CDS depth measures the number of contributors who are typically large institutions – such as commercial and investment banks - actively trading in CDS contracts. Increased number of contributors leads to potentially enhanced trading and thereby higher underlying liquidity. We hypothesize that information content of bond short sellers is more likely to be reflected in subsequent period CDS spreads if the underlying CDS market is more liquid and hence provides better access to trading. We accordingly find that the relationship between the CDS spread, and the bond short interest is primarily emanating from the sample of firms whose CDSs are most liquid.

We also consider the possible channels underlying the relationship between the firm level bond short interest and *CDS* spread. We argue that bond short sellers conduct in-depth analysis on underlying economics or fundamentals of different firms before taking the short positions in their bonds. This suggests that bond short sellers are able to predict certain firm level financial variables which are pertinent for credit risk evaluation. We test whether bond short sellers are able to predict the key financial variables such as leverage, volatility, and future growth options and accordingly decide to take short position in the underlying bond. We find that the firms with higher bond short selling activities have higher leverage, higher idiosyncratic volatility, lower value of growth options and lower returns on assets, implying higher credit risk profiles for such firms.

Our main analyses demonstrate the important informational role of bond short selling for the secondary market assessment of firms' credit risk. In the final set of analysis, we analyse the informational role of bond short interest for the investors in the primary bond market and for lenders in the bank loan market. We find that higher bond short selling activities for a firm leads to higher cost of raising a new bond or higher interest rate on bank loans. These results indicate that bond short sellers possess information which is value relevant for the investors in the primary debt markets as well, especially the banks.

The primary and most notable contribution of our paper is that we are the first to demonstrate the value of bond short sellers' information beyond the bond market. Prior work by Hendershott, Kozhan, and Raman (2020) and Duong, Kalev, and Tian (2023) has focused mainly on the role of bond short selling in the bond market. Hendershott, Kozhan, and Raman (2020) shows that bond short interest does not have any value relevance in predicting the future stock returns. We build on their work by highlighting the role of bond short interest in cross-asset information. The CDS is a better market setting than stocks because equity market returns could be driven by several other factors beyond the factors related to credit or default risk. Our research provides evidence that bond short sellers possess information which may be relevant for cross-market asset i.e. the CDS in this case. We demonstrate that despite controlling for equity short interest, put options trading, firm characteristics, and security pricing measures, bond short interest has a robust and positive association with the CDS spread of the underlying firm.

The remaining paper is organized as follows: Section 2 describes the data and key variables used in the paper. Section 3 provides empirical results on the relationship between bond short selling and *CDS* spread. Section 4 presents the results on the information content of bond short interest for future firm performance and financing costs. Section 5 provides the conclusion.

2 Data and Sample

We use Markit as the primary data source for corporate bond lending and *CDS* spreads. We source corporate bond data from Trade Reporting and Compliance Engine (TRACE) and Fixed Income Securities Database (FISD). We source firm specific financial information from Compustat North America Quarterly Database, and macro-financial control variables from the St. Louis Federal Reserve Economic Data (FRED) and Kenneth French database, stock price information from the Center for Research in Security Prices (CRSP). We also collect information on equity short selling activity from the Compustat database which provides information on stock short interest from across the New York Stock Exchange, American Stock Exchange, and NASDAQ.

The corporate bond lending data comes from Markit securities lending database. It collects this information from a significant number of largest custodians and prime brokers in the securities lending industry. The data set comprises the security-level daily information for the U.S. corporate bonds in the period from February 2006 to December 2020. We use information on quantity and value of borrowed bond securities, percentage of securities on loan out of total securities available for lending and indicator score on daily fee or rebate charged by the agent lender.

Our main variable is the bond short interest of a firm at the end of every month (*BONDSS*) which is the value-weighted bond short interest of all the bonds issued by a firm in a month. We first calculate the average daily quantity of bonds on loan in a month and scale it by the bond offering amount of each bond. We multiply the monthly bond short interest by the value weights. The value weights are the offering amount of the shorted bond divided by the sum of offering amounts of all the shorted bonds of the firm. Finally, we take the aggregate of monthly value-weighted bond level short interest of all the shorted bond of a firm to arrive at the firm level bond short interest. The bond short selling data are available for 1,603 firms for the period between Feb-2006 and Dec-2020.

Next, we use Markit database to obtain data on single-name 5-year *CDS* spread. The single-name *CDS* are the most common credit derivative contracts, accounting for almost a third of the trading activity in the *CDS* market (Ericsson, Jacobs, and Oviedo, 2009). Furthermore, we use 5-year *CDS* contract as it is the most liquid *CDS* instrument traded. We use single-name *CDS* spread data of firms headquartered in the U.S. during the period between Feb 2006 and Dec 2020. The beginning of the period is determined by the availability of the bond short selling data from Markit.

Markit provides information on *CDS* contracts of over 5,670 firms across 119 countries. We start with the *CDS* contracts of 2,151 unique firms headquartered in the U.S. given our dataset for the bond short selling is only available for the U.S. market. Following prior studies (Bai and Wu, 2016; Ericsson, Jacobs, and Oviedo, 2009; Griffin, Hong, and Kim, 2016), we clean the *CDS* data as follows: (i) retain only the U.S. denominated contracts; (ii) keep only the senior unsecured obligations as they are the most liquid *CDS* contracts; (iii) keep only those *CDS* contracts which have a modified restructuring (MR) documentation clause prior to April 2009 ("*CDS* Big Bang") and no restructuring clause afterwards; (4) exclude *CDS* contracts which have a spread of more than 2,000 basis points to minimize any measurement errors as such contracts are mostly illiquid due to bilateral arrangements for up-front payments. Finally, we transform the daily *CDS* spread data into monthly frequency data as the data on bond lending is available on a monthly basis as provided by our data vendor. We report results based on end-of-month *CDS* spreads (*CDS5*). However, all results are robust to the use of other measures of *CDS* spread such as monthly averages of daily *CDS* spread and natural logarithm of *CDS* spread, as shown in the robustness tests.

To merge the *CDS* spread dataset with bond short selling data, we first incorporate PERMNO identifier from the CRSP database in each of the datasets. The merge of the *CDS* dataset and the firm-level bond short interest dataset using the PERMNO identifier generates a *CDS5-BONDSS* sample of 59,958 firm-month bond short interest observations for 648 unique single-name or firm-level *CDS* spread.

Further, we use two sets of explanatory variables that have been identified in the literature as having an influence on credit spread of a firm – firm specific fundamental variables and aggregate macro-financial variables. Following structural credit risk models (Merton, 1974) , we include the theoretical determinants of the credit risk pricing such as asset value, volatility, and firm leverage. Asset value is the total assets of the firm reported quarterly. We use the natural logarithm of asset value (*SIZE*) in our regression analysis. To proxy asset volatility, we follow Kaviani et al. (2020) and Campbell and Taksler (2003) and utilize the idiosyncratic equity volatility (*IVOL*), measured as the standard deviation of daily excess returns over the past 180 days. We use the average book value of the debt of the firm as the proxy for firm leverage. We calculate this variable (*LEVERAGE)* as the total value of short- and long-term debt divided by total assets of the firm.

Following Bharath and Shumway (2008) and Bai and Wu (2016), we also include the return on assets (*ROA*) to capture the profitability of the firm, cash and cash equivalent scaled by total assets (*CASH*) to capture firm liquidity, revenue or turnover of the firm scaled by total assets (*TURNOVER*), capital expenditure scaled by total assets (*CAPEX*), Market to Book ratio (*MTB*), measure of firm's growth option captured by TOBIN's Q (*TOBINQ*), and property, plant, and equipment scaled by assets (*PPE*) to capture the tangibility of the firm. Data to measure these variables were obtained from the Compustat-North America quarterly database.

Finally, we include the excess stock market return (*MKTRET*), one-year US treasury rates (*TSYIELD*), government treasury yield curve (*TSSLOPE*) and market expectation of volatility (*VIX*) as the macro-financial variables that may influence *CDS* spreads, as per Zhang, Zhou, and Zhu (2009). We obtain data on excess market returns from the Kenneth French data library. The one-year US treasury bill rate and the yield curve slope, which is the difference between ten- and two-year US treasury bond rates, are from the FRED website. The data for *VIX*, which is CBOE S&P500 volatility index (closing), is obtained from the Chicago Board Options Exchange.

Table 1 reports the summary statistics of key variables where all the continuous variables are winsorized at the 1^{st} and 99^{th} percentile to mitigate any possible effects of either data errors or outliers. The statistics are based on the 59,958 firm-month observations. The mean and median of the monthly *CDS_SPREAD* are 156 bps and 93 bps respectively. The mean and median firm level bond short interest (*BONDSS*) across all firms and years are 1.65% and 0.84% respectively which are similar to those in Duong, Kalev, and Tian (2023) and Hendershott, Kozhan, and Raman (2020)

3 The relation between bond short interest and CDS spread

3.1 Baseline Regression results

In this section, we provide evidence on the relation between *CDS* spreads and bond short interest. We use the following general panel model specifications to test the relationship between the one-month ahead monthly 5-year *CDS* spread of a firm and the current month bond short interest:

$$\boldsymbol{CDS\_SPREAD_{i,t+1} = \beta_0 + \beta_{SS} BONDSS_{i,t} + \sum \beta_X X_{i,j,t} + \beta_Y Y_t + \varepsilon_{i,t+1}} \qquad \textbf{(1)}$$

where *t* is a month from year 2006 to 2020; $CDS\_SPREAD_{i,t}$ is the 5- year *CDS* spread of a sample firm *i* at the end of month *t+1*; $BONDSS_{i,t}$ is the value-weighted average of the daily bond short interest scaled by bond offering amount and aggregated for each firm *i* in month *t*.

$\boldsymbol{X_{i,t}}$ represents vectors of firm-specific fundamental control variables. $\boldsymbol{Y_t}$ controls for the macro-financial factors that may affect credit spreads over time. $\boldsymbol{\varepsilon_{i,t+1}}$ represents i.i.d. standard normal errors. While we include all the possible determinants of CDS spreads, it is possible that the model omits unknown firm characteristics. To address this concern, we include firm fixed effect to control for the influence of time invariant firm-specific factors. We also include time fixed effects (year-month fixed effects) in our models to account for biases from time-varying unobservable factors that are constant across firms and to control for entity-specific factors that remain constant over time. Finally, we cluster standard errors at the firm and the time level to account for cross-sectional and serial correlation in the error terms (Petersen, 2009).

Table 2 reports the main regression results examining the impact of bond short seller information on 5-year *CDS* spread. The first column shows the relation between the firm bond short interest in month *t* and 5-year *CDS* spread in month *t+1* without controlling for other determinants and with firm and time fixed effects. In the second column, we introduce several firm-level fundamental variables and macro-financial variables as controls and include the time fixed effects and industry fixed effects based on SIC2 codes for industry classification. In the third column, we include only the firm fixed effects. Finally, we include all the firm and time fixed effects in column four which we use as our main specification for subsequent analyses. When we use a model specification with time fixed effects, macro-financial variables, which have identical values for all firms over time periods, are absorbed by the time fixed effect. We find that coefficients on bond short interest are positive and significant at the 1% level across all the models. The results support our conjecture that firm's *CDS* spreads reflect the information in its bond short interest which are not apparently transmitted to *CDS* spread through firm level fundamental variables, and macro-financial variables, as we explicitly control for all these factors in the models.[2]

Our results are also economically significant. We calculate the economic significance of our findings by estimating the expected change in *CDS* spread due to a one standard deviation change in the firm level bond short interest. Based on the *BONDSS* estimate, a one percentage point increase in bond short interest raises the CDS spread by around 5.4%. Given that the average CDS spread of the sample firms is 156 basis points, a one standard deviation increase of *BONDSS* (about 2.28 percentage points, see Table 1) is associated with a 19.21 basis points (19.21 = 5.4% × 156 × 2.28) increase of CDS spread. This increase is around 12% (12% = 19.21 bps / 156 bps) of the mean of the *CDS* spread (or in dollar terms by about $123,000 for $1 million notional *CDS* contract).

The coefficients on control variables are qualitatively similar to previous literature and also coincide with expectation. For instance, we find that a firm's *CDS* spread is positively related to its leverage (*LEVERAGE*) and the volatility measures (*IVOL*) and negatively related to firm asset value (*SIZE*). The results are consistent with structural models of credit risk and associated theories (Ericsson, Jacobs, and Oviedo, 2009; Merton, 1974). The other firm-level determinants of *CDS* spread such as profitability (*ROA*), and growth option (*TOBINQ*) show negative and statistically significant relation with the *CDS* spread as established in previous work (Bai and Wu, 2016; Ericsson, Jacobs, and Oviedo, 2009). The explanatory powers of these regression tests ranges between 53% and 75%, which compares well with that in Augustin and Izhakian (2020) and Ericsson, Jacobs, and Oviedo (2009).

Overall, the results from the baseline model show that the bond short interest and CDS spread are positively associated. These findings suggest that CDS buyers perceive bond short

[2] When employing the Fama-Macbeth regression approach with Newey-West standard errors and incorporating three lags to address potential autocorrelation, our findings remain qualitatively consistent.

interest as an indicator of significant risk associated with the underlying firm and they consequently incorporate this information with higher CDS spreads.

[INSERT **Table 2** HERE]

3.2 Robustness Tests

3.2.1 Alternative Measures of CDS Spread and Bond Short Interest

The results in the previous section suggest a positive relationship between bond short-interest and *CDS* spreads. We test the reliability of our results using alternative measures of CDS spread and bond short interest, as well as introducing additional control variables in the baseline regression equation (1). We use three sets of alternative measures for the main dependent (*CDS5*) and independent variable (*BONDSS*) in our baseline results of **Table 2** and one set of tests with additional control variables. All the results are reported in **Table 3**. Panel A of the table shows the baseline results with alternative measures of 5-year *CDS* spread as the dependent variables. In column 1, we show the baseline results with natural logarithm of 5-year *CDS* spread (*Log(CDS5)*) as the dependent variable. In column 2, we use monthly average of *CDS* spread (*CDS5_AVG*) as the dependent variable in the baseline regression. We find that the relationship between the *BONDSS* and both the alternative measures of the 5-year *CDS* spread is positive and statistically significant at 1% level. In column 3 and 4, we use *CDS* spreads of other tenors as the dependent variable. We use *CDS* spreads of 3-year (*CDS3*) and 10-year tenors (*CDS10*), recorded at the end of the month *t+1* as the alternative dependent variables. Similar to our baseline results, we observe a strong positive relationship between *BONDSS* in month *t* and the one-month ahead *CDS* spreads of 3-year and 10-year.

In our second set of robustness tests presented in Panel B of **Table 3**, we employ various alternative measures of bond short interest in the baseline regression. *First*, we use firm level value-weighted average of the dollar value of the shorted bonds (*BONDSS_VALUE*) as the main independent variable (Column 1). *Second*, we use firm level bond utilization (*Utilization*) as the main proxy for bond short selling. The utilization measures the quantity of bond that is lent out for short selling as a percentage of the total quantity available for bond lending. It incorporates the demand-and supply-side of the bond lending market. To arrive at the monthly firm level measure of bond short interest utilization, we aggregate the value weighted bond level utilization value of all the shorted bonds of a firm in each month. The value weights are the offering amount of the shorted bond divided by the sum of offering amounts of all the shorted bonds of the firm. Third, we use bond short interest value (*BONDSS_Max)* of the bond which is shorted most amongst all the bonds issued by a firm in each month. *Finally*, we use the equal weighted bond short interest (*BONDSS_EW*) as the main independent variable. It is calculated as the average of the bond short interest (quantity of bond short interest scaled by the bond offering amount) of all the bonds of a firm in each month *t*. Overall, we find that our main results are robust to using the alternative measures of bond short interest.

3.2.2 The Role of Equity Short Selling and Option Markets

Debt and equity both represent claims on the same firm, but debt investors hold a priority in terms of claims. As suggested by (Asquith et al., 2013), if investors possess negative information about the firm, they may choose to short sell stocks instead of bonds due to the higher priority of claims for debt investors. Investors can also express negative views about the firm through put options trading, which is often seen as an alternative to short selling underlying stocks (Danielsen and Sorescu, 2001; Figlewski and Webb, 1993; Grundy, Lim, and Verwijmeren, 2012). Hence, it is essential to investigate whether bond short sellers are merely substitutes for stock short sellers and put option investors. If bond short sellers are substitutes, they may only convey information from stock short sellers and put option investors to CDS pricing. Conversely, if bond short sellers possess additional information compared to stock short sellers and put option investors, it should have a significant impact on the CDS spreads.

Duong, Kalev, and Tian (2023) demonstrated that short selling in the corporate bond market provides an independent platform for investors to express their differing opinions regarding bond-specific news and information, not just a substitute for equity short selling and options trading. If bond short sellers indeed possess credit market relevant news and information, it is likely to affect CDS spreads as well. In this section, we build on their research by investigating whether bond short sellers carry such additional news, and whether their activity affects the CDS spread independently of equity short sellers or put options traders. We address this question by running two baseline regression models after controlling for shorting in stocks of the firms and put options volume separately.

First, we import the stock short selling data from the Compustat database. It provides information on stock short interest from across the New York Stock Exchange, American Stock Exchange, and NASDAQ. The stock short selling data are published on two dates in a month – 15th of each month and at the end of the month. For each firm, we calculate the equity short interest as the number of short positions scaled by the total number of common shares outstanding from CRSP as of the end of the month. Our main measure of stock short selling is the average of the stock short interest data published in mid-month and at the end of the month scaled by the shares outstanding (*STOCK_SS*). The average *STOCK_SS* in the sample is 3.97% with a median value of 2.14% which are comparable to those reported by Engelberg, Reed, and Ringgenberg (2018).

We run the baseline regression with *STOCK_SS* as additional control variable. Column 1 of the Panel C shows that the relationship between the *CDS_SPREAD* and *BONDSS* holds strongly even after controlling for the stock short interest. This indicates that bond short sellers possess information which is additional to stock short sellers' information.[3] The stock short

[3] For robustness check, we also use the stock short interest at the end of the month scaled by shares outstanding for each firm in a month (*STOCK_SS_LAST*). The un-tabulated results are qualitatively similar to the main results. We also find that the results are strong and consistent across the full sample, investment grade and speculative grade subsamples.

interest variable is also positively related to *CDS* spread which is consistent with the results obtained by Griffin, Hong, and Kim (2016). One possible reason for this result may be that short sellers in both debt and equity markets are expressing similar views about the underlying firm.[4]

Next, we import the put options volume data from the OptionMetrics dataset. To match the main dataset with the OptionsMetrics dataset, we use the linking file between OptionsMetrics and CRSP provided by WRDS. The file links option SECID to CRSP_PERMNO which is the main firm level identifier in our main sample. We find that all the 648 firms in our main sample have put options at some point in the time frame of the sample except for 79 firms which do not have options at any point in time. Our main variable of interest is the average daily volume of put options of a firm in a month scaled by the total monthly traded volume of the underlying stocks obtained from CRSP dataset following Roll, Schwartz, and Subrahmanyam (2010). The results in column (2) of Panel C of **Table 3** shows no evidence that the put options trading reduces the impact of bond short selling information on the *CDS* spread. The coefficient estimates for the firm level bond short interest (*BONDSS*) over the full sample are significant at 1% level. The coefficient of put options volume is also positive but statistically insignificant for the sample.[5]

Overall, our results imply that firm level bond short selling is not simply a substitute for equity short selling or put options trading. These findings are also consistent with Hendershott, Kozhan, and Raman (2020) who show that bond short sellers' information predicts bond returns, independently of the informational role of short selling in stocks.

[4] We also orthogonalise *BONDSS* to *STOCKSS* to remove any possible informational content of stock short sellers subsumed by bond short selling measure and run the baseline regression of Table 2 with orthogonalised measure of bond short selling. The (unreported) results show a strong and positive relation of the measure with the CDS spread.

[5] We also use total volume of all the options, ratio of monthly call and put option volume, monthly open interest for put options as alternative control variables for put option volume in baseline regression. The (unreported) results are qualitatively similar to the one observed in column 2 of Panel C of Table 3.

3.2.3 Persistence in CDS Spread

It is possible that *CDS* spread can be quite "sticky" especially around the dates when the firm borrows loans (Demiroglu, James, and Velioglu, 2022). This may lead to biased estimates and incorrect statistical inferences. To allay the concerns of the *CDS* spread stickiness impacting the *CDS* spread-*BONDSS* relationship, we use one-month and two-months lagged values of CDS spread denoted as *CDS_lag1* and *CDS_lag2*, respectively. Our results in Column 3 show that the relationship between the *CDS* spread and *BONDSS* remains strong even after controlling for the lagged values of CDS spreads.

3.2.4 Bond and Stock Risk and Return Variables

Finally, we include several variables to control for the firm's equity and bond pricing from CRSP and TRACE-FISD datasets respectively. The vector of market pricing of stock variables includes average monthly stock returns in the previous 36 months (*Stock_Ret*), minimum monthly stock returns in the previous 36 months ($Stock\_Ret_{MIN}$), volatility (standard deviation) of monthly stock returns in the previous 36 months (*Stock_Volatility*). The bond pricing variables are first value-weighted using the weight as individual bond offering amount scaled by the total offering amount of bonds issued by a firm in each month and then these variables are aggregated for each firm in each time period. These variables are firm level bond returns in the previous 36 months (*Bond_Ret*), firm level minimum monthly bond returns in the previous 36 months ($Bond\_Ret_{MIN}$) and firm level bond returns volatility (standard deviation) of monthly firm level bond returns in the previous 36 months (*Bond_Volatility*).

The coefficients of *Stock_Ret* and *Bond_Ret* are negatively and strongly related to *CDS* spread which is consistent with the Merton Model suggesting a negative relation between a firm's market value of equity and its probability of default. The coefficients of *Bond_Volatility* and *Stock_Volatility* are both positive and statistically significant. This is again consistent with the Merton (1974) model which suggests that the higher asset volatility, proxied by stock and bond return volatility here, will lead to a greater probability of default or higher credit spread. Overall, the results in the Panel C show that the relationship between CDS spread and bond short interest is robust even after including several additional control variables.

[INSERT **Table 3** HERE]

3.3 Endogeneity Tests

In sections 3.1 and 3.2 of our analysis, after controlling for firm-specific and macro-financial variables, employing a one month ahead CDS spread, and incorporating firm and time fixed effects, we observe a positive correlation between bond short interest and CDS spread. However, it is important to acknowledge that this relationship may be influenced by endogeneity since both strategies are primarily driven by the underlying credit risk of the firm. Firstly, the actions undertaken by CDS investors may exert an influence on the observed relationship between bond short interest and CDS spreads. Secondly, the existence of common factors affecting both variables, such as overall market conditions or firm-specific characteristics, introduces the possibility of endogeneity. Thirdly, the presence of information asymmetry is an important consideration, as short interest in bonds may serve as an indicator of private information that impacts both bond short interest and CDS spreads. Lastly, the dynamics of the market itself, including changes in liquidity or market sentiment, may contribute to endogeneity concerns. Addressing these concerns necessitates the adoption of appropriate econometric techniques, such as instrumental variable approaches in addition to the panel regression methods, to mitigate endogeneity biases.

To address the endogeneity concerns, we employ two methods – matched sample analysis and instrumental variable method developed by Lewbel (2012). In matched sample analysis, we test the CDS spread and bond short interest relation only for the firms with similar characteristics i.e. the matched sample. We use the propensity score matching (PSM) to select firms with similar financial characteristics. The PSM approach helps to strengthen the validity of our findings and provides more robust evidence for drawing conclusions. We first classify the firms into two groups based on high and low firm level bond short interest in each month based on the median value of the bond short interest in each month. We then estimate the probability of the firms being assigned under high or low bond short interest groups using a logit regression with all firm level variables as specified in the baseline regression (eq 1) and use propensity scores to match the firms in the high bond short interest group to the nearest firm in the low bond short interest group.[6] The firms which do not get any match in a month are removed from the sample in that month. We are left with 23,498 observations in the matched sample which consists only those firms which are similar in financial characteristics. We rerun our baseline regression for the matched sample. The results are shown in column 1 in **Table 4**. We find that the relationship between the firm level bond short interest and the CDS spread is strong and positive for the matched sample as well.

Next, we utilize the instrumental variable (IV) approach introduced by Lewbel (2012) to address endogeneity concerns in our analysis. This methodology, employed in several recent finance research papers (Anderson and Core, 2018; Chen et al., 2021; Hasan, Lobo, and Qiu, 2021; Mavis et al., 2020), does not rely on external instruments. Instead, it leverages the heterogeneity in the error term of the first stage regression to generate instruments from within the existing model. In our study, we apply this internal IV method to estimate the relationship between the instrumented *BONDSS* and the CDS spread. We find that the instrumented *BONDSS* using Lewbel (2012) estimation method continues to be positively and significantly associated with the CDS spread ($p < 0.01$) as shown in Column 2 of Table 4. In addition, we find that the *Cragg-Donald Wald F-statistic* (weak-identification test) yields a value of 3,108, which indicates a strong instrument relevance in our analysis. Furthermore, the *Kleibergen-*

[6] We use the propensity score to perform one-to-one nearest-neighbor-matching method without replacement along with caliper matching using a caliper of 10%. This algorithm excludes all matches where the distance is above 10% by imposing a maximum propensity score distance of 10%.

Paap rk LM statistic (under-identification test) yields a value of 42.528 ($p<0.01$), providing substantial evidence against the null hypothesis of under-identification. These findings suggest that the internally generated instrumental variables effectively address endogeneity concerns and successfully identify the relationship between the instrumented *BONDSS* and the *CDS spread*. Overall, this internal IV analysis based on Lewbel (2012) show that the instrumented *BONDSS* is strongly and positively associated with the CDS spread of the underlying firms. The model passes the under-identification as well as the weak-identification but fails the over-identification test at 5% *p*-level.

[INSERT **Table 4** HERE]

3.4 Time-Series and Cross-Sectional Variations

Having documented a strong and robust relation between bond short selling and future CDS spreads in Sections 3.1-3.3, in this section, we examine the time-series and cross-sectional variations of this relation.

3.4.1 Impact of Natural Disasters on the CDS Spread and Bond Short Interest Relation

In this section, our main focus is to examine the impact of natural disasters on the relationship between bond short interest and CDS spread. We anticipate that the occurrence of natural disasters will reduce the availability of bonds for shorting in the market. This reduction stems from a decrease in the available supply of bonds for shorting, attributed to insurance companies recalling their bonds on loans and liquidating them to meet insurance claims following the disasters. Based on this premise, there may be two possibilities. First possibility suggests that the diminished bond supply may lead to diminished information in the bond short selling market which will lead to weakened information transmission for CDS investors. This effect is expected to be particularly pronounced during the periods following the disasters. Additionally, we anticipate that the weakened information transmission will be more significant in states not directly affected by the disasters during the disaster periods. The other possibility could be opposite wherein if the supply of bonds to be shorted reduces on account of natural disasters, only short sellers with really high conviction will continue shorting, and thus, bond short could become more informative. Hence, impact of natural disaster on the information content of bond short selling is an open empirical question. We test this hypothesis in two steps.

In the first step, we investigate whether natural disasters have an impact on the demand for short selling corporate bonds and the availability of bonds for short selling from lenders or beneficial owners. Notably, insurance companies, who constituted approximately 28% of the total outstanding corporate bonds as of 2019, are one of the largest institutional investors in the corporate bond market (Foley-Fisher, Gissler, and Verani, 2019). Given their buy-and-hold investment strategy, insurance companies naturally serve as major lenders of corporate bond securities. However, natural disasters result in a decrease in corporate bond ownership by insurance companies as they sell off their holdings to fulfill insurance claims. The adverse effects of these disaster shocks often lead to fire-sale scenarios that can persist for several months (Butler, Gao, and Uzmanoglu, 2023; Massa and Zhang, 2021). As a result, the available supply of corporate bonds for short selling is expected to decrease due to the diminished ownership by insurance companies. Consequently, this reduction in bond supply should lead to a decline in the demand for short selling.

We test this conjecture by running the panel regression analysis similar to equation (1) with bond short supply and the bond short interest as the main dependent variables and natural disaster period as the main independent variable. We utilize 12 natural disasters that led to the largest insured damages (please see Appendix A2) during our sample period as an exogenous shock to bond short supply and consequently to bond short interest. We define a *Disaster_Dummy* variable that equals 1 if the time period of the sample is within 6 months after the start date of a disaster, and 0 otherwise. The bond short supply (*BONDSS_Supply*) is measured as the aggregate of value–weighted (offering amount divided by sum of offering amount of all the bonds by the firm in month *t*) bond inventory quantity (supply) of all the bonds of firm *i* in month *t*. The bond inventory quantity is measured by the current inventory available from beneficial owners, specifically the bonds held by lenders that can be used for short selling. We include the state fixed effects to account for any state-specific factors or characteristics that may influence the relationship being analyzed. We do not include the time fixed effects in this analysis as it absorbs the *Disaster_Dummy* variable given its high collinearity with time fixed effect dummies.

The results of the first step are shown in Panel A of **Table 5**. The results in columns 1 and 2 are for the full sample. We find that the *Disaster_Dummy* is negatively related to both *BONDSS* (Column 1) and *BONDSS_Supply* (Column 2). Given the possibility of lower valuations of bonds issued by firms headquartered in disaster-affected states, it is plausible that investors exhibit reluctance to sell such bonds during the disaster period. Consequently, we anticipate a higher reduction in bond short supply for firms located in these states. To investigate this, we replicate the analysis from columns 1 and 2 using a subsample of states unaffected by disasters in the past six months, and the results are presented in columns 3 and 4. We observe a substantially stronger relationship between bond short supply (Column 4) within this subsample. Overall, we find that there is a reduction in the supply of the bonds available for shorting and hence the reduction in the bond short interest following natural disasters.

In the next step, we investigate the impact of the reduction in the bond short selling market on CDS spread on account of the natural disasters. On one hand, the overall reduction in the bond short selling can lead to reduced information amongst the bond short sellers and hence lower information transferred to CDS market. On the other hand, the bond short sellers with high conviction may continue shorting and thus, making them more informative for CDS investors. To answer this open empirical question, we run the baseline regression for two sets of subsamples based on natural disaster period and the impacted states. The results are shown in Panel B of **Table 5**. In the first set of subsample analysis, we divide the sample based on disaster (*Disaster_Dummy = 1*) and non-disaster periods (*Disaster_Dummy = 0*). The coefficient of *BONDSS* is weakly related to CDS spread for the subsample pertaining to the disaster period (Column 1). On the other hand, the coefficient of the *BONDSS* is quite strongly related to the CDS spread during the non-disaster period (Column 2).

There is a possibility that the CDS spreads of firms located in states affected by natural disasters may also be influenced during the disaster period. To obtain a subset of firms whose CDS spreads are less likely to have been affected by the natural disaster during the disaster period, we partition the sample based on firms headquartered in the disaster-impacted states and firms in states unaffected by any natural disasters during the same period. We expect that the *CDS5-BONDSS* relation would be weaker for the firms located in the affected states during the disaster period as compared for the firms located in the states which were not affected by the disasters during the disaster period. We find that the coefficient of *BONDSS* does not have any association with the CDS spread for the firms in the states which are impacted by the natural disasters in the last six months (Column 3). On the other hand, the coefficient of *BONDSS* has a strong positive relation with the CDS spread for the firms in the states which were unaffected by the disasters in the last six months.[7]

Overall, this analysis shows that the exogeneous shock of natural disasters lowers the informational value of the bond short interest which eventually weakens the impact of bond short selling on CDS spread.

[7] In another subsample analysis (unreported) focussed only on the states unaffected by the disasters in previous six months, we find that the *CDS-BONDSS* relationship is statistically stronger during the non-disaster period as compared to during the disaster period.

[INSERT **Table 5** HERE]

3.4.2 Impact of Bond Short Selling Fee on the CDS Spread-Bond Short Selling Relation

In this section, we examine whether the impact of short selling on *CDS* spread is influenced by the borrowing cost (fee) of short selling. The borrowing cost can be an important economic channel through which CDS spread incorporate the impact of bond short interest. A higher borrowing fee results in higher constraints to short selling as it makes shorting more costly. Diamond and Verrecchia (1987) find that short selling becomes more informative when the constraints on it increase. Additionally, when short sellers are willing to invest in stocks despite the high short selling fees, it reveals their confidence in the merit of their investments (Blocher, Reed, and Van Wesep, 2013; Cohen, Diether, and Malloy, 2007; Drechsler and Drechsler, 2014; Engelberg et al., 2022). Engelberg et al. (2022) find that equity loan fees are the most accurate predictors of stock market returns. This implies that equity short sellers have more information about a specific stock or company, having paid a relatively higher fee for it.

These findings from studies cantered on equity markets suggest that the higher cost of short selling improves the informational value of short interest, as those who are willing to pay more anticipate greater benefits. We test these conclusions for the bond market and analyze whether the borrowing cost of short selling affects the impact of short selling on *CDS* spreads. If short selling information as reflected by higher fee does not play a role in explaining *CDS* spreads, we expect no significant change in the impact of bond short selling on *CDS* spreads even when borrowing fees are higher, i.e., short-selling constraints, are higher. Conversely, if *CDS* spreads respond to short selling due to its informational role, we expect to see a more pronounced effect of short selling on *CDS* spreads when borrowing fees, i.e., short-selling constraints, are higher.

We use the daily cost of borrowing score (*DCBS*) to analyze the impact of cost of borrowing on the *CDS* spread and bond short selling relationship. DCBS, computed by Markit, is a normalized measure of the relative cost of borrowing for each bond, ranging from 1 (lowest cost) to 10 (highest cost). A DCBS value of 1 or 2 corresponds to bonds that are easiest to borrow and the ones with a high score of 9 or 10 are most difficult to borrow. To arrive at the firm level DCBS measure, we take the mean of DCBS value for each of the shorted bond issued by a firm in each time period.[8]

We divide the sample based on the top and bottom quartiles of *DCBS.* We separately run our baseline regression for the top quartile firms and bottom most quartile firms based on their DCBS values. As shown in columns 1 and 2 of **Table 6**, the *CDS5-BONDSS* relationship is present in the high fee subsample only. Furthermore, the median DCBS score in the sample is 1 which means most bonds in the sample have lowest possible score and are easy to borrow. Therefore, as an alternative way to classify the sample, we assign the sample as high fee sample if the average firm level DCBS score is greater than 1, else it is classified as low fee subsample. As shown in columns 3, the coefficient of *BONDSS* is strongly positive for the high fee subsample, while it is weakly positive for the low fee subsample (Column 4). Overall, these results show that high fee shorted bonds are the ones containing more information, which is eventually reflected in the corresponding *CDS* spreads of such firms.

[INSERT **Table 6** HERE]

3.4.3 Impact of CDS Liquidity

In this section, we conduct a repeat of the baseline regression presented in **Table 2**, but this time, we differentiate between *CDS*s that have low and high liquidity. We examine whether the higher credit spread of a *CDS* on account of higher bond short interest is simply a reflection

[8] There were around 10,000 missing values (26% of the total sample). We imputed the missing values with the average DCBS score which is the mean of DCBS score of a firm in that year leading to only around 2500 missing values in the sample.

of illiquidity in the *CDS* market. The liquidity measurement is evaluated using Markit's composite depth score, which is based on quotes from a minimum of two distinct contributors for composite spread calculation for 5-year *CDS* spread. The higher the depth score, the higher will be the liquidity of the *CDS*. We record the composite depth score of a *CDS* contract at the end of each month. We employ two measures of sorting the sample based on the depth score of CDS contracts.

First, we sort the sample based on the quartiles of *CDS* liquidity value in each month. The *CDS*s in the top quartile have the highest liquidity and the ones in the bottom quartile have the lowest liquidity. We run the baseline regressions of Table 2 separately for subsample of the firms with the highest *CDS* liquidity (TOP Quartile) and those with lowest *CDS* liquidity (BOTTOM Quartile). The results in Column (1) and (2) show that bond short sellers' information impact the *CDS* spread of *CDS*s with high liquidity values.

Alternatively, we use Griffin, Hong, and Kim (2016)'s measure of dividing the sample into high and low CDS liquidity based on the Markit's CDS depth score. If the depth score is less than or equal to three in a month, it is classified as the low CDS liquidity sample in that month. On the other hand, if the depth score is higher than three, the sample is classified as the high liquidity sample in a month. The results of the regression analysis run for the two subsamples are shown in column 3 and 4 of **Table 7**. Similar to the results in the previous two columns, the bond short interest impacts the CDS spread and bond short interest relationship for the CDSs with high liquidity.

[INSERT **Table 7** HERE]

4 Bond Short Selling, Future Firm Performance, and Financing Costs

4.1 Firm Performance

In this section, we examine what firm level information these short sellers base their trading decision on. We try to observe possible channels that can induce the relation between firm level bond short interest and *CDS* spread. More specifically, we test whether the bond short sellers can predictively explain the key financial variables. We consider model specification similar to equation 1, with the dependent variable being defined as one of the firm-level financial variables. Dependent variables represent one quarter ahead financial variables and independent variable is the firm level bond short interest in the previous quarter. We use several financial variables such as the one quarter ahead leverage (*F_LEVERAGE*), value of growth options (*F_TOBINQ*), return on assets (*F_ROA*), idiosyncratic volatility measure (*F_IVOL*).

We present the results in **Table 8**. We only report the coefficient of bond short interest variable for brevity. Firstly, there is a strong negative relationship between bond short interest and the firm's value of growth options (*F_TOBINQ*). Secondly, we find a robust and positive association between firm-level bond short interest and the idiosyncratic volatility of the firm (*F_IVOL*). Additionally, we observe a weak positive correlation between bond short interest and leverage one quarter ahead (*F_LEVERAGE*).[9] These results collectively indicate the ability of bond short sellers to predict the heightened credit risk through various financial channels.

[INSERT **Table 8** HERE]

4.2 Financing Costs

We have so far examined the impact of bond short seller information on the *CDS* spreads of the underlying firms, which is basically a secondary market credit instrument. In this section, we try to understand if the short sellers in the bond market provide valuable information to investors in the primary bond market and the lenders in the bank loan market. While previous studies have shown that the short sellers in the equity market provide valuable information to investors in the bond market (Kecskés, Mansi, and Zhang, 2013) and the bank loan market (Ho, Lin, and Lin, 2021; Rhee, Duong, and Vu, 2023), no such studies have been

[9] Our results are qualitatively similar when we run the analysis for the sample using monthly frequency data.

done to understand the role of bond short sellers in influencing the primary debt issuance cost of underlying firms. Kecskés, Mansi, and Zhang (2013), using a sample of publicly traded bond data over a period from 1988 to 2011, find that firms with high stock short interest have high bond yield spreads, lower credit ratings, and are more prone to credit rating downgrades. Similarly, Ho, Lin, and Lin (2021), using a difference-in-difference approach and exploiting the 2004 Securities Exchange Commission's new regulation called Regulation SHO, find that the loan spread of the firms whose stocks are shorted under no price-test constraint enjoy an 8.68 basis point loan spread reduction over the firms whose stocks are shorted under the price test constraint.

We first assess the impact of the bond short seller information on the loan spread of the firm issuing those bonds. We obtained the bank loan data for our analysis from Reuters' DealScan database. The database provides data on loan characteristics which include loan spread, loan maturity, loan size, and purpose and type of loan. We merge the loan data with firm level bond short selling data and firm level accounting data from Compustat. Our final sample includes 6,753 bank loan contracts at the loan-deal level from 1,072 individual firms between Jan-2006 to July-2020. Our main dependent variable is the loan spread (*LOAN_SPREAD*) which is measured as the natural log of all-in spread drawn (*ALLINDRAWN*) variable in the DealScan dataset. *ALLINDRAWN* is defined as the amount a borrower pays in terms of basis points over LIBOR or LIBOR equivalent for each dollar drawn. We include several control variables in the panel regression which include firm and loan level variables. The firm level control variables include *SIZE*, *LEVERAGE*, *TANGIBILITY*, *CASH*, *ROA*, *MTB*, *SALE_GROWTH* (growth rate of sales from two quarters prior to the quarter immediately before the loan inception date), *EARN_VOL* (earnings volatility which is calculated as standard deviation of quarterly earnings in the previous five years), and *Z_SCORE*. The vector of loan characteristics includes *LN_LOANSIZE* (natural log of amount of loan in US$ million), *LN_MATURITY* (natural log of loan maturity in months), *DSYN* (a dummy variable which equals to one if the loan obtained by a firm in a year *t* is syndicated and zero otherwise). We use panel regression with firm level bond short interest (*BONDSS*) as the main independent variable, vector of loan and firm characteristics as control variables and industry and year fixed effects. The firm-level bond short interest (*BONDSS*) is the main independent variable recorded in the time period before but not older than one year to the loan facility start date.

The column (1) and (2) of **Table 9** presents the results of the panel regression with all the fixed effects and firm-clustered, heteroskedasticity-robust standard errors (White 1980, Petersen 2009). We adjust standard-errors for within-firm clustering because firms can obtain multiple facilities in the same loan package in a given contract year leading to potential correlation in loan terms of same firm. The coefficient on bond short interest at firm level (*BONDSS*) is positive and significant at 1% level without (Column 1) and with firm controls (Column 2).[10] These results show that short sellers in the bond market provide valuable information to banks thus impacting the cost of the firm's private debt. These results warrant further research on what additional information do these short sellers in bond market have which is not privy to even banks.

Next, we examine whether the short sellers in the bond market provide valuable information to investors in the bond market. We match our firm level bond short sample with the Fixed Income Securities Database (FISD) and with firm level characteristics from Compustat. The FISD database provides detailed information on several corporate bond variables such as offering amount, offering yield, maturity date, coupon rate, treasury spread and credit rating of the bond. Our final sample includes 9,211 unique bond issues from 1,052 individual firms between Jan-2006 to Sep-2021. Our main dependent variable to proxy for the

[10] The results remain qualitatively similar if we exclude financial and utility companies (SIC codes in the 6000s or 4900–4999) from the sample.

cost of the primary bond issuance is the *BOND_SPREAD* measured as the natural log of the difference between the yield of the benchmark treasury issue and the issue's offering yield. We include all the usual firm level characteristics in the panel regressions as well as three bond level control variables – *LN_BONDAMT* (natural log of Bond Issuance Size in thousand US$), *LN_MATURITY* (natural log of bond maturity in months) and bond rating (provided by Moody's of S&P with Aaa/AAA = 1, C/C = 21 and anything below the rating C or missing rating = 22). The firm-level bond short interest (*BONDSS*) is the main independent variable recorded in the time period before but not older than one year to the bond offering date.

The column (3) and (4) of **Table 9** presents the results of the panel regression with all the industry and time fixed effects and firm-clustered, heteroskedasticity-robust standard errors (White 1980, Petersen 2009). The coefficient on bond short interest at firm level (*BONDSS*) is positive and significant at 1% level without (Column 1) and with firm controls (Column 2).[11] These results show that short sellers in the bond market are sophisticated investors and provide valuable information to the bond issuers.

Overall, these results provide evidence that short sellers in the bond market are able to influence the primary debt markets impacting the loan offering and bond offering cost.

[INSERT **Table 9** HERE]

5 Conclusion

While extant literature provides evidence on the information role of CDS market for price formation in corporate bonds, we provide novel evidence that short selling corporate bonds has a significant impact on the credit default swap (CDS) spreads of the underlying firms. Notably, utilizing a comprehensive data on bond short-selling spanning the 2006-2020 period, we demonstrate that bond short sellers possess information that is pertinent to participants in the

[11] The results remain qualitatively similar if we exclude financial and utility companies (SIC codes in the 6000s or 4900–4999) from the sample.

credit derivative market. We specifically examine the impact of bond short selling activity on the subsequent level of spread of 5-year CDS contract. We find that the bond short interest, calculated as the value-weighted bond short interest of all the bonds issued by a firm in each month, has economically and statistically significant positive relation with the one-month ahead CDS spread.

We analyse two primary channels that may contribute to this relationship: the borrowing fee associated with bond short interest and the short sellers' ability to predict key credit risk-related financial variables of the underlying firm. First, to assess the borrowing fee channel, we utilize the relative cost of borrowing a bond, as measured by Markit's daily cost of borrowing scores (DCBS). Our results demonstrate that bonds with high DCBS, which contain relatively more information, exhibit a significant and positive relation between bond short interest and CDS spread. Second, we find that CDS spread and bond short interest becomes weaker during the period following the large natural disasters. Third, we find that the bond short sellers are able to predict certain financial variables such as a firm’s leverage, volatility, and future growth options. Specifically, we observe that firms exhibiting higher bond short selling activities are associated with higher idiosyncratic volatility and leverage, lower TOBINQ and ROA, indicating elevated credit risk profiles for such firms, which ultimately manifest into CDS spread of the shorted firms. Our research has important implications for both investors and regulators, as it demonstrates that short selling in the corporate bond market provides valuable information for CDS investors.

References

Acharya, V., and T. Johnson. 2007. Insider trading in credit derivatives☆. *Journal of Financial Economics* 84: 110-141

Anderson, J. D., and J. E. Core. 2018. Managerial incentives to increase risk provided by debt, stock, and options. *Management Science* 64: 4408-4432

Asquith, P., A. S. Au, T. Covert, and P. A. Pathak. 2013. The market for borrowing corporate bonds. *Journal of Financial Economics* 107: 155-182

Augustin, P., and Y. Izhakian. 2020. Ambiguity, volatility, and credit risk. *The Review of Financial Studies* 33: 1618-1672

Baba, N., and M. Inada. 2009. Price discovery of subordinated credit spreads for Japanese mega-banks: Evidence from bond and credit default swap markets. *Journal of International Financial Markets, Institutions and Money* 19: 616-632

Bai, J., and L. Wu. 2016. Anchoring Credit Default Swap Spreads to Firm Fundamentals. *Journal of Financial and Quantitative Analysis* 51: 1521-1543

Bharath, S. T., and T. Shumway. 2008. Forecasting default with the Merton distance to default model. *The Review of Financial Studies* 21: 1339-1369

Blanco, R., S. Brennan, and I. W. Marsh. 2005. An empirical analysis of the dynamic relation between investment-grade bonds and credit default swaps. *The Journal of Finance* 60: 2255-2281

Blocher, J., A. V. Reed, and E. D. Van Wesep. 2013. Connecting two markets: An equilibrium framework for shorts, longs, and stock loans. *Journal of Financial Economics* 108: 302-322

Butler, A. W., X. Gao, and C. Uzmanoglu. 2023. Maturity clienteles and corporate bond maturities. *Journal of Financial and Quantitative Analysis* 58: 1263-1294

Campbell, J. Y., and G. B. Taksler. 2003. Equity volatility and corporate bond yields. *The Journal of Finance* 58: 2321-2350

Chen, Y., Q. Fan, X. Yang, and L. Zolotoy. 2021. CEO early-life disaster experience and stock price crash risk. *Journal of Corporate Finance* 68: 101928

Cohen, L., K. B. Diether, and C. J. Malloy. 2007. Supply and demand shifts in the shorting market. *The Journal of Finance* 62: 2061-2096

Czech, R. 2021. Credit default swaps and corporate bond trading. *Journal of Financial Intermediation* 48: 100932

Danielsen, B. R., and S. M. Sorescu. 2001. Why do option introductions depress stock prices? A study of diminishing short sale constraints. *Journal of Financial and Quantitative Analysis* 36: 451-484

Das, S., M. Kalimipalli, and S. Nayak. 2014. Did CDS trading improve the market for corporate bonds? *Journal of Financial Economics* 111: 495-525

Demiroglu, C., C. James, and G. Velioglu. 2022. Why are commercial loan rates so sticky? The effect of private information on loan spreads. *Journal of Financial Economics* 143: 959-972

Diamond, D. W., and R. E. Verrecchia. 1987. Constraints on short-selling and asset price adjustment to private information. *Journal of Financial Economics* 18: 277-311

Drechsler, I., and Q. F. Drechsler. 2014. The shorting premium and asset pricing anomalies. *National Bureau of Economic Research*

Duffie, D., and D. Lando. 2001. Term structures of credit spreads with incomplete accounting information. *Econometrica* 69: 633-664

Duong, H. N., P. S. Kalev, and X. Tian. 2023. Short selling, divergence of opinion and volatility in the corporate bond market. *Journal of Economic Dynamics and Control* 147:

Engelberg, J., R. B. Evans, G. Leonard, A. V. Reed, and M. C. Ringgenberg. 2022. The loan fee anomaly: A short seller's best ideas. *2022 American Finance Association Annual Meeting Paper*

Engelberg, J. E., A. V. Reed, and M. C. Ringgenberg. 2018. Short-selling risk. *The Journal of Finance* 73: 755-786

Ericsson, J., K. Jacobs, and R. Oviedo. 2009. The Determinants of Credit Default Swap Premia. *Journal of Financial and Quantitative Analysis* 44: 109-132

Figlewski, S., and G. P. Webb. 1993. Options, short sales, and market completeness. *The Journal of Finance* 48: 761-777

Foley-Fisher, N., S. Gissler, and S. Verani. 2019. Over-the-counter market liquidity and securities lending. *Review of Economic Dynamics* 33: 272-294

Forte, S., and J. I. Pena. 2009. Credit spreads: An empirical analysis on the informational content of stocks, bonds, and CDS. *Journal of Banking & Finance* 33: 2013-2025

Griffin, P. A., H. A. Hong, and J.-B. Kim. 2016. Price discovery in the CDS market: The informational role of equity short interest. *Review of Accounting Studies* 21: 1116-1148

Grundy, B. D., B. Lim, and P. Verwijmeren. 2012. Do option markets undo restrictions on short sales? Evidence from the 2008 short-sale ban. *Journal of Financial Economics* 106: 331-348

Hasan, M. M., G. J. Lobo, and B. Qiu. 2021. Organizational capital, corporate tax avoidance, and firm value. *Journal of Corporate Finance* 70: 102050

Hendershott, T., R. Kozhan, and V. Raman. 2020. Short selling and price discovery in corporate bonds. *Journal of Financial and Quantitative Analysis* 55: 77-115

Hilscher, J., J. M. Pollet, and M. Wilson. 2015. Are credit default swaps a sideshow? Evidence that information flows from equity to CDS markets. *Journal of Financial and Quantitative Analysis* 50: 543-567

Ho, P. H., C. Y. Lin, and T. C. Lin. 2021. Equity Short Selling and the Bank Loan Market. *Journal of Money, Credit and Banking* 54: 349-379

Hull, J., M. Predescu, and A. White. 2004. The relationship between credit default swap spreads, bond yields, and credit rating announcements. *Journal of Banking & Finance* 28: 2789-2811

Kaviani, M. S., L. Kryzanowski, H. Maleki, and P. Savor. 2020. Policy uncertainty and corporate credit spreads. *Journal of Financial Economics* 138: 838-865

Kecskés, A., S. A. Mansi, and A. Zhang. 2013. Are short sellers informed? Evidence from the bond market. *The Accounting Review* 88: 611-639

Kryzanowski, L., S. Perrakis, and R. Zhong. 2017. Price discovery in equity and CDS markets. *Journal of Financial Markets* 35: 21-46

Lewbel, A. 2012. Using Heteroscedasticity to Identify and Estimate Mismeasured and Endogenous Regressor Models. *Journal of Business & Economic Statistics* 30: 67-80

Marsh, I. W., and W. Wagner. 2016. News-Specific Price Discovery in Credit Default Swap Markets. *Financial Management* 45: 315-340

Massa, M., and L. Zhang. 2021. The spillover effects of Hurricane Katrina on corporate bonds and the choice between bank and bond financing. *Journal of Financial and Quantitative Analysis* 56: 885-913

Mavis, C. P., N. P. McNamee, D. Petmezas, and N. G. Travlos. 2020. Selling to buy: Asset sales and acquisitions. *Journal of Corporate Finance* 62: 101587

Merton, R. C. 1974. On the pricing of corporate debt: The risk structure of interest rates. *The Journal of Finance* 29: 449-470

Norden, L., and W. Wagner. 2008. Credit derivatives and loan pricing. *Journal of Banking & Finance* 32: 2560-2569

Norden, L., and M. Weber. 2009. The co-movement of credit default swap, bond and stock markets: An empirical analysis. *European financial management* 15: 529-562

Petersen, M. A. 2009. Estimating standard errors in finance panel data sets: Comparing approaches. *The Review of Financial Studies* 22: 435–480

Rhee, S. G., H. N. Duong, and V. H. Vu. 2023. The feedback effect: Evidence from bank loan pricing. *Working paper, available at SSRN: https://ssrn.com/abstract=4342026*

Roll, R., E. Schwartz, and A. Subrahmanyam. 2010. O/S: The relative trading activity in options and stock. *Journal of Financial Economics* 96: 1-17

Sambalaibat, B. 2022. A theory of liquidity spillover between bond and CDS markets. *The Review of Financial Studies* 35: 2525-2569

Zhang, B. Y., H. Zhou, and H. Zhu. 2009. Explaining credit default swap spreads with the equity volatility and jump risks of individual firms. *The Review of Financial Studies* 22: 5099-5131

Appendix A1: Variable Description

Variables	Definitions	Source
	CDS Variables	
$CDS\_SPREAD_{i,t}$	CDS spread for firm *i* at the end of month *t*.	Markit
	Bond Short Selling Variables	
$BONDSS_{i,t–1}$	The aggregate of value–weighted (offering amount divided by sum of offering amount of all the bonds by the firm in month t–1) bond short interest of all the bonds of firm i in month t–1. Bond Short Interest is proxied as the Total Demand Quantity which is equal to Total quantity of borrowed/loaned securities net of double counting.	Markit
DCBS	DCBS is Markit Securities Finance Daily Cost of Borrow Score; a number from 1 to 10 indicating the rebate/fee charged by the agent lender based on Data Explorers proprietary benchmark rate, where 1 is cheapest and 10 is most expensive. Our proxy for the relative cost of bond shorting at firm level is the average of DCBS of each shorted bond of a firm *i* at time *t–1*.	Markit
	Stock Short Selling Variables	
$STOCK\_SS_{i,t–1}$	The average of the short selling position (the number of shares shorted over the number of shares outstanding) for firm i held on mid and end of the month t–1	Compustat and CRSP
	Firm Level Variables	
SIZE	The natural logarithm of total asset, computed as log(*atq*). This variable is measured in the quarter before the CDS spread or loan facility start date or bond offering date.	Compustat – North America Quarterly
LEVERAGE	Firm leverage, computed as (*dlttq* + *dlcq*)/*atq*. This variable is measured in the quarter before the CDS spread or loan facility start date or bond offering date.	Compustat – North America Quarterly
TANGIBILITY	Fixed asset, computed as the ratio of plant, property, and equipment over total asset *ppenqt*/*atq*. This variable is measured in the quarter before the CDS spread or loan facility start date or bond offering date.	Compustat – North America Quarterly
CASH	Cash holding, computed as *cheq*/*atq*. This variable is measured in the quarter before the CDS spread or loan facility start date or bond offering date.	Compustat – North America Quarterly
ROA	Return on asset, computed as *oibdpq / atq*. This variable is measured in the quarter before the CDS spread or loan facility start date or bond offering date.	Compustat – North America Quarterly
MTB	Market to book ratio, computed as (*prccqxcshoq* + *dlttq* + *dlcq*)/*atq*. This variable is measured in the quarter before the CDS spread or loan facility start date or bond offering date.	Compustat – North America Quarterly
IVOL	Idiosynchratic Volatility computed as the standard deviation of difference between a firm's stock return and the CRSP value–weighted return over the past 180 days	CRSP
EARN_VOL	Earnings Volatility: Standard deviation of quarterly earnings (*epspiq*) in the previous 5 years.	Compustat – North America Quarterly
Z_SCORE	Z score, computed as [(3.3x*piq* + *saleq* + 1.4x*req* + 1.2x(*actq* – *lctq*)]/*atq*. This variable is measured in the quarter before the CDS spread or loan facility start date or bond offering date.	Compustat – North America Quarterly

SALE_GROWTH	The growth rate of sales (SALEQ) from two quarters prior to the quarter immediately before the loan inception date.	Compustat – North America Quarterly
	Firm Credit Rating Variable	
FIRM_RATING	Average of bond level credit rating on each date for a firm. The bond level rating is Moody's bond rating. If Moody's rating is not present, then we use S&P bond rating. If both ratings are absent, then we assign missing rating. The highest rating is coded as '1' and lowest rating or missing rating are coded as '22'.	FISD
	Bond Return Variables (averaged at firm level)	
BOND_RET	The firm level aggregate of value–weighted (offering amount divided by sum of offering amount of all the bonds by the firm in month *t–1*) average monthly bond returns in the previous 36 months	TRACE/FISD
$BOND\_RET_{MIN}$	The firm level aggregate of value–weighted minimum monthly bond returns in the previous 36 months	TRACE/FISD
BOND_VOL	The firm level aggregate of value–weighted volatility (standard deviation) of monthly bond returns in the previous 36 months	TRACE/FISD
	Stock Return Variables	
STOCK_RET	The average monthly stock returns in the previous 36 months	CRSP
$STOCK\_RET_{MIN}$	The minimum monthly stock returns in the previous 36 months	CRSP
STOCK_VOL	The volatility (standard deviation) of monthly stock returns in the previous 36 months	CRSP
	Macro–Financial Variables	
MKTRET	Difference between market return and risk free rate	Kenneth French data library
TSYIELD1	1–year constant–maturity Treasury yield	US Federal Reserve website
TSSLOPE	Government treasury yield Slope – difference between ten–year and two–year constant–maturity US treasury rate/yields	US Federal Reserve website
VIX	CBOE S&P500 Volatility Index – Close	CBOE
	Loan and Bond (Primary Debt Market) Variables	
LOAN_SPREAD	Natural log of all–in spread drawn (ALLINDRAWN). All–in spread drawn is defined as the amount the borrower pays in basis points over London Interbank Borrowing Rate (LIBOR) or LIBOR equivalent for each dollar drawn down.	DealScan
LN_LOANSIZE	The natural logarithm of the total loan amount.	DealScan
LN_LOANMATURITY	The natural logarithm of the loan time to maturity (in months)	DealScan
DSYN	A dummy variable for syndicated loans	DealScan
BOND_SPREAD	Natural log of the difference between the yield of the benchmark treasury issue and the issue's offering yield	TRACE/FISD
LN_BONDAMT	The natural logarithm of the total bond offering amount	TRACE/FISD
LN_BONDMATURITY	The natural logarithm of the time to maturity (in months) for a bond	TRACE/FISD

BOND_RATING	Categorical variable ranging from one (AAA rating) to 21 (missing rating). We use the borrower's S&P long–term issuer rating. A smaller number indicates a higher rating.	TRACE/FISD

Appendix A2: Natural Disasters

The information on natural disasters is sourced from the Emergency Events Database (EM-DAT) which is a global dataset on natural and technological disasters. In this table, we provide the list of the large natural disasters, their start dates, affected states and the amount (in billion U.S. dollars) of insured damages.

(Source: "EM-DAT, CRED / UCLouvain, Brussels, Belgium – www.emdat.be) "

Disaster Name	**Start Date**	**States Affected**	**Insured Damage (bn USD)**
Hurricane Gustav	01-Sep-2008	Alabama, Louisiana, Mississippi, Texas	4.76
Hurricane Ike	12-Sep-2008	Arkansas, Illinois, Indiana, Kentucky, Louisiana, Michigan, Missouri, Ohio, Pennsylvania, Tennessee	20.39
Super Outbreak	27-Apr-2011	Georgia, North Carolina	8.00
Hurricane Irene	26-Aug-2011	North Carolina	6.00
Hurricane Sandy	28-Oct-2012	Connecticut, Delaware, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, North Carolina, Ohio, Pennsylvania, Rhode Island, Vermont, Virginia, West Virginia	30.00
Hurricane Matthew	08-Oct-2016	Florida, Georgia, North Carolina, South Carolina, Virginia	6.10
Hurricane Harvey	25-Aug-2017	Louisiana, Texas	35.82
Hurricane Irma	10-Sep-2017	Florida, Georgia, South Carolina	34.62
Hurricane Florence	12-Sep-2018	North Carolina, South Carolina, Virginia	5.83
Hurricane Michael	10-Oct-2018	Alabama, Florida, Georgia, Maryland, North Carolina, Virginia	11.65
Hurricane Laura	27-Aug-2020	Arkansas, Louisiana, Mississippi, Texas	11.31
Hurricane Sally	11-Sep-2020	Alabama, Florida	3.96

Table 1: Descriptive Statistics

Panel A of the table provides the summary statistics of the key variables for a sample of 648 single–*CDS* of firms in the U.S. for the period from Feb–2006 to Dec 2020. Note that the *CDS_SPREAD* is reported in real values and expressed in basis points (bps). *BOND_SS* is an aggregate of value–weighted average (the number of bonds shorted over the bond offering amount) of the daily short interest of all the bonds of firm *i* in month *t–1*. *LEVERAGE* is the ratio of total liabilities to total assets. *IVOL* is the idiosyncratic volatility of a firm; it is the standard deviation of daily excess returns, computed as the difference between a firm's stock return and the CRSP value–weighted return over the past 180 days. *Total Asset Value* is the firm's size measured by total assets. We use the natural logarithm of *Total Asset Value* denoted as *SIZE* in our regression analysis. *ROA* is the return on assets, *TANGIBILITY* is the property, plant, and equipment scaled by the total assets of the firm, and *CAPEX* is the capital expenditure scaled by total assets. *CASH* and *TURNOVER* are the cash & short–term investments and total revenue of the firm, respectively, both scaled by the total assets of the firm. *TSYIELD1* is the 1–year US Treasury rate and *TSSLOPE* is the difference between 10–year and 2–year US Treasury rate. *MKTRET* is the monthly excess return of the market. The details of these variables are provided in Appendix A1. All continuous variables are winsorized at the 1st and 99th percentile.

	N	Mean	SD	p25	Median	p75	Max
			5–Year CDS Spread at the End of Month				
CDS5 (bps)	59,958	156	179	52	93	180	1,049
			Firm Level Bond Short Interest Measure				
BONDSS (%)	59,958	1.65	2.28	0.28	0.84	1.94	12.33
			Firm Characteristic Variables				
SIZE	58,455	9.72	1.40	8.71	9.60	10.53	13.76
LEVERAGE	54,502	0.31	0.16	0.19	0.29	0.41	0.82
TANGIBILITY	54,892	0.31	0.26	0.09	0.23	0.52	0.89
CASH	51,970	0.16	0.15	0.05	0.11	0.23	0.70
ROA	53,149	0.03	0.02	0.02	0.03	0.04	0.09
MTB	58,181	3.16	4.84	1.34	2.20	3.63	33.73
TOBINQ	58,181	1.64	0.72	1.12	1.42	1.90	4.63
CAPEX	58,236	0.03	0.03	0.01	0.02	0.04	0.18
TURNOVER	57,315	0.20	0.17	0.08	0.16	0.26	0.92
IVOL	59,925	0.07	0.05	0.04	0.06	0.08	0.29
			Macro–Financial Variables				
MKT_RET (%)	59,958	0.79	4.45	–1.53	1.29	3.24	13.65
TSYIELD1 (%)	59,958	1.35	1.61	0.19	0.50	2.06	5.16
TSSLOPE (%)	59,958	1.31	0.89	0.50	1.40	2.03	2.81
VIX	59,958	19.40	9.02	13.49	16.79	22.46	61.18

Table 2: The Relation between Bond Short Interest and 5–Year CDS Spread

This table presents the results from the panel regression of the one month ahead 5–year CDS spread (*CDS5*) for firm *i* at the end of month *t*. *BONDSS* is the value–weighted average (the number of bonds shorted over the bond offering amount) of the daily short interest of all the bonds of firm *i* in month *t–1*. The sample period is from Feb–2006 to Dec–2020. We use firm fundamental variables (*SIZE; LEVERAGE; TANGIBILITY; CASH; ROA; MTB; TOBINQ*) as the control variables, and b) macro–financial variables (*TSYIELD1*, *TSSLOPE*, *MKTRET and VIX*) as additional controls in estimations without the time fixed effects. We winsorize continuous variables at the 1st and 99th percentile. The standard errors are clustered by firm and by date. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively. The values in parentheses are the *t–statistics* of the estimated coefficients. Variable definitions are provided in the Appendix A1.

	CDS5	CDS5	CDS5	CDS5
	(1)	(2)	(3)	(4)
BONDSS	0.068***	0.103***	0.052***	0.054***
	(4.24)	(4.98)	(2.99)	(3.19)
SIZE		–0.003***	–0.002**	–0.001
		(–7.79)	(–2.31)	(–1.33)
LEVERAGE		0.031***	0.021***	0.023***
		(9.20)	(5.05)	(5.32)
TANGIBILITY		0.005	0.016**	0.020***
		(1.58)	(2.50)	(2.97)
CASH		0.004	0.001	0.002
		(1.60)	(0.35)	(0.99)
ROA		–0.138***	–0.104***	–0.112***
		(–4.97)	(–5.87)	(–6.46)
MTB		–0.000**	–0.000	–0.000
		(–2.41)	(–0.57)	(–0.52)
TOBINQ		–0.003***	–0.004***	–0.003***
		(–5.24)	(–4.96)	(–3.64)
CAPEX		–0.003	0.009	–0.005
		(–0.31)	(1.11)	(–0.60)
TURNOVER		0.006	0.013***	0.010**
		(1.37)	(2.71)	(2.20)
IVOL		0.117***	0.065***	0.065***
		(13.02)	(10.08)	(10.17)
MktRET			–0.020***	
			(–3.86)	
TSYield1			–0.075**	
			(–2.09)	
TSSlope			0.068	
			(1.18)	
VIX			0.0002***	
			(4.21)	
Firm FE	Yes	No	Yes	Yes
Industry FE	No	Yes	No	No
Time FE	Yes	Yes	No	Yes
N	59,935	45,111	45,099	45,099
Adj.R^2	0.670	0.536	0.735	0.750

Table 3: Robustness Checks

This table presents three sets of robustness tests of the main results. Panel A presents the baseline regression of Table 2 using alternative measures of CDS spread. In Model 1 and 2, we use the natural logarithm of the 5–year CDS spread (log(CDS5)) at the end of the month and the monthly average of the daily CDS spread (CDS5_Avg) as the dependent variable. In Model 3 and 4, we present the baseline regression results in Table 2 with dependent variable as end of month CDS spread of tenor 3 years (*CDS3*) and 10 years (*CDS10*). The Panel B presents the baselines results of Table 2 with alternative measures of firm level bond short interest as the main independent variable – model 1 uses the value–weighted average (the number of bonds shorted over the bond offering amount) of the daily dollar value of short interest (*BONDSS_VALUE*) of all the bonds of firm i at the end of month t–1; Model 2 uses the value–weighted average of the '*UTILIZATION*', which measures the quantity of bond that is lent out for short–selling as a percentage of the total quantity available for bond lending; Model 3 uses the maximum value among all the shorted bonds of a firm in a month (BONDSS_Max); Model 4 uses the firm level equal–weighted bond short interest (BONDSS_EW). The results in Panel C present the baseline regression with additional controls. In Model 1, we include *STOCKSS* variable, the short selling position of a firm's stock at the end of the month *t–1*. In Model 2, we include *PUTOPTIONS_Volume* as an additional control variable, which is the monthly traded volume of put options divided by the total trading volume of the underlying stock in a month. In Model 3, we include the one month (*CDS_lag1*) and two–month (*CDS_lag2*) lagged values of the 5–year CDS spreads. In the Model 4, we include several control variables related to the return and volatility of stocks and bonds of the firms in the sample. These include average monthly bond (*Bond_Ret*) and stock (*Stock_Ret*) returns, the volatility (standard deviation) of monthly bond returns (*Bond_Volatility*) and stock returns (*Stock_Volatility*) in the previous 36 months, the minimum monthly bond returns ($Bond\_Ret_{MIN}$) and shares returns ($Stock\_Ret_{MIN}$) in the previous 36 months. We also include the earnings volatility (Earning_*Volatility*) of each firm which is the standard deviation of quarterly earnings in the previous 5 years. The sample period is from Feb–2006 to Dec–2020. We use firm fundamental variables (SIZE; LEVERAGE; TANGIBILITY; CASH; ROA; MTB; TOBINQ) as additional controls. All the models include firm and time fixed effects. We winsorize continuous variables at the 1st and 99th percentile. The standard errors are clustered by firm and by date. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively. The values in parentheses are the t–statistics of the estimated coefficients. Variable definitions are provided in the Appendix A1.

Panel A: Alternative Measures of CDS Spread

	log(CDS5)	CDS5_Avg	CDS3	CDS10
	(1)	(2)	(1)	(2)
BONDSS	1.736***	0.055***	0.042**	0.064***
	(3.65)	(3.26)	(2.44)	(3.63)
Firm Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	45,099	45,099	37,811	37,811
Adj.R^2	0.829	0.755	0.711	0.780

Panel B: Alternative Measures of Bond Short Interest

	CDS5	CDS5	CDS5	CDS5
	(1)	(2)	(3)	(4)
BONDSS_Value	0.036**			
	(2.29)			
Utilisation		0.026***		
		(5.43)		
BONDSS_Max			0.022***	
			(3.79)	
BONDSS_EW				0.053***
				(3.09)

Firm Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	45,099	45,099	45,099	45,099
Adj.R^2	0.749	0.755	0.757	0.750
Panel C: Additional Controls				
	CDS5	CDS5	CDS5	CDS5
	(1)	(2)	(3)	(4)
BONDSS	0.040**	0.056***	0.011**	0.034**
	(2.41)	(3.27)	(2.20)	(2.36)
STOCKSS	0.051***			
	(5.33)			
PUTOptions_Volume		0.056		
		(0.90)		
CDS_lag1			0.688***	
			(21.43)	
CDS_lag2			0.067***	
			(3.16)	
Bond_Ret				-0.481***
				(-4.73)
Bond_Ret$_{MIN}$				0.006
				(0.65)
Bond_Volatility				0.201***
				(5.24)
Stock_Ret				-0.253***
				(-8.24)
Stock_Ret$_{MIN}$				0.000
				(0.07)
Stock_Volatility				0.081***
				(4.32)
Firm Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	43,027	44,395	43,027	44,976
Adj.R^2	0.760	0.750	0.753	0.787

Table 4: Heteroskedasticity based instrumental variable (IV) analysis and Matched Sample Analysis

This table presents two sets of results to tackle the endogeneity issue. The results in Column 1 are based on the matched sample constructed using the propensity score matching method The results in Column 2 are based on the instrumental variables (IV) estimation using heteroskedasticity-based instruments based on Lewbel (2012). The variable instrumented is the bond short interest (*BONDSS)*. CDS5, the main dependent variable, is the 5–year CDS spread for firm *i* at the end of month *t*. The sample period for both the models is from Feb–2006 to Dec–2020. We use two sets of control variables: a) firm fundamental variables (*SIZE; LEVERAGE; TANGIBILITY; CASH; ROA; MTB; TOBINQ*), and b) macro–financial variables (*TSYIELD1, TSSLOPE, MKTRET and VIX*) in estimations without the time fixed effects. We winsorize continuous variables at the 1st and 99th percentile. The standard errors are clustered by firm and by date. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively. The values in parentheses are the *t–statistics* of the estimated coefficients. Variable definitions are provided in the Appendix A1.

	Matched Sample	Lewbel (2012) IV Analysis
	CDS5	CDS5
	(2)	(2)
BONDSS	0.032**	
	(2.57)	
Instrumented BONDSS		0.093***
		(2.83)
Firm Controls	Yes	Yes
Macro-Financial Controls	Yes	Yes
Firm FE	Yes	No
Time FE	Yes	No
N	23,486	42,528
Adj.R^2	0.776	0.464
Under-identification Test:		
Kleibergen-Paap rk LM statistic		42.528
Weak instrument test:		
Cragg-Donald Wald F statistic		3,108
Stock-Yogo (2005) crit. Val		21.18

Table 5: Bond Short Interest and CDS Spread: Natural Disaster vs. Non-Natural Disaster Periods

This table presents the results from regressions that investigate the influence of large natural disasters (exogeneous shocks to the bond short interest) on the bond short interest (*BONDSS*) and CDS spread (*CDS5*). We identify 12 large natural disasters between 2008 and 2020 based on their insured losses (please see Appendix A2 for the list of disasters). *Disaster_Dummy*, a dummy constructed to proxy for the disaster periods, equals 1 if the time period of the sample is within 6 months after the start date of a disaster, and 0 otherwise. In first step (Panel A), we investigate the impact of natural disasters on the supply of bonds available for shorting from the beneficial owners (*BONDSS_Supply*) and on the *BONDSS*. Columns 1 and 2 present the results for the full sample, while Columns 3 and 4 focus on a subsample excluding observations from states affected by the disaster within the last 6 months. In the next step (Panel B), we assess the impact of the natural disasters on the CDS spread and *BONDSS* relation. Column 1 provides results for the subsample during the time period when a natural disaster occurred within the last 6 months, while Column 2 pertains to the time period without any recent natural disasters. In Column 3, we analyse a subsample that includes observations exclusively from states that experienced a disaster in the past 6 months. Finally, Column 4 presents results for a subsample consisting of states unaffected by any disasters in the past 6 months. The sample period is from Feb–2006 to Dec–2020. We use two sets of control variables: a) firm fundamental variables (*SIZE; LEVERAGE; TANGIBILITY; CASH; ROA; MTB; TOBINQ*), and b) macro–financial variables (*TSYIELD1*, *TSSLOPE*, *MKTRET and VIX*) in estimations without the time fixed effects. All the models in Panel B include firm, state and time fixed effects. We winsorize continuous variables at the 1st and 99th percentile. The standard errors are clustered by firm and by date. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively. The values in parentheses are the *t–statistics* of the estimated coefficients. Variable definitions are provided in the Appendix A1.

Panel A: Impact of Natural Disasters on Demand and Supply of Bond Short Selling

	Full Sample		States unaffected with Disaster in last 6 months	
	BONDSS	BONDSS_Supply	BONDSS	BONDSS_Supply
	(1)	(2)	(3)	(4)
Disaster_Dummy	–0.002**	–0.008*	–0.002**	–0.010**
	(–2.41)	(–1.75)	(–2.49)	(–2.19)
Firm Controls	Yes	Yes	Yes	Yes
Macro-Financial Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Time FE	No	No	No	No
N	45,099	45,099	42,251	42,251
Adj.R^2	0.442	0.604	0.449	0.602

Panel B: Impact of Natural Disasters on relation between CDS Spread and Bond Short Interest

	Disaster Period	Non-Disaster Period	States with Disaster in last 6 months	States with no Disaster in last 6 months
	CDS5	CDS5	CDS5	CDS5
	(1)	(2)	(3)	(4)
BONDSS	0.052*	0.054***	–0.048	0.060***
	(1.87)	(3.19)	(–0.94)	(3.30)
Firm Controls	Yes	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes	Yes
State FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	12,326	32,768	1,062	42,251
Adj.R^2	0.760	0.760	0.891	0.757

Table 6: Impact of Relative Borrowing Cost of Bond Shorting on CDS–Bond Short Selling

This table presents the impact of relative borrowing cost of bond short selling on the relation between CDS spread (*CDS5*) and firm level bond short selling (*BONDSS*). Markit computes Daily Cost of Borrowing Score (*DCBS*) for each of the shorted bonds which indicates the relative cost of borrowing a bond. To arrive at the firm level monthly relative borrowing cost indicator, we take the average DCBS value of all the shorted bonds of a firm in each month. The columns (1) and (2) show the baseline results of Table 2 for subsamples of top (highest relative fee) and bottom DCBS (lowest relative fee) quartile firms respectively. The results in column (3) show the baseline regression of Table 2 for the subsample having the average DCBS greater than one and the column (4) with subsample having the score equal to one, respectively. The sample period is from Feb–2006 to Dec–2020. We use firm fundamental variables (*SIZE; LEVERAGE; TANGIBILITY; CASH; ROA; MTB; TOBINQ*) as control variables. All the models include firm and time fixed effects. We winsorize continuous variables at the 1st and 99th percentile. The standard errors are clustered by firm and by date. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively. The values in parentheses are the *t–statistics* of the estimated coefficients. Variable definitions are provided in the Appendix A1.

	High Fee (Top DCBS Quartile)	Low Fee (Bottom DCBS Quartile)	High Fee (DCBS >1)	Low Fee (DCBS <=1)
	CDS5	CDS5	CDS5	CDS5
	(1)	(2)	(3)	(4)
BONDSS	0.089***	-0.032	0.083***	0.021*
	(3.28)	(-1.50)	(3.01)	(1.76)
SIZE	-0.004	0.002	-0.003	-0.000
	(-1.53)	(0.98)	(-1.38)	(-0.10)
LEVERAGE	0.031***	0.047***	0.028***	0.019***
	(3.41)	(4.66)	(3.30)	(5.20)
TANGIBILITY	0.024**	0.038**	0.019*	0.013**
	(2.28)	(2.73)	(1.90)	(2.47)
CASH	0.003	0.009*	0.002	0.002
	(0.56)	(1.73)	(0.58)	(1.22)
ROA	-0.139***	-0.098	-0.129***	-0.084***
	(-4.45)	(-1.66)	(-4.37)	(-5.37)
MTB	-0.000	0.000	-0.000	0.000
	(-0.55)	(0.13)	(-0.43)	(0.73)
TOBINQ	-0.009***	-0.001	-0.007***	-0.002***
	(-4.42)	(-0.54)	(-3.72)	(-3.94)
CAPEX	-0.001	-0.003	0.003	-0.002
	(-0.07)	(-0.24)	(0.20)	(-0.33)
TURNOVER	0.003	0.007	0.004	0.008**
	(0.22)	(0.60)	(0.35)	(2.08)
IVOL	0.076***	0.002	0.068***	0.045***
	(7.88)	(0.12)	(7.54)	(8.52)
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	8,305	2,059	10,314	30,164
Adj.R^2	0.803	0.765	0.814	0.766

Table 7: Impact of CDS Liquidity on the CDS Spread–Bond Short Selling Relation

This table presents the impact of CDS liquidity on the relationship between CDS spread and firm level bond short interest. The liquidity of CDS is the month end Markit's composite depth score for the CDSs in the sample. *CDS5,* the main dependent variable, is the 5– year CDS spread for firm *i* at the end of month *t*. *BONDSS* is the value–weighted average (the number of bonds shorted over the bond offering amount) of the daily short interest of all the bonds of firm *i* in month *t–1*. The column (1) and column (2) present the baseline regression results of Table 2 for the top and bottom quartile subsamples based on CDS liquidity in each month, respectively. The results in column (3) shows the baseline regression of Table 2 for the subsample having the '*CDS_Depth Score*' greater than three and the column (4) with subsample having the score less than or equal to three, respectively. The sample period is from Feb–2006 to Dec–2020. We use firm fundamental variables (*SIZE; LEVERAGE; TANGIBILITY; CASH; ROA; MTB; TOBINQ*) as control variables. All the models include firm and time fixed effects. We winsorize continuous variables at the 1st and 99th percentile. The standard errors are clustered by firm and by date. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively. The values in parentheses are the *t–statistics* of the estimated coefficients. Variable definitions are provided in the Appendix A1.

	High CDS Liquidity (Top CDS Depth Score Quartile)	Low CDS Liquidity (Bottom CDS Depth Score Quartile)	CDS_Depth Score > 3	CDS_Depth Score <= 3
	CDS5	CDS5	CDS5	CDS5
	(1)	(2)	(3)	(4)
BONDSS	0.041**	0.035	0.057***	0.047*
	(2.10)	(1.33)	(3.09)	(1.81)
SIZE	0.000	–0.002	–0.001	–0.002
	(0.04)	(–1.19)	(–0.80)	(–1.31)
LEVERAGE	0.024***	0.009	0.025***	0.015**
	(5.19)	(1.35)	(5.06)	(2.23)
TANGIBILITY	0.020**	0.008	0.022***	0.011
	(2.55)	(0.74)	(3.35)	(0.88)
CASH	0.001	–0.002	0.002	–0.000
	(0.35)	(–0.58)	(0.92)	(–0.08)
ROA	–0.124***	–0.044	–0.132***	–0.064**
	(–5.74)	(–1.54)	(–6.87)	(–2.27)
MTB	0.000	–0.000	–0.000	–0.000
	(0.32)	(–1.64)	(–0.14)	(–1.56)
TOBINQ	–0.004***	–0.001	–0.004***	–0.002*
	(–4.26)	(–1.60)	(–3.81)	(–1.80)
CAPEX	0.002	0.001	–0.007	–0.005
	(0.18)	(0.08)	(–0.87)	(–0.47)
TURNOVER	0.016***	0.003	0.012**	0.008
	(2.70)	(0.38)	(2.10)	(0.87)
IVOL	0.085***	0.038***	0.078***	0.036***
	(7.75)	(4.88)	(10.38)	(4.92)
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	11,957	10,283	31,622	13,442
Adj.R2	0.746	0.786	0.746	0.784

Table 8: Financial Channels Inducing the relationship between Bond Short Sell and CDS spreads

This table presents the results to identify financial channels inducing the relation between Bond Short Interest and CDS spreads. The regression outputs are similar to that reported in Table 2 with the dependent variable being one of the financial variables used as control. All the models use one quarter ahead financial variables. *BONDSS* is the value–weighted average (the number of bonds shorted over the bond offering amount) of the daily short interest of all the bonds of firm i in month t–1. Only the *BONDSS* is presented for brevity. We show only those financial variables as independent variables which show statistically significant association with the BONDSS for brevity. The sample period is from Feb–2006 to Dec–2020. We use firm fundamental variables (*SIZE; LEVERAGE; TANGIBILITY; CASH; ROA; MTB; TOBINQ*) as set of control variables. All the models include firm and time fixed effects. We winsorize continuous variables at the 1st and 99th percentile. The standard errors are clustered by firm and by date. ***, ** and * indicate statistical significance at the 0.01, 0.05, and 0.10 level, respectively. The values in parentheses are the *t–statistics* of the estimated coefficients. Variable definitions are provided in the Appendix A1.

	F_TOBINQ	F_IVOL	F_LEVERAGE
BONDSS	–1.771***	0.127***	0.152*
	(-3.65)	(2.88)	(1.69)
Firm Controls	Yes	Yes	Yes
Firm FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
N	13,057	13,034	13,102
Adj.R2	0.818	0.537	0.807

Table 9: Bond Short Selling and the Cost of New Loan and Bond Issuance

This table presents the results of the relation between bond short interest and the cost of new bond issues. In Models 1 and 2, the dependent variable is the natural log of the loan spread. In Model 3, the dependent variable is the natural log of the bond spread which is the difference between the yield of the benchmark treasury issue and the issue's offering yield expressed in basis points. The main independent variable in all models is *BONDSS* (the value–weighted average of the daily bond short interest divided by bond offering amount in the fiscal year prior to the offering date of the new bond issue). We winsorize continuous variables at the 1st and 99th percentile. We include year and industry effects (based on SIC2 codes) in all models. Standard errors are clustered at the firm level. ***, **, * indicate significance at the 1%, 5%, and 10% levels, respectively. Variable definitions are provided in the Appendix A1.

	Model 1	Model 2	Model 3	Model 4
BONDSS	3.447***	1.909***	5.838***	2.947***
	(0.687)	(0.675)	(0.845)	(0.816)
LN_LOANSIZE		–0.039***		
		(0.013)		
LN_LOANMATURITY		0.050***		
		(0.018)		
LN_BONDAMT				0.158***
				(0.019)
LN_BONDMATURITY				0.240***
				(0.012)
SIZE		–0.167***		–0.087***
		(0.015)		(0.018)
LEVERAGE		0.718***		0.081
		(0.091)		(0.102)
TANGIBILITY		0.073		0.249**
		(0.099)		(0.107)
CASH		0.039		0.208***
		(0.093)		(0.071)
ROA		–2.345***		–1.042***
		(0.306)		(0.247)
MTB		–0.003		–0.003***
		(0.004)		(0.001)
Z		–0.009		–0.001
		(0.015)		(0.011)
SALE_GROWTH		0.057		0.046
		(0.043)		(0.051)
EARN_VOL		0.031***		0.014**
		(0.007)		(0.006)
DSYN		0.119**		
		(0.050)		
BOND_RATING				0.118***
				(0.011)
Industry FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
N	6,752	5,229	6,715	4,200
Adj.R^2	0.305	0.489	0.357	0.677