Short Selling and Price Discovery in Corporate Bonds

Terrence Hendershott, Roman Kozhan, and Vikas Raman*

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*Hendershott (corresponding author), hender@berkeley.edu, University of California Berkeley Haas Business School; Kozhan, roman.kozhan@wbs.ac.uk, University of Warwick Business School; and Raman, v.raman@lancaster.ac.uk, Lancaster University Management School. We thank an anonymous referee and Hendrik Bessembinder (the editor). We are grateful to Lauren Cohen, Harald Hau, Charles Jones, Adam Reed, Pedro Saffi, and Elvira Sojli as well as participants at the 2018 Annual Meeting of the European Finance Association, and several research seminars for providing helpful comments and suggestions.

Abstract

We show short selling in corporate bonds forecasts future bond returns. Short selling predicts bond returns where private information is more likely, in high-yield bonds, particularly after Lehman Brothers collapse of 2008. Short selling predicts returns following both high and low past bond returns. This, together with short selling increasing following past buying order imbalances, suggests short sellers trade against price pressures as well as trade on information. Short selling predicts bond returns both in the individual bonds that are shorted and in other bonds by the same issuer. Past stock returns and short selling in stocks predict bond returns, but do not eliminate bond short selling predicting bond returns. Bond short selling does not predict the issuer's stock returns. These results show bond short sellers contribute to efficient bond prices and that short sellers' information flows from stocks to bonds, but not from bonds to stocks.

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I. Introduction

A significant element in firms' choice of capital structure and security design is the relative informational sensitivity of equity and debt (e.g., Myers and Majluf (1984), Innes (1990), and Freiwald, Hennessy, and Jankowitsch (2016)). This same informational sensitivity should manifest itself in securities markets through informed trading and price discovery across related assets. Numerous papers examine where price discovery occurs across related assets (e.g., options versus the underlying stock, credit default swaps versus bonds, and stocks versus bonds). We extend the study of price discovery across stocks and bonds by examining how a group of traders known to be informed, short sellers, impact price discovery in bonds and between stocks and bonds.

While there is a substantial literature on the importance of short selling in stocks, the literature on short selling in bonds is much more limited and primarily examines the nature and determinants of borrowing costs in the bond market. Asquith, Au, Covert, and Pathak (2013) briefly study the informativeness of short sellers between 2004 and 2007 and find no evidence of short sellers being informed. For our sample period prior to the Lehman Brothers 2008 collapse we also find a weak relationship between the level of shorting in bonds, as measured by short interest, and subsequent bond returns. However, after Lehman's collapse we find that short interest predicts bond returns in high-yield bonds. In the second half of 2008 bonds in the most shorted quintile underperform bonds in least shorted quintile by almost 10% annually. For high-yield bonds during this period, bonds in the most shorted quintile underperform bonds in least shorted quintile by more than 50% annually. From 2009 to 2011 heavily shorted high-yield bonds underperform lightly shorted high-yield bonds by almost 25% annually. We find little evidence that short interest predicts returns in investment-grade bonds.

The portfolio sort results of short selling predicting bond returns continue to hold in cross-sectional regressions with other predictors of bond returns, such as past order imbalance (customer buy minus sell volume) and past bond returns. Both short interest in the individual bonds as well as short interest across all bonds in a firm predict future bonds returns. As with the portfolio sorts, short interest predicts returns more post-Lehman and in high-yield bonds. Double sorting on past bond returns and short interest shows that shorting predicts returns following both high and low past bond returns. Together with short interest increasing following past buying order imbalances, this suggests that short sellers trade against price pressures as well as trade on information. The double sort results are also stronger post-Lehman and in high-yield bonds. Overall, these results are consistent with informed trading models (e.g., Kyle (1985)), where informed traders trade in the direction of the difference between their signal of value and the price, and price impacts are higher in assets and at times with greater uncertainty about value.

We also examine short selling and price discovery within and across stocks and bonds. Past stock returns and short selling in stocks predict bond returns, but do not eliminate bond short selling predicting bond returns. The magnitude of the coefficient on stock short interest is similar to the magnitude of the coefficient on bond short interest. A 10-percentage-point increase in bond short interest and stock short interest (as a percentage of bonds/shares outstanding) both lead to a 3%–4% average decrease in subsequent abnormal bond returns. Bond short selling does not predict the issuer's stock returns.[1] As with the within bonds price discovery analysis, the predictability results are stronger post-Lehman and in firms with high-yield bonds. These results

[1]There are a few possible reasons why stock short selling predicts bond return while bond short selling does not predict stock returns. First, trading costs for bonds are higher in our sample. Second, bond trading is not anonymous while stock trading is anonymous and informed traders prefer anonymity.

show bond short sellers contribute to efficient bond prices and that short sellers' information flows from stocks to bonds, but not from bonds to stocks. In addition, the price discovery relations between bonds and stocks is stronger post-Lehman and in smaller firms.

The paper is organized as follows: Section II reviews the related literature on short selling in stocks and bonds and price discovery between stocks and bonds. Section III describes the data. Section IV examines short selling and future returns in the cross section of bonds. Section V studies future returns and short selling conditional on past returns. Section VI analyzes the relations among short selling in stocks and bonds and future returns in stocks and bonds. Section VII studies what leads to higher short selling in bonds. Section VIII concludes.

II. Literature Review

Our paper is related to short selling in general,[2] informed trading in bond markets, price discovery in stocks and bonds, and the impact of the financial crisis and Lehman's collapse on price discovery and efficiency. There is limited prior evidence regarding whether short selling in bonds is informative. Our results indicate that the informativeness of short sellers varies over time

[2] The ability of short sellers to identify overvalued or "suspicious" stocks is well studied in stocks (e.g., Senchack and Starks (1993), Dechow, Hatton, Meulbroek, and Sloan (2001), Christophe, Ferry, and Angel (2004), Asquith, Pathak, and Ritter (2005), Desai, Krishnamurthy, and Venkataraman (2006), Cohen, Diether, and Malloy (2007), Boehmer, Jones, and Zhang (2008), Diether, Lee, and Werner (2009), Christophe, Ferry, and Hsieh (2010), Karpoff and Lou, (2010), Engelberg, Reed, and Riggenberg (2012), Hirshleifer, Teoh, and Yu (2011), Boehmer and Wu (2013), Ljungqvist and Qian (2016), and Richardson, Saffi, and Sigurdsson (2017)). Where possible our empirical approaches are based on the stock short selling literature.

and in the cross section of bonds and that short sellers are informed over the post-Lehman period in high-yield bonds. Hence, our results are not inconsistent with Asquith et al. (2013), but indicate that short selling's role in bond price discovery is a more recent phenomenon. Short selling's contribution to price discovery is concentrated in high-yield bonds, which have payoff structures more similar to equity. Our results also extend the literature on informed trading in the corporate bond market (e.g., Kedia and Zhou (2014), Han and Zhou (2014), and Wei and Zhou (2016)) by systematically examining group of traders thought to be informed, short sellers.

The theoretical results regarding equity being more sensitive to information than debt suggest that price discovery about the value of a firm should occur more in the stock market. However, the literature contains mixed results regarding the relative informational efficiency of bond and stock markets and whether stock returns lead bond returns. Kwan (1996), Alexander, Edwards, and Ferri (2000), and Downing, Underwood, and Xing (2009) conclude that stock markets lead bond markets. On the other hand, Hotchkiss and Ronen (2002), Ronen and Zhou (2013), and Kedia and Zhou (2014) find that bond markets are as informationally efficient as related equities. While our results are only about information that short sellers have, our findings suggest that short sellers incorporate some information in stock prices before bond prices, but do not incorporate information in bond prices before stock prices.

Back and Crotty (2015) theoretically model informed trading in the stock and bond of a firm when there is information about both the mean asset returns and the volatility of the asset returns. These two sources of information have potentially different implications for the cross-asset price impact of trading (e.g., the stock price impact of order flow in the bond market). Back and Crotty empirically measure these cross-asset price impacts and conclude that most information is about asset means. This suggests that informed short selling in bond and stock markets should positively

predict cross-asset returns. We find this is true for stock short selling, but bond short selling does not predict stock returns.

The financial crisis together with Lehman's collapse increased uncertainty and pushed high-yield bonds closer to default, making their payoffs more similar to equity. In addition, the Lehman bankruptcy increased funding costs substantially (see Brunnermeier (2009)), likely increasing frictions for arbitrage capital (Mitchell, Pedersen, and Pulvino (2007), Mitchell and Pulvino (2012)). This leads to lower price efficiency and greater price distortions. The very large profitability in high-yield bonds following the Lehman bankruptcy is consistent with short sellers have greater opportunities due to increased informational sensitivity and reduced competition in those assets. The fact that short interest strongly predicts bond returns after both positive and negative abnormal returns is consistent with reduced competition in impounding new information into bond prices and in trading against mispricing to buying pressure. The predictability of short interest for high-yield bonds returns falls post-Lehman, but does not disappear. We cannot determine whether this is due to a permanent change in the informational environment for high-yield bonds or in constraints in competitors to short sellers (e.g., banks having reducing capital for trading and banking regulatory changes).

III. Sample and Summary Statistics

Our sample of corporate bonds lending and loans data comes from the Markit securities lending database. Markit collects this information from a significant number of the largest custodians and prime brokers in the securities lending industry. The dataset covers security-level daily information for the U.S. corporate bonds for the period from Jan. 2006 to Dec. 2011. It contains lending fees, the number of bonds available for lending, the number of bonds on loan, and the number of lending-borrowing transactions.

Asquith et al. (2013) describe the primary purpose of borrowing a corporate bond is to facilitate its short sale. Asquith et al. (2013) classify three main reasons for shorting corporate bonds: market making (provide liquidity to the liquidity demanders), speculation (to bet that the security will decline in price) and arbitrage (capital structure arbitrage or CDS arbitrage). In order to sell a bond short, one has to locate it, post collateral, and borrow it. Investors usually borrow bonds through a custodian bank who serves as an intermediary for the transaction. The collateral usually exceeds the value of the borrowed security (usually 102%) to protect the lender against the counterparty risk. When the bond loan is terminated the borrower returns the bond to its owner and receives collateral plus interest. Since naked short selling is prohibited in the corporate bond market, we estimate short interest based on the number of bonds borrowed (similar is done in the literature on stock shorting that employs lending and borrowing data).

Short selling in equity markets experienced a large number of regulatory restrictions and bans during our sample period: the short selling ban in 2008 in the U.S. market, the Financial Services Authority's (FSA) short selling ban of financial stocks in the United Kingdom in 2008, and short selling bans of financial stocks in France, Italy, Spain, and Belgium 2011 (see Beber and Pagano (2013)). However, there were no such restrictions imposed on short selling in the U.S. corporate bond market.

We match our sample with the Trade Reporting and Compliance Engine (TRACE) database and the Fixed Income Securities Database (FISD). TRACE is a database of all over-the-counter (OTC) corporate bond transactions that reports the time, price, and quantity of bond trades as well as information on the trading. It also includes information on the trading direction, an indicator for the side of a trade that the reporting party (a dealer) takes. The FISD database contains detailed information on all corporate bond issues including the offering amount, issue date, maturity date, coupon rate, and Moody's bond rating.

We exclude any corporate bond in the Markit bonds lending file that we cannot match to FISD and TRACE. In addition we also exclude all convertibles, exchangeables, equity-linked bonds, and unit deals. We apply a standard filter in the literature, described in Bessembinder, Kahle, Maxwell, and Xu (2009), to eliminate cancelled, corrected, and commission trades from the data.

We use the following variables in our analysis (see also Table 1 for variables definition). We define the short interest of a bond (SHORT_BOND_t^i) as the daily number of bonds on loan (shorted) to the number of bonds outstanding. Short interest of a firm excluding the current bond issue is defined as average value-weighted ratio of the daily number of bonds on loan (shorted) to the number of bonds outstanding for all bonds issues by the firm except the current issue. The lending fee (LENDING_FEE_t^i) is defined as the interest rate on cash funds minus the rebate rate (that is paid for collateral). The raw return on bond i is computed as

$$R_t^i = \frac{\left(P_t^i - P_{t-1}^i\right) + \text{AI}_t^i}{P_{t-1}^i},$$

where AI_t^i is accrued interest and P_t^i is last traded price of the bond. The daily abnormal return on bond i (RET_BOND_t^i) is computed as the difference between the raw return on the bond and the raw return on the corresponding rating matching portfolio based on 6 major rating categories: Aaa, Aa, A, Baa, Ba, and B. Hereafter, we refer to abnormal returns simply as returns. We use absolute daily return as a proxy for bond return volatility (VOLAT_BOND_t^i). We define daily order imbalance (OIB_BOND_t^i) as the daily difference between customer buy and sell trading volumes scaled by the total trading volume. Realized spread ($\text{REALIZED\_SPREAD}_t^i$) is the daily average price at which customers buy minus the average price at which sell scaled by the average of the buy and sell prices. Turnover (TURN_BOND_t^i) is defined as the total daily number of bonds traded scaled by the total number of bonds outstanding.

[Insert Table 1 about here]

Table 2 provides summary statistics for short interest and other variables used in the analysis for all bonds in our sample. For the period from 2006 to 2011, the number of bonds in the merged database is 15,093. We have 12,654 of investment-grade bonds (rated "Baa3" and above) and 5,112 of high-yield bonds (rated below Baa3) throughout the sample period. Figure 1 shows the number of bonds lent against calendar years. This number is relatively stable over time with a slight steady increase throughout the sample period. The average par value of corporate bonds outstanding during the period 2006–2011 is $6.8 trillion, or about $563 million per issue. There is substantial amount of short interest in the corporate bond market. During our sample, there were on average about $1.35 trillion in bonds available to borrow, out of which about $125 billion were actually lent out and shorted subsequently. This corresponds to an amount shorted divided by size at value of around 1.86% and the utilization of about 7.4% (an amount shorted to an amount available for lending).

[Insert Table 2 about here]

[Insert Figure 1 about here]

On average, the short interest is slightly larger for investment-grade bonds than for high-yield bonds in the pre-Lehman bankruptcy period, 2.90% versus 2.83%, respectively. After Lehman's collapse, the short interest drops for both types of bonds, and investment-grade bonds short interest becomes lower than that of high-yield bonds, 1.13% versus 1.45%, respectively. Figure 2 plots the

time series of the short interests across our sample. The short interest is steadily increasing from 2006 to until the Lehman bankruptcy when it spiked up to 3.5% and then dropped to about 1% for investment-grade bonds and to about 1.5% for high-yield bonds in matters of weeks and remained on that level until the end of the sample, possibly in response to TARP announcements after the Lehman bankruptcy.

[Insert Figure 2 about here]

For investment-grade bonds, the average value-weighted lending fee is about 15.08 basis points (bps) per annum (p.a.) during the pre-Lehman period and is about 8.97 bps in the post-Lehman periods. High-yield bonds are on average more expensive to borrow than investment-grade bonds. The lending fees for high-yield bonds decrease from about 40.8 bps in the pre-Lehman period to 34.07. Graph A of Figure 3 depicts time series of lending fees during our sample. The average lending fee was steadily decreasing from 2006 to the beginning of 2008, then spikes dramatically during Lehman bankruptcy, and then quickly drops after a few months. The difference between lending fees of investment grade bonds and high-yield bonds is due to a subset of high-yield bonds that are particularly expensive to short. Graph B shows that medians of lending fees are not very much different across credit ratings.

[Insert Figure 3 about here]

High-yield bonds are not only more expensive to short but they are also riskier with an average annualized volatility of daily returns of 114.56% as compared to 75.49% volatility of investment-grade bonds in the pre-Lehman period. Volatility of both types of bonds dramatically

increases in the post-Lehman period, 188.74% and 133.61% for high-yield and investment-grade bonds, respectively. In addition, high-yield bonds have a larger trading costs in the pre-Lehman period, a realized spread of 0.92% for high-yield bonds and 0.75% for investment-grade bonds. The cost of trading increases in the post-Lehman for both types of bonds to 1.50% and 1.15% for high-yield and investment-grade bonds, respectively (as in Dick-Nielsen, Feldhutter, and Lando (2012), Friewald, Jankowitsch, and Subrahmanyam (2012)). Graph C of Figure 3 shows that the spreads increase sharply during Lehman bankruptcy period.[3] This drop in liquidity is consistent with the evidence that the conventional market makers substantially reduced their inventories in the corporate bond market during the 4th quarter of 2008. While liquidity improves in 2009 onwards, it never comes back to the pre-crisis level, especially for high-yield bonds. Finally, high-yield bonds are less liquid in the pre-Lehman period as measured by the turnover as well, 0.55% for high-yield bonds versus 0.61% for investment-grade bonds. Turnover and trading volume decrease after Lehman bankruptcy for both types of bonds.

Investment-grade bonds are bought more aggressively than sold, while the opposite is true for high-yield bonds. In the pre-crisis period, order imbalance for investment-grade bonds is about 6.13% while for high-yield bonds it equals to −4.89%. In the post-crisis period order imbalance

[3] The peaks and declines in illiquidity in investment-grade and high-yield bonds are not simultaneous. The later spike in high-yield trading costs could arise from the interaction of two different effects. First, the market gradually learned that the economy was steadily deteriorating. Second, the government appeared more willing to bail out larger firms at an earlier date. The first effect could cause liquidity to decline for all bonds. The second effect would cause liquidity to improve earlier for larger firms' bonds, which are more likely to be investment grade.

decrease in absolute value, to 1.19% for investment-grade bonds and to −1.89% for high-yield bonds.

Panels B and C of Table 2 present correlations among variables of interest for investment-grade bonds (Panel B) and high-yield bonds (Panel C). To be consistent with our subsequent regression methodology we compute correlations first cross-sectionally every day and then averaged across time. Standard errors for correlations are calculated using Newey–West (1987) with 20 lags. Bond returns exhibit no significant autocorrelation for investment-grade bonds and are positively auto-correlated for high-yield bonds. Consistent with the hypothesis that bond short selling is informative of future bond returns in more informationally sensitive bonds, we find that bond returns negatively correlate with past bond short interest for high-yield bonds. We also report correlations between bond returns and past shorting in the rest of the bonds of the firm. We find that investment-grade bond returns are not correlated with past short interest of the rest of the bonds of the corresponding firm while high-yield bonds exhibit negative and significant correlation.

The correlation between bond returns and past order imbalance is negative for both investment-grade and high-yield bonds. This is consistent with order flow causing price pressures that are profit opportunities for informed traders. Bond returns are positively correlated with past volatility and are not correlated with contemporaneous volatility. Short interest of individual bond is positively correlated with the short interest of the remaining issues of the same firm, consistent with informed traders shorting multiple bonds by the same issuer.

IV. The Cross Section of Shorting and Future Returns

A. Portfolio Analysis: Simple Sorts

We first examine how informed short sellers are in the corporate bond market. While there is a large literature documenting profitability of short selling strategies in the equity markets, to our knowledge only Asquith et al. (2013) study this question in the corporate bond market. Based on their 2004 to 2007 sample, they conclude that the short sellers are not informed in the corporate bond markets. This sample period is a relatively quiet period with no major market stresses and crisis. We study whether the informativeness of short sellers increases during and after the Lehman bankruptcy.

If short sellers are informed, the bonds they short heavily should underperform the bonds they avoid shorting. To test this we follow the methodology used by Boehmer et al. (2008) by sorting bonds into portfolios based on their short interest. Each day we sort bonds into quintiles based on their short interest that day. We skip 1 day and then hold an equal-weighted portfolio of those bonds for 20 trading days. Therefore, on any given trading day for each quintile we hold 20 portfolios selected on the current day as well as on the previous 19 days, so there are overlapping 20-day holding period returns. Following Boehmer et al. (2008), we use a calendar-time approach to calculate average daily returns. Each trading day's portfolio return is the simple average of 20 different daily portfolio returns, and 1/20 of the portfolio is revised each day while the rest of the portfolio is carried to the next day.

Table 3 shows the returns for each of the shorting quintile portfolios. The basic result is that short sellers are informed in the corporate bond market as short interest predicts subsequent bond returns. The returns on heavily shorted bonds are smaller than the returns of lightly shorted bonds (−2.21% p.a. for quintile 5 vs. 2.74% for quintile 1).[4] These returns suggest that short sellers are

[4] A potential concern is that our results could be driven by outliers and data errors. To examine this, we identify potential data errors and eliminate them from the data. We use the following procedure to identify

good at shorting overvalued bonds and at avoiding shorting undervalued bonds. Looking at the return differences, heavily shorted bonds significantly underperform lightly shorted bonds by an average of 4.96% p.a. on a risk-adjusted basis. This value is statistically significant with a *t*-statistic of 5.11.

[Insert Table 3 about here]

Table 3 also shows the returns of the shorting portfolios for the periods preceding (from Jan. 1, 2006 until May 31, 2008) and following the Lehman bankruptcy (from Jan. 1, 2009 to Dec. 30, 2011). We also separately report the results for the 7 months around the Lehman collapse (from June 1, 2008 to Dec. 30, 2008). We find that short sellers are significantly less informed prior to the Lehman bankruptcy as return differences between lightly and heavily shorted bonds are economically small (annualized returns of about 2.02%; it is however statistically significant at 5% level). The informativeness of short interest increases dramatically after the Lehman default. The trading strategy of buying bonds with low short interest and selling short bonds with a high short interest generates a return of 6.83% p.a. with a *t*-statistic of 4.85. These returns are even

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data errors. We identify days where a particular daily bond absolute return is in excess of 10% (approximately 0.5% of all observations) and promptly reverses during the following trading day. Specifically, we identify days when a greater than 10% absolute return is reversed on the next day when a trade occurs by between 90% and 110% of the original return. These are classified as a potential data errors. We find that less than 8% of all large absolute returns (in excess of 10%) reverse in this way. Table IA1 in the Internet Appendix of shows that when these observations are excluded from the sample, the results remain virtually the same.

higher during the Lehman bankruptcy episode (9.64% p.a.). This is consistent with short sellers having greater incentive to acquire information during periods of market uncertainty. In addition to this, the short selling in the U.S. equity market has been banned immediately after the Lehman's bankruptcy. Given that such restriction was absent in the U.S. corporate bond market, bond shorting could be a way for informed short sellers to avoid short sale restriction. We further elaborate on this point in Section VI.C.

Graph A of Figure 4 illustrates our findings. Returns of both heavily and lightly shorted portfolios are small before the Lehman bankruptcy and dramatically increase from Sept. 15, 2008. High returns remained until middle of 2009. Thus, the evidence suggests that short sellers' ability to identify over and undervalued bonds came to the fore during periods following the Lehman bankruptcy, which presented opportunities to exploit significant price dislocations. We perform additional tests related to this explanation in the subsequent sections.

[Insert Figure 4 about here]

B. Investment-Grade versus High-Yield Bonds

Bonds closer to default are more informationally sensitive. To explore if this impacts the relation between short interest and future bond returns this section examines short interest separately for investment and high-yield bonds. To do so, we conduct double sorts based on credit ratings. We first sort bonds into 2 groups: investment grade and high-yield. Within a credit rating group, we then sort a second time into quintiles each day based on the short interest on a given day. As before, we skip 1 day and calculate value-weighted portfolio returns using a 20-day holding period. We roll forward 1 day and repeat the portfolio formation and return calculation

process. Table 3 reports the annualized value-weighted risk-adjusted returns for each portfolio as well as for the difference between the heavily-shorted and lightly-shorted quintiles for each characteristic group.

Heavily-shorted high-yield bonds underperform lightly-shorted high-yield bonds. However, similar to our previous findings, the short interest predictability is mostly in the post-Lehman bankruptcy period. The average return from this strategy for the pre-Lehman bankruptcy period is small and statistically insignificant, annual return of 2.07% on average with a *t*-statistic of 1.05. This is consistent with the finding of Asquith et al. (2013). However, when conditioning on the post-Lehman bankruptcy period, the heavily shorted high-yield bonds underperform lightly shorted high-yield bonds by a 24.12% annual average returns. This finding is illustrated in Graph C of Figure 4.

We observe a different story for investment-grade bonds. The return difference between lightly- and heavily-shorted investment-grade bonds is economically negligible and statistically significant at 10% level only for the pre-Lehman period (see also Graph B of Figure 4 for the illustration). Thus, our results imply that the overall informativeness of short interest comes from the post-Lehman bankruptcy period and the high-yield bond market.

Furthermore, measuring bond returns is challenging due to infrequent trading and prices only being observed when trades occur. When no trade occurs on a day, the bond price is set to the prior day price. If there is little or no trading over days t+2 to t+21, then the returns to the long-short portfolio based on short interest may be underestimated because not all of the price adjustment is observed. If there is little or no trading over days t−20 to t, then the returns to the long-short short-interest portfolio based could be overestimated if information that would have depressed bond prices is revealed and caused short selling before a trade occurs, that is, the information causes the short sellers to increase their short position after the market would revise the price of a bond down,

but this downward revision is not observed because there are no trades. To explore these potential effects we repeat the portfolio analysis using only heavily traded bonds. Table IA2 in the Internet Appendix shows that when thinly traded bonds are excluded from the sample, the results long-short portfolio returns become larger.

C. Cross-Sectional Regressions

The portfolio analysis limits the number of factors that can be simultaneously taken into account. Therefore, we extend our analysis using cross-sectional predictive regressions. Each day, we estimate the following cross-sectional predictive regression:

$$\text{(1)} \qquad \begin{aligned} \text{RET\_BOND}^{i}_{t+2,t+21} = {} & \alpha_{1t}\text{SHORT\_BOND}^{i}_{t} + \alpha_{2t}\text{SHORT\_FIRM}^{i}_{t} + \alpha_{3t}\text{RET\_BOND}^{i}_{t-20,t} \\ & + \alpha_{4t}\text{OIB\_BOND}^{i}_{t-20,t} + \gamma_{t}X^{i}_{t} + u^{i}_{t}, \end{aligned}$$

where the set of control variables X^{i}_{t} includes volatility of bond returns ($\text{VOLAT\_BOND}^{i}_{t-20,t}$), bond turnover ($\text{TURN\_BOND}^{i}_{t-20,t}$), natural log of the debt outstanding ($\ln(\text{PAR\_DEBT}^{i}_{t})$) and time-to-maturity ($\text{TTM}^{i}_{t}$). All variables are defined as in Table 1. The choice of variables follows from Boehmer et al. (2008). As in our portfolio exercise, we skip 1 day between returns and control variables to avoid econometric issues. We then average each coefficient over the time series. Similar to Boehmer et al. (2008), we use a Fama–MacBeth (1973) approach to conduct inference with the Newey–West (1987) standard errors with 20 lags to account for the overlapping observations.

Table 4 presents the estimation results for the full sample period, pre- and post-Lehman bankruptcy periods as well as for 7 months around the Lehman bankruptcy itself. We estimate the

regression for all bonds as well as for investment-grade and high-yield bonds separately. To simplify reporting the results, we only include coefficient estimates and the corresponding *t*-statistics for SHORT_BOND_t^i, SHORT_FIRM_t^i, and $\text{OIB\_BOND}_{t-20,t}^i$ variables. All coefficient estimates are in the Internet Appendix (Table IA3).

[Insert Table 4 about here]

Short selling significantly predicts negative returns in the cross-section: a 10-percentage-point increase in short interest results in returns being lower by 8.3% p.a., on average. When controlling for SHORT_FIRM_t^i, and $\text{OIB\_BOND}_{t-20,t}^i$, this coefficient drops to 4.6%. The coefficient for short interest is statistically significant at 5% level. Aggregate firm short interest conveys information about future bond returns beyond short interest in the individual bonds. A 10-percentage-point increase in the short interest of the firms' other bonds predicts a decrease in an average bond return by 11.9% p.a. More importantly, short interest in the post-Lehman bankruptcy period is about three times as informative as during the pre-Lehman bankruptcy period. Informativeness of firm short interest more than doubles in the post-Lehman bankruptcy period. This is consistent with the prior portfolio results.

The short interest is not significantly related to future returns for investment-grade bonds during the overall period. It is statistically significant at 5% level in the pre-Lehman bankruptcy period (only when firm shorting is not included in the specification of the regression), but the economic magnitude is small: a 10-percentage-point increase in short interest for investment-grade bonds yields a drop in future returns by 0.8% p.a. In the post-Lehman bankruptcy and Lehman bankruptcy periods short interest is not significantly related to the future returns for investment-grade bonds. In contrast, the short interest and future returns relation is significantly negative

across all periods for high-yield bonds. Again, short interest is about two and a half times as informative of future returns in the post-Lehman bankruptcy period than in the pre-Lehman bankruptcy period. For example, a 10-percentage-point increase in short interest results in future return being lower by 15.3% and 45.9% in the post-Lehman bankruptcy and Lehman bankruptcy periods, respectively. In sum, the inclusion of other variables that predict bond returns does not impact the conclusion that short sellers are informed in the corporate bond market primarily in high-yield bonds in the Lehman bankruptcy and post-Lehman periods.

The firm-level short interest (short interest of other bond issues by the same firm) also carries information about future returns of a specific bond beyond information in the short interest of that bond. The coefficient related to SHORT_FIRM_t^i is of a similar magnitude to the SHORT_BOND_t^i coefficient and is also statistically significant at 1% level, except for investment-grade bonds in the pre-Lehman bankruptcy and Lehman bankruptcy periods. Moreover, the informativeness of firm short interest is twice as large as that of bond short selling during the Lehman period. As noted above, firm short interest does not subsume the effect of individual bond short interest.

V. What Information Do Short Sellers Trade On?

A. Portfolio Analysis: Double Sorts on Short Interest and Past Returns

The previous section show that short sellers in the corporate bond market predict future returns. We now examine what market conditions and kind of information short sellers base their trading strategies on. More specifically, we test whether short sellers appear to exploit temporary

price overreaction (act against price pressures) or under-reaction to negative information.[5] If it is only the former, we should find that short sales are informative *only* after high positive past returns. However, if short sellers are informative after negative past returns we can infer that they exploit negative information not yet in price.

We start with performing portfolio analysis similar to Table 3. Each day, we double sort bonds into terciles based on the past 20 days returns and into quintiles based on the short interest on a given day. As before, we skip 1 day and then hold a value-weighted portfolio for 20 trading days.

[Insert Table 5 about here]

Table 5 presents portfolio returns for different sample periods and bond categories. Short sales are informative after high past returns as well as after low negative returns. In the overall period of all bonds, a trading strategy that buys lightly shorted bonds with low past returns and sells heavily shorted bonds with low past returns generates on average 7.89% p.a. (with *t*-statistic = 6.13). Similar trading strategy conditioned on the past high returns produces 5.91% p.a. (with *t*-statistic = 4.89). The returns on a similar strategy conditioned on medium past returns are substantially lower (only 1.75% p.a.) and are only significant at the 10% level. In the post-Lehman bankruptcy period, the returns of the strategies based on the low and high past returns increase to 9.37% and 7.41%, respectively.

[Insert Table 5 about here]

[5] A more formal analysis of how short selling relates to the efficient price and any pricing errors requires additional identifying assumptions (see, e.g., Hendershott and Menkveld (2014)) and is challenging given the frequency of bond trading.

Strategies based on short interest generate much higher returns in high-yield bonds. During the post-Lehman bankruptcy period, a trading strategy that buys lightly-shorted high-yield bonds with low (high) past returns and sells heavily-shorted high-yield bonds with low (high) past returns generates on average 24.85% p.a. (30.72% p.a.). A high-yield bonds based trading strategy conditioned on medium past returns also generates statistically significant returns in the post-Lehman bankruptcy period, but only 12.10%, less than half the magnitude of the other two strategies. Finally, analogous trading strategies for investment-grade bonds generally do not produce statistically and economically significant returns.

Overall, the results suggest that short sellers successfully capitalize on mispricing following positive returns and on information not yet incorporated into prices following negative returns. In both cases short sellers correct mispricing and incorporate information into bond prices.

B. Cross-Sectional Return Regressions: Interacting Short Interest with Past Returns

To examine whether the short interest predicting future return results conditional on past returns is driven by the omission of other variables that predict bond returns, we perform a cross-sectional regression analysis where we interact the bond short interest variable with past returns. We define dummy variables $\text{RET\_BOND}^{\text{high}}_{t-20,t}$ and $\text{RET\_BOND}^{\text{low}}_{t-20,t}$ as follows. Each day *t* we sort bonds into terciles based on the returns over the past 20 trading days from *t*−20 to *t*. We define $\text{RET\_BOND}^{\text{high}}_{t-20,t} = 1$ if the bond's return over the past 20 trading days falls into the highest tercile and $\text{RET\_BOND}^{\text{high}}_{t-20,t} = 0$ otherwise. Similarly, $\text{RET\_BOND}^{\text{low}}_{t-20,t} = 1$ if the bond's return over the past 20 trading days falls into the lowest tercile and $\text{RET\_BOND}^{\text{low}}_{t-20,t} = 0$ otherwise. We continue

to follow the Fama–MacBeth (1973) approach by estimating the following cross-sectional predictive regressions and averaging the time series of the resulting coefficients over time:

$$\begin{aligned}(2)\quad \text{RET\_BOND}^{i}_{t+2,t+21} = {} & \alpha_{1t}\text{SHORT\_BOND}^{i}_{t} + \alpha_{2t}\text{RET\_BOND}^{\text{high}}_{t-20,t} + \alpha_{3t}\text{RET\_BOND}^{\text{low}}_{t-20,t} + \alpha_{4t}\text{OIB\_BOND}^{i}_{t-20,t} \\ & + \alpha_{5t}\text{SHORT\_BOND}^{i}_{t} \times \text{RET\_BOND}^{\text{high}}_{t-20,t} + \alpha_{6t}\text{SHORT\_BOND}^{i}_{t} \times \text{RET\_BOND}^{\text{low}}_{t-20,t} + \gamma_{t} X^{i}_{t} + u^{i}_{t},\end{aligned}$$

where the set of control variables X^{i}_{t} includes volatility of bond returns ($\text{VOLAT\_BOND}^{i}_{t-20,t}$), bond turnover ($\text{TURN\_BOND}^{i}_{t-20,t}$), natural log debt outstanding ($\ln(\text{PAR\_DEBT}^{i}_{t})$) and time-to-maturity ($\text{TTM}^{i}_{t}$).

The estimation results are in Table 6 (see Table IA4 in the Internet Appendix for the complete set of coefficient estimates) and the conclusions are similar to those made based on the portfolio analysis. The coefficient in front of interaction variable $\text{SHORT\_BOND}^{i}_{t} \times \text{RET\_BOND}^{\text{low}}_{t-20,t}$ is negative and statistically significant at 1% level in the "All Bonds" column of Panel A, implying that short sellers earn higher returns after low past returns as compared to the returns they earn after intermediate past returns. This is consistent with short sellers trading on negative information not yet in prices. In the pre-Lehman bankruptcy period there is weak evidence that short sellers can predict future negative return after negative past returns. However, the average returns to a short interest strategy are not significant, which is in line with our previous findings. In the post-Lehman bankruptcy period the coefficient on $\text{SHORT\_BOND}^{i}_{t} \times \text{RET\_BOND}^{\text{low}}_{t-20,t}$ is again negative and significant. The interaction term $\text{SHORT\_BOND}^{i}_{t} \times \text{RET\_BOND}^{\text{high}}_{t-20,t}$ positively predicts future bond returns. While the total effect of short interest is still negative after high positive returns ($-0.72 + 0.37 = -0.35$), a greater proportion of the predictability in the post-Lehman period comes after large negative past returns.

[Insert Table 6 about here]

For investment-grade bonds, the returns to a short interest strategy are small. For the high-yield bonds, coefficients in front of interaction variable $\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{high}}$ is again positive and significant (with total negative effect) while negative and significant for $\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{low}}$. Hence, short sellers appear to be more informed during days after large negative as compared to days after moderate and large positive returns.

VI. Bond versus Stock Short Selling: Where Do Short Sellers Contribute to Price Discovery?

There is a large literature documenting short sellers' information in equity markets. Given that both debt and equity are claims on the same firm, the question arises if the information in bond short interest in the previous section relates to the stock market. In other words, do bond short sellers remain informed after controlling for shorting and returns in stocks? To address this question we merge our sample of bond variables with the corresponding stock return, stock short interest and other stock characteristic variables (e.g., market capitalization, book-to-market, and volatility).

We match our sample with the Center for Research in Security Prices (CRSP) and Compustat databases and retain only firms that issue both bonds and common stock. We proxy for stock short sale interest by on-loan value from borrowing-lending market. The corresponding data also comes from the Markit security lending database. We exclude any stock that does not enter Markit database at least once.

We use the following stock variables in our analysis (see Panel B of Table 1 for variables definition). In particular, we define the short interest of stock *i* on day *t* (SHORT_STOCK_t^i) as the daily number of shares on loan (shorted) divided by the number of shares outstanding. The daily

return on stock i (RET_STOCK_t^i) is computed as the difference between the return on the stock and the return on the corresponding size and book-to-market matching portfolio (we sort stocks into 5 quintiles based on size and five quintiles based on book-to-market ratio). We use absolute daily return as a proxy for stock return volatility (VOLAT_STOCK_t^i). We define daily stock order imbalance (OIB_STOCK_t^i) as the daily difference between buy and sell initiated trading volumes scaled by the total trading volume. Turnover (TURN_STOCK_t^i) is defined as total daily number of stock shares traded scaled by the number of shares outstanding. Finally, we control for characteristics that proved to significantly predict stock returns in the cross section. Specifically, we control for book-to-market ratio (BM_t^i), natural log of size ($\ln(\text{MCAP}_t^i)$), leverage (LEVERAGE_t^i) which is defined as a ratio of debt to stockholders total equity and institutional ownership (IHOLDING_t^i) defined as the number of shares held by institutional investors as recorded in 13F filings scaled by the total number of shares outstanding (see Boehmer et al. (2008), Christophe et. al. (2016)).[6]

Table 7 provides summary statistics about stock short interest and other stock characteristics for the pre- and post-Lehman bankruptcy periods for all stocks and for the quintiles of the largest and smallest stocks with respect to the market capitalization. The number of firms in the merged database over our sample period is 1,401 which have 5,291 bond issues.

[Insert Table 7 about here]

[6] The average institutional holdings in our sample is high due to the requirement of publically traded stock and bonds.

Panel A of Table 7 shows that small stocks' shares are shorted about 5 times more than large stocks' shares on average: in the pre-Lehman bankruptcy period short interest for small stocks equals 10.36% while only about 2.15% of large stocks are shorted. After the Lehman's collapse, the short interest drops for small and large stocks to 5.69% and 1.52%, respectively.

Small stocks in our sample are much riskier than large stocks: the annualized volatility of daily returns for is 36.29% as compared to 8.77% volatility of large stocks in the pre-Lehman bankruptcy period. Volatility of both types of stocks dramatically increases in the post-Lehman bankruptcy period, 20.36% and 79.38% for large and small stocks, respectively. In the pre-Lehman bankruptcy period small stocks have higher turnover than large stocks, 1.15% versus 0.85%, respectively. Turnover somewhat increases for large stocks and barely changes for small stocks after Lehman's bankruptcy. In the pre-Lehman bankruptcy period, order imbalance for small stocks is about 0.05% while for large stocks it equals 1.19%. In the post-Lehman bankruptcy period both types of stocks are sold more aggressively than bought as order imbalance becomes negative: -1.77% for small stocks and -0.24% for large stocks.

Panels B and C of Table 7 present correlations among the variables of interest for large stocks (Panel B) and small stocks (Panel C). Stock returns exhibit no significant auto-correlation but are positively correlated with the contemporaneous bond returns. Furthermore, returns on large stocks are negatively correlated with past stock short interest and are positively correlated with contemporaneous stock short interest. The contemporaneous correlation between returns and short interest for small stocks is negative and significant. Stock returns positively correlate with contemporaneous volatility and have zero correlation past volatility. The correlation between stock returns and past order imbalance is borderline positive and significant only for large stocks.

The correlation between stock and bond short interest is positive and highly significant only for small stocks.[7] Stock short interest has positive correlation with volatility and turnover for both large and small stocks and it positively correlates with order imbalance in large stocks.

Figure 5 plots time series of short interest in both bond and stock markets for our matched sample (Graph A) as well as short interest for small and large stocks and their corresponding bonds (Graphs B and C). In both markets short interest significantly dropped after Lehman bankruptcy. There was a steady increase in short interest prior to Lehman's collapse and post-Lehman shorting dropped below its pre-Lehman level. Differently from shorting in the equity market, the level of bond shorting decreased below the pre-Lehman level and does not recover to its pre-Lehman level until the end of the sample.

[Insert Figure 5 about here]

Figure 6 plots the time series of lending fees and trading costs (as measured by realized spreads) in both bond and equity markets. On average, equity lending fees are higher than bond lending fees (Graph A). Consistent with increasing demand in the equity short selling, the equity lending fees exhibit a positive trend prior to the Lehman collapse. The lending fees in both markets sharply dropped in the post-Lehman period along with the shorting demands. Graph B plots medians of the lending fees. Unlike the comparison of mean lending fees, median lending fees' in equity and bond markets are quite similar. Moreover, the median of the equity lending fees does not experience positive trend in the pre-Lehman period suggesting that the abovementioned trend

[7] Back and Crotty (2015) find total order imbalances in the stock and bonds of the same firm are positively contemporaneously correlated.

is due to an increase in borrowing costs for a subset of stocks. The median of both equity and bond lending fees experienced sharp drop after Lehman's collapse and partially recovered only in the first quarter of 2010.

[Insert Figure 6 about here]

It is about 10 times more expensive to trade corporate bonds than the corresponding equity as measured by the realize spreads (see Graph C of Figure 6). The average realized spread in both markets sharply increases during the Lehman episode and slowly falls back to the pre-Lehman levels in 2010.

A. Cross-Sectional Bond Return Regressions: Including Stock Short Interest

To analyze the relation between bond returns and stock short interest we extend the Fama–MacBeth (1973) cross-sectional regressions from Table 4 with the addition of stock variables, including short interest:

$$\begin{aligned}(3)\qquad \mathrm{RET\_BOND}^{i}_{t+2,t+21} = {} & \alpha_{1t}\mathrm{SHORT\_BOND}^{i}_{t} + \alpha_{2t}\mathrm{SHORT\_FIRM}^{i}_{t} + \alpha_{3t}\mathrm{SHORT\_STOCK}^{i}_{t} \\ & + \alpha_{4t}\mathrm{RET\_BOND}^{i}_{t-20,t} + \alpha_{5t}\mathrm{RET\_STOCK}^{i}_{t-20,t} + \alpha_{6t}\mathrm{OIB\_BOND}^{i}_{t-20,t} + \gamma_{t}X^{i}_{t} + u^{i}_{t}.\end{aligned}$$

In equation (3), the index *i* runs over all individual bond issues in our sample. With slight abuse of notations we also index stock variables with index *i* meaning that $\mathrm{SHORT\_STOCK}^{i}_{t}$ and $\mathrm{RET\_STOCK}^{i}_{t-20,t}$ denote short interest and stock return of firm issued bond *i*. The set of control variables X^{i}_{t} includes volatility of bond returns ($\mathrm{VOLAT\_BOND}^{i}_{t-20,t}$), bond turnover ($\mathrm{TURN\_BOND}^{i}_{t-20,t}$), natural log of debt outstanding ($\ln(\mathrm{PAR\_DEBT}^{i}_{t})$) and time-to-maturity

(TTM_t^i), natural log of market capitalization of firm issuing bond *i* ($\ln(\mathrm{MCAP}_t^i)$), book-to-market ratio of firm *i* (BM_t^i), leverage ratio of bond *i* issuer ($\mathrm{LEVERAGE}_t^i$) and institutional holding of firm issuing bond *i* ($\mathrm{IHOLDING}_t^i$). All stock and bonds variables are defined as in Table 1. As before, we estimate the regression every day, average each coefficient across the time-series, and use the Newey–West (1987) standard errors with 20 lags to account for the autocorrelation.

The results are given in Table 8 (a full set of coefficient estimates are in Table IA5 in the Internet Appendix). The individual and firm bond short interest exhibit a significant negative relation to future bond returns even with the inclusion of the corresponding stock short interest. Specifically, a 10-percentage-point increase in bond short interest results in returns being lower by 4.3% p.a., on average, and by about 3.4% when $\mathrm{SHORT\_FIRM}_t^i$, and $\mathrm{OIB\_BOND}_{t-20,t}^i$ are included in the regression. This is about twice lower than the coefficient estimate reported in Table 4. Stock short selling also negatively predicts future bond returns: a 10-percentage-point increase in stock short interest corresponds to 4.1% decrease in average abnormal bond returns. When we control for firm bond short interest, this value is reduced to 3.0%.

[Insert Table 8 about here]

While this predictability is present in the pre- and post-Lehman bankruptcy periods, the magnitude of the coefficient for bond short interest is about 3 times larger in the post-Lehman period and about 7 times larger during Lehman bankruptcy as compared to the pre-Lehman period. The coefficient on stock short interest is of similar magnitude as the coefficient on bond short interest. For high-yield bonds the stock short interest coefficient is 4 times larger than the bond short interest coefficient in the pre-Lehman period and of a similar magnitude in the post-Lehman

period. We find that stock short interest does not predict future bond returns for investment grade bonds.

Similar to bond short sellers, stock short sellers are informed about future bond returns in the post-Lehman periods and mainly in high-yield bonds. Bond short interest conditional on stock short interest continues to carry significant information statistically and economically in the post-Lehman periods, mainly in high-yield bonds.

B. Cross-Sectional Stock Return Regressions

Table 8 shows that stock short interest predicts bond returns. This could arise from short sellers shorting both debt and equity. In the more uncertain times and in the more risky firms the short sellers do not fully incorporate all their information into bond prices so short interest predicts bond returns. This result is in line with Christophe et al. (2016) findings. We now turn to the question of whether bond short interest contains information about future stock returns. We follow the same process as in Table 8 while replacing bond returns with stock returns, each day we estimate the following cross-sectional stock return regression and perform Fama–MacBeth (1973) inference with the Newey–West (1987) standard errors:

$$\begin{aligned}(4)\quad \mathrm{RET\_STOCK}^{i}_{t+2,t+21} = {} & \alpha_{1t}\mathrm{SHORT\_FIRM}^{i}_{t} + \alpha_{2t}\mathrm{SHORT\_STOCK}^{i}_{t} + \alpha_{3t}\mathrm{RET\_STOCK}^{i}_{t-20,t} + \alpha_{4t}\mathrm{RET\_BOND}^{i}_{t-20,t} \\ & + \alpha_{5t}\mathrm{OIB\_STOCK}^{i}_{t-20,t} + X^{i}_{t} + u^{i}_{t},\end{aligned}$$

where the set of control variables X^{i}_{t} includes stock return volatility ($\mathrm{VOLAT\_STOCK}^{i}_{t-20,t}$), turnover of stock *i* ($\mathrm{TURN\_STOCK}^{i}_{t-20,t}$), natural log of the market capitalization of firm *i* ($\ln(\mathrm{MCAP}^{i}_{t})$), book-to-market ratio (BM^{i}_{t}), leverage ratio ($\mathrm{LEVERAGE}^{i}_{t}$) and institutional

ownership (IHOLDING_t^i). Note that in this regression index *i* runs over firms rather than over individual bonds.

Table 9 contains the estimation results (Table IA6 for all coefficient estimates including the control variables). Stock short interest negatively predicts future stock returns. In the full sample period for all stocks, a 10-percentage-point increase in stock short interest results in a 7.5% decrease in stock returns p.a. This is consistent with the literature documenting the informativeness of stock short sellers in the stock market. The results hold in the pre-Lehman and post-Lehman periods with the magnitude of the coefficients in front of stock short selling remaining similar.

[Insert Table 9 about here]

For large stocks a 10-percentage-point increase in short selling yields a 14.1% decline in future returns per annum. This is statistically significant at 1% level. In the pre-Lehman bankruptcy period a 10-percentage-point increase in short selling yields 2.9% decrease in stock returns. All results are robust to including order imbalance and bond short selling. Stock short interest, however, becomes insignificant when only examining small stocks. This conflicts with the existing academic literature (see Boehmer et al. (2008)). However, because we are also examining bond short interest our sample is different as we require each stock to have valid bond data as well as shorting variables for both stocks and bonds.

Bond shorting is generally insignificant for all subperiods and types of stocks considered. The only noticeable exception is in the pre-Lehman period for large stocks. This implies that bond short sellers generally are not informed about future stock returns. Moreover, bond short interest does not exhibit any significant relation with future stock returns even when stock short interest or stock order imbalance are not included in the specification.

In sum, bond and stock short sellers are informed about future bond returns and this informativeness comes mainly for high-yield bonds in the post-Lehman period. At the same time, stock short sellers are informed about future stock and bond returns while bond short sellers do not have information about future stock returns.

There are a few possible reasons why bond short selling does not predict future stock returns while stock short selling does so. First, higher trading costs in corporate bonds as compared to stocks (Figure 6) likely discourage short sellers in the corporate bond market. A second reason is that stock market trading is anonymous while bond trading is not. Informed traders generally prefer anonymity so their information in revealed more slowly, making stocks more attractive to short on private information.

C. Bond Shorting Around Equity Short Sale Ban

To further examine the relation between shorting in the stock and bond markets we examine the 2008 short-sale ban in equities. Unlike shorting in the equity market, there were no such restrictions imposed on short selling in the U.S. corporate bond market. Battalio and Schultz (2011) show that equity options provided a mechanism to circumvent the short-sale restrictions/ban in the equity market. A natural question arises whether the corporate bond market also offers a mechanism to get around the short-sale restrictions/ban. We examine whether a substitution effect between stocks and bonds short selling during stock short selling ban. To do this, we merge our bond and stock short selling sample with the list of banned stocks. Given that many of banned stocks do not have bond counterpart in the FISD, our sample contains 117 banned stock-bond issuers and 824 non-banned stock-bond issuers.

We define the following variables for each firm: the difference between bond and stock short interest ($\text{DIFF\_SHORT}_t^i = \text{SHORT\_FIRM}_t^i - \text{SHORT\_STOCK}_t^i$); the difference between bond and

stock net new shorting ($\text{DIFF}\Delta\text{SHORT}_t^i = \Delta\text{SHORT\_FIRM}_t^i - \Delta\text{SHORT\_STOCK}_t^i$), where net new shorting $\Delta\text{SHORT\_FIRM}_t^i$ and $\Delta\text{SHORT\_FIRM}_t^i$ are measured as changes in daily short interests and expressed as a ratio of daily trading volume for bond and stock, respectively; the difference between bond and stock shorting fees ($\text{DIFF\_FEE}_t^i = \text{LENDING FEE\_FIRM}_t^i - \text{LENDING\_FEE\_STOCK}_t^i$).

We estimate the impact of the ban on substitution between stock and bond shorting by running the following pooled regression:

$$Y_t^i = \alpha_0 + \alpha_1 \text{BAN}_t + \alpha_2 \text{EVENT}^i + \alpha_3 \text{BAN}_t \times \text{EVENT}^i + u_t^i, \quad (5)$$

where Y_t^i corresponds to one of the following three variables DIFF_SHORT_t^i , $\text{DIFF}\Delta\text{SHORT}_t^i$, and DIFF_FEE_t^i. Control variables EVENT^i is a dummy variable equal to 1 if the corresponding stock of firm *i* was banned from short selling by U.S. Securities Exchange Committee (SEC) between Sept. 19, 2008 and Oct. 7, 2008, and 0 otherwise; BAN_t is a dummy variable equals to 1 if day *t* is between Sept. 19, 2008 and Oct. 7, 2008, and 0 otherwise. The sample period for the analysis starts on the Aug. 1, 2008 and ends at the end of the ban on Oct. 7, 2008.

Table 10 shows the coefficient on the interaction between EVENT^i and BAN_t is positive and statistically significant at 1% level for net new shorting and shorting fees, and positive statistically significant at 5% level for short interest. The interaction coefficient measures the change between bond and stock short selling for banned firms during the ban. Furthermore, the interaction coefficient is also economically significant. For example, the interaction coefficient for the analysis of the difference in short interest is approximately 0.8%. Therefore, during the short-sale ban, the difference between bond and stock short interests for short-sale ban stocks changes by

about 14% of the absolute value of its pre-event average (-5.8%). Similarly, the interaction coefficient for the shorting fees analysis is 70.9 bps, or approximately 2.75 times the pre-event average of the difference in shorting fees for all bonds in the sample (-26.24 bps). Our findings are consistent with the hypothesis that shorting activity in the shorting-ban stocks significantly migrated to the bond market.

[Insert Table 10 about here]

VII. What Leads to an Increase in Bond Shorting?

In this section we study what leads to an increase in bond short interest. Diether, Lee, and Werner (2009) examine this for stock short selling. Beyond short sellers speculating on negative information not in price, Diether et al. (2009) explore whether short sellers appear to be liquidity providers, either regularly or opportunistically. Liquidity provision by short seller should follow increases in prices and occurs opportunistically if liquidity provision is sensitive to the volatility of returns, as opposed to just the recent direction of returns. All of these motivations for short selling should predict future bond returns.

In the previous section we provide evidence consistent with short sellers trading on both mispricing due to past buying pressure pushing prices too high and on negative information not yet impounded into prices. To examine these further, we regress short interest on past returns and past order imbalance. Short interest increasing following buying is consistent with short sellers providing liquidity to correct over pricing due to price pressure. Tables 5 and 6 show that short interest predicts bond returns following both positive and negative abnormal returns. The relationship between past returns and short interest measures whether the short sellers are predominately trying to correct over or under pricing.

Employing our Fama–MacBeth (1973) procedure on weekly variables, each day we estimate the following cross-sectional regression using various bond characteristics motivated by Diether et al. (2009) to explain future short interest:

$$\begin{aligned}(6)\qquad \text{SHORT\_BOND}^{i}_{t+2,t+6} = {} & \alpha_{0t} + \alpha_{1t}\text{RET\_BOND}^{\text{high}}_{t-5,t} + \alpha_{2t}\text{RET\_BOND}^{\text{low}}_{t-5,t} + \alpha_{3t}\text{OIB\_BOND}^{i}_{t-5,t} \\ & + \alpha_{4t}\text{VOLAT\_BOND}^{i}_{t-5,t} + \alpha_{5t}\text{TURN\_BOND}^{i}_{t-5,t} + \alpha_{6t}\ln(\text{PAR\_DEBT}^{i}_{t}) \\ & + \alpha_{7t}\text{SHORT\_BOND}^{i}_{t-5,t} + \alpha_{8t}\text{SHORT\_FIRM}^{i}_{t-5,t} + u^{i}_{t}.\end{aligned}$$

Following Diether et al. (2009), we include the past bond returns interest, order imbalance, and volatility. Bond prices might increase due to a buying liquidity shock. Short sellers may act as voluntary liquidity providers expecting to benefit from negative returns they anticipate as prices revert in the near future. If short sellers act as voluntary liquidity providers we expect to see short sale interest to increase along with large positive trade imbalances. It is also possible that bond short sellers act as opportunistic risk bearers during periods of increased uncertainty (see Diether et al. (2009)). We also include lagged short interest for bonds and firms to account for time variation in short interest.

Table 11 presents the estimation results of the predictive regression for the different sample periods and types of bonds.[8] Short interest is significantly higher after large positive and large negative past returns than after intermediate returns. These differences are statistically significant at the 1% level. This result is consistent with the previous finding that bond short sellers trade on both negative information not yet fully incorporated into prices as well as on overreaction to

[8] In Table IA7 in the Internet Appendix we also present the estimation results of the model where we include contemporaneous terns into the regression to control for potential autocorrelation of the predictors. The results are qualitatively similar.

positive price pressures. Further, the results show that bond short interest is positively correlated with order imbalances as predicted by the voluntary liquidity provision hypothesis. The results also show that short interest is not predicted by lagged volatility. The results are similar for both investment grade and high-yield bonds.

[Insert Table 11 about here]

We also find evidence that short sellers trade on negative information not yet in prices, trade against positive price pressures and act as liquidity providers for high-yield bonds in both pre- and post-Lehman periods. The short volume response to past positive returns is twice smaller than to past negative returns in the pre-Lehman period. The response to past positive returns becomes about three times larger than the response to past negative returns in the post-Lehman period.

There is no significant relation between bond short interest and past positive returns for high-yield bonds in the pre-Lehman periods. This relation is positive and statistically significant in the post-Lehman period. This is consistent with the interpretation that after the Lehman bankruptcy short sellers traded more aggressively to exploit and correct for the overpricing due to temporary price pressures.

During the Lehman bankruptcy period the relation between short interest and past returns dummies for high-yield bonds reverses and becomes negative (although insignificant). It could be that regular liquidity providers, such as banks, were constrained following Lehman's bankruptcy and short sellers took their place. The relation of short interest with order imbalance remains positive and significant in the Lehman period. Interestingly, the past volatility negatively predicts future bond short interest in the Lehman period. This finding is consistent with the argument that, in periods of binding financial constraint, even short sellers are hesitant to sustain risky positions.

VIII. Conclusions

We provide novel evidence that short selling in corporate bonds forecasts future bond returns. Our findings are consistent with the capital structure and security design literature in several ways. First, short selling predicts bond returns where private information is more likely, in high-yield bonds. Second, short selling predicts bond returns when informational uncertainty is higher, around Lehman's collapse (the second half of 2008) high-yield bonds in the most shorted quintile underperform bonds in least shorted quintile by more than 50% annually. However, these are the bonds and circumstances when shorting was the most difficult and expensive so capturing these returns is challenging. Third, when examining stocks and bonds together past stock returns and short selling in stocks predict bond returns, but do not eliminate bond short selling predicting bond returns. Bond short selling does not predict the issuer's stock returns. These results show bond short sellers contribute to efficient bond prices and that short sellers' information flows from stocks to bonds, but not from bonds to stocks.

Our findings suggest that research examining price discovery across related assets should carefully examine the time-series and cross-sectional properties. While assets classes with less information sensitivity may play a smaller role in price discovery, the mostly informationally sensitive securities in those asset classes may be important for price discovery and their role may be heightened at times of market stress.

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TABLE 1

Variables Description

Table 1 defines the variables used in the paper. Panel A defines bond variables, while Panel B defines the stock variables.

Variable	Definition
Panel A. Bond Variables	
SHORT_BOND	Ratio of the daily number of bonds on loan (shorted) to the number of bonds outstanding.
SHORT_FIRM	Average value-weighted ratio of the daily number of bonds on loan (shorted) to the total number of bonds outstanding for all bonds issues by the firm except the current issue.
LENDING_FEE	Average value-weighted (with respect to the loan quantity) lending fee is defined as the interest rate on cash funds minus the rebate rate (that is paid for collateral).
RET_BOND	Bond abnormal return equals $R_t^i - \mathrm{ER}_t^i$, where the expected return ER_t^i is the return from the corresponding rating matching portfolio and the bond raw return R_t^i equals $\left(\left(P_t^i - P_{t-1}^i\right) + \mathrm{AI}_t^i\right) / P_{t-1}^i$, where AI_t^i is accrued interest and P_t^i is last traded price of the bond.
OIB_BOND	Order imbalance is daily difference between buy and sell trading volumes divided by the total trading volume.
VOLAT_BOND	Volatility of bond returns is defined as the absolute value of the daily bond returns.
REALIZED_SPR	Realized spread is daily average buy price minus sell price of the bond scaled by the mid-price of the two last buy and sell transactions.
TURN_BOND	Turnover is total daily number of bonds traded scaled by the total number of bonds outstanding.
TTM	Time-to-maturity for the bond (expressed in years).

TABLE 1 (continued)

Panel B. Stock Variables

SHORT_STOCK	Ratio of the daily number of shares on loan (shorted) to shares outstanding.
RET_STOCK	Stock abnormal return $R_t^i - \mathrm{ER}_t^i$ where R_t^i is the stocks raw return and ER_t^i is the expected return calculated as the return from the corresponding size and book-to-market matching portfolio.
OIB_STOCK	Order imbalance is daily difference between buy and sell initiated trading volumes divided by the total trading volume.
VOLAT_STOCK	Volatility of stock returns is defined as the absolute value of the daily stock returns.
MCAP	Market capitalization of the firm.
BM	Book-to-market ratio is lagged book value of equity divided by market value of equity.
TURN_STOCK	Turnover is total daily shares traded scaled by the total shares outstanding.
LEVERAGE	Leverage ratio is defined as the sum of long-term and short-term debts (DDLQ + DLTTQ) divided by stockholders total equity (SEQQ).
IHOLDING	Institutional holding is defined as the number of shares held by institutional investors as recorded in 13F filings and are scaled by the total number of shares outstanding.

TABLE 2

Summary Statistics

All variables are as defined in Table 1. In Table 2, the variables are computed for all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases over the interval Jan. 1, 2006 to Dec. 30, 2011. Daily statistics are first computed by security and descriptive statistics of those security averages are reported below. SHORT_BOND_t^i is a ratio of the daily number of bonds on loan (shorted) to the number of bonds outstanding (in percentages); SHORT_FIRM_t^i is an average value-weighted ratio of the daily number of bonds on loan (shorted) to the number of bonds outstanding for all bonds issued by the firm except bond *i* (in percentages); RET_BOND_t^i is annualized bond abnormal return defined as a raw return minus the return from the corresponding rating matching portfolio (in percentages); OIB_BOND_t^i is trade imbalance defined as daily difference between buy and sell trading volumes scaled by the total trading volume of bond *i* (in percentages); VOLAT_BOND_t^i is defined as absolute daily bond return (annualized and expressed in percentages); TURN_BOND_t^i is total daily number of bonds traded scaled by the total amount of bonds outstanding (in percentages); TR_VOLUME_t^i is total daily value of bonds traded (in US dollars); PAR_DEBT_t^i is the total number of bonds outstanding (in USD dollars); LENDING_FEE_t^i is average value-weighted (with respect to the loan quantity) lending fee is defined as the interest rate on cash funds minus the rebate rate (annualized and in basis points); REALIZED_SPR_t^i is daily average buy price minus sell price of the bond scaled by the mid-price of the two last buy and sell transactions (in percentages). Panel A reports mean and standard deviation for investment-grade (rated by Moody's "Baa3"and higher) and high-yield bonds for the pre-Lehman (from Jan. 1, 2006 to May 31, 2008) and post-Lehman (from Jan. 1, 2009 to Dec. 30, 2011) periods. Panels B and C report correlations among variables for investment and high-yield bonds, respectively. Correlations are computed cross-sectionally every day and then averaged across time. Standard errors for correlations are autocorrelation adjusted using Newey–West (1987) with 20 lags. *, **, and *** indicate significance at the 10%, 5%, and 1% levels, respectively.

TABLE 2 (continued)

	Investment-Grade Bonds				High-Yield Bonds			
	Pre-Lehman		Post-Lehman		Pre-Lehman		Post-Lehman	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A. Averages and Standard Deviations								
$SHORT\_BOND_t^i$	2.90%	0.29%	1.13%	0.20%	2.83%	0.33%	1.45%	0.24%
$RET\_BOND_t^i$	-1.02%	17.6%	7.10%	41.0%	0.20%	33.8%	23.5%	114.8%
$OIB\_BOND_t^i$	6.13%	6.83%	1.19%	7.34%	-4.89%	6.62%	-1.89%	6.44%
$VOLAT\_BOND_t^i$	75.5%	24.6%	133.6%	75.8%	114.6%	29.7%	188.7%	168.5%
$TURN\_BOND_t^i$	0.61%	0.22%	0.57%	0.36%	0.55%	0.13%	0.48%	0.18%
$TR\_VOLUME_t^i$	3,035,722	695,303	2,819,365	684,514	1,802,229	401,572	1,685,580	429,656
$PAR\_DEBT_t^i$	441,240	17,221	512,970	18,878	308,763	8,100	340,142	4,592
$LENDING\_FEE_t^i$	15.08	4.43	8.97	6.62	40.80	9.71	34.07	9.59
$REALIZED\_SPR_t^i$	0.75%	0.28%	1.15%	0.55%	0.92%	0.26%	1.50%	0.59%
No. of bonds			12,654				5,112	

Variable	$RET\_BOND_{t-20,}^i$	$SHORT\_BOND_t^i$	$SHORT\_FIRM_t^i$	$OIB\_BOND_{t-20,t}^i$	$VOLAT\_BOND_{t-20,}^i$	$TURN\_BOND_{t-20,t}^i$
Panel B. Correlations (Investment-Grade Bonds)						
$RET\_BOND_{t+1,t+20}^i$	-0.005	-0.000	0.001	-0.072***	0.065***	0.035
$RET\_BOND_{t-20,t}^i$	1.000	0.005	-0.008	-0.015***	0.000	-0.003
$SHORT\_BOND_t^i$		1.000	0.155***	-0.008***	0.056***	0.114***
$SHORT\_FIRM_t^i$			1.000	-0.002	-0.003	0.020***
$OIB\_BOND_{t-20,t}^i$				1.000	-0.011**	-0.022***
$VOLAT\_BOND_{t-20,}^i$					1.000	0.015***
Panel C. Correlations (High-Yield Bonds)						
$RET\_BOND_{t+1,t+20}^i$	0.063***	-0.021***	-0.018**	-0.039***	0.068***	0.016*
$RET\_BOND_{t-20,t}^i$	1.000	-0.032***	-0.031***	-0.018***	-0.036	-0.028**
$SHORT\_BOND_t^i$		1.000	0.288***	0.007**	0.013***	0.142***
$SHORT\_FIRM_t^i$			1.000	0.010***	0.030***	0.057***
$OIB\_BOND_{t-20,t}^i$				1.000	-0.005	0.012***
$VOLAT\_BOND_{t-20,}^i$					1.000	0.094***

TABLE 3

Portfolio Returns and Short Interest

Table 3 presents returns for portfolios sorted based on short interest. Sample for Panel A consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases over the interval Jan. 1, 2006 to Dec. 30, 2011, the pre-Lehman period (Panel B) consists of all trading days from Jan. 1, 2006 to May 31, 2008, the post-Lehman period (Panel C) is from Jan. 1, 2009 to Dec. 30, 2011 and the Lehman period (Panel D) is from Jun. 1, 2008 to Dec. 30, 2008. Bonds are sorted every day into quintiles based on the daily short interest ratio. After skipping 1 day, value-weighted portfolios are held for 20 trading days. This process is repeated each trading day, so that each trading day's portfolio return is an average of 20 different portfolios, with 1/20 of the portfolio rebalanced each day. Portfolio returns are credit rating matched and are defined as the difference between raw returns (the equal-weighted average of daily returns) and issue-size equal-weighted returns of bonds with similar credit rating, calculated as in Bessembinder et al. (2009). Returns are reported in percent multiplied by 252 to reflect an approximately annual return, with *t*-statistics based on the daily time series. Investment-grade bonds are defined as those rated by Moody's "Baa3" and higher 5 days prior to the sorting while the rest of the bonds are categorized as high-yield bonds. The *t*-statistics are reported in parentheses are based on the time series of coefficient estimates from the cross-sectional regressions using Newey–West (1987) with 20 lags.

TABLE 3 (continued)

Portfolio	All Bonds		Investment-Grade Bonds		High Yield Bonds	
Panel A. Full Sample						
P1 (least)	2.74%	(6.08)	0.48%	(1.14)	8.85%	(7.39)
P2	-0.54%	(-0.66)	-0.80%	(-1.57)	3.45%	(1.13)
P3	-0.67%	(-1.27)	-0.34%	(-0.90)	-1.00%	(-0.57)
P4	-0.57%	(-0.97)	-0.03%	(-0.07)	-2.15%	(-1.22)
P5 (most)	-2.21%	(-3.05)	-0.11%	(-0.18)	-8.67%	(-4.02)
P1 – P5	4.96%	(5.11)	0.58%	(0.64)	17.53%	(7.17)
Panel B. Pre-Lehman Period						
P1 (least)	0.50%	(1.25)	0.68%	(1.55)	0.05%	(0.06)
P2	-0.50%	(-0.68)	-0.25%	(-0.57)	-1.26%	(-0.92)
P3	-0.25%	(-0.74)	-0.25%	(-0.81)	0.24%	(0.32)
P4	-0.25%	(-0.52)	-0.25%	(-0.56)	0.38%	(0.40)
P5 (most)	-1.51%	(-2.14)	-1.26%	(-1.90)	-2.02%	(-1.32)
P1 – P5	2.02%	(2.02)	1.94%	(1.89)	2.07%	(1.05)
Panel C. Post-Lehman Period						
P1 (least)	5.07%	(7.69)	0.78%	(1.31)	16.30%	(9.63)
P2	-0.04%	(-0.04)	-0.76%	(-1.23)	6.65%	(1.60)
P3	-0.50%	(-1.17)	-0.76%	(-1.58)	0.09%	(0.05)
P4	-0.25%	(-0.50)	-0.50%	(-0.89)	-0.23%	(-0.12)
P5 (most)	-1.76%	(-1.77)	0.13%	(0.15)	-7.81%	(-3.40)
P1 – P5	6.83%	(4.85)	0.65%	(0.48)	24.12%	(7.78)
Panel D. Lehman Period						
P1 (least)	0.40%	(0.13)	-2.34%	(-0.85)	9.41%	(1.04)
P2	-4.00%	(-0.52)	-3.74%	(-0.90)	7.77%	(0.30)
P3	-2.96%	(-0.58)	1.08%	(0.32)	-13.6%	(-0.75)
P4	-3.27%	(-0.67)	4.57%	(1.32)	-26.0%	(-1.56)
P5 (most)	-9.24%	(-1.61)	3.86%	(1.22)	-46.5%	(-2.33)
P1 – P5	9.64%	(1.45)	-6.20%	(-1.16)	55.92%	(2.85)

TABLE 4

Cross-Sectional Return Regressions

Table 4 presents Fama–MacBeth (1973) regressions predicting 20-day abnormal returns. Each day we estimate the following cross-sectional predictive regression:

$$\text{RET\_BOND}^i_{t+2,t+21} = \alpha_{0t} + \alpha_{1t}\text{SHORT\_BOND}^i_t + \alpha_{2t}\text{SHORT\_FIRM}^i_t + \alpha_{3t}\text{RET\_BOND}^i_{t-20,t} + \alpha_{4t}\text{OIB\_BOND}^i_{t-20,t} + \gamma_t X^i_t + u^i_t.$$

We average then each coefficient over time-series dimension. The sample consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases from Jan. 1, 2006 to Dec. 30, 2011. Bonds with Moody's credit rating of "Baa3" and higher five days prior to the sorting are categorized as Investment-Grade Bonds; others are categorized as High-Yield Bonds. Pre-Lehman period (Panel B) consists of all trading days from Jan. 1, 2006 to May 31, 2008, the post-Lehman period (Panel C) is from Jan. 1, 2009 to Dec. 30, 2011 and the Lehman period (Panel D) is from June 1, 2008 to Dec. 30, 2008. Dependent variable is a simple average of abnormal bond returns over the future 20 days defined as a raw return minus the return from the corresponding rating matching portfolio (annualized and expressed in percentages); SHORT_BOND^i_t is a ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding (in percentages); SHORT_FIRM^i_t is an average value-weighted ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding for all bonds issued by the firm except bond *i* (in percentages); $\text{RET\_BOND}^i_{t-20,t}$ is a simple average of abnormal returns on bond *i* over the past 20 days (in percentages); $\text{OIB\_BOND}^i_{t-20,t}$ is a simple average over past 20 days of a trade imbalance of bond *i* defined as daily difference between buy and sell trading volumes scaled by the total trading volume of the bond (in percentages). Variables X^i_t include the following controls: $\text{VOLAT\_BOND}^i_{t-20,t}$ is defined as a sum of absolute daily returns on bond *i* over the past 20 days (annualized and expressed in percentages); $\text{TURN\_BOND}^i_{t-20,t}$ is total daily number of bonds of issue *i* traded scaled by the total number of bonds outstanding (in percentages); $\ln(\text{PAR\_DEBT}^i_t)$ is the natural log value of total amount of bonds outstanding for bond issue *i* (in USD dollars); TTM^i_t is time-to-maturity expressed in years. The *t*-statistics are reported in parentheses are based on the time series of coefficient estimates from the cross-sectional regressions using Newey–West (1987) with 20 lags.

Table 4 (continued)

	All Bonds				Investment-Grade Bonds				High-Yield Bonds			
Panel A. Full Sample												
$SHORT\_BOND_t^i$	-0.83 (-5.74)	-0.78 (-5.42)	-0.63 (-5.15)	-0.46 (-2.45)	-0.08 (-1.09)	-0.06 (-0.90)	-0.07 (-0.99)	-0.06 (-0.93)	-1.36 (-6.06)	-1.40 (-6.05)	-0.88 (-5.22)	-0.86 (-5.16)
$SHORT\_FIRM_t^i$			-1.11 (-4.72)	-1.19 (-4.49)			-0.09 (-0.80)	-0.05 (-0.53)			-1.71 (-4.93)	-1.61 (-4.65)
$RET\_BOND_{t-20,t}^i$	-0.07 (-4.25)	-0.05 (-2.85)	-0.04 (-2.31)	-0.03 (-1.48)	-0.10 (-7.30)	-0.08 (-6.76)	-0.11 (-9.31)	-0.09 (-7.96)	-0.05 (-2.21)	-0.24 (-1.29)	-0.02 (-0.87)	-0.02 (-0.71)
$OIB\_BOND_{t-20,t}^i$		-0.04 (-5.70)		-0.04 (-4.59)		-0.03 (-4.06)		-0.03 -3.93)		-0.13 (-3.02)		-0.06 (-3.15)
Adj. R^2	11.53%	11.99 %	11.10 %	11.71%	10.24 %	9.31%	9.09%	9.06%	15.41%	16.11%	16.18 %	16.85%
Panel B. Pre-Lehman Period												
$SHORT\_BOND_t^i$	-0.24 (-4.14)	-0.17 (-2.71)	-0.24 (-2.51)	0.22 (0.59)	-0.08 (-2.49)	-0.06 (-2.07)	-0.04 (-1.16)	-0.03 (-0.94)	-0.35 (-2.46)	-0.62 (-2.52)	-0.30 (-2.89)	-0.29 (-2.87)
$SHORT\_FIRM_t^i$			-0.20 (-2.21)	-0.48 (-1.43)			-0.07 (-1.10)	-0.07 (-1.01)			-0.27 (-1.98)	-0.26 (-1.94)
$RET\_BOND_{t-20}^i$	-0.05 (-1.65)	-0.03 (-0.93)	0.01 (0.17)	0.02 (0.50)	-0.11 (-5.72)	-0.09 (-6.88)	-0.11 (-9.18)	-0.10 (-7.41)	-0.00 (-0.10)	-0.49 (-1.03)	0.07 (1.56)	0.07 (1.68)
$OIB\_BOND_{t-20}^i$		-0.02 (-5.36)		-0.02 (-5.35)		-0.02 (-5.08)		-0.02 (-5.23)		-0.11 (-1.05)		-0.01 (-1.02)
Adj. R^2	8.92 %	8.72 %	7.98 %	8.50 %	9.45%l	7.79 %	8.30 %	8.54 %	11.72 %	12.23 %	12.40 %	12.82%

TABLE 4 (continued)

	All Bonds				Investment-Grade Bonds				High-Yield Bonds			
Panel C. Post-Lehman Period												
$SHORT\_BOND_t^i$	-0.94	-0.91	-0.66	-0.65	-0.10	-0.08	-0.07	-0.07	-1.53	-1.42	-0.90	-0.86
	(-5.99)	(-5.81)	(-5.07)	(-4.99)	(-0.93)	(-0.79)	(-0.68)	(-0.68)	(-7.20)	(-6.80)	(-5.65)	(-5.46)
$SHORT\_FIRM_t^i$			-1.29	-1.18			-0.23	-0.14			-1.89	-1.70
			(-4.93)	(-4.69)			(-1.43)	(-0.94)			(-5.09)	(-4.61)
$RET\_BOND_{t-20,t}^i$	-0.08	-0.06	-0.06	-0.04	-0.10	-0.08	-0.11	-0.09	-0.08	-0.08	-0.06	-0.06
	(-4.14)	(-2.85)	(-3.13)	(-2.19)	(-4.53)	(-4.00)	(-5.91)	(-5.04)	(-2.82)	(-2.70)	(-1.90)	(-1.95)
$OIB\_BOND_{t-20,t}^i$		-0.06		-0.05		-0.03		-0.02		-0.13		-0.11
		(-4.80)		(-4.39)		(-2.77)		(-2.63)		(-4.34)		(-3.33)
Adj. R^2	13.95%	14.93%	13.72%	14.49%	11.09%	10.48%	9.60%	9.31%	18.74%	19.64%	19.42%	20.43%
Panel D. Lehman Period												
$SHORT\_BOND_t^i$	-2.64	-2.65	-2.12	-2.12	0.04	0.02	-0.17	-0.17	-4.59	-4.56	-3.19	-3.19
	(-3.14)	(-3.19)	(-2.90)	(-2.96)	(0.08)	(0.05)	(-0.37)	(-0.36)	(-3.70)	(-3.70)	(-3.01)	(-3.09)
$SHORT\_FIRM_t^i$			-3.95	-4.14			0.65	0.51			-6.61	-6.67
			(-2.92)	(-3.04)			(1.15)	(0.98)			(-3.81)	(-3.86)
$RET\_BOND_{t-20,t}^i$	-0.07	-0.06	-0.11	-0.10	-0.12	-0.10	-0.12	-0.11	-0.08	-0.07	-0.16	-0.15
	(-2.11)	(-1.68)	(-2.89)	(-2.50)	(-2.29)	(-1.96)	(-2.13)	(-1.88)	(-2.19)	(-1.96)	(-3.51)	(-3.31)
$OIB\_BOND_{t-20,t}^i$		-0.06		-0.00		-0.05		-0.05		-0.22		0.00
		(-1.47)		(-0.09)		(-1.13)		(-1.12)		(-3.28)		(0.08)
Adj. R^2	8.50%	8.65%	9.07%	9.06%	8.71%	8.87%	9.50%	9.77%	11.69%	12.00%	13.24%	12.97%

TABLE 5

Do Short Sellers Predict Returns Conditional on Past Returns? Portfolio Analysis

Table 5 presents returns for portfolios sorted based on short interest and past bond returns. Sample for Panel A consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases over the interval Jan. 1, 2006 to Dec. 30, 2011, the pre-Lehman period (Panel B) consists of all trading days from Jan. 1, 2006 to May 31, 2008, the post-Lehman period (Panel C) is from Jan. 1, 2009 to Dec. 30, 2011 and the Lehman period (Panel D) is from Jun. 1, 2008 to Dec. 30, 2008. Bonds are double sorted every day into quintiles based on the daily short interest ratio and into terciles based on the abnormal returns over the past 20 days. After skipping 1 day, value-weighted portfolios are held for 20 trading days. This process is repeated each trading day, so that each trading day's portfolio return is an average of 20 different portfolios, with 1/20 of the portfolio rebalanced each day. Portfolio returns are credit rating matched and are defined as the difference between raw returns (equal-weighted average of daily returns) and equal-weighted returns of bonds with similar credit rating, calculated as in Bessembinder et al. (2009). Returns are reported in percent multiplied by 252 to reflect an approximately annual return, with *t*-statistics based on the daily time series. Investment-Grade bonds are defined as those rated by Moody's "Baa3"and higher 5 days prior to the sorting while the rest of the bonds are categorized as high-yield bonds. The *t*-statistics are reported in parentheses are based on the time series of coefficient estimates from the cross-sectional regressions using Newey–West (1987) with 20 lags.

TABLE 5 (continued)

$\text{RET\_BOND}^{i}_{t-20,t}$

	All Bonds			Investment-Grade Bonds			High-Yield Bonds		
Portfolio	Low	Medium	High	Low	Medium	High	Low	Medium	High
Panel A. Full Sample									
P1	7.41%	-1.41%	2.54%	4.21%	-1.65%	-0.61%	13.12%	-4.72%	15.13%
	(10.7)	(-2.41)	(3.54)	(8.18)	(-3.02)	(-1.17)	(7.60)	(-2.58)	(6.26)
P2	4.51%	-3.44%	-1.56%	3.46%	-2.31%	-1.61%	10.1%	-9.50%	3.00%
	(4.12)	(-5.10)	(-1.47)	(4.61)	(-5.13)	(-2.50)	(2.90)	(-3.88)	(0.84)
P3	2.87%	-2.58%	-1.93%	2.74%	-1.69%	-1.53%	3.91%	-8.60%	-1.56%
	(4.02)	(-5.53)	(-3.00)	(4.55)	(-4.38)	(-3.09)	(1.99)	(-4.39)	(-0.74)
P4	2.40%	-2.37%	-1.96%	2.93%	-1.13%	-1.68%	1.14%	-10.1%	-4.00%
	(3.03)	(-4.18)	(-2.70)	(3.87)	(-2.33)	(-2.81)	(0.54)	(-5.84)	(-2.01)
P5	-0.48%	-3.16%	-3.37%	3.03%	-1.39%	-1.81%	-7.30%	-13.4%	-8.14%
	(-0.48)	(-4.63)	(-4.01)	(4.40)	(-2.01)	(-2.52)	(-3.12)	(-6.22)	(-3.37)
P1 − P5	7.89%	1.75%	5.91%	1.18%	-0.26%	1.20%	20.41%	8.69%	23.27%
	(6.13)	(1.83)	(4.89)	(1.15)	(-0.27)	(1.17)	(6.86)	(4.00)	(6.51)
Panel B. Pre-Lehman Period									
P1	2.67%	0.04%	-0.22%	3.07%	-0.13%	-0.76%	1.51%	-0.76%	0.14%
	(5.2)	(0.09)	(-0.28)	(6.25)	(-0.27)	(-1.49)	(1.45)	(-0.58)	(0.11)
P2	1.08%	-1.01%	-1.01%	2.22%	-0.50%	-1.51%	0.71%	-2.77%	-0.76%
	(1.5)	(-2.21)	(-1.19)	(3.38)	(-1.08)	(-1.56)	(0.48)	(-2.69)	(-0.47)
P3	1.11%	-0.76%	-1.26%	1.41%	-0.76%	-2.02%	1.76%	-1.01%	0.30%
	(2.19)	(-1.89)	(-2.84)	(3.08)	(-1.7)	(-4.23)	(1.71)	(-1.01)	(0.3)
P4	0.91%	-1.01%	-1.26%	0.58%	-0.76%	-2.27%	1.18%	-1.01%	-0.50%
	(1.3)	(-2.03)	(-1.54)	(0.51)	(-1.35)	(-3.78)	(0.86)	(-0.92)	(-0.36)
P5	-1.01%	-1.76%	-3.02%	0.93%	-2.27%	-3.53%	-2.02%	-3.28%	-1.51%
	(-0.72)	(-3.3)	(-3.86)	(1.27)	(-2.27)	(-4.63)	(-1.11)	(-2.66)	(-0.79)
P1 − P5	3.68%	1.81%	2.81%	2.14%	2.14%	2.77%	3.53%	2.52%	1.65%
	(2.35)	(2.01)	(1.98)	(1.99)	(1.74)	(2.48)	(1.60)	(1.11)	(0.67)

TABLE 5 (continued)

$\text{RET\_BOND}^{i}_{t-20,t}$

	All Bonds			Investment-Grade Bonds			High-Yield Bonds		
Portfolio	Low	Medium	High	Low	Medium	High	Low	Medium	High
Panel C. Post-Lehman Period									
P1	10.03%	-1.51%	5.90%	4.36%	-2.27%	-0.21%	19.05%	-3.53%	22.65%
	(11.4)	(-1.97)	(6.05)	(6.15)	(-3.15)	(-0.28)	(8.94)	(-1.66)	(8.64)
P2	5.87%	-3.53%	-0.12%	4.26%	-2.77%	-1.01%	15.4%	-9.58%	4.46%
	(4.71)	(-5.25)	(-0.11)	(5.25)	(-4.56)	(-1.30)	(2.96)	(-3.17)	(1.20)
P3	3.45%	-3.28%	-1.26%	2.72%	-2.52%	-1.26%	5.32%	-11.6%	-1.26%
	(4.69)	(-7.19)	(-1.68)	(4.95)	(-5.64)	(-2.17)	(2.44)	(-6.27)	(-0.69)
P4	3.07%	-2.77%	-0.50%	2.97%	-2.02%	-1.26%	4.11%	-13.1%	-0.13%
	(3.15)	(-3.98)	(-0.57)	(3.79)	(-2.86)	(-1.31)	(1.50)	(-6.96)	(-0.06)
P5	0.66%	-2.77%	-1.51%	3.30%	-1.26%	-0.76%	-5.80%	-15.62%	-8.06%
	(0.55)	(-3.16)	(-1.40)	(3.21)	(-1.33)	(-0.72)	(-2.26)	(-7.11)	(-3.39)
P1 − P5	9.37%	1.26%	7.41%	1.06%	-1.01%	0.55%	25.85%	12.10%	30.72%
	(5.68)	(1.08)	(4.58)	(0.70)	(-0.76)	(0.37)	(6.84)	(3.91)	(8.16)
Panel D. Lehman Period									
P1	15.86%	-8.70%	-3.34%	8.99%	-5.31%	-2.17%	36.52%	-31.31%	46.21%
	(2.79)	(-1.76)	(-0.68)	(2.42)	(-1.28)	(-0.61)	(2.43)	(-1.92)	(2.01)
P2	13.74%	-15.49%	-12.95%	5.09%	-8.86%	-6.00%	26.15%	-42.67%	13.21%
	(1.36)	(-2.37)	(-1.29)	(0.75)	(-2.76)	(-1.49)	(0.98)	(-1.93)	(0.37)
P3	8.30%	-7.46%	-9.07%	9.45%	-1.49%	-0.55%	6.36%	-31.22%	-12.20%
	(1.21)	(-1.70)	(-1.54)	(1.60)	(-0.48)	(-0.14)	(0.34)	(-1.60)	(-0.56)
P4	5.88%	-7.28%	-13.41%	14.47%	2.11%	-1.36%	-16.52%	-38.74%	-44.48%
	(0.90)	(-1.52)	(-2.70)	(2.92)	(0.73)	(-0.36)	(-0.92)	(-2.49)	(-2.47)
P5	-5.02%	-11.14%	-15.98%	11.97%	2.24%	0.49%	-41.41%	-52.81%	-42.03%
	(-0.68)	(-2.09)	(-2.52)	(2.96)	(0.66)	(0.12)	(-1.98)	(-2.58)	(-1.81)
P1 − P5	20.88%	2.44%	12.64%	-2.97%	-7.55%	-2.65%	77.93%	21.51%	88.23%
	(2.28)	(0.40)	(1.54)	(-0.47)	(-1.38)	(-0.45)	(3.12)	(1.43)	(2.63)

TABLE 6

Do Short Sellers Predict Returns Conditional on Past Returns? Cross-Sectional Regressions

Table 6 presents Fama–MacBeth (1973) regressions predicting 20-day abnormal returns by short interest interacted with past bond returns. Each day we estimate the following cross-sectional predictive regression:

$$\begin{aligned}\text{RET\_BOND}^{i}_{t+2,t+21} &= \alpha_{1t}\text{SHORT\_BOND}^{i}_{t} + \alpha_{2t}\text{SHORT\_BOND}^{i}_{t} \times \text{RET\_BOND}^{\text{high}}_{t} + \alpha_{3t}\text{SHORT\_BOND}^{i}_{t} \times \text{RET\_BOND}^{\text{low}}_{t-20,t} \\ &+ \alpha_{4t}\text{RET\_BOND}^{\text{high}}_{t-20,t} + \alpha_{5t}\text{RET\_BOND}^{\text{low}}_{t-20,t} + \alpha_{6t}\text{OIB\_BOND}^{i}_{t-20,t} + \gamma_{t}X^{i}_{t} + u^{i}_{t}.\end{aligned}$$

We average then each coefficient over time-series dimension. The sample consists of all corporate bonds in Markit's securities lending database for which corresponding data is available in the FISD and TRACE databases from Jan. 1, 2006 to Dec. 30, 2011. Bonds with Moody's credit rating of "Baa-3" and higher five days prior to the sorting are categorized as Investment-Grade Bonds; others are categorized as High-Yield Bonds. Pre-Lehman period (Panel B) consists of all trading days from Jan. 1, 2006 to May 31, 2008, the post-Lehman period (Panel C) is from Jan. 1, 2009 to Dec. 30, 2011 and the Lehman period (Panel D) is from Jun. 1, 2008 to Dec. 30, 2008. Dependent variable is a simple average of abnormal bond returns over the future 20 days defined as a raw return minus the return from the corresponding rating matching portfolio (annualized and expressed in percentages); $\text{SHORT\_BOND}^{i}_{t}$ is a ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding (in percentages); $\text{OIB\_BOND}^{i}_{t-20,t}$ is a simple average over past 20 days of a trade imbalance of bond *i* defined as daily difference between buy and sell trading volumes scaled by the total trading volume of the bond (in percentages). To define $\text{RET\_BOND}^{\text{high}}_{t-20,t}$ and $\text{RET\_BOND}^{\text{low}}_{t-20,t}$ variables, we sort bonds on day *t* into terciles based on $\text{RET\_BOND}^{i}_{t-20,t}$, where $\text{RET\_BOND}^{i}_{t-20,t}$ is a simple average of abnormal returns on bond *i* over the past 20 days (in percentages). $\text{RET\_BOND}^{\text{high}}_{t-20,t} = 1$ if the bond abnormal return over the past 20 trading days falls into the highest tercile and $\text{RET\_BOND}^{\text{high}}_{t-20,t} = 0$ otherwise. Similarly, $\text{RET\_BOND}^{\text{low}}_{t-20,t} = 1$ if the bond abnormal return over the past 20 trading days falls into the lowest tercile and $\text{RET\_BOND}^{\text{low}}_{t-20,t} = 0$ otherwise. Control variables X^{i}_{t} include; $\text{VOLAT\_BOND}^{i}_{t-20,t}$ is defined as a sum of absolute daily returns on bond *i* over the past 20 days (annualized and expressed in percentages); $\text{TURN\_BOND}^{i}_{t-20,t}$ is total daily number of bonds of issue *i* traded scaled by the total number of bonds outstanding (in percentages); $\ln(\text{PAR\_DEBT}^{i}_{t})$ is the natural log value of the total amount of bonds outstanding for bond issue *i* (in USD dollars); TTM^{i}_{t} is time-to-maturity expressed in years. The *t*-statistics are reported in parentheses are based on the time series of coefficient estimates from the cross-sectional regressions using Newey–West (1987) with 20 lags.

TABLE 6 (continued)

	All Bonds		Investment Grade		High-Yield Bonds	
Panel A. Full Sample						
SHORT_BOND_t^i	-0.43 (-2.81)	-0.36 (-1.80)	-0.01 (-0.21)	0.01 (0.16)	-1.70 (-6.12)	-1.63 (-6.07)
$\text{RET\_BOND}_{t-20,t}^{\text{high}}$	-8.68 (-7.53)	-8.12 (-7.32)	-2.42 (-4.31)	-1.59 (-3.07)	-9.85 (-5.94)	-8.85 (-5.81)
$\text{RET\_BOND}_{t-20,t}^{\text{low}}$	0.15 (0.13)	-0.39 (-0.34)	3.81 (5.25)	3.93 (5.85)	5.21 (3.27)	4.79 (3.11)
$\text{OIB\_BOND}_{t-20,t}^i$		-0.05 (-5.33)		-0.03 (-4.73)		-0.11 (-4.78)
$\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{high}}$	-0.02 (-0.01)	-0.12 (-0.57)	0.03 (0.53)	-0.01 (-0.04)	0.79 (3.63)	0.75 (3.63)
$\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{low}}$	-0.66 (-4.59)	-0.64 (-4.45)	-0.14 (-2.48)	-0.14 (-2.65)	-0.37 (-3.33)	-0.36 (-3.20)
Adj. R^2	9.24%	9.78%	7.82%	7.51%	11.57%	12.28%
Panel B. Pre-Lehman Period						
SHORT_BOND_t^i	0.13 (0.40)	0.28 (0.60)	-0.06 (-1.44)	-0.05 (-1.32)	-0.42 (-3.76)	-0.43 (-3.80)
$\text{RET\_BOND}_{t-20,t}^{\text{high}}$	-4.13 (-3.83)	-3.57 (-3.57)	-2.05 (-3.28)	-1.17 (-2.65)	-3.39 (-2.59)	-3.48 (-2.65)
$\text{RET\_BOND}_{t-20,t}^{\text{low}}$	-0.21 (-0.26)	-0.62 (-0.70)	1.64 (3.14)	1.95 (5.19)	0.82 (0.86)	0.49 (0.50)
$\text{OIB\_BOND}_{t-20,t}^i$		-0.02 (-4.50)		-0.03 (-5.57)		-0.01 (-0.97)
$\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{high}}$	-0.30 (-0.92)	-0.48 (-0.95)	-0.07 (-1.01)	-0.06 (-0.97)	0.08 (1.01)	0.10 (1.11)
$\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{low}}$	-0.08 (-1.49)	-0.06 (-1.23)	0.01 (0.28)	0.03 (0.90)	-0.18 (-1.91)	-0.15 (-1.62)
Adj. R^2	6.12%	6.24%	7.35%	6.70%	7.70%	8.07%

TABLE 6 (continued)

	All Bonds		Investment Grade		High-Yield Bonds	
Panel C. Post-Lehman Period						
SHORT_BOND_t^i	-0.72 (-5.79)	-0.71 (-5.77)	0.05 (0.56)	0.07 (0.89)	-1.97 (-7.03)	-1.86 (-6.64)
$\text{RET\_BOND}_{t-20,t}^{\text{high}}$	-10.22 (-9.22)	-9.78 (-9.40)	-2.31 (-3.12)	-1.46 (-2.26)	-12.64 (-6.64)	-11.33 (-6.10)
$\text{RET\_BOND}_{t-20,t}^{\text{low}}$	-0.46 (-0.33)	-1.11 (-0.85)	4.49 (4.78)	4.60 (5.31)	7.74 (2.97)	7.20 (2.83)
$\text{OIB\_BOND}_{t-20,t}^{i}$		-0.07 (-4.34)		-0.03 (-3.03)		-0.16 (-4.42)
$\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{high}}$	0.37 (4.33)	0.34 (4.22)	0.04 (0.47)	-0.02 (-0.29)	1.36 (5.53)	1.32 (5.55)
$\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{low}}$	-0.73 (-4.53)	-0.69 (-4.47)	-0.27 (-3.03)	-0.28 (-3.12)	-0.47 (-2.57)	-0.47 (-2.63)
Adj. R^2	11.73%	12.64%	8.33%	8.15%	14.53%	15.56%
Panel D. Lehman Period						
SHORT_BOND_t^i	-1.13 (-2.44)	-1.04 (-2.43)	-0.16 (-0.31)	-0.09 (-0.18)	-5.43 (-3.42)	-5.33 (-3.58)
$\text{RET\_BOND}_{t-20,t}^{\text{high}}$	-18.79 (-2.33)	-17.44 (-2.23)	-4.56 (-1.34)	-4.11 (-1.11)	-20.71 (-1.81)	-16.98 (-1.66)
$\text{RET\_BOND}_{t-20,t}^{\text{low}}$	5.17 (0.57)	4.71 (0.52)	8.95 (1.91)	8.29 (1.81)	8.88 (1.38)	8.87 (1.55)
$\text{OIB\_BOND}_{t-20,t}^{i}$		-0.08 (-2.00)		-0.08 (-1.88)		-0.27 (-3.22)
$\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{high}}$	-1.05 (-2.50)	-1.23 (-2.78)	0.43 (1.19)	0.35 (1.01)	0.47 (0.29)	0.24 (0.15)
$\text{SHORT\_BOND}_t^i \times \text{RET\_BOND}_{t-20,t}^{\text{low}}$	-2.66 (-3.18)	-2.74 (-3.28)	0.02 (0.10)	-0.08 (-0.42)	-0.64 (-1.38)	-0.62 (-1.15)
Adj. R^2	7.88%	8.10%	6.85%	7.16%	10.60%	10.91%

TABLE 7

Summary Statistics: Stocks Variable

All variables are as defined in Table I. The variables are computed for all stocks in CRSP database that have also corporate bonds in the FISD and TRACE databases and the data in the Markit securities lending database from Jan. 1, 2006 to Dec. 30, 2011. Daily statistics are first computed by security and descriptive statistics of those security averages are reported below. SHORT_STOCK_t^i is a ratio of the daily number of shares of stock *i* on loan (shorted) on day *t* to a number of shares outstanding (in percentages); SHORT_FIRM_t^i of firm *i* is an average value-weighted ratio of the daily number of bonds on loan (shorted) to the number of bonds outstanding for all bonds issued by the firm on day *t* (in percentages); RET_STOCK_t^i is annualized stock abnormal return on day *t* defined as a raw return minus the return from the corresponding size and book-to-market ratio matching portfolio (in percentages); RET_BOND_t^i is annualized bond abnormal return on day *t* defined as a raw return minus the return from the corresponding credit rating matching portfolio (in percentages); OIB_STOCK_t^i is stock *i* trade imbalance defined as daily difference between buy and sell trading volumes scaled by the total trading volume of the stock (in percentages); VOLAT_STOCK_t^i is defined as absolute value of stock *i* abnormal return on day *t* (annualized and expressed in percentages); TURN_STOCK_t^i is total daily shares of stock *i* traded scaled on day *t* by the total number of shares outstanding (in percentages); MCAP_t^i is the market capitalization of firm *i* (in USD dollars); BM_t^i is the book-to-market ratio of firm i*;* LEVERAGE_t^i is defined as the sum of long-term and short-term debts divided by stockholders total equity of the firm issuing bond *i*; IHOLDING_t^i institutional holding is defined as the number of shares held by institutional investors as recorded in 13F filings and are scaled by the total number of shares outstanding of the firm issuing bond *i* (in percentages). Panel A reports mean and standard deviation for Large stocks (largest quintile in terms of market capitalization) and Small stocks (smallest quintile) for the pre-Lehman (from Jan. 1, 2006 to May 31, 2008) and post-Lehman (from Jan. 1, 2009 to Dec. 30, 2011) periods. Panels B and C report correlations among variables for large and small stocks respectively. Correlations are computed cross-sectionally every day and then averaged across time. Standard errors for correlations are autocorrelation adjusted using Newey–West (1987) with 20 lags.

TABLE 7 (continued)

	Large Stocks				Small Stocks			
	Pre-Lehman		Post-Lehman		Pre-Lehman		Post-Lehman	
Variable	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
Panel A. Averages and Standard Deviations								
$SHORT\_STOCK_t^i$	2.15%	0.55%	1.52%	0.30%	10.36%	2.11%	5.69%	1.25%
$SHORT\_FIRM_t^i$	3.35%	0.36%	1.26%	0.23%	3.04%	0.75%	1.33%	0.48%
$RET\_STOCK_t^i$	6.33%	8.19%	5.92%	9.95%	-15.62%	26.96%	9.32%	56.95%
$RET\_BOND_t^i$	1.41%	4.33%	-0.76%	11.24%	-2.52%	11.19%	-7.81%	28.98%
$OIB\_STOCK_t^i$	1.19%	2.86%	-0.24%	1.64%	0.05%	6.23%	-1.77%	4.42%
$VOLAT\_STOCK_t^i$	8.77%	6.00%	20.36%	26.21%	36.29%	24.72%	79.38%	71.57%
$TURN\_STOCK_t^i$	0.85%	0.27%	1.11%	0.32%	1.15%	0.28%	1.10%	0.35%
$MCAP_t^i$ *(USD Billions)*	49.72	6.24	38.89	4.77	0.36	0.06	0.29	0.09
BM_t^i	0.42	0.02	0.55	0.07	1.02	0.27	1.63	0.70
$LEVERAGE_t^i$	1.15	0.12	1.05	0.17	1.43	0.19	1.92	0.35
$IHOLDING_t^i$	72.76%	2.61%	73.63%	0.73%	70.14%	1.59%	66.61%	2.26%
number of stocks	288				467			
total number of stocks	1,401							
total number of bonds with traded stocks	5,291							

TABLE 7 (continued)

	$RET\_STOCK^i_{t-20,t}$	$RET\_BOND^i_{t-20,t}$	$SHORT\_STOCK^i_t$	$SHORT\_FIRM^i_t$	$OIB\_STOCK^i_{t-20,t}$	$VOLAT\_STOCK^i_{t-20,t}$	$TURN\_STOCK^i_{t-20,t}$
Panel B. Correlations (large stocks)							
$RET\_STOCK^i_{t+2,t+21}$	-0.003	-0.010	-0.038***	-0.005	0.008*	-0.021	-0.011
$RET\_STOCK^i_{t-20,t}$	1.000	0.222***	0.054***	-0.005	-0.004	0.048**	-0.010
$RET\_BOND^i_{t-20,t}$		1.000	0.035*	0.022	0.010**	-0.014	-0.017
$SHORT\_STOCK^i_t$			1.000	0.011	0.018***	0.175***	0.297***
$SHORT\_FIRM^i_t$				1.000	-0.003	0.006	0.023***
$OIB\_STOCK^i_{t-20,t}$					1.000	0.006	0.024***
$VOLAT\_STOCK^i_{t-20,t}$						1.000	0.497***
Panel C. Correlations (small stocks)							
$RET\_STOCK^i_{t+2,t+21}$	0.020	0.009	-0.028	0.003	0.001	0.037	0.013
$RET\_STOCK^i_{t-20,t}$	1.000	0.383***	-0.045**	-0.000	0.033***	0.154***	-0.027
$RET\_BOND^i_{t-20,t}$		1.000	-0.028	-0.001	0.016***	0.019	-0.022
$SHORT\_STOCK^i_t$			1.000	0.118***	-0.000	0.154***	0.392***
$SHORT\_FIRM^i_t$				1.000	0.011	0.073***	0.084***
$OIB\_STOCK^i_{t-20,t}$					1.000	-0.003	0.025***
$VOLAT\_STOCK^i_{t-20,t}$						1.000	0.374***

TABLE 8

Bond Short Selling versus Stock Short Selling: Cross-Sectional Bond Return Regressions

Table 8 presents Fama–MacBeth (1973) regressions predicting 20-day abnormal returns. Each day we estimate the following cross-sectional predictive regression:

$$\text{RET\_BOND}^i_{t+2,t+21} = \alpha_{0t} + \alpha_{1t}\text{SHORT\_BOND}^i_t + \alpha_{2t}\text{SHORT\_FIRM}^i_t + \alpha_{3t}\text{SHORT\_STOCK}^i_t + \alpha_{4t}\text{RET\_BOND}^i_{t-20,t} + \alpha_{5t}\text{RET\_STOCK}^i_{t-20,t} + \alpha_{6t}\text{OIB\_BOND}^i_{t-20,t} + \gamma_t X^i_t + u^i_t.$$

We average then each coefficient over time-series dimension. The sample consists of all corporate bonds that have the corresponding stock traded and have entries in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases from Jan. 1, 2006 to Dec. 30, 2011. Bonds with Moody's credit rating of "Baa3" and higher five days prior to the sorting are categorized as Investment-Grade Bonds; others are categorized as High-Yield Bonds. Pre-Lehman period (Panel B) consists of all trading days from Jan. 1, 2006 to May 31, 2008, the post-Lehman period (Panel C) is from Jan. 1, 2009 to Dec. 30, 2011 and the Lehman period (Panel D) is from Jun. 1, 2008 to Dec. 30, 2008. Dependent variable is a simple average of abnormal bond returns over the future 20 days defined as a raw return minus the return from the corresponding rating matching portfolio (annualized and expressed in percentages); SHORT_BOND^i_t is a ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding (in percentages); SHORT_FIRM^i_t is an average value-weighted ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding for all bonds issued by the firm except bond *i* (in percentages); SHORT_STOCK^i_t is a ratio of the daily number of shares on loan (shorted) for stock corresponding to bond issue *i* on day *t* to a number of shares outstanding (in percentages); $\text{RET\_BOND}^i_{t-20,t}$ is a simple average of abnormal returns on bond *i* over the past 20 days (in percentages); $\text{RET\_STOCK}^i_{t-20,t}$ is a simple average of abnormal returns on stock corresponding to bond issue *i* over the past 20 days (in percentages); $\text{OIB\_BOND}^i_{t-20,t}$ is a simple average over past 20 days of a trade imbalance of bond *i* defined as daily difference between buy and sell trading volumes scaled by the total trading volume of the bond (in percentages). Control variables X^i_t include: $\text{VOLAT\_BOND}^i_{t-20,t}$ is defined as a sum of absolute daily returns on bond *i* over the past 20 days (annualized and expressed in percentages); $\text{TURN\_BOND}^i_{t-20,t}$ is total daily number of bonds of issue *i* traded scaled by the total number of bonds outstanding (in percentages); $\ln(\text{PAR\_DEBT}^i_t)$ is the natural log value of the total amount of bonds outstanding for bond issue *i*; TTM^i_t is time-to-maturity expressed in years; $\ln(\text{MCAP}^i_t)$ is the natural log value of the market capitalization of the firm issuing bond *i* (in USD dollars); BM^i_t is book-to-market ratio of the firm issuing bond *i*; LEVERAGE^i_t is defined as the sum of long-term and short-term debts divided by stockholders total equity of the firm issuing bond *i*; IHOLDING^i_t institutional holding is defined as the number of shares held by institutional investors as recorded in 13F filings and are scaled by the total number of shares outstanding of the firm issuing bond *i* (in percentages). The *t*-statistics are reported in parentheses are based on the time series of coefficient estimates from the cross-sectional regressions using Newey–West (1987) with 20 lags.

TABLE 8 (continued)

Variable	All Bonds				Investment-Grade Bonds				High-Yield Bonds			
Panel A. Full Sample												
$SHORT\_BOND_t^i$	-0.43 (-2.89)	-0.45 (-2.91)	-0.35 (-2.60)	-0.34 (-2.53)	0.04 (0.46)	0.05 (0.55)	-0.01 (-0.11)	0.01 (0.03)	-0.53 (-2.56)	-0.55 (-2.62)	-0.47 (-2.34)	-0.49 (-2.44)
$SHORT\_FIRM_t^i$			-0.56 (-2.56)	-0.57 (-2.58)			0.23 (1.54)	0.21 (1.44)			-0.67 (-2.42)	-0.66 (-2.40)
$SHORT\_STOCK_t^i$	-0.41 (-3.22)	-0.43 (-3.09)	-0.30 (-3.16)	-0.30 (-3.10)	0.01 (0.08)	0.01 (0.02)	-0.06 (-0.52)	-0.07 (-0.58)	-0.79 (-2.10)	-0.77 (-2.06)	-0.36 (-2.89)	-0.34 (-2.77)
$RET\_BOND_{t-20,t}^i$	-0.07 (-7.38)	-0.07 (-7.20)	-0.09 (-7.24)	-0.09 (-7.02)	-0.11 (-9.34)	-0.11 (-9.01)	-0.12 (-10.6)	-0.12 (-10.3)	-0.05 (-3.71)	-0.05 (-3.66)	-0.07 (-4.21)	-0.07 (-4.11)
$RET\_STOCK_{t-20,t}^i$	7.30 (9.87)	7.25 (9.84)	7.31 (10.3)	7.22 (10.2)	6.49 (9.29)	6.37 (9.09)	6.44 (9.39)	6.28 (9.16)	8.25 (9.04)	8.33 (9.14)	8.30 (7.93)	8.37 (9.95)
$OIB\_BOND_{t-20,t}^i$		-0.01 (-2.76)		-0.01 (-1.51)		-0.02 (-3.95)		-0.02 (-3.80)		-0.01 (-0.53)		0.01 (0.92)
Adj. R^2	11.80%	12.00%	12.53%	12.76%	15.16%	15.45%	15.25%	15.53%	15.93%	16.10%	18.30%	18.55%
Panel B. Pre-Lehman Period												
$SHORT\_BOND_t^i$	-0.18 (-2.63)	-0.23 (-1.92)	-0.12 (-2.89)	-0.11 (-2.68)	0.07 (0.51)	0.08 (0.63)	-0.03 (-0.86)	-0.02 (-0.48)	-0.24 (-2.40)	-0.24 (-2.44)	-0.20 (-2.47)	-0.20 (-2.54)
$SHORT\_FIRM_t^i$			-0.21 (-2.26)	-0.22 (-2.34)			-0.09 (-1.00)	-0.10 (-1.11)			-0.26 (-2.16)	-0.26 (-2.24)
$SHORT\_STOCK_t^i$	-0.30 (-1.59)	-0.37 (-1.56)	-0.16 (-1.12)	-0.16 (-1.18)	-0.03 (-0.14)	-0.04 (-0.16)	-0.21 (-1.40)	-0.22 (-1.42)	-1.08 (-1.19)	-1.09 (-1.20)	-0.12 (-0.82)	-0.12 (-0.85)
$RET\_BOND_{t-20,t}^i$	-0.07 (-4.83)	-0.07 (-4.72)	-0.08 (-4.30)	-0.07 (-4.11)	-0.12 (-8.07)	-0.11 (-7.77)	-0.13 (-8.31)	-0.13 (-7.99)	-0.04 (-2.28)	-0.05 (-2.28)	-0.04 (-1.38)	-0.04 (-1.33)
$RET\_STOCK_{t-20,t}^i$	7.10 (7.60)	7.10 (7.62)	6.16 (6.39)	6.10 (6.32)	5.77 (6.20)	5.68 (6.01)	5.50 (5.71)	5.39 (5.50)	7.84 (7.56)	7.96 (7.66)	6.53 (5.50)	6.62 (5.42)
$OIB\_BOND_{t-20,t}^i$		-0.02 (-3.27)		-0.02 (-4.07)		-0.03 (-4.86)		-0.03 (-4.96)		0.01 (0.61)		0.01 (0.73)
Adj. R^2	8.71%	8.92%	10.37%	10.63%	12.78%	13.13%	13.64%	14.00%	11.34%	11.49%	14.93%	15.17%

TABLE 8 (continued)

Variable	All Bonds				Investment-Grade Bonds				High-Yield Bonds			
Panel C. Post-Lehman Period												
$SHORT\_BOND_t^i$	-0.48	-0.49	-0.43	-0.44	-0.09	-0.10	-0.09	-0.10	-0.35	-0.37	-0.34	-0.37
	(-2.33)	(-2.37)	(-2.33)	(-2.38)	(-0.87)	(-0.94)	(-0.89)	(-0.95)	(-1.76)	(-1.88)	(-1.69)	(-1.85)
$SHORT\_FIRM_t^i$			-0.44	-0.44			0.31	0.30			-0.54	-0.54
			(-1.48)	(-1.47)			(1.25)	(1.24)			(-1.28)	(-1.27)
$SHORT\_STOCK_t^i$	-0.31	-0.30	-0.28	-0.27	0.13	0.12	0.14	0.13	-0.35	-0.32	-0.39	-0.36
	(-2.02)	(-1.90)	(-2.26)	(-2.13)	(0.72)	(0.67)	(0.83)	(0.76)	(-1.74)	(-1.55)	(-2.33)	(-2.12)
$RET\_BOND_{t-20,t}^i$	-0.07	-0.07	-0.08	-0.08	-0.10	-0.10	-0.11	-0.11	-0.07	-0.07	-0.09	-0.09
	(-4.95)	(-4.89)	(-5.51)	(-5.44)	(-5.51)	(-5.38)	(-6.78)	(-6.60)	(-3.38)	(-3.33)	(-4.10)	(-4.10)
$RET\_STOCK_{t-20,t}^i$	6.46	6.40	7.07	6.99	6.07	5.94	6.24	6.09	8.67	8.69	8.60	8.68
	(6.18)	(6.12)	(7.75)	(7.59)	(6.51)	(6.29)	(7.18)	(6.87)	(6.03)	(6.05)	(5.36)	(5.41)
$OIB\_BOND_{t-20,t}^i$		-0.01		0.01		-0.01		-0.01		0.01		0.02
		(-0.43)		(0.31)		(-1.55)		(-1.57)		(0.31)		(1.12)
Adj. R^2	13.31%	13.50%	13.41%	13.61%	16.49%	16.73%	15.96%	16.16%	18.56%	18.72%	20.54%	20.78%
Panel D. Lehman Period												
$SHORT\_BOND_t^i$	-1.23	-1.17	-0.81	-0.74	0.71	0.79	0.56	0.65	-2.84	-2.88	-2.31	-2.39
	(-1.30)	(-1.76)	(-0.94)	(-0.84)	(1.30)	(1.76)	(0.99)	(1.20)	(-1.85)	(-0.63)	(-1.56)	(-1.58)
$SHORT\_FIRM_t^i$			-2.72	-2.72			1.10	1.00			-3.17	-3.04
			(-2.04)	(-2.06)			(2.07)	(2.00)			(-2.16)	(-2.11)
$SHORT\_STOCK_t^i$	-1.44	-1.44	-1.06	-1.02	-0.46	-0.48	-0.56	-0.55	-2.09	-2.05	-1.20	-1.15
	(-2.59)	(-2.59)	(-2.81)	(-2.89)	(-0.92)	(-0.92)	(-1.23)	(-1.20)	(-2.58)	(-2.69)	(-1.88)	(-1.91)
$RET\_BOND_{t-20,t}^i$	-0.10	-0.09	-0.15	-0.14	-0.13	-0.12	-0.14	-0.13	0.02	0.02	-0.11	-0.10
	(-3.00)	(-2.71)	(-2.56)	(-2.38)	(-3.33)	(-3.10)	(-3.01)	(-2.80)	(0.39)	(0.50)	(-1.63)	(-1.50)
$RET\_STOCK_{t-20,t}^i$	12.96	12.78	13.55	13.21	11.94	11.72	11.49	11.08	7.55	7.86	13.87	14.24
	(4.96)	(4.98)	(4.75)	(4.75)	(4.21)	(4.32)	(3.78)	(3.86)	(2.35)	(2.46)	(3.99)	(4.10)
$OIB\_BOND_{t-20,t}^i$		-0.05		-0.02		-0.05		-0.04		-0.11		-0.03
		(-2.74)		(-0.46)		(-1.64)		(-1.41)		(-2.61)		(-0.50)
Adj. R^2	15.95%	16.20%	16.46%	16.75%	17.35%	17.70%	17.84%	18.20%	19.84%	20.15%	19.49%	19.75%

TABLE 9

Do Bond Short Sellers Have Information about Stock Returns? Cross-Sectional Regressions

Table 9 presents Fama–MacBeth (1973) regressions predicting 20-day stock abnormal returns. Each day we estimate the following cross-sectional predictive regression:

$$\text{RET\_STOCK}^{i}_{t+2,t+21} = \alpha_{0t} + \alpha_{1t}\text{SHORT\_FIRM}^{i}_{t} + \alpha_{2t}\text{SHORT\_STOCK}^{i}_{t} + \alpha_{3t}\text{RET\_STOCK}^{i}_{t-20,t} + \alpha_{4t}\text{RET\_BOND}^{i}_{t-20,t} + \alpha_{5t}\text{OIB\_STOCK}^{i}_{t-20,t} + \gamma_t X^{i}_{t} + u^{i}_{t}.$$

We average then each coefficient over time-series dimension. The sample consists of all corporate bonds that have the corresponding stock traded and have entries in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases from Jan. 1, 2006 to Dec. 30, 2011. Stocks that are in the upper market capitalization quintile across the sample five days prior to the sorting are categorized as Large stocks; stocks that are in the lowest market capitalization quintile are categorized as Small stocks. Pre-Lehman period (Panel B) consists of all trading days from Jan. 1, 2006 to May 31, 2008, the post-Lehman period (Panel C) is from Jan. 1, 2009 to Dec. 30, 2011 and the Lehman period (Panel D) is from Jun. 1, 2008 to Dec. 30, 2008. Dependent variable is a simple average of abnormal stock returns over the future 20 days defined as a raw return minus the return from the corresponding size and book-to-market matching portfolio (annualized and expressed in percentages); $\text{SHORT\_FIRM}^{i}_{t}$ is an average value-weighted ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding for all bonds issued by the firm except bond *i* (in percentages); $\text{SHORT\_STOCK}^{i}_{t}$ is a ratio of the daily number of shares on loan (shorted) for stock corresponding to bond issue *i* on day *t* to a number of shares outstanding (in percentages); $\text{RET\_BOND}^{i}_{t-20,t}$ is a simple average of abnormal returns on bond *i* over the past 20 days (in percentages); $\text{RET\_STOCK}^{i}_{t-20,t}$ is a simple average of abnormal returns on stock corresponding to bond issue *i* over the past 20 days (in percentages); $\text{OIB\_STOCK}^{i}_{t-20,t}$ is a simple average over past 20 days of a trade imbalance of stock *i* defined as daily difference between buy and sell trading volumes scaled by the total trading volume of the stock (in percentages). Control variables X^{i}_{t} include: $\text{VOLAT\_STOCK}^{i}_{t-20,t}$ is defined as a sum of absolute daily returns on stock *i* over the past 20 days (annualized and expressed in percentages); $\text{TURN\_STOCK}^{i}_{t-20,t}$ is total daily value of bonds of stock *i* traded scaled by the total number of shares outstanding (in percentages); $\ln(\text{PAR\_DEBT}^{i}_{t})$ is the natural log value of market capitalization of the firm *i* (in USD dollars); BM^{i}_{t} is book-to-market ratio; LEVERAGE^{i}_{t} is defined as the sum of long-term and short-term debts divided by stockholders total equity; IHOLDING^{i}_{t} institutional holding is defined as the number of shares held by institutional investors as recorded in 13F filings and are scaled by the total number of shares outstanding (in percentages). The *t*-statistics are reported in parentheses are based on the time series of coefficient estimates from the cross-sectional regressions using Newey–West (1987) with 20 lags.

TABLE 9 (continued)

Variable	All Stocks				Small Stocks				Large Stocks			
Panel A. Full Sample												
$SHORT\_FIRM_t^i$	0.24	0.10	0.25	0.29	-0.37	-0.63	-0.46	-0.80	0.03	-0.02	0.09	0.23
	(0.45)	(0.20)	(0.49)	(0.60)	(-0.16)	(-0.28)	(-0.19)	(-0.35)	(0.06)	(-0.04)	(0.17)	(0.43)
$SHORT\_STOCK_t^i$			-0.75	-0.79			0.12	0.16			-1.41	-1.44
			(-2.21)	(-2.29)			(0.18)	(0.24)			(-2.53)	(-2.93)
$RET\_STOCK_{t-20,t}^i$	0.01	0.01	0.01	0.01	0.02	0.03	0.02	0.03	0.00	0.00	0.00	0.00
	(0.56)	(0.94)	(0.84)	(0.82)	(0.73)	(1.36)	(0.96)	(1.27)	(0.01)	(0.10)	(0.17)	(0.03)
$RET\_BOND_{t-20,t}^i$	-0.01	-0.01	-0.01	-0.01	-0.01	-0.03	-0.05	-0.06	-0.01	-0.01	0.00	-0.00
	(-0.11)	(-0.18)	(-0.12)	(-0.15)	(-0.10)	(-0.26)	(-0.45)	(-0.56)	(-0.33)	(-0.46)	(0.06)	(-0.08)
$OIB\_STOCK_{t-20,t}^i$		-0.09		-0.13		0.22		0.53		0.56		0.51
		(-0.34)		(-0.49)		(0.26)		(0.66)		(1.74)		(1.59)
Adj. R^2	7.13%	7.33%	7.66%	7.87%	13.84%	14.86%	15.12%	15.79%	8.68%	8.85%	9.32%	9.51%
Panel B. Pre-Lehman Period												
$SHORT\_FIRM_t^i$	-0.04	-0.18	-0.11	-0.24	-0.39	-1.13	-0.45	-1.33	-0.51	-0.50	-0.50	-0.48
	(-0.05)	(-0.20)	(-0.13)	(-0.29)	(-0.09)	(-0.27)	(-0.10)	(-0.31)	(-0.57)	(-0.56)	(-0.56)	(-0.54)
$SHORT\_STOCK_t^i$			-0.29	-0.26			0.38	0.43			-1.25	-1.22
			(-0.66)	(-0.60)			(0.38)	(0.46)			(-2.50)	(-2.43)
$RET\_STOCK_{t-20,t}^i$	-0.02	-0.02	-0.02	-0.02	-0.02	0.02	-0.01	0.01	-0.02	-0.02	-0.02	-0.02
	(-1.64)	(-1.27)	(-1.43)	(-1.25)	(-0.62)	(0.54)	(-0.20)	(0.42)	(-1.50)	(-1.55)	(-1.26)	(-1.31)
$RET\_BOND_{t-20,t}^i$	0.01	0.01	0.01	0.01	-0.08	-0.06	-0.11	-0.09	0.04	0.04	0.04	0.04
	(0.43)	(0.33)	(0.44)	(0.36)	(-0.49)	(-0.37)	(-0.67)	(-0.54)	(1.07)	(1.05)	(1.19)	(1.16)
$OIB\_STOCK_{t-20,t}^i$		-0.30		-0.30		-1.56		-1.21		0.73		0.66
		(-0.71)		(-0.74)		(-1.36)		(-1.11)		(1.65)		(1.49)
Adj. R^2	6.67%	6.91%	7.13%	7.37%	11.66%	12.62%	12.40%	12.92%	8.33%	8.33%	8.67%	8.71%

TABLE 9 (continued)

Variable		All Stocks			Small Stocks				Large Stocks			
Panel C. Post-Lehman Period												
$SHORT\_FIRM_t^i$	0.47 (1.37)	0.27 (0.65)	0.39 (1.14)	0.68 (1.81)	-0.01 (-0.01)	0.14 (0.12)	-0.35 (-0.27)	-0.21 (-0.17)	0.38 (1.44)	0.18 (0.52)	0.30 (1.13)	0.59 (1.83)
$SHORT\_STOCK_t^i$			-0.75 (-2.29)	-0.93 (-2.44)			-0.04 (-0.02)	0.12 (0.07)			-1.16 (-1.89)	-1.26 (-1.93)
$RET\_STOCK_{t-20,t}^i$	0.03 (1.72)	0.04 (1.98)	0.04 (1.91)	0.03 (1.73)	0.07 (1.76)	0.06 (1.60)	0.07 (1.76)	0.06 (1.63)	0.01 (0.41)	0.02 (0.56)	0.01 (0.49)	0.01 (0.31)
$RET\_BOND_{t-20,t}^i$	0.01 (0.30)	0.01 (0.30)	0.01 (0.40)	0.01 (0.42)	0.12 (0.97)	0.06 (0.49)	0.06 (0.51)	0.01 (0.11)	-0.07 (-1.52)	-0.08 (-1.72)	-0.05 (-1.18)	-0.06 (-1.38)
$OIB\_STOCK_{t-20,t}^i$		0.17 (0.64)		0.08 (0.29)		2.66 (2.35)		2.78 (2.60)		0.34 (0.80)		0.26 (0.60)
Adj. R^2	6.34%	6.49%	6.77%	6.96%	16.09%	17.25%	18.44%	19.37%	7.81%	8.30%	8.50%	8.99%
Panel D. Lehman Period												
$SHORT\_FIRM_t^i$	0.89 (0.51)	0.99 (0.59)	1.69 (1.11)	1.75 (1.18)	-1.77 (-0.52)	-0.96 (-0.28)	-0.94 (-0.29)	-0.27 (-0.08)	1.67 (0.68)	1.83 (0.76)	2.63 (1.25)	2.81 (1.36)
$SHORT\_STOCK_t^i$			-3.68 (-1.68)	-3.20 (-1.64)			-2.68 (-1.03)	-2.26 (-0.93)			-3.32 (-0.99)	-3.33 (-0.99)
$RET\_STOCK_{t-20,t}^i$	0.04 (0.71)	0.04 (0.71)	0.04 (0.86)	0.04 (0.85)	-0.01 (-0.10)	-0.01 (-0.15)	-0.00 (-0.03)	-0.01 (-0.14)	0.07 (0.90)	0.07 (0.92)	0.07 (1.02)	0.07 (1.05)
$RET\_BOND_{t-20,t}^i$	-0.13 (-1.53)	-0.13 (-1.51)	-0.15 (-1.65)	-0.15 (-1.63)	-0.12 (-0.37)	-0.17 (-0.56)	-0.11 (-0.33)	-0.15 (-0.47)	-0.01 (-0.18)	-0.01 (-0.18)	0.00 (0.05)	0.01 (0.06)
$OIB\_STOCK_{t-20,t}^i$		-0.03 (-0.03)		-0.06 (-0.05)		0.38 (0.11)		1.27 (0.36)		0.41 (0.32)		0.60 (0.48)
Adj. R^2	13.33%	13.41%	14.60%	14.67%	17.27%	18.10%	17.19%	17.60%	14.53%	14.30%	16.70%	16.47%

TABLE 10

Substitution Effect in Short Selling around the Short Sale Ban

Table 10 presents a diff-in-diff analysis of the difference in short bond and stock interest, the difference in net new short interest of bonds and stocks, and the difference in bond and stock lending fees around stock short sale ban. The sample consists of all corporate bonds that have the corresponding stock traded, have entries in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases from Aug. 1, 2008 to Oct. 7, 2008. We further merge this sample with a list of firms which stocks were banned from short selling short sale ban period between Sept. 19, 2008 and Oct. 7, 2008. Our final sample consists of 117 banned firms and 824 non-banned firms. Specifically we estimate the following regression:

$$Y_t^i = \alpha_0 + \alpha_1 \mathrm{BAN}_t + \alpha_2 \mathrm{EVENT}^i + \alpha_3 \mathrm{BAN}_t \times \mathrm{EVENT}^i + u_t^i,$$

where Y_t^i corresponds to one of the following three variables: $\mathrm{DIFF\_SHORT}_t^i = \mathrm{SHORT\_FIRM}_t^i - \mathrm{SHORT\_STOCK}_t^i$ is the difference between stock and bond shorting for firm *i* and day *t*; $\mathrm{DIFF\Delta SHORT}_t^i = \Delta\mathrm{SHORT\_FIRM}_t^i - \Delta\mathrm{SHORT\_STOCK}_t^i$ is the difference between net new short interest; $\mathrm{DIFF\_FEE}_t^i = \mathrm{LENDING\_FEE\_FIRM}_t^i - \mathrm{LENDING\_FEE\_STOCK}_t^i$. We define $\mathrm{SHORT\_FIRM}_t^i$ as an average value-weighted ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding for all bonds issued by the firm except bond *i* (in percentages); $\mathrm{SHORT\_STOCK}_t^i$ is a ratio of the daily number of shares on loan (shorted) for stock corresponding to bond issue *i* on day *t* to a number of shares outstanding (in percentages); net new short interest $\Delta\mathrm{SHORT\_FIRM}_t^i$ and $\Delta\mathrm{SHORT\_STOCK}_t^i$ are defined as the first differences in short interest scaled by daily total trading volumes in bonds and stocks respectively; $\mathrm{LENDING\_FEE\_STOCK}_t^i$ is defined as the interest rate on cash funds minus the rebate rate for borrowing stock *i* (in basis points); $\mathrm{LENDING\_FEE\_FIRM}_t^i$ is an average value-weighted ratio of the bond lending fees for each bond issued by the firm *i* on day *t* (in basis points); EVENT^i is a dummy variable equal to 1 if the corresponding stock of firm *i* was banned from short selling by SEC between Sept. 19, 2008 and Oct. 7, 2008 and 0 otherwise; BAN_t is a dummy variable equals to 1 if *t* is between Sept. 19, 2008 and Oct. 7, 2008 and 0 otherwise. The *t*-statistics are reported in parentheses.

VARIABLE	$\mathrm{DIFF\_SHORT}_t^i$	$\mathrm{DIFF\Delta SHORT}_t^i$	$\mathrm{DIFF\_FEE}_t^i$
BAN_t	0.007 (0.06)	0.046 (4.71)	16.252 (2.90)
EVENT^i	0.173 (0.79)	-0.016 (-1.14)	29.413 (3.56)
$BAN_t \times \mathrm{EVENT}^i$	0.792 (2.46)	0.080 (3.01)	70.931 (4.70)
INTERCEPT	-5.847 (-91.8)	0.002 (0.46)	-30.352 (-9.82)
Adj. R^2	0.03%	0.14%	0.49%

TABLE 11

Predicting Bond Short Interest: Cross-Sectional Regressions

Table 11 presents Fama–MacBeth (1973) regressions of predicting 5-day bond short interest. Each day we estimate the following cross-sectional regression:

$$\begin{aligned}\text{SHORT\_BOND}^{i}_{t+2,t+6} &= \alpha_{0t} + \alpha_{1t}\text{RET\_BOND}^{\text{high}}_{t-5,t} + \alpha_{2t}\text{RET\_BOND}^{\text{low}}_{t-5,t} + \alpha_{3t}\text{OIB\_BOND}^{i}_{t-5,t} + \alpha_{4t}\text{VOLAT\_BOND}^{i}_{t-5,t} \\ &+ \alpha_{5t}\text{TURN\_BOND}^{i}_{t-5,t} + \alpha_{6t}\ln(\text{PAR\_DEBT}^{i}_{t}) + \alpha_{7t}\text{SHORT\_BOND}^{i}_{t-5,t} + \alpha_{8t}\text{SHORT\_FIRM}^{i}_{t-5,t} + u^{i}_{t}.\end{aligned}$$

We average then each coefficient over time-series dimension. The sample consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases and the issuer's stock from Jan. 1, 2006 to Dec. 30, 2011. Bonds with Moody's credit rating of "Baa-3" and higher five days prior to the sorting are categorized as Investment-Grade Bonds; others are categorized as High-Yield Bonds. Pre-Lehman period (Panel B) consists of all trading days from Jan. 1, 2006 to May 31, 2008, the post-Lehman period (Panel C) is from Jan. 1, 2009 to Dec. 30, 2011 and the Lehman period (Panel D) is from Jun. 1, 2008 to Dec. 30, 2008. Dependent variable $\text{SHORT\_BOND}^{i}_{t+2,t+6}$ is a simple average of bond short interest over the future 5 days defined a ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding (expressed in percentages). To define $\text{RET\_BOND}^{\text{high}}_{t-5,t}$ and $\text{RET\_BOND}^{\text{low}}_{t-5,t}$ variables, we sort bonds on day *t* into terciles based on $\text{RET\_BOND}^{i}_{t-5,t}$, where $\text{RET\_BOND}^{i}_{t-5,t}$ is a simple average of abnormal returns on bond *i* over the past 5 days (in percentages). $\text{RET\_BOND}^{\text{high}}_{t-5,t} = 1$ if the bond abnormal return over the past 5 trading days falls into the highest tercile and $\text{RET\_BOND}^{\text{high}}_{t-5,t} = 0$ otherwise. Similarly, $\text{RET\_BOND}^{\text{low}}_{t-5,t} = 1$ if the bond abnormal return over the past 5 trading days falls into the lowest tercile and $\text{RET\_BOND}^{\text{low}}_{t-5,5} = 0$ otherwise; $\text{SHORT\_FIRM}^{i}_{t-5,t}$ is simple average over the past 5 days of an average value-weighted ratio of the daily number of bonds on loan (shorted) for bond issue *i* on day *t* to the number of bonds outstanding for all bonds issued by the firm except bond *i* (in percentages); $\text{OIB\_BOND}^{i}_{t-5,t}$ is a simple average over past and future 5 days of a trade imbalance of bond *i* defined as daily difference between buy and sell trading volumes scaled by the total trading volume of the bond (in percentages); $\text{VOLAT\_BOND}^{i}_{t-5,t}$ is defined as a sum of absolute daily returns on bond *i* over the past and future 5 days respectively (daily and expressed in percentages); $\text{TURN\_BOND}^{i}_{t-5,t}$ is total daily number of bonds of issue *i* traded scaled by the total number of bonds outstanding (in percentages); $\ln(\text{PAR\_DEBT}^{i}_{t})$ is the natural log value of the total amount of bonds outstanding for bond issue *i* (in USD dollars). The *t*-statistics are reported in parentheses are based on the time series of coefficient estimates from the cross-sectional regressions using Newey–West (1987) with 20 lags.

TABLE 11 (continued)

Variable	All Bonds	Investment-Grade Bonds	High-Yield Bonds
Panel A. Full Sample			
$\text{RET\_BOND}^{\text{high}}_{t-5,t}$	0.023 (5.78)	0.024 (5.79)	0.017 (2.52)
$\text{RET\_BOND}^{\text{low}}_{t-5,t}$	0.020 (4.72)	0.013 (2.77)	0.027 (4.03)
$\text{OIB\_BOND}^{i}_{t-5,t}$	0.244 (39.4)	0.216 (32.0)	0.347 (38.0)
$\text{VOLAT\_BOND}^{i}_{t-5,t}$	-0.320 (-0.65)	0.654 (1.12)	-1.304 (-1.49)
$\text{TURN\_BOND}^{i}_{t-5,t}$	1.133 (2.84)	0.993 (2.46)	3.539 (3.26)
$\ln(\text{PAR\_DEBT}^{i}_{t})$	1.241 (4.24)	1.437 (4.14)	1.655 (3.77)
$\text{SHORT\_BOND}^{i}_{t-5,t}$	0.960 (211.4)	0.957 (175.2)	0.962 (232.2)
$\text{SHORT\_FIRM}^{i}_{t-5,t}$	0.011 (7.51)	0.009 (4.69)	0.009 (4.13)
Adj. R^2	91.61%	90.82%	92.95%
Panel B. Pre-Lehman			
$\text{RET\_BOND}^{\text{high}}_{t-5,t}$	0.013 (1.80)	0.013 (1.92)	0.004 (0.35)
$\text{RET\_BOND}^{\text{low}}_{t-5,t}$	0.031 (4.17)	0.025 (3.09)	0.043 (3.67)
$\text{OIB\_BOND}^{i}_{t-5,t}$	0.227 (29.83)	0.187 (21.3)	0.369 (31.6)
$\text{VOLAT\_BOND}^{i}_{t-5,t}$	-0.627 (-0.56)	0.762 (0.60)	-2.118 (-1.05)
$\text{TURN\_BOND}^{i}_{t-5,t}$	1.523 (3.45)	1.176 (3.29)	4.747 (2.79)
$\ln(\text{PAR\_DEBT}^{i}_{t})$	0.264 (0.50)	0.128 (0.23)	1.254 (1.42)
$\text{SHORT\_BOND}^{i}_{t-5,t}$	0.980 (201.6)	0.982 (192.6)	0.977 (185.3)
$\text{SHORT\_FIRM}^{i}_{t-5,t}$	0.007 (0.16)	0.005 (2.17)	0.007 (3.54)
Adj. R^2	93.29%	93.32%	93.27%

TABLE 11 (continued)

Variable	All Bonds	Investment-Grade Bonds	High Yield Bonds
Panel C. Post-Lehman Period			
$\text{RET\_BOND}_{t-5,t}^{\text{high}}$	0.031 (7.67)	0.033 (7.93)	0.031 (4.29)
$\text{RET\_BOND}_{t-5,t}^{\text{low}}$	0.010 (3.37)	0.003 (0.93)	0.020 (2.58)
$\text{OIB\_BOND}_{t-5,t}^{i}$	0.269 (34.9)	0.249 (30.9)	0.343 (27.3)
$\text{VOLAT\_BOND}_{t-5,t}^{i}$	0.116 (0.56)	0.701 (1.61)	-0.148 (-0.77)
$\text{TURN\_BOND}_{t-5,t}^{i}$	1.145 (1.68)	1.258 (1.75)	3.695 (2.46)
$\ln(\text{PAR\_DEBT}_{t}^{i})$	1.587 (6.18)	1.818 (5.80)	2.089 (5.20)
$\text{SHORT\_BOND}_{t-5,t}^{i}$	0.953 (218.8)	0.949 (166.9)	0.956 (194.5)
$\text{SHORT\_FIRM}_{t-5,t}^{i}$	0.015 (6.65)	0.014 (6.01)	0.011 (2.71)
Adj. R^2	90.72%	89.66%	92.54%
Panel D. Lehman Period			
$\text{RET\_BOND}_{t-5,t}^{\text{high}}$	0.029 (1.68)	0.022 (1.07)	-0.004 (-0.20)
$\text{RET\_BOND}_{t-5,t}^{\text{low}}$	0.023 (0.96)	0.004 (0.19)	-0.006 (-0.25)
$\text{OIB\_BOND}_{t-5,t}^{i}$	0.182 (11.1)	0.174 (12.6)	0.262 (8.40)
$\text{VOLAT\_BOND}_{t-5,t}^{i}$	-1.312 (-2.93)	-0.146 (-0.45)	-3.943 (-3.58)
$\text{TURN\_BOND}_{t-5,t}^{i}$	-0.857 (-0.92)	-1.430 (-1.38)	-3.31 (-1.40)
$\ln(\text{PAR\_DEBT}_{t}^{i})$	4.061 (5.79)	5.688 (5.20)	1.135 (0.88)
$\text{SHORT\_BOND}_{t-5,t}^{i}$	0.895 (38.4)	0.876 (32.3)	0.927 (44.6)
$\text{SHORT\_FIRM}_{t-5,t}^{i}$	0.010 (2.19)	-0.006 (-0.74)	0.012 (1.43)
Adj. R^2	88.47%	85.22%	93.72%

FIGURE 1

Sample Size

Plot of number of bonds lent against calendar years. Bonds in the sample include all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases.

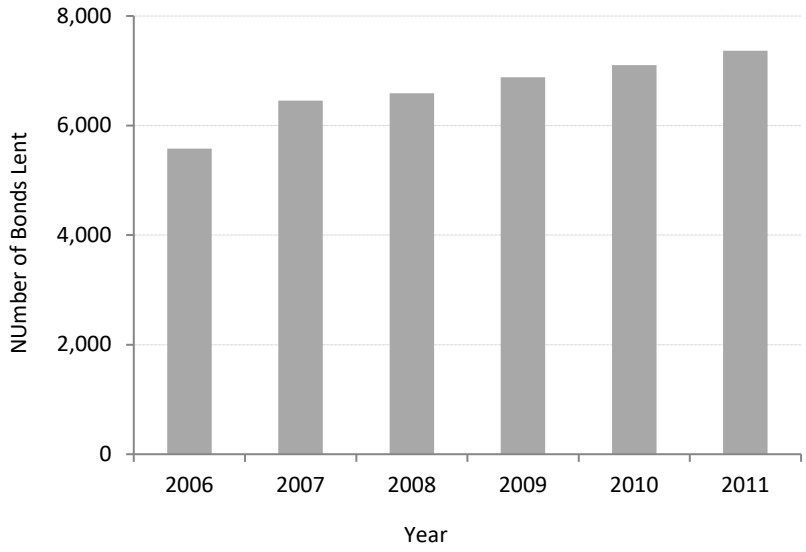


FIGURE 2

Short Interest

Plot of short interest (SHORT_BOND_t^i) defined as value-weights average of ratios of the number of bonds on loan (shorted) to the number of bonds outstanding (in percentages) against calendar date. The sample consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases from Jan. 1, 2006 to Dec. 30, 2011. Bonds with Moody's credit rating of "Baa3" and higher five days prior to the sorting are categorized as Investment-Grade Bonds; others are categorized as High-Yield Bonds.

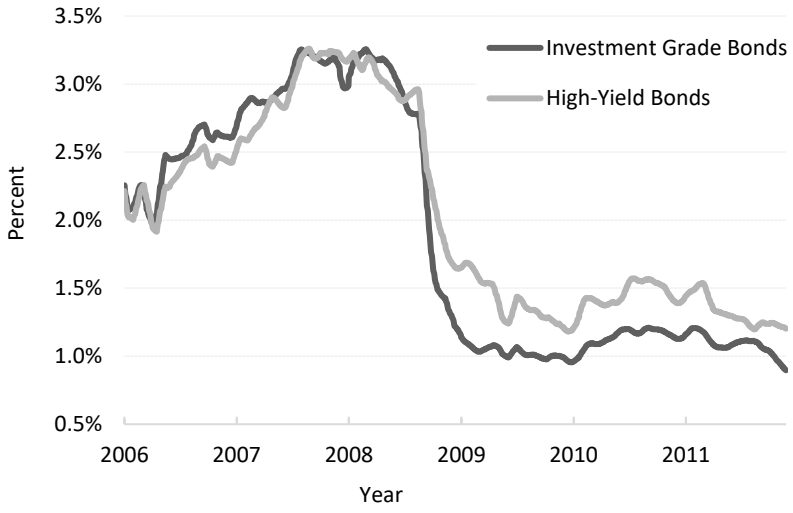


FIGURE 3

Costs: Lending Fees and Realized Spreads

Figure 3 plots lending fees (Graph A plots means and Graph B plots medians) and realized spread (Graph C) against calendar date for Investment and High-Yield bonds. Lending fee is average value-weighted (with respect to the loan quantity) lending fee is defined as the interest rate on cash funds minus the rebate rate (annualized and in basis points); realized spread is defined as daily average buy price minus sell price of the bond scaled by the mid-price of the two last buy and sell transactions (in percentages). The sample consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases from Jan. 1, 2006 to Dec. 30, 2011. Bonds with Moody's credit rating of "Baa3" and higher five days prior to the sorting are categorized as Investment-Grade Bonds; others are categorized as High-Yield Bonds.

Graph A. Lending Fees: Means

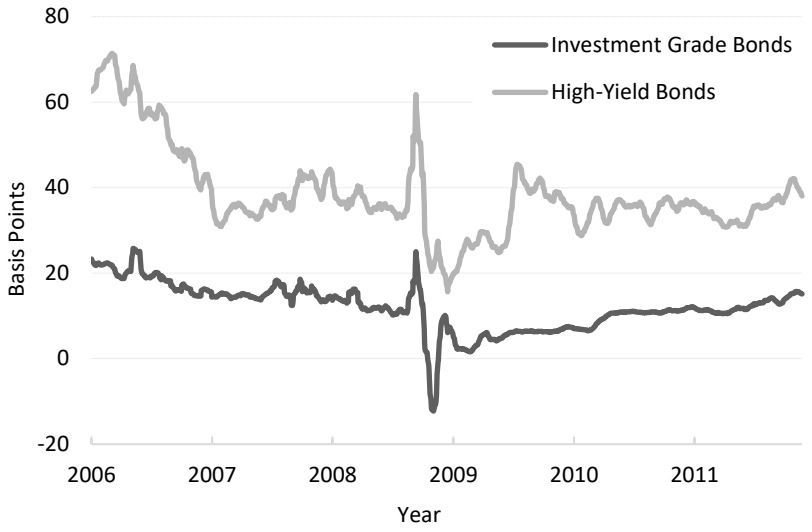
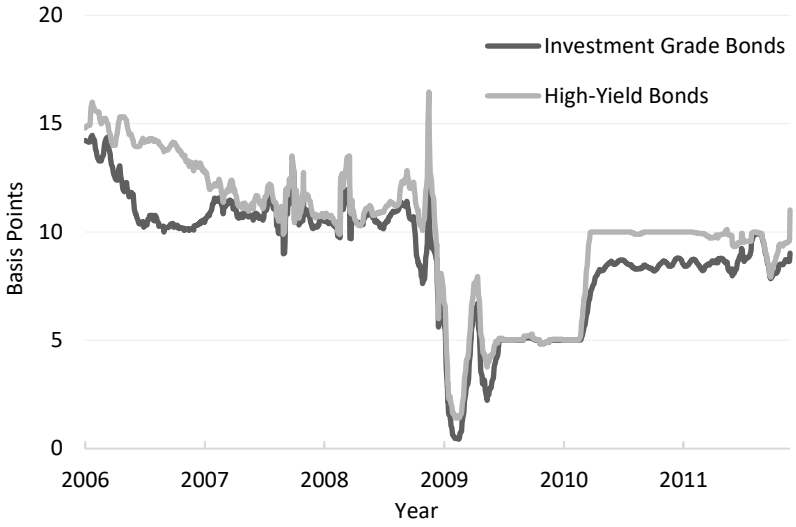


FIGURE 3 (continued)

Graph B. Lending Fees: Medians



Graph C. Realized Spreads

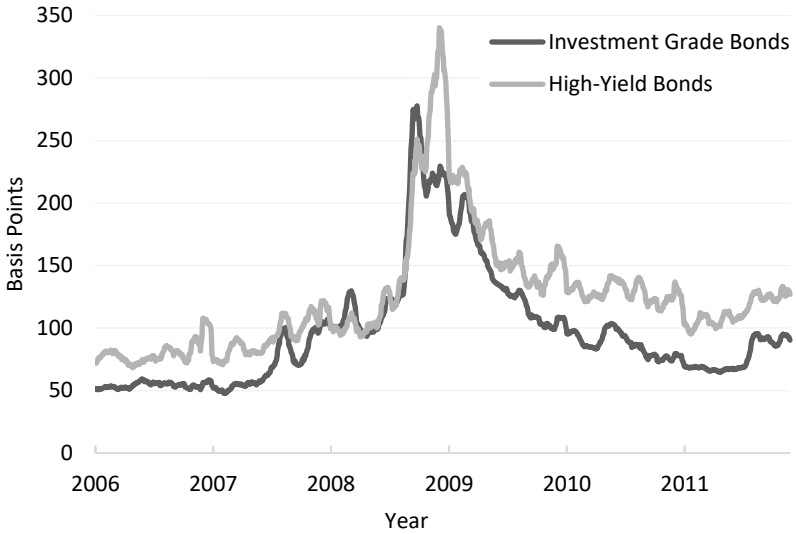


FIGURE 4

Risk-Adjusted Daily Returns on Short Selling Positions

Figure 4 plots cumulative abnormal returns for portfolio of bonds sorted based on the short interest. The sample consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases from Jan. 1, 2006 to Dec. 30, 2011. Bonds are sorted into quintiles based on the estimated short interest ratio over the previous 5 trading days. After skipping 1 day, value-weighted portfolios are held for 20 trading days. This process is repeated each trading day, so that each trading day's portfolio abnormal return (defined as a difference between raw return and the corresponding credit rating matched portfolio return) is an average of 20 different portfolios, with 1/20 of the portfolio rebalanced each day. Daily abnormal returns and cumulative abnormal returns of the least and most shorted portfolios are plotted. Graph A plots returns for portfolios of all bonds in the same, results in Graph B corresponds to Investment-Grade bonds and Graph C contains results for High-Yield bonds. Bonds with Moody's credit rating of "Baa3" and higher five days prior to the sorting are categorized as Investment-Grade Bonds; others are categorized as High-Yield Bonds.

Graph A. All Bonds

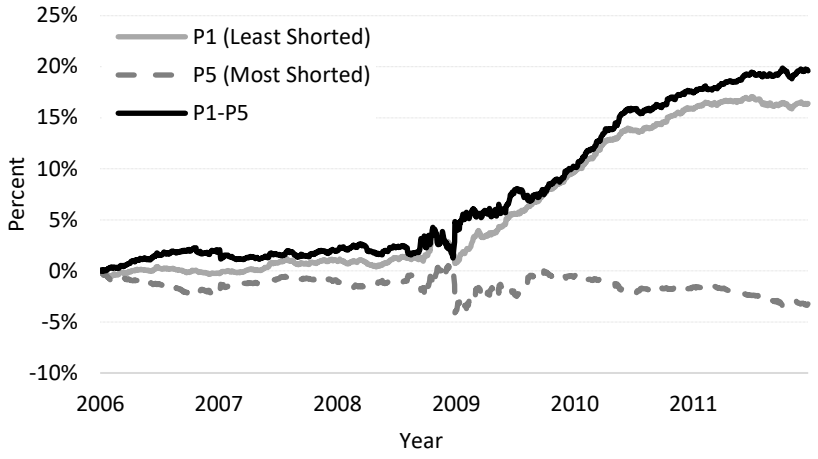
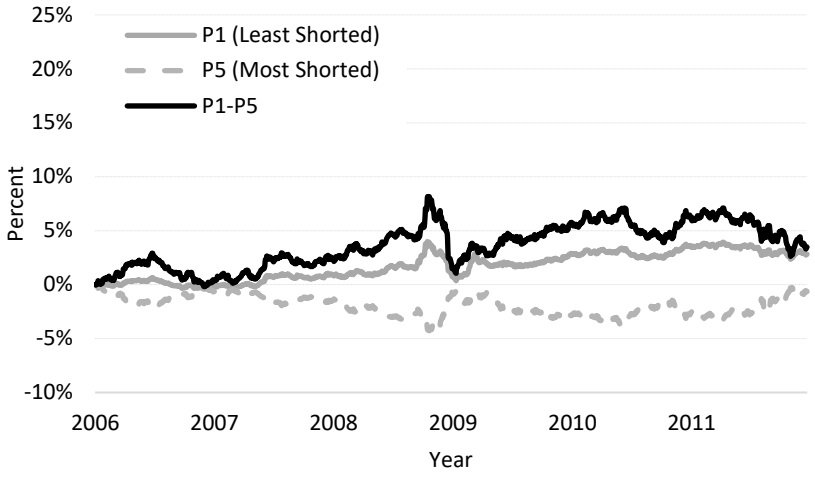


FIGURE 4 (continued)

Graph B. Investment-Grade Bonds



Graph C. High-Yield Bonds

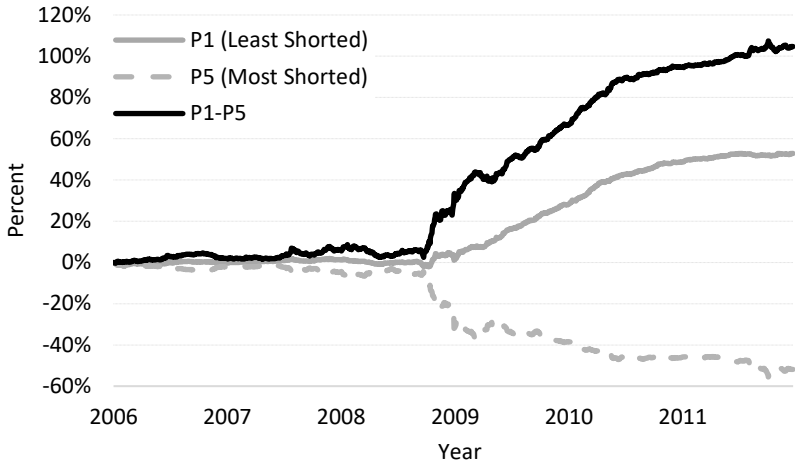


FIGURE 5

Short Interest: Bonds versus Stocks

Plot of short interest for bonds and stocks matched sample. SHORT_BOND_t^i defined as value-weights average of ratios of the number of bonds on loan (shorted) to the number of bonds outstanding (in percentages) against calendar date; SHORT_STOCK_t^i defined as value-weights average of ratios of the number of shares shorted to the number of shares outstanding (in percentages) against calendar date. The sample consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases and corresponding stock data in CRSP from Jan. 1, 2006 to Dec. 30, 2011. Graph A plots short interest for all bonds and stocks in matched sample, Graph B plots short interest for small stocks and Graph C for large stocks. Small stocks correspond to the smallest quintile of market size while large stocks are in the largest size quintile.

Graph A. Full Matched Sample of Bonds and Stocks

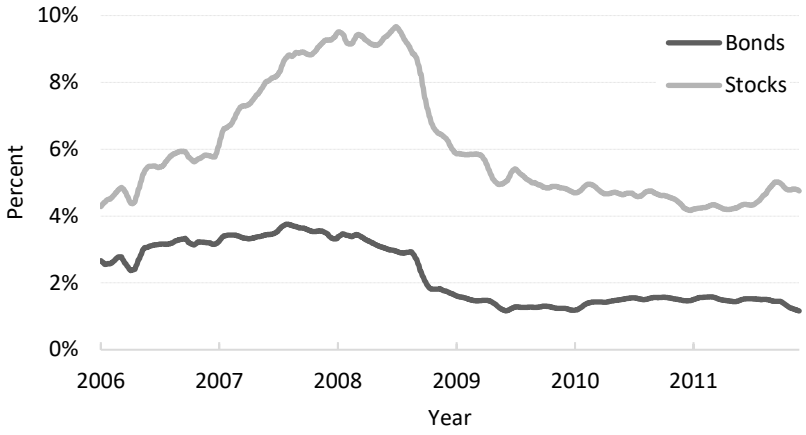
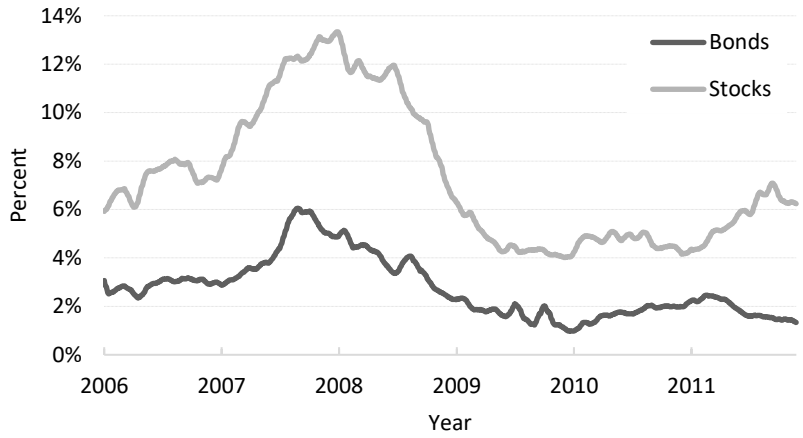


FIGURE 5 (continued)

Graph B. Matched Sample of Small Stocks



Graph C. Matched Sample of Large Stocks

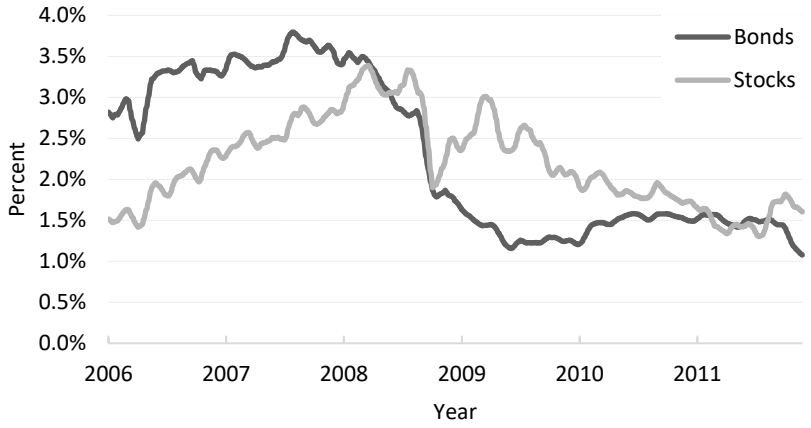


FIGURE 6

Bonds versus Stocks costs: Lending Fees and Realized Spreads

Figure 6 plots lending fees (Graph A plots means and Graph B plots medians) and realized spread (Graph C) against calendar date for bonds and stocks. Lending fee is average value-weighted (with respect to the loan quantity) lending fee is defined as the interest rate on cash funds minus the rebate rate (annualized and in basis points); realized spread is defined as daily average buy price minus sell price scaled by the mid-price of the two last buy and sell transactions (in basis points). The sample consists of all corporate bonds in the Markit securities lending database for which corresponding data is available in the FISD and TRACE databases and the corresponding stock data in CRSP from Jan. 1, 2006 to Dec. 30, 2011.

Graph A. Lending Fees: Means

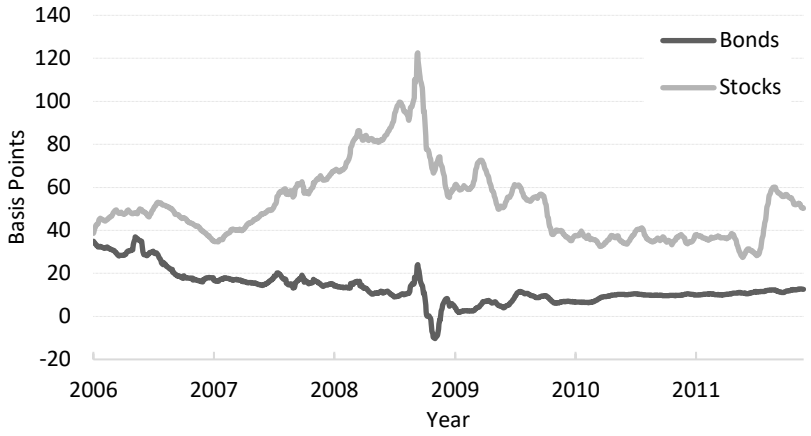
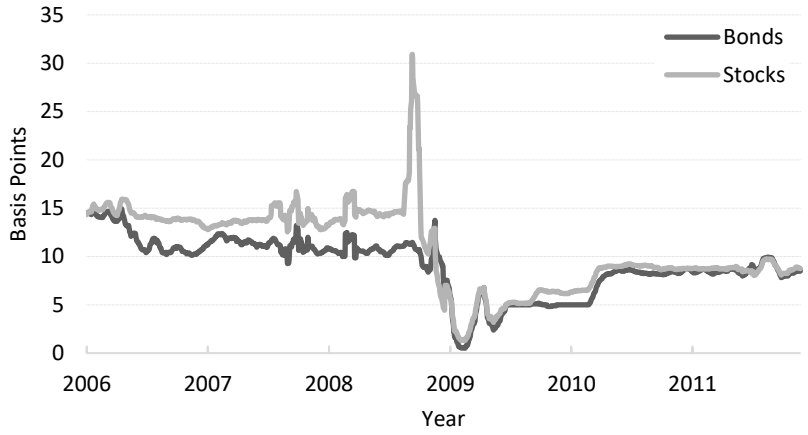


FIGURE 6 (continued)

Graph B. Lending Fees: Medians



Graph C. Realized Spreads