Essays in asset management and corporate bonds

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by

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In the first essay of this dissertation, I study the impact of fund redemptions and resulting sell-offs on corporate bond yields. To control for unobserved changes in fundamentals, I study within-issuer variation of yield changes, resulting from differential exposure to redemptions and sell-offs. In contrast to previous findings for equity funds, I find no evidence indicating that bond funds destabilize the corporate bond market by moving prices beyond fundamental values. I attribute this finding to bond fund management. Although I find that investors demonstrate a bank-run like behavior, which is a potential source of destabilization, bond fund managers hold a significant level of liquid assets, allowing them to manage redemptions without excessively liquidating corporate bonds.

Second essay of this dissertation looks at corporate bond Exchange Traded Funds (ETFs) which are a new form of financial innovation. Since these investment vehicles are relatively new, little is known about their risks. In this paper, we study an event in the summer 2013, knows as the Taper Tantrum, when bond ETFs and mutual funds experienced massive unexpected outflows due to speculations about interest rate hikes. We find that ETF outflows during the Taper Tantrum lead to a significant increase in exposed corporate bond yields. The increase in yields lasts for seven months, which indicates a temporary fire sale effect. In contrast, we find no fire sale effect resulting from mutual fund outflows. We attribute this contrasting finding between the two vehicles to differences in portfolio construction and investor sensitivities. Finally, we study arbitrage opportunities, created by ETF shares mispricing, and their impact on bond yields.

Third essay of this dissertation is about liquidity in the corporate bond market. In market distress, corporate bond investors tend to sell liquid assets and hold onto illiquid ones, a phenomenon which we call flight to illiquidity. We study the impact of flight to illiquidity on corporate bond prices/yields in cross-section as well as corporate bond returns in time-series. First, we show that liquidity price premium disappears in market distress, meaning that liquid bonds are not more expensive than illiquid bonds in distress times. Second, we show that

illiquiduity return premium which exists during normal times, not only does not change sign or disappears, but also widens in market distress. In other words, liquid bonds deliver a lower return both on average and during market distress. This pattern is limited to investment grade corporate bonds. Our findings suggest that keeping the credit risk fixed, liquid bonds do not provide safety during the time it is needed the most.

To My Parents

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ESSAY ONE

Do bond mutual funds destabilize the corporate bond market?

Saeid Hoseinzade*

Abstract

Bond mutual funds engagement in liquidity transformation and their rapid growth over the past several years have created concerns about the threats they pose to corporate bond market stability. In this paper, I study the impact of fund redemptions and resulting sell-offs on corporate bond yields. To control for unobserved changes in fundamentals, I study within-issuer variation of yield changes, resulting from differential exposure to redemptions and sell-offs. In contrast to previous findings for equity funds, I find no evidence indicating that bond funds destabilize the corporate bond market by moving prices beyond fundamental values. I attribute this finding to bond fund management. Although I find that investors demonstrate a bank-run like behavior, which is a potential source of destabilization, bond fund managers hold a significant level of liquid assets, allowing them to manage redemptions without excessively liquidating corporate bonds.

JEL classifications: G12, G20, G23

Keywords: Corporate Bond Mutual Funds, Market Destabilization, Bank Runs, Fire Sales

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1 Introduction

Do redemptions from corporate bond funds and the resulting sell-offs move corporate bond prices beyond their fundamental values? While similar questions have been answered in the equity literature, little is known about bond mutual funds with increasing importance in the corporate bond market. As bond funds assets have grown significantly, so have the concerns of regulators and investors in this important market for corporate financing. In its 2015 annual report, Financial Stability Oversight Council (FSOC) listed the expansion of open-end bond mutual funds as a potential threat to financial stability.[1] In contrast to the previous studies of equity mutual funds, analyzing corporate bond yields between January 2004 and June 2014, I find no evidence that fund redemptions or resulting sell-offs push yields beyond fundamental values. Even during the financial crisis of 2008-2009, when bond funds experienced huge redemptions and the corporate bond market was very illiquid, the impact of sell-offs on bond yields is shown to be short-lived, small in magnitude and limited to the subsample of distressed funds.

{Insert Figure 1}

To identify the impact of redemptions and the resulting sell-offs on bond yields, simultaneous changes in bond fundamentals need to be controlled for. Changes in bond fundamentals are usually unobserved and failing to properly control for them creates two types of endogeneity issues. First, redemptions from a fund are correlated to the performance of its holdings. Therefore, bonds that experience a negative shock to their fundamental values and perform poorly are more exposed to investor redemptions. Second, when facing redemptions, fund managers may choose to sell bonds with a negative (less positive) outlook. As a result, bonds that are sold off usually have weaker fundamentals than other bonds. The first issue creates omitted variable or reverse causality and the second issue creates selection bias in identifying the impact of redemptions and the resulting sell-offs on bond yields. In other words, an

[1]The "Asset Management and Financial Stability" report by the US Treasury's Office of Financial Research is another example showing regulators concern about this issue. This report, released in September 2013, intended to help regulators better understand asset management industry and its activities to be able to decide about weather - and how - such firms should be considered for enhanced prudential standards and supervision under the section 113 of the Dodd-Frank Act.

observed decline in price (increase in yield) may be erroneously attributed to redemptions and the resulting sell-offs while it is just due to changes in the fundamental value.

While different methods have been used in the literature, I use a distinct feature of corporate bonds to address these issues. In this paper, by examining issuers with multiple bond offerings, I am able to control for the unobserved changes in fundamentals and tease out the impact of redemptions and resulting sell-offs on bond yields. In particular, I analyze within-issuer variation of yield changes, caused by differential exposure to fund redemptions and resulting sell-offs. I implement this strategy by including issuer-time fixed effects in my regressions. Interestingly, when issuer-time FEs are excluded which makes the identification subject to endogeneity issues, the results completely change and show a positive and significant impact of redemptions and resulting sell-offs on bond yields. This hence, shows that not addressing endogeneity issues properly distorts the results and leads to a misleading conclusion.

My finding that bond funds do not move bond yields beyond fundamental values is somewhat puzzling because the literature has found the opposite for equity funds. Given that the corporate bond market is less liquid than the stock market, the adverse impacts of bond funds are expected to be even higher than those of the equity funds. Trying to explain my finding, I study the redemption behavior of bond fund investors as well as fund management techniques in response to those redemptions. Finally to better understand the differences between bond funds and equity funds, I compare their redemption management practices.

Corporate bond funds engage in liquidity and maturity transformation, that is, they finance their long-term illiquid assets with short-term liquid liabilities. According to Diamond and Dybvig (1983), this creates first-mover advantage and makes bond funds subject to investor runs. Using correlated flows as a measure for runs, I find that bond fund investors exhibit a bank-run like behavior. As expected, this behavior is more pronounced for funds whose holdings are less liquid and when the overall market liquidity is low. My results are consistent with Chen, Goldestein and Jiang (2010) who document runs on equity funds as a source of destabilization.

Establishing the potential for runs on bond funds not only cannot explain why bond funds do not destabilize the corporate bond market, but also makes it even more puzzling. Therefore looking for an explanation for my finding, I next investigate redemption management practices of bond fund managers. First, I show that the portfolio composition of corporate bond funds looks different than those of equity funds. In contrast to equity funds, bond funds hold a significant amount of liquid assets, such as cash and government securities. Second, I show that when facing redemptions, bond fund managers sell cash and government securities first rather than transacting in the corporate bond market. Even when transacting in the corporate bond market, bond managers sell the most liquid corporate bonds to minimize the price impact. Therefore, my results show that bond fund managers tend not to transmit redemptions to the corporate bond market.

Finally, trying to justify my results compared to previous findings for equity funds, I compare bond funds and equity funds in their redemption management practices. Given similar redemption levels, I show that equity funds sell stocks in a much larger magnitude than bond funds sell corporate bonds. These massive equity sell-offs may lead to significant price movements. Conversely, bond funds holding adequate buffer, do not have to excessively liquidate corporate bonds to meet redemption requests and hence, do not destabilize corporate bond prices.

This paper contributes to several strands of literature. First, there is a vast and still growing literature studying stock price movements induced by mutual funds and other institutions, including Lakonishok, Shleifer and Vishny (1992), Gibson, Safieddine and Titman (2000), Edelen and Warner (2001), Stein (2005), Coval and Stafford (2007), Jotikasthira, Lundblad and Ramadorai (2007), Chen, Hanson, Hong and Stein (2008), Zhang (2009), Shleifer and Vishny (2010), Ben-Rephael, Kandel and Wohl (2011), Greenwood and Thesmar (2011), Lou (2012), Merrill, Nadauld, Stulz and Sherlund (2012), Hau and Lai (2013). Additionally, Ambrose, Cai and Helwege (2008) and Ellul, Jotikasthira and Lundblad (2011) look at price pressure on corporate bonds caused by insurance companies sell-offs. This paper fills the gap by studying the impact of bond mutual funds on corporate bond prices.

The second strand of literature this paper contributes to studies investor runs on financial institutions. This literature begins with Diamond and Dybvig (1983) on bank runs and expands to other markets and institutions such as equity funds, Chen, Goldestein and Jiang (2010), repo market, Gorton and Metrick (2012), money market funds, Schmidt, Timmermann, and Wermers (2014) and asset-backed commercial paper market, Schroth, Suare and Taylor (2014).

Finally, this paper is related to the theoretical and empirical literature studying the behavior of fund managers facing flows, including Vayanos (2004), Alexander, Cici and Gibson (2007), Lou (2012), Manconi, Massa and Yasuda, (2012), Raddatz and Schmukler (2012).

2 Data

My empirical analysis focuses on 4,647 corporate bond funds between 2004-Q1 and 2014-Q2. I define a corporate bond fund as a fund that on average invests more than 20% of its net asset value in corporate bonds throughout the sample period. Usually there is more than one fund (share class) for each portfolio; therefore in total I have 1,238 distinct portfolios in my sample. All my analysis occurs at the portfolio level because my main focus is on fund holdings and trades, which are the same for different share classes within a portfolio. Different share classes within a portfolio, however, usually have different returns, management fees, expenses, etc. To calculate these variables at the portfolio level, I take the net asset value-weighted average of share classes within a portfolio.

My data comes from a variety of sources. I use the CRSP Mutual Fund database to get the data on monthly fund returns and total net assets. Monthly and quarterly fund flows are then calculated using these two data points for each fund. Fund characteristics such as expense ratios and portfolio turn-over also come from CRSP. I use Morningstar to get quarterly portfolio related data such as asset class weights, average credit rating and average maturity of each portfolio. For quarterly bond mutual fund holdings, I combine the CRSP Mutual Fund database and Morningstar.[2] I use Thomson Reuters to get quarterly equity mutual fund holdings. I use the TRACE to get bond transaction data such as price, yield and trading volume. I use Mergent FISD to get corporate bond characteristics. Finally, I use Bloomberg for fixed income related indices. Table 1 presents variable definitions and summary statistics.

{Insert Table 1}

[2] CRSP Mutual Fund database is not complete for bond funds especially before 2008.

3 Corporate bond market destabilization

According to Lakonishok, Shleifer and Vishny (1992), destabilization means prices move away from fundamental values which leads to an increase in long-run price volatility. While the impact of equity mutual funds on stock prices has been largely studied in the literature, there is almost no study on bond mutual funds and their impact on corporate bond prices (yields). In this paper I try to fill this gap by studying the impact of redemptions from bond funds and the resulting sell-offs on bond yields. Needless to say, I am interested in changes in bond yields as far as they are induced by bond funds, not by changes in the fundamental values.

Mutual funds engage in liquidity transformation, that is, providing daily liquidity to investors while investing in less liquid assets. This liquidity mismatch between assets and liabilities may lead to price pressure when mutual funds have to sell assets in large amounts to meet investor redemptions. According to Shleifer and Vishny (2010), these redemption-induced or sell-offs may turn into fire sales because the potential buyers of an asset cannot buy it due to financial constraints.[3] Therefore, these assets have to be sold to an investor with less expertise with that asset, hence willing to pay a lower price for it. In this paper I study the impact of redemption from bond mutual funds, and the resulting sell-offs on changes in corporate bond yields. Identifying these impacts is a challenging task because they usually confound with the fundamental changes of corporate bonds. Therefore, if we observe a change in bond yields, we cannot distinguish if this change is due to fund redemptions and sell-offs or due to changes in the fundamental value of the bond.

Thinking of this problem in a regression framework, exposure to funds redemptions or the exposure to resulting sell-offs is the independent variable of interest, while the change in the bond yield is the dependent variable. To identify the impact of the independent variable of interest, I have to control for other variables that are correlated with it and has an impact on the dependent variable. One variable that I need to control for is the changes in the fundamental values. Changes in the fundamental value clearly have an impact on bond yields, and meanwhile are correlated with redemptions and the resulting sell-offs because of two

[3] Asset fire sales and price pressure have been studied for other institutional investors too. For example, Ambrose et al. (2008) and Ellul et al. (2011) study the price impact of corporate bond sell-offs by insurance companies, as a result of credit rating downgrades.

reasons. First, redemptions from bond funds are not usually exogenous to the fund holdings fundamentals. Funds whose holdings have weak fundamentals experience larger redemptions. Second, trying to meet redemptions, fund managers may choose to sell bonds with declining fundamental values. Therefore, to properly identify the impact of redemptions and resulting sell-offs on bond yields, I have to control for changes in the fundamental values.

Different methods have been used in the literature to address these issues. For example, Coval and Stafford (2007) and Ellul et al. (2011) use resulting price reversals as evidence that price changes are not due to changes in fundamental values. Hau and Lai (2013) use the exposure of equity mutual funds to the financial stocks prior to the recent financial crisis as an exogenous shock to the mutual fund flows during the crisis. Ambrose et al. (2008) use a simultaneous changes in the stock price as an indication of a change in the firm fundamentals studying the price pressure on corporate bonds.[4] The problem with these methods is that the impact of fundamentals is not completely controlled for. For example, Coval and Stafford (2007) show that the stocks that are sold as a result of fund flows are fundamentally different from an average stock held by mutual funds.

An ideal setting to identify the effect of redemption from funds on market destabilization is to have multiple assets with the same fundamentals but different exposures to redemptions and sell-offs. The corporate bond market provides this setting. Many firms have more than one outstanding corporate bond. Different bonds of the same firm are exposed to the same fundamental risks but might be held by different funds, hence exposed differentially to redemptions and sell-offs. I exploit this feature by using firm-time fixed effects in my identification. As a result, any differential changes in the yields of bonds, issued by the same firm, can be attributed to the differential exposures to redemptions and sell-offs.[5]

My empirical setting is as follows. In each quarter, I pick the funds in the bottom quartile of flows. These funds experience the largest redemption and hence, may be forced to sell some of their corporate bond holdings. I call these funds "distressed bond funds" throughout the paper. I am interested in studying the impact of two different measures on changes in bond yields. The first measure, exposure to redemptions, is based on the ex-ante potential sales of corporate

[4] I cannot implement this method in this paper because the exact trading day by mutual funds is not known. I can only observe fund holdings in the beginning and at the end of the quarter.

[5] Khwaja and Mian (2008) use a similar concept to study the impact of bank liquidity shocks on borrower firms.

bonds. In this measure, which is defined for each bond issue in each quarter, I aggregate the holdings of all distressed funds in the beginning of each quarter. Then I normalize it by the outstanding amount of each bond issue. The logic behind this measure is that if a large fraction of a corporate bond issue is held by funds that experience large outflows over the next quarter, that bond potentially experiences a higher pressure on its yield.

$$RedemptionExpo_{it} = \sum_{f=1}^{F} Holding_{if(t-1)}, \qquad f \in \{funds\ in\ the\ lowest\ flow\ quartile\ at\ t\} \tag{1}$$

In defining the second measure, exposure to sell-offs, I follow Coval and Stafford (2007). This measure is based on actual sales by bond funds. In this measure which is defined for each bond issue in each quarter, I aggregate corporate bond sales by all distressed funds over the current quarter. Then I normalize it by the outstanding amount of each bond issue. I call this measure exposure to sell-offs because these sales are executed by distressed funds, it is very likely that fund managers are forced to sell these bonds to meet the redemptions. Therefore if a large fraction of a corporate bond issue is subject to sell-offs, that bond potentially experiences a higher pressure on its yield.

$$Sell\text{-}offExpo_{it} = \sum_{f=1}^{F} Sell_{ift}, \qquad f \in \{funds\ in\ the\ lowest\ flow\ quartile\ at\ t\} \tag{2}$$

There is a main difference between the first and the second measure. A corporate bond may be held by distressed funds, but not necessarily being sold, because the fund manager prefers to sell more liquid assets to meet the redemptions. Therefore, I expect that the second measure, exposure to sell-offs, will have a larger impact on yields, if there are any.

As Shleifer and Vishny (2010) state, fire sale happens when the potential buyers of an asset cannot buy it because they are constrained. So the asset has to be sold to an investor with less expertise with that asset, hence willing to pay a lower price for it. The recent financial crisis (2008-2009) is a good example of when sell-offs could turn into fire sales, because the potential buyers of corporate bonds such as banks, hedge funds and bond mutual funds were financially constrained and could not provide enough liquidity to the corporate bond market. Therefore, I also investigate whether the impact of redemptions and the resulting sell-offs on bond yields are higher during the crisis.

I run the following regressions to see if redemptions from bond funds and the resulting sell-offs have a significant impact on bond yields. Moreover I let these impacts be different during the crisis. I exclude all corporate bonds that are in a foreign currency or convertible because their yields may change due to other reasons such as changes in stock prices and exchange rates.[6]

$$\Delta Yield\,spread_{ijt} = \alpha + \beta_1 RedemptionExpo_{ijt} + \beta_2 RedemptionExpo_{ijt} * crisis + \gamma' controls + \mu_{jt} + \epsilon_{ijt} \tag{3}$$

$$\Delta Yield\,spread_{ijt} = \alpha + \beta_1 Sell\text{-}offExpo_{ijt} + \beta_2 Sell\text{-}offExpo_{ijt} * crisis + \gamma' controls + \mu_{jt} + \epsilon_{ijt} \tag{4}$$

On the left hand side, the dependent variable is the change in the yield spread of bond i for firm j over the quarter t. Yield spread is calculated as the difference between bond yield, reported by TRACE, and the Treasury rate with the matching time to maturity. I use yield spread instead of yield to account for nonparallel shifts in the yield curve, when comparing bonds with different maturities. On the right hand side, I have the exposure of each bond to sell-offs or redemptions by distressed funds and its interaction with the crisis dummy. The crisis dummy is one for 2008-Q1 until 2009-Q2 and zero otherwise. I also control for some bond characteristics such as size, time to maturity and age. In my second specification, I also control for bond Amihud illiquidity and its interaction with the crisis dummy.[7]

Finally I add firm-quarter fixed effect, μ_{jt}, to absorb any changes in the fundamentals of a firm over the quarter. These FEs help me to capture the yield spread changes which are solely due to differential exposure to sell-offs by distressed funds. I also run the regressions excluding the firm-quarter FEs to see if my results change. Excluding firm-quarter FEs make my identification subject to endogeneity. It means that the impact of changes in the fundamental value of a bond might be confounded with the impacts of redemptions and sell-offs. Therefore, I expect to see a larger impact of the coefficients of interest, when firm-quarter fixed effects are excluded from the regressions. The left panel of Table 2 presents the results using the preferred identification, including the firm-quarter FEs. The right panel of Table 2 presents the results of the same regressions as in the left panel but excluding firm-quarter FEs.

[6]If I exclude all bonds that are callable, puttable and sinking fund, I lose a lot of observations. However, even excluding them results are qualitatively similar.

[7]Different bond issues of the same firm may also be different in the security level. Since more than 60% of the corporate bond in my sample are senior debt, I run regressions (3) and (4) only for senior bonds as a robustness check and the results still hold.

{Insert Table 2}

In the left panel, as we can see in columns (1) to (4), using both measures and in both specifications the impact of redemptions and sell-offs on bond yield spreads are not significant during normal times. However, increasing exposure to sell-offs by one standard deviation during the crisis increases the yield spread of the bond by 18.5 bps (column 1). This figure is 9.2 bps in the second specification (column 2) when I control for the bond illiquidity. The lower impact when I control for liquidity is expected, because the yield change is partially just due to illiquidity.[8]

In the right panel, as we can see in columns (5) to (8), the impact of redemptions and sell-offs are significant, even during the normal times.[9] Since excluding firm-quarter fixed effects make the identification subject to endogeneity, I argue that the results are misleadingly overstated. In other words, what the coefficients of interests are capturing is the impact of changes in the fundamental value of bonds, as opposed to the impact of redemptions and sell-offs. Comparing the right panel and the left panel, one can conclude that a proper identification is crucial to get valid results.

Using the preferred identification (the left panel), the impact of sell-offs on bond yields is statistically significant during the crisis, while economically very small. During the crisis, the average corporate bond yield spread is 670 bps. Therefore, 9.2 pbs is less than 1.5% increase in yield spread as a result of one standard deviation increase in exposure to sell-offs. In addition, I want to investigate this impact even further. Hence, I try to answer three questions: 1) Is this impact only limited to the crisis time? 2) Is this impact limited to distressed funds? 3) Does this impact last for more than a quarter? In order to answer these questions, I run four tests, each of them in specification corresponding to the Table 2 columns (1) and (2).

In the first test, I run the same regression, equation (4), for funds in the second lowest flow quartile. Since redemptions from those funds are not as high as distressed funds, I expect fund

[8] I also run the regression (4) for bonds issued by financial firms and bonds issued by non-financial firms, separately. The results (not reported) show that the sell-offs' impact during the crisis is not only limited to financial firms. Bonds issued by financial firms are identified by their industry group equal to 2 in the Mergent FISD database.

[9] Note that during the studying period between January 2004 and June 2014, excluding the crisis Q1-2008 to Q2-2009, the average yield spread is 210 bps. Therefore 12.51 bps (Table 2, column 8 second row) is almost 6% increase in yield spread as a result of one standard deviation increase in exposure to redemptions. This 6% increase is both economically and statistically significant.

managers to be able to manage redemptions by selling more liquid assets such as cash and government bonds. Therefore, they do not have to engage in a lot of corporate bonds sales, hence we should not find a significant yield change of the bonds they sell. Table 3 columns (1) and (2) confirm that sales by non-distressed funds have no significant impact on bond yields, even during the crisis.

In the second and third tests, I move the crisis 6 quarters backward and 6 quarters forward, respectively. Table 3 columns (3) to (6) show the results which confirm that the impact of sell-offs on bond yields is only limited to the crisis. These findings are consistent with the definition of fire sale by Shleifer and Vishny (2010). Right before the crisis and right after the crisis we do not see significant yield changes as a result of sell-offs because potential buyers of corporate bonds were not constrained and could provide enough liquidity to the market.

Finally in the last test, I measure the change in the yield spread from the beginning of the quarter where the sell-offs happen and the end of the next quarter. The purpose of this test is to see if the impact of sell-offs during the crisis lasts beyond one quarter. As the results in Table 3 columns (7) and (8) show, the yield pressure is short-lived and does not last beyond one quarter. In summary, Table 3 shows that the impact of sell-offs on bond yields is short-lived, limited to distressed funds and limited to the financial crisis.

{Insert Table 3}

The previous literature has shown that equity funds have destabilizing impacts on the stock market. Given the illiquidity of the corporate bond market, the adverse impact of bond funds on corporate bonds are expected to be high. However, my findings so far show that bond funds do not have a significant destabilizing impact on the corporate bond market. In the rest of the paper I will try to investigate why my results are contrary to expectations. In order to do that, first I study the behavior of bond fund investors in redeeming shares to see whether they show a destabilizing behavior. Then I examine the behavior of fund managers in response to investor redemptions. Finally, I lay out a comparison between bond funds and equity funds in the way they manage flows to explain the contrasting findings for equity and bond funds.

4 Do investors run to exit from bond funds?

4.1 Institutional background

Runs on financial institutions as a source of destabilization and fragility are mostly studied in the context of banking. In principal however, runs can happen to any financial institution or even a firm where there is a liquidity mismatch between assets and liabilities (liabilities are more liquid than assets), according to Diamond and Dybvig (1983). For example, Chen, Goldestein and Jiang (2010) document a run-like behavior by equity mutual fund investors. They also show that this behavior is stronger for illiquid funds. Similarly during the recent financial crisis, this run-like behavior happened to financial institutions such as exchange-traded funds, asset-backed SIVs and money market funds (Schmidt et al. (2013)). In this section, I investigate whether open-end bond mutual funds are subject to investor runs.

In general, when an investor anticipates an adverse effect on her own future return if other investors withdraw their money from an institution, her optimal response is to pull her money right away regardless of the fundamentals. This is also known as the "first-mover advantage" in the literature. This happens because open-end mutual fund structure gives the investors the right to redeem their shares for cash based on the end of the day net asset value (NAV).[10] Unlike money market funds where price is bound to a threshold, mutual funds' NAV reflects the value of the underlying portfolio at each point in time. Moreover, there is no implicit or explicit guarantee by the investment management company that NAV stays above for instance a threshold. Therefore, theoretically a mutual fund investor should not care about the activities of other investors and as a result, there should not be a first-mover advantage.

However, first-mover advantage and consequently run on mutual funds, exist in reality. The reason behind the first-mover advantage is that there are some costs borne by the remaining investors when an investor redeems her shares and leaves the fund. When an investor redeems her shares, she is being paid based on the NAV calculated at the end of that trading day, while portfolio re-balancing usually happens the next day. So all the costs associated with portfolio

[10] Many mutual funds state they may pay-in-kind to investors in securities rather than cash when they are under stress but due to practical challenges this tool was rarely used, (Asset management and financial stability, office of Financial Research, Sep 2013)

rebalancing will be reflected in the future NAV and are borne only by remaining investors. These costs include commissions, bid-ask spreads, fire sale or even indirect costs such as deviating from the optimal portfolio (Edelen (1999), Brunnermeier and Pedersen (2005), Alexander et al. (2007), Coval and Stafford (2007), Bu and Lacey (2013)). Chen et al. (2010) claim these costs are not negligible and can result in payoff complementarities among investors.

Fund managers are aware of these costs and try to mitigate the adverse effect of redemptions to remaining investors. In order to do that they take various measures such as holding cash, charging redemption fees, limiting the number of times an investor can enter and exit a fund and suspending redemptions or delivering redemption in kind in the case of emergency. Chen et al. (2010) argue that even though these measures are undertaken by many funds, they cannot completely prevent investors from running on a mutual fund especially when the underlying portfolio is illiquid.

4.2 Hypotheses Development

In this section I investigate whether investors run to exit from bond mutual funds. I identify investors run by measuring flow correlation (the sensitivity of the current flow to past flow). If the current flow is positively correlated with the past flow, I argue that current flow follows the past flow. In other words, investors' decision to move their money in or out of a fund is influenced by what other investors did in the previous period.[11] Schmidt et al. (2013) use a similar measure to identify runs on money market funds.

As discussed before, the costs associated with portfolio rebalancing create first-mover advantage. When these costs are higher, the first-mover advantage is larger, so is the incentive for run among investors. The portfolio rebalancing costs such as commissions, bid-ask spreads and price impact are higher when the liquidity of the funds holdings are low. Therefore, there should be a stronger incentive among investors to run on illiquid funds and at the time of low overall market illiquidity. Using these variations in liquidity, I develop the following hypotheses:

H(I). Flow correlation increases when the liquidity of the bond market drops. Moreover, this increase is asymmetrically larger for negative flows.

[11] Correlated flows may not be solely attributed to investor runs. In Appendix 1, I discuss two alternate explanations for correlated flows and I show that neither of them can justify my hypotheses and my empirical results.

H(II). Flow correlation is higher (lower) for less (more) liquid funds.

H(III). During the time of low overall market liquidity, flow correlation increases as the fund liquidity decreases. Moreover, this increase is asymmetrically larger for negative flows.

4.3 Empirical Evidence

H(I) states that the flow correlation increases during the time periods when the liquidity of the bond market drops. As Figure 2 depicts, during the financial crisis, 2008-Q1 to 2009-Q2, the liquidity of corporate bond market dropped significantly. Figure 3, Panel B shows that corporate bonds are a large part of bond funds portfolios, but they still invest in other asset classes as well. Another asset class that became less liquid during the crisis was securitized bonds. According to Manconi et al. (2012) securitized bonds became toxic in August 2007 as the negative news about subprime mortgages became public.[12] Consequently, their trades collapsed because investors were not sure about the quality of their collateral. This opacity made these assets information-sensitive and hence illiquid whereas they were previously very liquid.

{Insert Figure 2}

Therefore as discussed, at the very least the liquidity of corporate and non-agency backed securitized bonds, which make more than 65% of bond mutual funds' holdings, dropped significantly during the crisis. Therefore, I claim that during the crisis the overall liquidity of bond funds' holdings dropped.

{Insert Figure 3}

I run the following regressions to test H(I). According to H(I), β_2 must be positive and significant. I also run the regressions on the subsample of negative flows. H(I) states that β_2/β_1 should be greater for the subsample of negative flows.

$$flow_{j,t} = \beta_1 flow_{j,(t-1)} + \beta_2 flow_{j,(t-1)} * Amihud + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt} \tag{5}$$

$$flow_{j,t} = \beta_1 flow_{j,(t-1)} + \beta_2 flow_{j,(t-1)} * crisis + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt} \tag{6}$$

[12]They exclude agency backed securitized bonds as being toxic assets.

In the first regression, I use Amihud as a proxy for market illiquidity. Amihud is calculated as the equally weighted average of the individual Amihud illiquidity measures of all corporate bonds. In the second regression, I use crisis dummy (Q1-2008 to Q2-2009) as the time period where the liquidity of the bond market dropped significantly. This helps me to focus on the run-like behavior of investors during the financial crisis.

In both regressions, I also control for flows of lag 2 and lag 3, past performance, interaction between past performance and Amihud/crisis, log of total net assets and fund expense ratio. Note that I include fund fixed effects and time fixed effects to absorb any time invariant fund specific factors and any fund invariant time specific factors, respectively. For the ease of interpretation, I normalize the Amihud variable by subtracting the mean from each value and dividing by the standard deviation. Therefore, the corresponding coefficients are the change in the dependent variable for one standard deviation change in Amihud illiquidity measure.

Table 4, Panels A and B, columns (1) and (3) present the results. The results confirm H(I) and indicate that investors' decision to redeem their shares in the current period is more affected by the other investors' decision, when the market is less liquid and also during the crisis. Moreover, as we can see in Table 4, Panel A, for one standard deviation increase in market illiquidity, flow correlation increases by 30% for the subsample of negative flows whereas this figure is only 25% for the full sample. These two figures for Panel B, are 103% and 47% respectively. This asymmetrical behavior for negative flows confirms the second part of H(I).[13]

{Insert Table 4}

In H(II), I test the effect of fund liquidity, in the cross section, on flow correlation. H(II) states that when the liquidity of fund holdings is low, investors are more concerned about the adverse effects of departing investors; hence investors show a stronger run-like behavior. H(III) combines the implications of H(I) and H(II) in the time series and the in cross-section. It states that during the overall market illiquidity, the flow correlation should be even higher for funds whose holdings are less liquid.

[13]The general level of flow correlation for the full sample is higher that the subsample of negative flows. While explaining this phenomenon is not in the scope of this paper, one potential reason is that a significant portion of these funds are in retirement plans. As a results, there is a persistent monthly inflow, which to a large extent is not influenced by the performance or the action of other investors.

In the cross-section, funds vary in terms of the liquidity of their holdings. Due to data limitations, I cannot precisely measure the liquidity of each fund's holdings.[14] Therefore, I use the volatility of the past fund flows as a proxy for the overall liquidity of a fund, as in Manconi et al. (2012).[15] If a fund's flow volatility is high, it must hold more liquid assets, otherwise the transaction costs and bid-ask spreads that the fund has to pay each time it re-balances its portfolio would be huge. So higher flow volatility translates into higher fund liquidity. I calculate flow volatility for each fund as the standard deviation of flows over the past 12 months.

To test H(II) and H(III), I run the following regressions where the coefficients of interest in these regressions are β_3 and β_4. I run these regressions on both the full sample and the subsample of negative flows.

$$\begin{aligned} flow_{j,t} =& \beta_1 flow_{j,(t-1)} + \beta_2 flow\ vol._{j,(t-1)} * Amihud + \beta_3 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} \\ &+ \beta_4 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} * Amihud + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt} \end{aligned} \tag{7}$$

$$\begin{aligned} flow_{j,t} =& \beta_1 flow_{j,(t-1)} + \beta_2 flow\ vol._{j,(t-1)} * crisis + \beta_3 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} \\ &+ \beta_4 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} * crisis + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt} \end{aligned} \tag{8}$$

In these regressions, I also control for flows of lag 2 and lag 3, past performance, interaction between past performance and Amihud/crisis, log of total net assets and fund expense ratio. Note that I include fund fixed effects and time fixed effects to absorb any time invariant fund specific factors and any fund invariant time specific factors, respectively. To make interpreting the results easier, I normalize the flow volatility by subtracting the mean from each value and dividing by the standard deviation. Therefore the corresponding coefficients are the change in the dependent variable for one standard deviation change in flow volatility.

Table 4, Panels A and B, columns (2) and (4) present the results of regressions (7) and (8) respectively. As H(II) predicts, for more liquid funds, flow correlation is lower, β_3 is negative

[14] To precisely calculate liquidity measures such as Amihud, I need trading data. The detailed trading data is only available for corporate bonds.

[15] They also use portfolio turnover as another proxy for fund liquidity. The only problem using portfolio turnover is that CRSP reports this data annually. My regressions are quarterly so it does not give me enough variation especially during the crisis which is only two years (six quarters). Nevertheless, I run regressions (7) and (8) using turnover instead of flow volatility as a robustness check.

and significant. This confirms that for more liquid funds, investors are less concerned about the adverse effects of departing investors, hence they have less incentive to run.

The results in Table 4, Panels A and B support the predictions of H(III) as well. As we can see in in columns (2) and (4), the increase in flow correlation for illiquid funds is exacerbated when the market illiquidity increases and also during the crisis. In both cases β_4 is negative and significant. This means that when the market is illiquid, the incentive to run is incrementally higher for illiquid funds. We can also observe an asymmetry in this incremental impact. For instance, looking at column (4) Panel B, we can see that during the crisis, one standard deviation decrease in flow volatility, increases the flow correlation by 24.2% for the subsample of negative flows; this figure is 17.2% for the full sample.[16]

5 How do fund managers manage redemptions?

5.1 Asset allocation

Unlike equity funds that mainly invest either in cash or in equities, bond funds invest in asset classes with different risk-return and liquidity characteristics. Therefore, bond funds may have a flexibility to reallocate assets more effectively to manage redemptions. For instance Manconi et al. (2012) show that in the beginning of the crisis securitized bonds became toxic and hence less liquid. As a result, bond funds facing redemptions tended to sell more corporate bonds which were more liquid than securitized bonds.[17]

{Insert Figure 2}

In this section I study how bond fund managers reallocate assets between asset classes to manage flows, in particular, redemptions. I focus on the four major asset classes: cash and

[16]These figures are calculated as $(\beta_4 + \beta_3)/(\beta_1 + \beta_2)$. Note that β_4 for the full sample is not statistically different from zero.

[17]There are three differences between this paper and Manconi et al. (2012). First, they just look at two asset classes, corporate bonds and non-agency backed securitized bonds. Second, they look at just the time period right before the crisis. Third they use net sales as their left hand side variable while I use portfolio weights. In this paper since I look at more than just two asset classes, studying portfolio weights gives me a better understanding how the portfolio composition changes in response to flows. Moreover, weight changes incorporate changes in asset prices as well.

cash equivalents, government securities, corporate bonds and securitized bonds.[18] On one hand, cash and government securities provide a low return but almost no default risk. They can also be used as a cushion against redemptions because they are highly liquid. On the other hand, corporate and securitized bonds deliver a higher return and also higher risk.[19] These assets are less liquid and might be subject to high bid-ask spreads and high transaction costs.[20]

Fund managers may follow three strategies in the asset (re)allocation level to meet redemptions. The first strategy is to liquidate the most liquid asset classes first. This strategy has the least adverse effect on the fund's performance since these assets usually generate lower return. In addition, due to their high liquidity they can be sold on a short notice with the least price impact. However, this strategy leads to a lower fund liquidity since the fund is left mostly with illiquid assets. As discussed in Section 4, this might lead to more redemptions which is not desirable for fund managers. The second strategy is to keep the more liquid asset and sell less liquid assets. This hurts the fund performance due to the high price impact of selling illiquid assets. However, if the fund manager believes that redemptions will continue, this strategy might be optimal, (Vayanos (2004)). And finally the third strategy is just being passive and selling all assets proportionally.

These three strategies have different implications on the stability of the corporate bond market. For instance, by following the first strategy, fund managers mitigate the impact of redemption shocks on the corporate bond market. In the second strategy, by contrast, redemption shocks are amplified and transmitted to the corporate bond market. The third strategy is neutral and transmit redemptions to the corporate bond market without affecting their magnitude.

In the empirical setting, my goal is to explain how asset class weights change in response to fund flows, controlling for other important factors. I begin with the identity equation which relates the weight of asset class j in fund i in two consecutive time periods. Note that j takes four values: cash and cash equivalents, government securities, securitized bonds and corporate

[18] They also invest in municipal bonds and derivatives but the magnitudes are negligible. Appendix 2 has the detailed constituents of each asset class.

[19] Agency mortgage-backed securities that are a part of securitized bonds are perceived safe because they used to have implicit government guarantee before the crisis. This guarantee became explicit during the crisis.

[20] Begalle et al. (2013) estimate of liquidity of different asset classes under normal market conditions and provide a consistent liquidity ranking.

bonds.

$$W_{ijt} = W_{ij(t-1)} \frac{return_{ijt} + flow_{ijt}}{return_{it} + flow_{it}} \tag{9}$$

In equation (9), W_{ijt} is the weight of asset class j in fund i at time t, $return_{ijt}$ is the gross return of asset class j in fund i at time t, $flow_{ijt}$ is the flow to the asset class j in fund i at time t, defined as the dollar amount of flow to the asset class j divided by the net assets invested in that asset class at the end of the previous period.[21] $return_{it}$ is the total gross return of fund i at time t and $flow_{it}$ is the total flow to fund i at time t, defined as the dollar amount of flow divided by the total net assets at the end of the previous period. As we can see, the current weight of each asset class depends on its weight on the previous period, the return of that asset class, the flow to that asset class, total fund return and total fund flow, all of them at time t. Note in equation (9), the flow to each asset class is determined by the fund manager and all other factors are exogenous.

In equation (9), the variable W_{ijt} which I want to explain, does not have a linear relationship with $flow_{it}$. Therefore, I use log-linearization around the steady state to make it linear. I define the steady state as when flows both to the fund and to each asset class are equal to zero and gross returns are equal to one, i.e., no weight change. After log-linearizing equation (9), I will have the following equation in which ω is the natural logarithm of weights and ε is the second order approximation error.

$$\omega_{ijt} = \omega_{ij(t-1)} + (return_{ijt} - return_{it}) + (flow_{ijt} - flow_{it}) + \varepsilon_{ijt} \tag{10}$$

The change in the log weight of each asset class in the first order approximation, is the sum of the relative return and the relative flow. For instance, if a fund manager is passive in reallocating capital over different asset classes, $(flow_{ijt} - flow_{it}) = 0$, then the log weight of that asset class changes by its return relative to the total fund return. As I mentioned earlier, fund managers have discretion only over the flow to each asset class (reallocating capital over asset classes) and all other factors in equation (10) are determined either by the market or

[21] To calculate $return_{ijt}$, I use the return on the corresponding index provided by Bloomberg. For instance for corporate bonds, the corresponding index is the index with the closest maturity and credit rating to the holdings of any given fund. As an example, if the average maturity and the average credit rating of the holdings of a fund are four years and AA respectively, the return of the corporate bond asset class of that fund is equal to the return on the index representing investment grade corporate bonds with three to five years to maturity, provided by Bloomberg.

the investors.[22] I hypothesize the flow to each asset class can be determined by the following factors: lagged log-weight of the asset class, relative performance of the asset class in the current period, total flow to the fund, the sign of the fund flow and the interaction between the fund flow and its sign.

$$\begin{aligned} flow_{ijt} =&\alpha + \gamma_1 \omega_{ij(t-1)} + \gamma_2 (return_{ijt} - return_{it}) + \gamma_3 flow_{it} + \gamma_4 flow\ sign_{it} \\ &+ \gamma_5 flow_{it} * flow\ sign_{it} + \nu_{ijt} \end{aligned} \tag{11}$$

I include the lagged weight because each fund may have an optimal long term target weight for each asset class. Therefore, the lagged weight might be an important determinant of how much capital the fund manager decides to allocate to the asset class to bring it back to its optimal level. Performance of each asset class relative to the total performance of the fund is included as well because if an asset class is doing well (poorly) relative to other asset classes, the fund manager may decide to allocate more (less) capital to the asset class. Fund flow sign is a dummy which is equal to one when flow is negative and zero otherwise. I include flow sign because the reaction of fund managers might not be symmetric facing inflows and outflows. Later in the empirical results I show that this is actually the case. Moreover, I include the interaction between flow and its sign to capture the difference in the slop of the flow depending on its sign.

In equation (10), I substitute $flow_{ijt}$ with its equivalent in equation (11) and I come up with the following equation which is linear in asset class weights.[23] Note that equation (11) can be also estimated separately but it does not serve my purpose. The reason is that I want to study how asset class weights change relative to each other, while $flow_{ijt}$ is a measure of absolute change. For example, when there is an outflow from a fund, $flow_{ijt}$ for all asset classes j may be negative. It means that the fund manager decides to sell assets from all asset classes. However, these sell-offs may not be proportional which indicates the manager's preferences to reallocate capital over asset classes. These non-proportional flows eventually show up in the

[22]The only restriction fund managers might face is that they have to follow the general rules mentioned in the prospectus of the fund.

[23]I run Im-Pesaran-Shin unit-root test for Panel data for each asset class since there is concern that weights might be non-stationary. The results of the unit-root test reject the null hypothesis that all Panels are unit-root and this is true for all asset classes.

asset class weights which are studied in equation (12).

$$\omega_{ijt} = \alpha + \beta_1 \omega_{ij(t-1)} + \beta_2(return_{ijt} - return_{it}) + \beta_3 flow_{it} + \gamma_4 flow\ sign_{it} + \gamma_5 flow_{it} * flow\ sign_{it} + \eta_i + \tau_t + \epsilon_{ijt} \tag{12}$$

In equation (12), $\beta_1 = 1 + \gamma_1$, $\beta_2 = 1 + \gamma_2$, $\beta_3 = \gamma_3 - 1$ and $\epsilon_{ijt} = \varepsilon_{ijt} + \nu_{ijt}$. I add quarter fixed effects to absorb any unobservable time specific factor that affects asset class weights. I also include fund fixed effects to absorb any time invariant fund specific factor that may have an effect on asset class weights. Now I can run this regression for each asset class to see how their weights change in response to flows. As shown in Figure 2, the main asset classes that corporate bond mutual funds invest in are cash and cash equivalents, government securities, securitized bonds and corporate bonds.

In each regression corresponding to an asset class, I have a panel with fund fixed effects and the lagged dependent variable, $(\omega_{ij(t-1)})$, as an explanatory variable. Nickell (1981) shows that in this setting lagged dependent variable and the errors are correlated. Therefore OLS produces inconsistent coefficient for the lagged dependent variable. The inconsistency is in the order of 1/T so for small Ts the inconsistency is large. If other independent variables are correlated with the lagged dependent variable, their coefficients might be biased too. Thus I use the method developed by Arellano and Bond (1991) for estimating dynamic panel data. As Roodman (2006) states, this method is complicated and many parameters need to be set so it can easily generates invalid estimates. Thus, I also report the results from the OLS regression just to make sure that my estimates are not totally off the chart.

Results are reported in Table 5. The coefficient of flow is positive and significant for cash and government securities. This indicates the weights of these two asset classes move in the same direction as fund flows. In other words, when fund managers face redemptions (inflow), they decrease (increase) the weight of cash and government securities in their portfolio. Conversely, the coefficients of flow are negative and significant for securitized bonds and corporate bonds. This means that when funds face redemptions (inflows), the weight of the corporate and securitized bonds go up (down). Note that this does not mean that bond funds buy corporate bonds when they face redemptions. It means corporate bonds might get sold but relatively less than other asset classes, hence, their weight in the portfolio goes up.

{Insert Table 5}

The coefficient of the flow sign is also negative and significant for cash and government bonds and positive and significant for corporate bonds and securitized bonds. Note that flow sign dummy is equal to one for negative flows. The results show that when there is a redemption, regardless of its magnitude, the weight of the cash and government bonds decrease and the weights of corporate and securitized bonds increase. This again confirms that less liquid asset classes are sold last when a fund gets hit by a redemption shock. Lastly, the coefficients of the interaction between the flow and the flow sign for cash and government bonds are positive and significant. This indicates that in response to flows, fund managers change the weights of these two asset classes asymmetrically depending on whether flow is negative or positive. In other words, fund managers sell cash and government bonds more aggressively when facing redemptions than buy those assets when they face inflows.

These results together show that bond fund managers follow the first asset (re)allocation strategy when facing redemptions. They sell more liquid assets such as cash and government bonds more relative to less liquid assets, such as securitized and corporate bonds. Therefore, fund managers mitigate the impact of redemptions and hence, tend not to destabilize the corporate bond market.

5.2 Security selection

In the previous section I show that facing redemptions, fund managers tend to sell corporate bonds less than other asset classes. Since the focus of this paper is on corporate bonds, in this section I want to study withing the corporate bond asset class, which assets are old more. Similar to strategies in asset (re)allocation discussed in the previous section, fund managers may follow strategies in security selection when facing redemptions. They can sell more liquid corporate, less liquid ones or be neutral. These three strategies, again have different implications on the stability of the bond market.

To investigate which of these strategies are followed by fund managers, I study the impact of bond liquidity on the probability of bonds being sold. I use a comprehensive set of measures used in the literature as a proxy for bond liquidity. These measures include: Amihud illiquidity measure, number of trades, trading volume, time to maturity, issue size, bond age and credit rating. My empirical setting is as follows.

In each quarter, I pick funds in the bottom quartile of flows, distressed funds. Then I observe their holdings in the beginning and in the end of the quarter and identify the corporate bonds that are sold over the quarter and the ones that are not. Then I run a linear probability model regressions in which the dependent variable is one if a bond was sold and zero otherwise.[24] The independent variables are liquidity measures. Since I want to compare bonds in the same portfolio, I include fund-quarter fixed effects in the regressions as well. The results are reported in Table 6.

{Insert Table 6}

As we can see in Table (6), higher Amihud illiquidity, longer time to maturity, higher age and higher credit rating (lower credit quality), reduce the chance of selling a bond. However, number of trades, trading volume and issue size have a positive impact on the probability of selling a bond. These results show that within the corporate bond asset class, fund managers sell more liquid bonds. By doing so, they avoid large price impacts and hence, tend not to destabilize the corporate bond market.[25]

5.3 Bond funds vs. equity funds

In sections 5.1 and 5.2, I find evidences indicating that the redemption management is the reason why bond funds do not have destabilizing impacts on the corporate bond market. The literature, by contrast, has documented the opposite for equity funds. To better understand these contrasting findings, in this section I lay out a comparison between bond funds and equity funds in the way they manage redemptions.

In order to do that, in each quarter I group funds in deciles based on their flow level. The firs decile in each quarter includes the funds with the lowest flows (highest redemptions), whereas the tenth decile includes funds with the highest flows. Then for funds in each flow decile, I look at what fraction of positions are maintained, what fraction is expanded, what fraction is

[24] I also ran Logit regressions and the results are qualitatively the same. I only show the LPM results because they are easier to interpret.

[25] Hotchkiss and Jostova (2007) and Edwards et al. (2007) show that time to maturity, age and credit rating have an impact on the transaction costs. Therefore, I can also conclude that fund managers try to minimize transaction costs as well.

reduced and lastly, what fraction is eliminated from the portfolio since the previous quarter.[26] The left panel reports these figures for bond funds and the right panel for equity funds. As we can see in Table 7, in each flow decile, the average flows for bond funds and equity funds are quite similar. Therefore in each row of the table, corresponding columns are comparable.

{Insert Table 7}

Table 7 presents interesting patterns helping us understand redemption management practices by bond funds and equity funds. As we expect for both equity and bond funds, the fraction of positions expanded monotonically increases as the flow level increases. This pattern is the opposite for the fraction of positions reduced and the fraction of positions eliminated. The pattern for the fraction of positions maintained however, is u-shaped. Funds faced with high flows (inflow or outflow) tend to trade on many of their positions, while funds with low flow magnitudes tend to maintain many of their existing positions.

Another interesting pattern in Table 7, is that facing similar flows, the fraction of positions maintained is by far larger for bond funds than equity funds. For example, bond funds in the lowest flow decile (with an average flow of -16.46%) maintain 52.83% of their positions from the previous quarter. This figure for equity funds (with an average flow of -15.94%) is only 14.67%. This pattern confirms the results in Table 5 stating that bond funds first trade cash and government securities and then transact in the corporate bond market. However, looking at the portfolio composition of equity funds, we realize that equity funds hold a small amount of cash buffer, forcing them to sell equities to meet redemptions. This is consistent with the findings of Lou (2012). As a result, equity funds destabilize stock prices while bond funds do not destabilize corporate bond prices.

Lastly, as we can see in Table 7, the ratio of the positions reduced to the positions eliminated is significantly different for bond funds compared to equity funds. For instance, facing redemptions (in lower flow quartiles), bond funds prefer to completely eliminate a position fro their portfolio, while equity funds tend to just reduce the position. One explanation for this phenomenon might be transaction costs in the corporate bond market. Edwards et al. (2007) show trade size is a significant determinant of the corporate bonds transaction cost. Thus fund managers not

[26]Note that the existing positions in the previous quarter is the base for calculating these figures. Therefore new position are reported in this table.

willing to pay high transaction costs tend to increase the trade size as much as they can which leads to completely selling some of their holdings.

6 Robustness check

I run several robustness checks in this section to make sure my results are robust to changes in some arbitrary parameters and also to using different proxies for the variables of interest. In equations (1) and (2), I define distress funds as funds in the bottom quartile of flow in a given quarter. Therefore the threshold that separates distress funds from non-distress funds changes every quarter depending on the general pattern of flows. As a robustness check, I define a fixed threshold, -5%, and categorize funds according to this predetermined cutoff. I run regressions (3) and (4) using the new definition of distressed funds and the results (not reported) hold.

Moreover in section 4.2 and 4.3, H(I)-H(III) predict that the sensitivity of the flow correlation becomes asymmetrically stronger for the subsample of negative flows, as the bond market and fund holdings becomes less. Therefore, I run regressions (5)-(8) on both the full sample and the subsample of negative flows. The problem of running regressions on the subsample of negative flows is that this subsample is not chosen randomly, hence the estimates may be biased. I use Heckman (1979) selection model to solve this potential problem. Heckman selection model has two stages. In the first stage, using some independent variables I estimate the likelihood that a negative flow is observed in a given month. I use the sign of the lagged flows (up to 3 months) as well as the average return of the fund over the past 3 months to estimate the first stage. In the second stage, I use the predicted individual probabilities as an additional explanatory variable to estimate the regressions (5)-(8). The results shown in Table 8 using the Heckman selection model, support H(I), H(II) and H(III).

7 Conclusion

The corporate bond market has grown significantly over the past several years. Meanwhile, corporate bond funds have increased their market share and become a major player in this important market. In contrast to the traditional players in the corporate bond market such as insurance companies and pension funds, corporate bond funds engage in liquidity transformation that is, issuing liquid claims while investing in relatively illiquid assets. The liquidity mismatch between assets and liabilities make bond funds vulnerable to investor runs as well as asset fire sales, which may pose threats to corporate bond market stability.

In this paper, using an identification which is unique to the corporate bond market, I find that despite concerns, bond funds do not destabilize the corporate bond market. Even in extreme market conditions such as the recent financial crisis (2008-2009), the impact of sell-offs by bond funds on corporate bond prices is short-lived, small in magnitude and limited to the subsample of distressed funds. Given that the literature has found the opposite for equity funds and their impact on stock prices, my finding for bond funds is somewhat puzzling.

I find that differences in fund management can explain this puzzling finding. I show that bond funds hold a significant amount of cash and government securities as a buffer. Then I show that they actually use this buffer to absorb redemption shocks and therefore, do not have to significantly liquidate corporate bonds. Equity funds by contrast, hold only a small amount of cash. Hence to meet redemption requests, equity funds have to sell equities in large magnitudes which may destabilize stock prices.

Appendix A. Alternate explanations for correlated flows

There are two alternate explanations for correlated flows. The first explanation is investors' reaction to the same information but at different times and the second explanation is information content of flows. In this section I show that even though these explanations may be true, they are not sufficient to justify my hypotheses and the supporting results in Table 4, Panel A and B.

A1. Investors' reaction to the same information

To examine the first explanation, let us assume new information comes out at time t, then some investors react to it at time $t+1$, some react with a delay at time $t+2$ and so on until $t+K$. Flow at time $t+K$ can be separated into two components: the information component due to the new information released between t and $t+K-1$ and a random component. We can think of the new information as fund specific information or any economic news that may trigger flows. The random component can be thought of as investors' idiosyncratic liquidity needs. I also assume that the random component is orthogonal to the fund specific or economic news. Moreover, both the new information and random liquidity needs are independent over time. Therefore I can decompose the flow to fund j at time $t+K$ as:

$$flow_{j,t+K} = \sum_{k=0}^{K-1} \alpha_{j,K-k} I_{j,t+k} + \epsilon_{j,t+K} \tag{13}$$

where:

$$corr(I_{j,t}, \epsilon_{j,t+k}) = 0, \quad for \quad k >= 0$$

$$corr(\epsilon_{j,t+m}, \epsilon_{j,t+n}) = 0 \quad for \quad m \neq n$$

$$corr(I_{j,t+m}, I_{j,t+n}) = 0 \quad for \quad m \neq n$$

$\alpha_{j,k}$ is a constant which represents the fraction of investors who react to a new piece of information after k periods, ($\sum_{k=1}^{K} \alpha_{j,k} = 1$). Without loss of generality, I assume that $K = 2$. It means that investors react to new information either after one period or after two periods. After some simplifications, the correlation between two consecutive flows can be written as:

$$corr(flow_{j,t+1}, flow_{j,t+2}) = \tag{14}$$
$$\frac{\alpha_1 \alpha_2 var(I_{j,t})}{\sqrt{\alpha_2^2 var(I_{j,t-1}) + \alpha_1^2 var(I_{j,t}) + var(\epsilon_{j,t+1})}\sqrt{\alpha_2^2 var(I_j,t) + \alpha_1^2 var(I_{j,t+1}) + var(\epsilon_{j,t+2})}}$$

If I assume the variance of the random component for fund j does not change over time and the variance of new information does not change between $t-1$ and $t+1$, after some simplifications I have:

$$corr(flow_{j,t+1}, flow_{j,t+2}) = \frac{\alpha_1\alpha_2}{(\alpha_1^2+\alpha_2^2)+\frac{var(\epsilon_j)}{var(I_{j,t})}} \tag{15}$$

As we can see, the correlation between two consecutive flows is positively related to the ratio of the variance of new information over the variance of the random component. For instance, in one extreme case, if there is no new information at time t, there is no correlation between flows at times $t+1$ and $t+2$. In the other extreme case, if there is no random component in flows and all the flow variation comes from the new information, the correlation between two consecutive flows becomes maximum.

One interpretation of $var(I_{j,t})$ is uncertainty about the new information. I expect that during the crisis the uncertainty about the new information increases. Assuming that investors' idiosyncratic liquidity needs does not change during the crisis, this model implies that the flow correlation should increase during the crisis. The first part of H(I) is consistent with the implication of the model. However, I expect that the uncertainty about the positive new information increases more than the uncertainty about the negative new information. The reason is because during a crisis, investors tend to perceive positive information with less confidence. Therefore, if this alternate explanation holds, I expect to see a larger increase in flow correlation for the full sample than for the subsample of negative flows. This asymmetric behavior is in contrast with the second part of H(I) and the results in Table 4, panel B. Note that according to Table 4 panel B, the flow correlation during the crisis increases by 47% for the full sample and 103% for the subsample of negative flows.

A2. Information content of flows

The second alternate explanation for correlated flows is the information content of flows. According to this explanation, when a flow happens at time $t+1$, the flow itself reveals some new information about the fund fundamentals to the investors. Some investors use that information at time $t+2$ to decide about the flow and this is the reason flows are correlated. Therefore, the higher the information content of the flow is, the higher is the correlation between consecutive flows.

To formally formulate the model, I again use a similar method as in the previous section. Assume there are two types of investors. Type 1 investors are informed and can observe the new information at time t and react to it at time $t+1$. Type 2 investors are not informed and cannot observe the new information, yet they can observe the flow in the previous period. There is again a random component in the flow in each time period which is due to investors' idiosyncratic liquidity needs. Note that I assume uninformed investors can tell apart the uninformed component of the flow and the rest, which are the informed component and the random component. As a results, flow to fund j at time $t+2$ can be written as:

$$flow_{j,t+2} = \alpha_{j,1} I_{j,t+1} + \alpha_{j,2} \gamma_{t+2} g_{t+2}(\alpha_{j,1} I_{j,t} + \epsilon_{j,t+1}) + \epsilon_{j,t+2} \quad (16)$$

where:

$$corr(I_{j,t}, \epsilon_{j,t+k}) = 0, \quad for \quad k >= 0$$

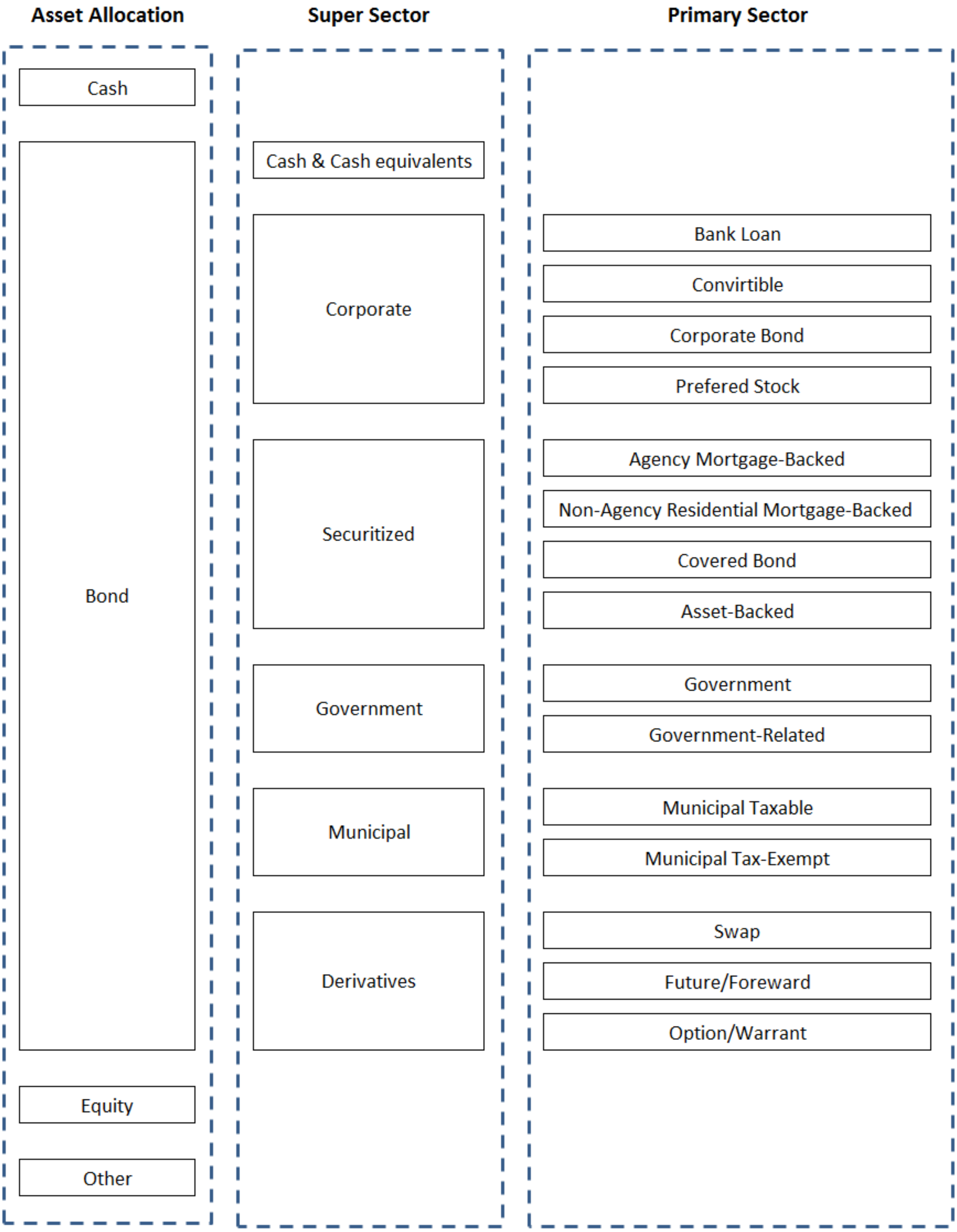
$$corre(\epsilon_{j,t+m}, \epsilon_{j,t+n}) = 0 \quad for \quad m \neq n$$

$$corre(I_{j,t+m}, I_{j,t+n}) = 0 \quad for \quad m \neq n$$

In equation (16), α_1 and α_2 are the fraction of informed and uninformed investors, respectively. g is a function that maps observed flows to the decision of uninformed investors in the current period. $\gamma \in [0, 1]$ is a parameter indicating the information content of the previous flow. For example $\gamma_{t+1} = 0$ means that uninformed investors do not find the flow at t informative, hence show no reaction, and vice versa for $\gamma_{t+1} = 1$. As we can see in equation (16), flow correlation of fund j is positively related to γ_{t+1}, which means the higher the informativeness of flows, the higher the flow correlation.

Due to the higher uncertainty during the crisis, the informativeness of flows is expected to decrease. Therefore, according to the model, the flow correlation during the crisis should drop. This is exactly the opposite of H(I) and the results in Table 4 panel B that show flow correlation increases during the crisis. Thus, this model alone cannot be reason behind observing correlated flows.

Appendix B. Bond mutual fund holdings breakdown according to Morningstar



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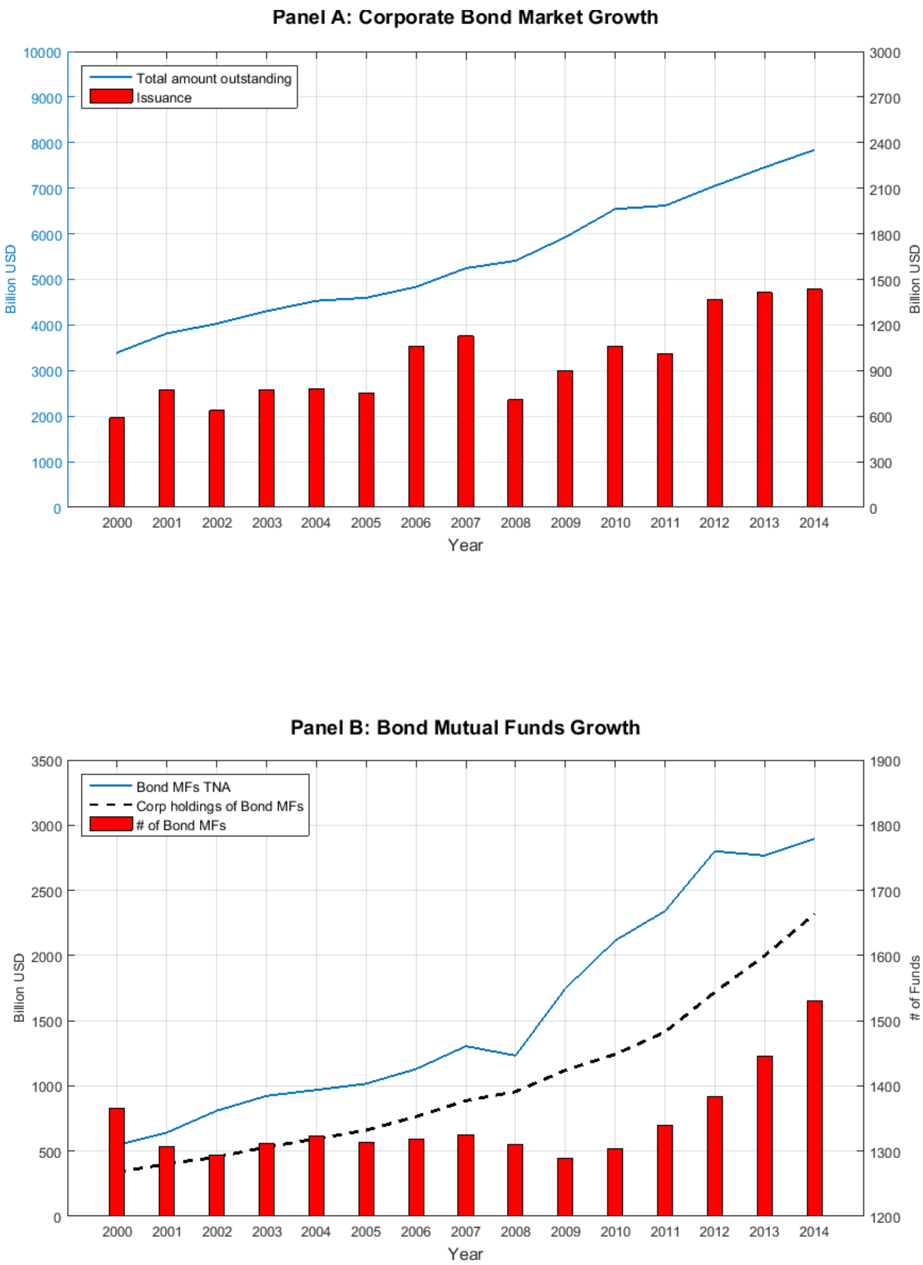
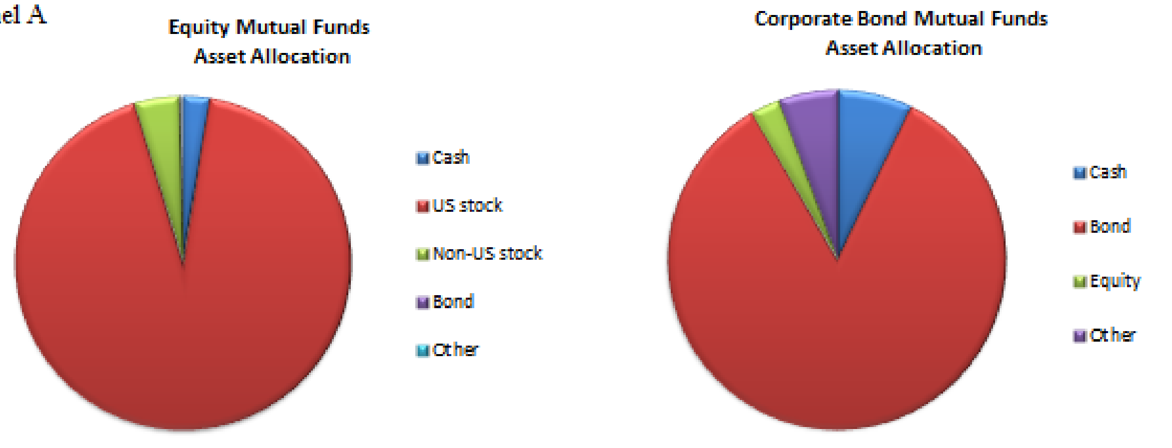


Figure 1: Panel A plots the growth of the corporate bond market since 2000. The left hand axis and blue line represent the total dollar amount outstanding in corporate bonds. The right hand axis and the red bars document the total amount of corporate bonds issuance each year. Panel B plots the growth in assets under management and the number of bond mutual funds. The left axis documents the total assets under management. The solid line represents all taxable long-term bond fund assets from ICI Factbook, while the dashed line depicts the total corporate bond assets held by long-term open-end mutual funds from the Federal Reserve Board L.212(A) filing. The right axis and red bars plot the number of long-term taxable bond mutual fund offerings from ICI.

Panel A



Panel B

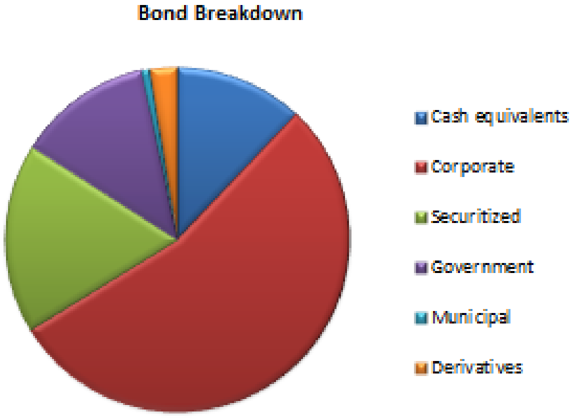


Figure 2: Panel A. Asset allocation of domestic equity mutual funds vs. domestic corporate bond mutual funds. Panel B. Breakdown of the bond part of bond domestic corporate bond mutual funds. Data collected from Morningstar as of 06/30/2014.

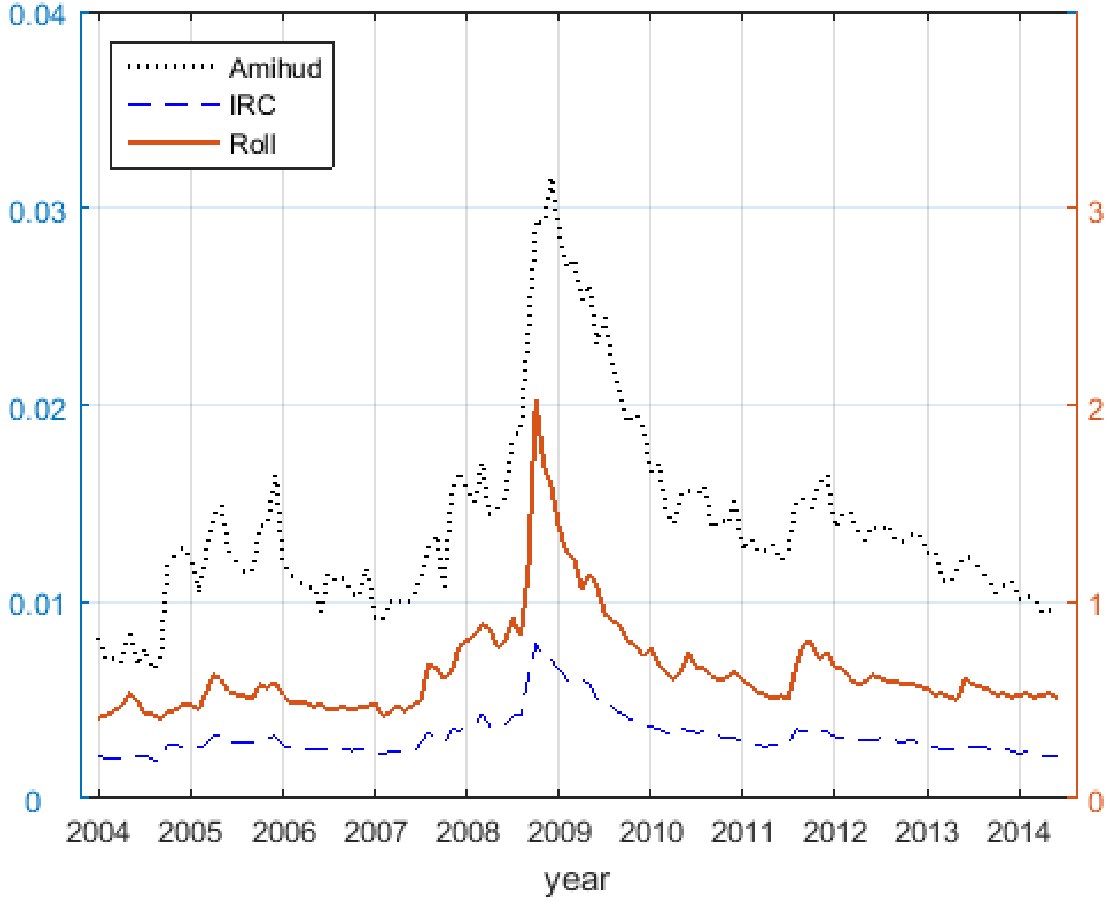


Figure 3: Amihud liquidity measure is calculated in each day based on Amihud (2002). At least two transactions are required in on a given day to calculate daily Amihud liquidity measure. Then I define monthly Amihud measure by taking the median of daily measures over a month. Roll measure, base on Roll (1984), is calculated for the days when there is at least one transaction available. Following Dick-Nielsen et al. (2012), I use a rolling window of 21 days with at least 4 transactions in the window, to calculate the daily Roll measure. I define the monthly Roll measure by taking the median of daily measures over a month. Imputed roundtrip cost (IRC) is a daily liquidity measure based on Feldhtter (2011). Monthly IRC is the median of daily measures within a month.

Table 1

Variable definition and summary statistics

Panel A: Summary statistics

Variable	Mean	Standard deviation	%5	25%	50%	75%	95%
Portfolio level							
Flow	0.83	5.28	-5.10	-1.26	0.05	1.87	9.44
Flow Sign	0.50	0.50	0.00	0.00	0.00	1.00	1.00
Turnover	1.23	1.29	0.18	0.43	0.75	1.46	4.24
Flow volatility	4.22	4.97	0.53	1.33	2.57	4.98	9.54
Perf	0.48	1.26	-1.11	0.05	0.45	0.95	2.15
TNA	1585.11	7975.22	24.20	94.70	308.60	1009.80	6018.50
Log(TNA)	5.80	1.67	3.19	4.56	5.74	6.93	8.71
ExpRatio	0.84	0.39	0.24	0.58	0.80	1.07	1.54
AvgCreditQuality	4.16	1.44	2.00	3.00	4.00	6.00	6.00
AvgEffMaturity	6.32	3.53	1.87	4.40	6.28	7.47	11.57
%Cash	9.79	8.97	0.64	3.51	7.03	13.33	28.64
%Government	13.73	16.06	0.00	0.00	8.48	22.36	45.12
%Corporate	55.04	31.40	9.98	26.95	49.05	89.64	97.82
%Securitized	18.17	19.95	0.00	0.40	9.66	33.87	54.36
%Minicipal	0.91	3.65	0.00	0.00	0.00	0.51	4.15
%Derivatives	2.41	8.24	0.00	0.00	0.00	0.01	17.00
Bond level							
Time-to-maturity	8.72	9.64	0.75	3.00	5.75	9.25	28.00
AmihudIlliquidity	0.01	0.02	0.00	0.00	0.00	0.01	0.03
IssueSize	784.56	5043.93	100.00	250.00	400.00	750.00	2000.00
Time-from-issuance	4.39	4.13	0.25	1.50	3.25	6.25	13.00
Credit Rating	9.99	5.74	3.00	6.00	9.00	12.00	27.00
PastPerf-3m	0.01	0.02	-0.02	0.00	0.00	0.01	0.04
PastPerf-6m	0.01	0.02	-0.01	0.00	0.01	0.01	0.03
No. of Trades	33.82	59.63	2.00	6.00	15.00	38.00	123.00
TradingVol	0.05	0.06	0.00	0.02	0.03	0.06	0.14
ΔYieldSpread	0.08	2.52	-2.05	-0.45	-0.04	0.47	2.52
Sell-offExpo	0.65	1.69	0.01	0.05	0.21	0.68	2.53

Panel B: Variable definition

Variable	Unit	Definition
Portfolio level		
Flow	Percent	Monthly flow to a fund as a percentage of the beginning of the month net asset value
Flow Sign	Dummy	0 when flow is positive and 1 when flow is negative
Turnover	Unit	Yearly portfolio turnover
Flow volatility	Percent	Standard deviation of the flow pver the past 12 months
Perf	Percent	Average monthly return over the past 3 months including the current month
TNA	$million	Total asset under management at the end of each month/quarter. This is a portfolio level variable
Log(TNA)	$million	Natural logarithm of TNA
ExpRatio	Percent	Percentage of assets deducted for all asset-based costs such as 12b-1 fees, management fees, operating costs etc.
AvgCreditQuality	Ordinal	1 for AAA, 2 for AA, 3 for A, 4 for BBB, 5 for BB, 6 for B and 7 for below B. This is a portfolio level variable.
AvgEffMaturity	Year	Average time to maturity of bond holdings. This is a portfolio level variable.
%Cash	Percent	Percentage of portfolio's net assets invested in cash and cash equivalents
%Government	Percent	Percentage of portfolio's net assets invested in governemnt securities
%Corporate	Percent	Percentage of portfolio's net assets invested in corporate bonds
%Securitized	Percent	Percentage of portfolio's net assets invested in securitized bonds
%Minicipal	Percent	Percentage of portfolio's net assets invested in municipal bonds
%Derivatives	Percent	Percentage of portfolio's net assets invested in derivatives
Bond level		
Time-to-maturity	Year	Time to maturity of a bond
AmihudIlliquidity	-	Median Amihud illiquidity measure over a quarter
IssueSize	$million	Bond initial issue size
Time-from-issuance	Year	Time from issuance
Credit Rating	Ordinal	Starts from 1 for AAA and goes up by increaments of one for each fine credit notch up to 27 for not-rated bonds
PastPerf-3m	Unit	Monthly return averaged over the past 3 months
PastPerf-6m	Unit	Monthly return averaged over the past 6 months
No. of Trades	Integer	Number of trades in a month averaged over a quarter
TradingVol	Unit	Volume of trade as a fraction of a bond outstanding amount, averaged over a quarter
ΔYieldSpread	Percent	Change in the yield spread of a bond over the quarter
Sell-offExpo	Percent	Percentage of the outstanding amount of a bond being sold by distressed mutual funds over the quarter

Table 2

This table shows the effect of redemptions and the resulting sell-offs on the change in corporate bonds yield spread by running the following regressions. In columns (1) to (4) firm-time fixed effects are included in the regressions. In columns (5) to (8) there is no firm-time fixed effect.

$$\Delta Yield\ spread_{ijt} = \alpha + \beta_1 Sell\text{-}offExpo_{ijt} + \beta_2 Sell\text{-}offExpo_{ijt} * crisis + \gamma' controls + \mu_{jt} + \epsilon_{ijt}$$

$$\Delta Yield\ spread_{ijt} = \alpha + \beta_1 RedemptionExpo_{ijt} + \beta_2 RedemptionExpo_{ijt} * crisis + \gamma' controls + \mu_{jt} + \epsilon_{ijt}$$

$\Delta YieldSpread$ is the change (in basis points) in the bond yield spread over quarter t. *Sell-offExpo* is the fraction of a corporate bond outstanding which is sold by distressed bond funds in quarter t. *RedemptionExpo* is the fraction of a corporate bond outstanding which is held by distressed funds in the beginning of quarter t. For the ease of interpretation, I normalize both variables by dividing them by their standard deviation. Distressed funds defined as funds in the bottom quartile of flow in each quarter. *Crisis* is a dummy which is equal to one between 2008-Q1 and 2009-Q2. *Issue size* is in million dollars. *Time to maturity* and *Age* are in years. All standard errors are clustered by quarter. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Dependent variable	ΔYield Spread$_t$							
	with firm-quarter FEs (Preferred Identification)				without firm-quarter FEs			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exposure to sell-offs	-1.03	-0.62			7.28**	7.53**		
	(-0.82)	(-0.52)			(2.38)	(2.40)		
Exposure to redemptions			1.10	1.10			12.09***	12.51***
			(1.52)	(1.49)			(3.03)	(3.00)
Exposure to sell-offs * Crisis	18.49*	9.19***			-0.94	-4.17		
	(1.81)	(2.79)			(-0.07)	(-0.26)		
Exposure to redemptions * Crisis			1.94	-2.67			15.08	13.98
			(0.30)	(-0.53)			(0.91)	(0.84)
Crisis					63.46	62.33	80.95	76.81
					(1.21)	(1.16)	(1.27)	(1.26)
Log(Issue size)	3.66*	3.78**	1.22	1.81	-11.44	-12.60*	-8.66	-8.90
	(1.89)	(2.06)	(0.71)	(1.08)	(-1.66)	(-1.81)	(-1.56)	(-1.58)
Yield Spread (Lag 1)	-0.23***	-0.24***	-0.31***	-0.30***	-0.12*	-0.12*	-0.13**	-0.13**
	(-3.95)	(-3.97)	(-5.91)	(-5.59)	(-1.72)	(-1.81)	(-2.06)	(-2.11)
Time to maturity	0.59**	0.49	0.87***	0.77***	-0.29	-0.47	-0.10	-0.20
	(2.11)	(1.68)	(3.29)	(3.02)	(-0.83)	(-1.26)	(-0.31)	(-0.64)
Age	0.57	0.25	0.73***	0.50**	-0.36	-0.90**	-0.22	-0.57
	(1.34)	(0.67)	(3.33)	(2.44)	(-1.10)	(-2.42)	(-0.62)	(-1.51)
Amihud Illiquidity		8.55**		4.25***		15.35**		6.60**
		(2.47)		(4.20)		(2.69)		(2.61)
Amihud Illiquidity * crisis		-4.64		-1.04		-4.29		1.34
		(-1.16)		(-0.49)		(-0.36)		(0.18)
Constant	40.60**	38.38**	64.03***	56.65***	107.90*	113.30*	78.57*	79.62*
	(2.67)	(2.57)	(4.16)	(3.70)	(1.83)	(1.94)	(1.71)	(1.73)
Firm-quarter Fixed Effects	Yes	Yes	Yes	Yes	No	No	No	No
No. obs.	38,816	38,467	95,240	92,990	54,763	54,188	110,379	107,726
R^2	0.76	0.77	0.78	0.79	0.04	0.04	0.05	0.05

Table 3

This table shows the results of some tests on the following regression.

$$\Delta Yield\ spread_{ijt} = \alpha + \beta_1 Sell\text{-}offExpo_{ijt} + \beta_2 Sell\text{-}offExpo_{ijt} * crisis + \gamma' controls + \mu_{jt} + \epsilon_{ijt}$$

In the first test, funds in the bottom flow quartile are replaced with the funds in the second lowest flow quartile. In the second and the third tests, the crisis period is moved to Q3-2006 to Q4-2007 and Q3-2009 to Q4-2010, respectively. In the forth test, the dependent variable is the change in the yield spread between the beginning of the current quarter, t, and one quarter after the forced sale, $t+1$. I run this test to see if the change in the yield spread during the crisis lasts beyond the current quarter.
$\Delta YieldSpread_t$ is the change (in basis points) in the bond yield spread over quarter t. $\Delta YieldSpread_{t+1}$ is the change (in basis points) in the bond yield spread over quarters t and $t+1$. *Sell-offExpo* is the fraction of a corporate bond outstanding which is sold by distressed bond funds in quarter t. For the ease of interpretation, I normalize the variable by dividing them by their standard deviation. Distressed funds defined as funds in the bottom quartile of flow in each quarter. In the base specification *crisis* is a dummy which is equal to one between 2008-Q1 and 2009-Q2. *Issue size* is in million dollars. *Time to maturity* and *Age* are in years. All standard errors are clustered by quarter. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Dependent variable	ΔYield Spread$_t$						ΔYield Spread$_{t+1}$	
	Test(1)		Test(2)		Test(3)		Test(4)	
	Funds in the second lowest flow quartile + Q1-08 to Q2-09 as crisis		Funds in the bottom flow quartile + Q3-06 to Q4-07 as crisis		Funds in the bottom flow quartile + Q3-09 to Q4-10 as crisis		Base Specification	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Exposure to sell-offs	0.068	0.185	0.184	-0.287	0.977	0.416	-0.282	-0.177
	(0.04)	(0.12)	(0.11)	(-0.26)	(0.47)	(0.29)	(-0.18)	(-0.11)
Exposure to sell-offs * Crisis	4.447	2.532	3.458	3.839	-2.995	-2.206	4.476	-6.707
	(1.24)	(0.77)	(0.48)	(0.58)	(-1.35)	(-1.39)	(0.39)	(-1.12)
Log(Issue size)	1.250	1.464	3.503*	3.642*	3.530*	3.620*	4.056	4.418*
	(0.39)	(0.44)	(1.83)	(2.00)	(1.83)	(1.98)	(1.63)	(1.73)
Yield Spread (Lag 1)	-0.266***	-0.264***	-0.239***	-0.240***	-0.232***	-0.241***	-0.371***	-0.370***
	(-3.02)	(-3.06)	(-3.89)	(-3.97)	(-3.84)	(-3.96)	(-3.00)	(-3.05)
Time to maturity	0.752*	0.620	0.603**	0.519*	0.605**	0.513*	1.205***	1.102**
	(1.94)	(1.64)	(2.14)	(1.81)	(2.15)	(1.78)	(2.79)	(2.66)
Age	0.344	0.0182	0.585	0.299	0.593	0.316	0.241	-0.019
	(0.59)	(0.03)	(1.36)	(0.78)	(1.38)	(0.81)	(0.51)	(-0.04)
Amihud Illiquidity		10.56**		6.370***		7.279***		6.967**
		(2.33)		(3.22)		(3.34)		(2.61)
Amihud Illiquidity * crisis		-4.333		9.752		-5.943		-5.979
		(-0.93)		(0.93)		(-1.62)		(-1.64)
Constant	68.19**	63.02**	41.79***	39.00**	41.47***	39.26**	65.60**	61.64**
	(2.36)	(2.34)	(2.74)	(2.58)	(2.71)	(2.60)	(2.26)	(2.13)
Firm-quarter Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes		
No. obs.	30,796	30,615	38,816	38,467	39,105	38,893	37,963	37,656
R^2	0.78	0.78	0.76	0.77	0.72	0.76	0.82	0.82

Table 4 Panel A

In this table I study the sensitivity of the current flow to the past flow, flow correlation, as an indication of investors run. I run the following regressions to test my hypotheses. In the first equation, the coefficient of interest is β_2. H(I) predicts that β_2 should be positive. In the second equation, the coefficients of interest are β_3 and β_4. H(II) and H(III) predict that β_3 and β_4 should be negative.

$$flow_{j,t} = \beta_1 flow_{j,(t-1)} + \beta_2 flow_{j,(t-1)} * Amihud + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt}$$

$$\begin{aligned} flow_{j,t} =& \beta_1 flow_{j,(t-1)} + \beta_2 flow\ vol._{j,(t-1)} * Amihud + \beta_3 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} \\ &+ \beta_4 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} * Amihud + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt} \end{aligned}$$

In the obove equations Amihud is the equal weighted average of Amihud illiquidity measure of individual bonds in each month. I use it as a proxy for the illiquidity of the bond market. Flow volatility is the standard deviation of fund flows over the past 12 months and I use it as a proxy for fund liquidity. Performance is the average fund returns over the past 3 months. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Full sample		Subsample of negative flows	
	(1)	(2)	(3)	(4)
Flow(lag1)	0.146***	0.237***	0.0329***	0.0610***
	(18.71)	(23.26)	(8.13)	(9.54)
Flow(lag1)*Amihud	0.0376***	0.0466***	0.00995**	0.0177***
	(5.68)	(5.90)	(2.20)	(3.02)
Flow(lag1)*Flow vol.		-0.0567***		-0.0154***
		(-15.85)		(-6.97)
Flow(lag1)*Flow vol.*Amihud		-0.00708*		-0.00635**
		(-1.73)		(-2.43)
Flow(lag2)	0.104***	0.0948***	0.0203***	0.0196***
	(16.73)	(15.32)	(4.99)	(4.77)
Flow(lag3)	0.0874***	0.0824***	0.0131***	0.0144***
	(15.61)	(14.95)	(3.27)	(3.60)
Perf	0.277***	0.242***	0.109***	0.0948**
	(3.32)	(3.02)	(2.88)	(2.50)
Log(TNA)	-0.0991*	-0.117**	0.129***	0.108***
	(-1.67)	(-2.11)	(3.03)	(2.65)
ExpRatio	-116.6***	-104.4***	-5.519	-13.47
	(-3.68)	(-3.44)	(-0.26)	(-0.65)
Flow vol.		0.224***		-0.237***
		(4.88)		(-6.70)
Perf*Amihud	-0.121***	-0.109***	-0.0339**	-0.0329**
	(-3.20)	(-3.05)	(-2.06)	(-2.06)
Flow vol.*Amihud		0.0400		-0.0526**
		(0.83)		(-2.48)
Fund fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes
St. errors clustered by fund	Yes	Yes	Yes	Yes
St. errors clustered by month	Yes	Yes	Yes	Yes
No. obs.	74,128	74,128	36,782	36,782
R^2	0.1301	0.1468	0.0132	0.0220

Table 4 continues on the next page.

Table 4 Panel B

In this table I study the sensitivity of the current flow to the past flow, flow correlation, as an indication of investors run. I run the following regressions to test my hypotheses. In the first equation, the coefficient of interest is β_2. H(I) predicts that β_2 should be positive. In the second equation, the coefficients of interest are β_3 and β_4. H(II) and H(III) predict that β_3 and β_4 should be negative.

$$flow_{j,t} = \beta_1 flow_{j,(t-1)} + \beta_2 flow_{j,(t-1)} * crisis + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt}$$

$$\begin{aligned} flow_{j,t} =& \beta_1 flow_{j,(t-1)} + \beta_2 flow\ vol._{j,(t-1)} * crisis + \beta_3 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} \\ &+ \beta_4 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} * crisis + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt} \end{aligned}$$

In the above equations crisis is a dummy which is equal to one for 2008-Q1 to 2009-Q2. I use it as a proxy for the illiquidity of the bond market. Flow volatility is the standard deviation of fund flows over the past 12 months and I use it as a proxy for fund liquidity. Performance is the average fund returns over the past 3 months. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Full sample		Subsample of negative flows	
	(1)	(2)	(3)	(4)
Flow(lag1)	0.139***	0.228***	0.0281***	0.0526***
	(16.89)	(21.14)	(6.87)	(8.05)
Flow(lag1)*Crisis	0.0663**	0.0945***	0.0291**	0.0560***
	(2.49)	(3.09)	(2.23)	(3.12)
Flow(lag1)*Flow vol.		-0.0557***		-0.0136***
		(-15.06)		(-6.00)
Flow(lag1)*Flow vol.*Crisis		-0.0138		-0.0127*
		(-1.30)		(-1.93)
Flow(lag2)	0.106***	0.0960***	0.0202***	0.0195***
	(16.61)	(15.25)	(4.93)	(4.75)
Flow(lag3)	0.0881***	0.0830***	0.0131***	0.0143***
	(15.85)	(15.17)	(3.28)	(3.56)
Perf	0.161*	0.139	0.0790*	0.0709*
	(1.71)	(1.55)	(1.92)	(1.73)
Log(TNA)	-0.0940	-0.110**	0.127***	0.105**
	(-1.57)	(-1.97)	(2.95)	(2.54)
ExpRatio	-113.9***	-101.7***	-5.232	-13.58
	(-3.62)	(-3.37)	(-0.24)	(-0.66)
Flow vol.		0.213***		-0.217***
		(4.49)		(-5.77)
Perf*Crisis	-0.0786	-0.0833	-0.0132	-0.0252
	(-0.53)	(-0.60)	(-0.23)	(-0.46)
Flow vol.*Crisis		0.0948		-0.146**
		(0.76)		(-2.14)
Fund fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes
St. errors clustered by fund	Yes	Yes	Yes	Yes
St. errors clustered by month	Yes	Yes	Yes	Yes
No. obs.	74,128	74,128	36,782	36,782
R^2	0.1334	0.1501	0.0282	0.0355

Table 5

This table shows how fund managers reallocate capital over different asset classes when facing flows. Among six asset classes that bond funds invest in I only study four of them, cash and cash equivalents, government securities, securitized bonds and corporate bonds. I run the following regression for each class separately to investigate how different asset class weights change in response to fund flows.

$$\omega_{ijt} = \alpha + \beta_1 \omega_{ij(t-1)} + \beta_2 (return_{ijt} - return_{it}) + \beta_3 f_{it} + \gamma_4 flow\ sign_{it} + \gamma_5 flow_{it} * flow\ sign_{it} + \eta_i + \tau_t + \epsilon_{ijt}$$

I get quarterly asset class weights from Morningstar. Flow and return data come from CRSP mutual fund database. I calculate fund specific asset class returns, $return_{ijt}$, using asset class indices from Bloomberg, adjusted to the holding characteristics of each fund i.e. maturity and credit quality. Flow sign is equal to one when flow is negative and zero otherwise.

Since I have the lagged dependent variable and fund fixed effect in the regression, I also estimate this regression using Arellano and Bond (1991) method for dynamic panel data. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Pooled OLS				Dynamic Panel Data			
	Log(%Cash)	Log(%Government)	Log(%Securitized)	Log(%Corporate)	Log(%Cash)	Log(%Government)	Log(%Securitized)	Log(%Corporate)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Flow	0.0026***	0.0004	-0.0008	-0.0005*	0.0057***	0.0020*	-0.0013**	-0.0013***
	(3.17)	(0.59)	(-1.45)	(-1.87)	(5.47)	(1.91)	(-1.97)	(-5.04)
Flow sign	-0.0811***	-0.0080	0.0097	0.0105**	-0.0651***	-0.0402**	0.0107	0.0137***
	(-6.55)	(-0.69)	(1.42)	(2.55)	(-4.31)	(-2.30)	(1.32)	(2.63)
Flow*Flow sign	0.0081***	0.0078***	-0.0016*	-0.0001	0.0078***	0.0050**	-0.0015	0.0005
	(4.59)	(4.49)	(-1.68)	(-0.28)	(3.03)	(2.43)	(-1.33)	(1.2)
Log(weight(lag1))	0.450***	0.689***	0.785***	0.783***	0.304***	0.401***	0.522***	0.517***
	(32.24)	(25.76)	(35.02)	(25.31)	(8.28)	(4.61)	(4.88)	(3.79)
Relative return	0.425	-0.235	0.725***	-0.0791	0.251	-0.251	0.478**	-0.13
	(0.81)	(-0.55)	(3.89)	(-0.40)	(0.74)	(-0.53)	(2.41)	(-0.59)
Fund fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
St. errors clustered by fund	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
St. errors clustered by quarter	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. obs.	26,324	14,834	21,575	25,546	24,015	13,121	19,636	23,266
R^2	0.61	0.85	0.94	0.93	-	-	-	-

Table 6

This table shows security selection by the managers of distressed funds. Funds in the bottom quartile of flow in each quarter are considered distressed funds. I run a linear probability model in which the dependent variable is one if a bond is sold and zero if it is maintained in the portfolio. Note that higher credit rating means lower credit quality. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Dependent variable	1 if a bond is sold, 0 otherwise							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Number of Trades	0.000330***							-0.00000673
	(34.18)							(-0.47)
Trading Volume		0.593***						0.545***
		(47.49)						(32.83)
Time to Maturity			-0.000552***					-0.000813***
			(-6.99)					(-9.43)
Age				-0.00419***				-0.000344
				(-21.83)				(-1.55)
log(Issue Size)					0.0367***			0.0388***
					(46.68)			(35.57)
Credit Rating						-0.00233***		-0.000838***
						(-16.45)		(-5.55)
Amihud Illiquidity							-0.502***	-0.428***
							(-10.07)	(-7.74)
Constant	0.254***	0.238***	0.274***	0.283***	0.0332***	0.297***	0.276***	0.0110
	(324.88)	(275.96)	(305.81)	(322.10)	(6.57)	(173.39)	(404.42)	(1.45)
No. obs.	520,457	492,402	527,850	531,524	531,514	487,230	512,519	447,870
R^2	0.205	0.209	0.201	0.202	0.206	0.202	0.201	0.213

Table 7

This table shows how funds in different flow deciles change their positions on corporate bonds (left panel) and equity (right panel). Corporate bond holdings come from CRSP mutual fund database and Morningstar. Equity holdings come from Thomson Reuters mutual fund database.

	Corporate bond funds					Domestic equity funds				
		Fraction of positions:					Fraction of positions:			
Flow decile	Flow	Maintained	Expanded	Reduced	Eliminated	Flow	Maintained	Expanded	Reduced	Eliminated
1 (outflow)	-16.46	52.83	17.28	14.26	15.63	-15.94	14.67	26.45	43.9	14.97
2	-6.48	58.14	19.47	8.41	13.98	-6.73	22.29	27.3	35.73	14.68
3	-3.83	62.19	18.06	7.14	12.61	-4.45	26.98	27.24	31.86	13.91
4	-2.07	64.79	18	6.57	10.64	-3.01	30.3	28.32	28.13	13.25
5	-0.58	65.47	18.39	5.36	10.78	-1.75	35.12	29.19	23.51	12.18
6	0.91	67.16	17.59	5.22	10.03	-0.48	38.99	31.38	19.16	10.47
7	2.84	65.73	19.11	4.49	10.67	1.02	36.39	38.69	15.35	9.58
8	5.71	64.45	22.53	4.17	8.85	3.46	30.95	47.78	12.19	9.08
9	11.09	61.51	24.41	4.34	9.74	7.96	25.37	54.08	9.95	10.6
10 (inflow)	34.21	53.25	34.15	2.82	9.78	28.53	14.85	64.2	9.64	11.31

Table 8

As a robustness check, I run the regression (5)-(8) on the subsample of negative flows using the Heckman correction model. I use the sign of lagged flows (up to 3 months) as well as the fund performance over the past 3 months, in the first stage to estimate the likelihood of a flow being negative. Then I use the predicted individual probabilities as an additional explanatory variable in the second stage to estimate the coefficients of interest. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

$$flow_{j,t} = \beta_1 flow_{j,(t-1)} + \beta_2 flow_{j,(t-1)} * Amihud + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt}$$

$$flow_{j,t} = \beta_1 flow_{j,(t-1)} + \beta_2 flow_{j,(t-1)} * crisis + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt}$$

$$\begin{aligned} flow_{j,t} =& \beta_1 flow_{j,(t-1)} + \beta_2 flow\ vol._{j,(t-1)} * Amihud + \beta_3 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} \\ &+ \beta_4 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} * Amihud + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt} \end{aligned}$$

$$\begin{aligned} flow_{j,t} =& \beta_1 flow_{j,(t-1)} + \beta_2 flow\ vol._{j,(t-1)} * crisis + \beta_3 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} \\ &+ \beta_4 flow_{j,(t-1)} * flow\ vol._{j,(t-1)} * crisis + \gamma' controls + \eta_j + \tau_t + \epsilon_{jt} \end{aligned}$$

	Subsample of negative flows			
	(1)	(2)	(3)	(4)
Flow(lag1)	0.0166***	0.0386***	0.0196***	0.0446***
	(4.55)	(5.52)	(8.14)	(12.67)
Flow(lag1)*Crisis	0.0314***	0.0611***		
	(2.80)	(3.38)		
Flow(lag1)*Amihud			0.0108***	0.0210***
			(4.70)	(6.59)
Flow(lag1)*Flow volatility		-0.0126***		-0.0141***
		(-3.72)		(-9.82)
Flow(lag1)*Flow vol.*Crisis		-0.0135*		
		(-1.83)		
Flow(lag1)*Flow vol.*Amihud				-0.00750***
				(-4.66)
Flow(lag2)	0.0108***	0.0097**	0.0090***	0.0082***
	(2.65)	(2.34)	(3.81)	(3.44)
Flow(lag3)	0.0044	0.0041	0.0028	0.0027
	(1.21)	(1.13)	(1.26)	(1.20)
Perf	0.0798*	0.0773*	0.106***	0.101***
	(1.95)	(1.89)	(5.29)	(5.02)
Log(TNA)	0.118***	0.107***	0.112***	0.107***
	(3.70)	(3.38)	(4.87)	(4.66)
ExpRatio	-0.0768	-0.193	-0.705	0.964
	(-0.01)	(-0.01)	(-0.06)	(0.08)
Flow volatility		-0.199***		-0.218***
		(-4.85)		(-5.07)
Perf*Crisis	0.0073	-0.005		
	(0.13)	(-0.09)		
Perf*Amihud			-0.0243**	-0.0245**
			(-2.17)	(-2.19)
Flow volatility*Crisis		-0.263***		
		(-2.77)		
Flow volatility*Amihud				-0.0742***
				(-4.53)
Fund fixed effects	Yes	Yes	Yes	Yes
Month fixed effects	Yes	Yes	Yes	Yes
St. errors clustered by month	Yes	Yes	No	No
No. obs.	74,128	74,128	74,128	74,128

ESSAY TWO

Financial Innovation and Corporate Bonds*

Caitlin Dannhauser Saeid Hoseinzade

Abstract

Corporate bond Exchange Traded Funds (ETFs), a new form of financial innovation, provide investors with intra-day liquidity in the illiquid corporate bond market. Since these investment vehicles are relatively new, little is known about their risks. In this paper, we study an event in the summer 2013, knows as the Taper Tantrum, when bond ETFs and mutual funds experienced massive unexpected outflows due to speculations about interest rate hikes. We find that ETF outflows during the Taper Tantrum lead to a significant increase in exposed corporate bond yields. The increase in yields lasts for seven months, which indicates a temporary fire sale effect. In contrast, we find no fire sale effect resulting from mutual fund outflows. We attribute this contrasting finding between the two vehicles to differences in portfolio construction and investor sensitivities. Finally, we study arbitrage opportunities, created by ETF shares mispricing, and their impact on bond yields.

JEL classifications: G12, G20, G23

Keywords: Exchange Traded Funds, Mutual Funds, Corporate Bonds, Fire Sale

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1 Introduction

Recent financial history has shown that evolving financial markets and emerging financial innovations may have unanticipated consequences, which can result in financial fragility (Gennaioli, Shleifer, and Vishny (2012)). The goal of this paper is to evaluate potential vulnerabilities created by a new form of financial innovation, Exchange Traded Funds (ETFs). Even though ETFs have grown significantly over the past several years, the risks associated with them have not been studied. In this paper we study the impact of outflows from ETFs on their corporate bond holdings. Moreover, we shed light on differences between ETFs and their more traditional counterparts, bond mutual funds.

Since 2001, the total amount of corporate bonds outstanding has nearly doubled. Despite this growth, the inventory level of dealers who once dominated this over-the-counter market is unchanged due to heightened regulatory requirements. Under this backdrop, mutual funds and ETFs are taking on an increasingly important role in the market with their assets, respectively, doubling and quadrupling over the last six years. As of 2014, the combined corporate bond holdings of these vehicles are equivalent to those of insurance companies, who were the traditionally dominant institutional investors in corporate bonds. In a market known for illiquidity and long-term investors, the daily and intra-day liquidity provided by mutual funds and ETFs, respectively, has heightened the concern of regulators and academics alike. For instance, in their 2015 annual report, the Financial Stability Oversight Council (FSOC) listed the expansion of ETFs and bond mutual funds as a potential emerging systematic threat.

Given the relative infancy of corporate bond ETF offerings, there have been limited opportunities to study them during market distress. However, during the summer of 2013, investors responded to the potential end of the Federal Reserves bond buyback program, Quantitative Easing (QE), by sharply reducing corporate bond exposure. This event which is known as the Taper Tantrum triggered unexpected and significant outflows from bond ETFs and mutual funds. We use the Taper Tantrum as a quasi-natural experiment to identify the yield pressure created by outflows from ETFs. Our findings suggest that one standard deviation increase in ETF outflows during the Taper Tantrum leads to a 14.3 basis point greater increase in the yield spread of corporate bonds in the month immediately following the shock. In terms of economic magnitude, this is a 10.7% increase in the yield spread for an average corporate bond.[1] However consistent with Hoseinzade (2015), we find that outflows from mutual funds have no impact on corporate bond yields.

We follow Mitchell, Pulvino, and Stafford (2004) and Coval and Stafford (2007) to examine if this yield effect is permanent or temporary. A permanent change in yield would indicate the initial movement was in response to information and changes in the fundamental value. A temporary effect, in which yield spreads return to their original levels, is indicative of a fire sale in which the asset price is pushed beyond its fundamental value. We show that the yield pressure continues to be significant and positive for seven months after which the yields revert to their pre-tantrum levels. Therefore, our results suggest that the initial increase on bond yields were due to fire sales.

Next, we examine two unique features of ETFs as potential explanations for the differential results for ETFs and mutual funds. First, we consider if mutual fund and ETF structures impact their response to flow shocks. ETFs utilize a unique in-kind creation and redemption process, in which the fund and only designated traders exchange large units of the underlying basket for ETF shares. Combined with other managerial features, this element of ETF design enables the funds to be more fully invested in representative securities allowing them to closely replicate the benchmark, but reducing any liquidity buffer. Examining the differences in cash reserves and other liquid holdings between the two investment vehicles, we find that mutual funds on average have a significantly greater portion of their fund invested in cash and government securities. This construction technique allows mutual funds to meet redemption requests without selling corporate bonds at potentially distressed prices. Another structural distinction between ETFs and the broad universe of mutual funds is that ETFs usually follow an index strategy while the majority of mutual funds in our sample are active. To examine whether our finding for mutual funds is due to their investment strategy, we compare active mutual funds to index mutual funds. We find that neither subclass of mutual funds has an impact on the yield spread of their corporate bond holdings. Therefore, we conclude that the structural and operational features, outside of the investment strategy, may play a role in the differential results.

[1] The median yield spread for all corporate bonds in the sample is 1.33 percentage points in May 2013.

Next, we examine differences in the sensitivity of flows to changes in interest rates, between ETFs and mutual funds. As described by Chordia (1996), Deli and Varma (2002) and Nanda, Narayanan, and Warther (2000) funds adopt different structures to appeal to different stochastic liquidity needs of investors. Following Poterba and Shoven (2002), we posit that the structure of ETFs with its intraday exchange trading is likely to attract short-term traders.[2] To test this prediction we first document that monthly ETF flows are more volatile, particularly during the Taper Tantrum, than monthly mutual fund flows. We then show that ETF flows are significantly more sensitive to changes in interest rates indicating that this investment vehicle attracts investors with shorter horizons.

Finally, we consider the impact of arbitrage activities between ETF shares and the Net Asset Value (NAV) of the underlying basket. During the Taper Tantrum, the ETFs in which arbitrageurs were previously successful at maintaining a tight market price to NAV relationship began trading at a steep discount. To profit from this mispricing, arbitrageurs would buy the ETF and sell the underlying bonds, regardless of their fundamental value.[3] To study the impact of arbitrage activity on bond yields, we build two portfolios of corporate bonds, one with a high exposure and one with a low exposure to arbitrage activities. Tracking these portfolios after the Taper Tantrum, we find that the high exposure portfolio shows a significant increase in yield compared to the low exposure portfolio. This finding shows that the trades of arbitrageurs have a significant impact on bond yields. Together our tests suggest that the structural and operational features that allow ETFs to offer intra-day liquidity, high price transparency and lower expense ratios, may also be responsible for corporate bond fire sales.

Our findings contribute to the growing research on ETFs. In particular, we identify another possible unintended risk induced by ETFs. To date, the literature has shown that ETFs increase the volatility (Ben-David, Franzoni, and Moussawi (2014)) and the co-movement (Da and Shive (2013)) of their equity constituents, as well as, decreasing the liquidity of both equity (Hamm (2014)) and corporate bond (Dannhauser (2014)) constituents. Moreover, this paper is related to a broader literature that studies asset price movements induced by financial

[2]This conjecture conforms to those of Amihud and Mendelson (1986) and Constantinides (1986) who predict that short-term investors self-select into more liquid assets.

[3]As described in Mitchell and Pulvino (2012) arbitrage ensures not that prices equal fundamental values, but that they are correctly priced on a relative basis.

institutions. In the stock market, prices are moved by equity funds according to Coval and Stafford (2007), Jotikasthira, Lundblad and Ramadorai (2007), Chen, Hanson, Hong and Stein (2008), Ben-Rephael, Kandel and Wohl (2011), Greenwood and Thesmar (2011), Lou (2012), Merrill, Nadauld, Stulz and Sherlund (2012), Hau and Lai (2013). However, in the corporate bond market the findings are mixed. While Ellul, Jotikasthira and Lundblad (2011) document yield increase as a result of corporate bond sales by insurance companies, Ambrose, Cai and Helwege (2008) and Hoseinzade (2015), respectively, find that insurance companies and mutual funds do not move corporate bond prices beyond fundamental values. This paper while confirming the results of Hoseinzade (2015), finds that ETFs can be quite different than mutual funds.

2 Background

Since this paper bridges the literature between financial innovation, fire sales, and institutional investors by investigating the role of different investment vehicles on corporate bond prices, a detailed discussion of the corporate bond market and its participants is necessary. In particular, we focus on the role of mutual fund and ETF redemptions during a temporary market shock, the Taper Tantrum, on corporate bond yields. In the following subsections, we discuss the recent changes in corporate bond markets, the distinctions between mutual funds and ETFs, and the impetus for the Taper Tantrum.

2.1 Financial Innovation in the Corporate Bond Market

Faced with increased regulatory pressures and historically low rates on government bonds, the corporate bond market has undergone a radical change in recent years. Foremost, the size of corporate bonds outstanding has increased over the past several years in response to low borrowing rates following the Financial Crisis of 2008. Panel A of Figure 1 documents the growth in the dollar amount and number of corporate bonds outstanding.

{Insert Figure 1}

Next, the corporate bond market was historically opaque. Broker-dealers held large inventories in order to facilitate trades with large institutional investors. Bid-ask quotes and transaction prices were not readily available. Furthermore, a large portion of corporate bonds outstanding were held by insurance companies, who follow a buy and hold strategy. In recent years, market dynamics have changed. Faced with increased regulation and capital requirement, broker-dealers have drastically reduced inventory levels. The withdrawal of these intermediaries has increased transaction costs and decreased the frequency of trades as investors face a more difficult search for liquidity.

Amidst these changes mutual funds and ETFs became much more prevalent. Panel B of Figure 1 plots the Federal Reserve Board data on the amount of corporate and foreign bonds held by two groups. The figure shows that the assets held by mutual funds and ETFs are now equal to those of insurance companies. The accumulation of assets by these funds has implications for the underlying market because of the liquidity they provide their investors and thus the liquidity they may demand. Panels C and D of Figure 1 present details on the growth of mutual funds and ETFs, respectively. The figure presents the number and assets under management of all long-term taxable bond funds from ICI FactBook, as well as, corporate bond specific assets from the Federal Reserve Board. From these figures it is evident that a large portion of growth in these investment vehicles has occurred since 2009 with the corporate bond assets of mutual funds doubling and ETF corporate bond assets quadrupling.

Given the focus of this paper on mutual funds and ETFs an extended discussion of their structures is needed. At the most basic level, mutual funds and ETFs are investment vehicles backed by a basket of corporate bonds. Mutual funds are distinguished by their investment mandate as either active mutual funds, who attempt to outperform their benchmark, or passive mutual fund, who attempt to replicate their benchmark. Regardless of the type of mutual fund, investors are provided with daily liquidity. That is an investor can submit a buy or sell order for the mutual fund shares at any point throughout the day and all transactions will occur at the closing NAV.

Corporate bond ETFs first introduced in 2002 are a hybrid between traditional open-end mutual funds and closed end funds (CEFs). The unique features of ETFs allows them to offer lower management fees, greater transparency, and tax efficiencies to attract investors (Poterba and Shoven (2002)). ETFs provide liquidity to investors in two venues, the primary and secondary markets. The primary market is used by ETFs to handle liquidity shocks in the secondary market, to ensure that orders are filled, and to arbitrage excessive market price deviations from NAV. This market is the direct channel linking ETFs to the underlying. It involves large transactions between Authorized Participants (APs) market makers, specialists, and other institutional investors and the fund manager through the in-kind creation and redemption process. In contrast, the creation and redemption process of traditional mutual funds occurs between the fund and individual investors and entails an exchange of cash for individual units of the underlying basket. The secondary market is where buyers and sellers of the ETF transact directly on the equity exchange without any fund involvement. Another distinguishing feature from CEFs is that, ETF investors with access to the corporate bond market can also engage in risky arbitrage between the secondary ETF market and the underlying market. Dannhauser (2014)uses quasi-natural experiments to document that the yield spread of bonds decreases when ETFs hold a bond. She also finds that the liquidity of high yield corporate bonds is adversely affected by ETF involvement, while investment grade bond liquidity is unaffected. These findings are shown to support the theoretical predictions of Gorton and Pennacchi (1993) and Subrahmanyam (1991). Table 1 presents summary statistics for the two investment vehicles.

{Insert Table 1}

The consequences of the different fund structures are made evident by contrasting the summary statistics for mutual funds in Panel A and ETFs in Panel B. Foremost, ETFs have lower expense and turnover ratios because the fund rarely trades on its own behalf. In addition, ETFs have a much greater percentage of fund assets invested in corporate securities than mutual funds. The bond average duration and credit quality of both ETF and mutual fund holdings are similar. Interestingly, the average ETF is larger than the average mutual fund. This statistic is the result of a significant concentration of ETF assets in the largest funds.

2.2 The Taper Tantrum

In order to examine potential vulnerabilities created by the evolution of the corporate bond market, we need to identify a market shock. Given the relatively short time frame in which these more liquid investment alternatives have exerted a larger presence in the market, we are limited to shocks after the 2008 crisis. Therefore, we use the Taper Tantrum of 2013 as a quasi-natural experiment to test the impact of an unexpected shock to investor beliefs. The Taper Tantrum occurred in the summer of 2013 following the Fed unanticipated warning that it was contemplating winding down its bond purchase program, known as Quantitative Easing (QE). The QE program in place since November of 2008 was intended to lower long-term interest rates in an effort to bolster housing markets, employment, and real activity. Following positive economic developments in early 2013, Chairman Ben Bernanke testified to congress on May 22$^{\text{nd}}$ that the Fed would likely begin slowing the pace of its bond purchases conditional on continued economic stability. On June 19$^{\text{th}}$ the Chairman held a conference to document the economic justification for the purchase slowdown. Convinced that the end of QE was near, the market tantrum, in which risk premiums fluctuated widely began. Over two days the 10 year Treasury rate jumped nearly 10% as seen in Figure 2.

{Insert Figure 2}

Beyond the Treasury rate, investors anticipating a sharp reevaluation of risk took advantage of the liquidity provisions of mutual funds and ETFs by swiftly withdrawing assets. The fall out of the change in market beliefs was not limited to bond markets, as investors reevaluated portfolio risk emerging markets were particularly hard hit. Feroli et al. (2014) also examine this non-bank driven event from a policy perspective. They document that financial instability can be driven by investors and conclude that unconventional monetary policies, such as QE, can encourage risk-taking.

3 Date

Our data on corporate bonds funds comes from a variety of sources. We begin by using the Morningstar mutual fund database identify corporate bond funds. In particular, we include any mutual fund or ETF with more than twenty percent of its assets in corporate bonds. For the funds meeting this requirement, we use the same database to collect information on the number of holdings, the concentration of holdings, as well as, the average duration and credit quality of the funds holdings. Matching on fund cusip , we use the CRSP mutual fund database to acquire their quarterly holdings, monthly returns, monthly total net assets, turnover, expense ratio, and the retail or institutional share class data. Furthermore, we use the CRSP database to distinguish ETFs from mutual funds using the variable, et_flag, and to distinguish active mutual funds from index mutual funds using the variable, $index\_fund\_flag$.

Portfolio characteristics are at the fund level, meaning different shares classes of the same fund have the same characteristics. These portfolio characteristics include holdings, portfolio turnover, portfolio composition, average duration and average credit quality. However, some characteristics are at the share class level such as total net asset, monthly return, expense ratio, retail or institutional. All our analysis is at the fund level. Therefore for each fund, we aggregate its share class characteristics using total net asset-weighted average.

Finally, we use TRACE database for bond transactions data. Bond characteristics come from Mergent FISD. We use CRSP for the daily closing price of ETFs. Our data starts from January 2010 and ends at March 2015. We elect to begin the data in 2010 as ETF assets began to achieve significant growth around this time.

4 Methodology and Results

This section details the methodology and results that we use to examine the role of mutual funds and ETFs in the yield spreads of associated bonds following the Taper Tantrum. We begin by considering the price effects of the broad investment vehicles and then examine three potential explanations for our main results. Finally, the section concludes with robustness tests.

4.1 Yield Effect of Investment Vehicles

Our attempts to identify a causal effect begin with panel regressions of changes in daily yield spreads relative to pre-shock levels on tantrum outflows and a variety of controls. To correct for correlations between bonds from the same issuer and across bonds on the same day standard errors are clustered by issuer and day. In particular, for each of the t months following the end of the Tantrum we run the following specification,

$$
\begin{aligned}
(Spread_{d,t} - Spread_{May})_{i,j} = \alpha &+ \lambda j + \beta_1 Fund\ Outflow_{i,Tantrum} + \beta_2 Fund\ Outflow^2_{i,Tantrum} \\
&+ \beta_3 Time\ to\ Maturity_{i,May} + \beta_4 Time\ to\ Maturity^2_{i,May} \\
&+ \beta_5 Size_{i,May} + \beta_6 Amihud_{i,May} + \beta_7 Spread_{i,May} \\
&+ \beta 8 (Time\ to\ Maturity_{i,May} * Fund\ Outflow_{i,Tantrum}) \\
&+ \beta_9 (Amihud_{i,May} * Fund\ Outflow_{i,Tantrum}) + \epsilon_{ijt} \qquad (1)
\end{aligned}
$$

The dependent variable,$(Spread_{d,t} - Spread_{May})_{i,j}$, is the change in yield spread relative to the maturity-matched Treasury rate of bond i from issuer j. The change is measured between day d in month t and the onset of the event in May. The months t run from September 2013 to December 2014. More precisely, the base date is the volume-weighted average yield of bond i in month May over the Treasury rate.[4] By running the test over several months, we are following the methodology of Coval and Stafford (2007) and Mitchell, Pulvino, and Stafford (2004). The tests look at cumulative returns and subsequent reversals to provide evidence of a non-fundamental shock to prices, a fire sale. To account for multiple offerings from the same issuer we include an issuer fixed effect, λ_j. The inclusion of these fixed effects addresses endogeneity issues associated with changes in the fundamentals of an issuer. If our event, Taper Tantrum, is accompanied by changes in fundamentals for some firms, we cannot conclude that the outflows from a certain investment vehicle are the driver of yield spread changes. The issuer fixed effect helps us keep the bond fundamentals fixed and capture only the difference in yield spread changes which is due to differential exposure to outflows. Therefore, if a firm has only one outstanding issue, it automatically drops out of the analysis. $Fund\ Outflow_{i,Tantrum}$ is the weighted average monthly flow for all mutual funds or ETFs that reported bond i as a holding immediately prior to the onset of the event. The Taper Tantrum event is 3 months between June to August 2013. To be included in the regression we require the weighted average flow to which a bond is exposed is negative, i.e. outflows. Furthermore, we multiply the flow measure by -1 to help with interpretation of the covariate of interest, β_1. The coefficient measures the impact of Tantrum outflows on the change in spread relative to

[4]The results are robust to the exclusion of trading days in May after Bernankes May 22$^{\text{nd}}$ speech.

pre-event levels. We also include the square of the covariate of interest, $Fund\,Outflow^2_{i,Tantrum}$, to control for nonlinearities in the relationship of interest. The controls account for bond specific characteristics, including $Size$ in millions of dollars, and $Time\ to\ Maturity$ and $Time\ to\ Maturity^2$, both in years. In addition, we control for the liquidity of individual bonds using the $Amihud$ illiquidity measure, which measure the median price impact of a trade. All of these measures are set to their levels prior to the onset of the event . The base spread, $Spread_{May}$, is used as a control to account for differences in issues from an issuer that are not captured by our other controls, for instance, differences in covenants. Finally we include interactions to account for the likelihood that investors are likely to sell bonds with greater interest rate exposure, $(Time\ to\ Maturity_{i,May} * Fund\ Outflow_{i,Tantrum})$, and more liquid bonds, $(Amihud_{May} * Fund\ Outflow_{Tantrum})$.

4.1.1 The Impact of Mutual Fund and ETF Outflows

We begin by considering the impact of the two distinct investment vehicle types, mutual funds and ETFs on their constituent bonds. We run the specification of equation (1) for the two vehicles separately and present the results in Table 2.

{Insert Table 2}

Panel A presents the results for all mutual funds, while Panel B documents the impact of ETFs. The results of the table show that there is no significant effect or distinguishable pattern for mutual fund outflows. Conversely, ETF outflows drive bond spreads significantly higher for up to seven months beyond the event . One month after the conclusion of the Tantrum, bonds with 1% higher Tantrum outflows have 8.8 basis points higher yield spreads relative to their pre-Tantrum spread.[5] Four months after the spreads are 6 basis points higher and seven months later they are 5.1 basis points higher. The effect diminishes after seven months after the conclusion of the shock with yield spreads reverting to their pre-crisis level. Figure 3 plots the ETF coefficients and documents that ETF outflows have a significant impact on yield spreads up to seven months after the conclusion of the shock.

[5] Standard deviation of the independent variable, Fund Outflow, is 1.62%. Therefore one standard deviation increase in Tantrum outflows leads to 8.8*1.62=14.3 bps higher yield spreads relative to their pre-Tantrum spread.

{Insert Figure 3}

According to Coval and Stafford (2007) if these yield changes are due to changes in fundamentals, the yields should remain permanently higher. However, the figure documents that there is a reversion back to pre-Tantrum levels after seven months. Together the higher yield spreads coupled with the reversion suggests that ETFs put temporary pressure on bonds, pushing yields beyond their fundamental levels. Therefore the evidence suggests that changes in yield spreads can be attributed to price pressure created by outflows from ETFs not changes in fundamentals.

In the following subsections we consider three potential explanations for the differential effect for the two investment vehicles. First, we consider if there are structural difference between mutual funds and ETFs that may impact their response to flow shocks. In particular, we examine the differences in cash reserves and other liquid holdings. Furthermore, we consider if the restrictions imposed by the index strategy of ETFs contributes to the different findings, by comparing the active mutual funds to index mutual funds. Second, we examine differences in the sensitivity of flows between ETFs and mutual funds. This study is motivated by the possibility that the two structures attract investors with different investment horizons and liquidity needs. Finally, we consider the impact of arbitrage activities between ETFs and the underlying basket.

4.1.2 Structural Differences between Mutual Funds and ETFs

The structural features that distinguish ETFs from mutual funds are a potential explanation for the results above. The distinct redemption process and other managerial features enable ETFs to be fully invested in representative securities. While the strategy allows ETFs to closely replicate the benchmark indices, it also reduces any buffer in the event of extreme flows. For example, if an ETF receives a large redemption the fund accepts shares of the ETF and delivers the corresponding underlying basket to the AP . It is unlikely that the AP will want to keep the bonds on its book and therefore enters the underlying market and sells the bonds immediately. Conversely, mutual funds that receive a large redemption have to deliver cash to investors. They usually prefer to meet redemptions with their cash holdings or selling their more liquid securities, such as Treasuries, rather than transacting in the corporate bond market.[6] (Hoseinzade (2015)) To identify if the portfolio composition strategies of mutual funds and ETFs are distinct we compare the portion of fund assets attributed to different investment categories and then measure the statistical difference between the two values. Table 3 presents the results of the comparison. Panel A presents the results for the mean and median figures for all funds, while Panel B presents those for just ETFs and mutual funds in the lowest quartile of fund flows for each investment vehicle.

{Insert Table 3}

The results suggest that the structural differences between the two investment vehicles lead to significant disparities in the types of assets held. For instance, the median mutual fund holds 21.72% of its assets in cash and government bonds. The size of the liquid holdings may have been sufficient to buffer less liquid holding from the impact of this temporary shock. Our results do not rule out the possibility that even sharper outflows would not lead to yield effects for bonds exposed to mutual funds. In contrast, the median ETF has just 2.74% in these high liquidity assets. Furthermore, the median ETF corporate bond holdings are nearly double that of the median mutual fund. The magnitude of the results is reduced when considering the funds most likely to have to liquidate corporate bonds in Panel B. However, the same pattern is evident with mutual funds holding more cash and fewer corporate bonds. In addition, comparing the holdings of the funds in the lowest quartile to those of all funds suggests that the fund managers did not anticipate the withdrawals by adjusting their portfolios.

Another distinguishing feature of ETFs relative to the broad mutual fund universe is that ETFs are universally index based products. The nature of the product requires that changes to the portfolio are done in predetermined weights to maintain similarity to the benchmark. Therefore, the decision making process of managers is highly constrained. In contrast, mutual funds can be either index based or active. Index mutual funds face the same limitations when responding to flows (Christoffersen, Keim, and Musto (2011)). However, active mutual funds are able to use discretion in selecting which assets to liquidate to meet redemption requests. This flexibility may allow mutual fund managers to seek out bonds on which they will have

[6] Manconi, Massa, and Yasuda (2012) show that in the onset of the financial crisis 2007-2008 when securitized assets became toxic, mutual funds tended to sell corporate bonds which were more liquid than securitized bonds.

the lowest price impact. To examine if the ETF yield pressure results can be attributed to their index strategies we break down the mutual fund universe into active and index funds. We then execute the same tests as in Table 4 for the two subsets of mutual funds. Panel A presents the results for only active mutual funds, while Panel B documents the role of index mutual fund outflows on yield spread changes.

{Insert Table 4}

Neither active nor index mutual fund outflows have a significant relationship with the yield spread change. The results suggest that the mutual fund structure, with relatively high cash and government bond levels, provides a sufficient buffer for underlying bonds when the funds are faced with outflows. Overall, the results of this section suggest that structural and operational features, outside of the index strategy, that influence the construction of mutual fund and ETF portfolios may play a role in the differential results.

4.1.3 Sensitivities of ETF and Mutual Fund Flows

Chordia (1996), Deli and Varma (2002) and Nanda, Narayanan, and Warther (2000)all posit that funds adopt different fund structures and fees to separate costly short-term investors from long-term investors. Furthermore, Amihud and Mendelson (1986) and Constantinides (1986) predict that short-term investors self-select into more liquid assets. In one of the first academic papers on ETFs, Poterba and Shoven (2002) claim that ETFs are more appropriate for investors who demand short-term liquidity. Anecdotally, ETFs were first marketed towards retail investors, who are assumed to be uninformed. Under this framework, we posit that ETFs are likely to attract short-term liquidity investors because of their relatively low expense ratios and high liquidity. To examine the potential for different investment types between mutual funds and ETFs, we document and examine differences in their monthly fund funds. To start Table 5 presents summary statistics of the average monthly flows during the height of the Taper Tantrum, from June 2013 to August 2013, for the different investment vehicles.

{Insert Table 5}

The statistics presented above show that on average ETFs have greater inflows than the all mutual funds during the period. The average ETF had an inflow of 4.52%, while all mutual funds average 0.55% with the mean passive subset experiencing an outflow. For all investment types the median flow is around zero. Interestingly the standard deviation of ETFs is much higher at 12.73% that the 6.96% of mutual funds suggesting that ETF investors may be more inclined to demand liquidity than mutual fund investors. Figure 4 shows the volatility of fund flows for mutual funds and ETFs from January 2010 to March 2015.

{Insert Figure 4}

The figure documents that ETFs not only have significantly higher standard deviation of flows over a long time frame, but also have more flow uncertainty as the standard deviation of ETF flows is less smooth than that of mutual funds. Finally, there is an increase in flow standard deviation for ETFs of nearly one percentage point during the Taper Tantrum.

Continuing to examine the potential for different investor types in ETFs and mutual funds, we examine the sensitivity of investors to changes in interest rates over the period from January 2010 to March 2015. Since interest rates dictate the price of the underlying corporate bonds, we test if ETFs are more likely to respond using the following specification

$$Flow_{f,t} = \alpha + \delta(\Delta I/R_{t-1} * ETF_f) + \beta_1 \Delta I/R_{t-1} + \beta_2 ETF_f + \beta_2 X_f + \epsilon_{f,t} \tag{2}$$

The dependent variable in the above regression, $Flow_{f,t}$, is the monthly flow to fund f in month t, where flow is defined

$$Flow_{f,t} = \frac{TNA_{f,t} - TNA_{f,t-1} * (1 + R_{f,t})}{TNA_{f,t}} * 100 \tag{3}$$

$\Delta I/R_{t-1}$ is the change in one of two treasury rates in the prior month normalized by its standard deviation. The rates that we consider are the one-year, five-year, and treasury rates. ETF_f is a dummy variable equal to one if the fund is an ETF and zero for mutual funds. We also include a variety of fund specific controls commonly cited in the literature. These include the average effective duration and rating of the fund's holdings. The expense ratio, turnover, portion of retail investors, and one, two, and three month lagged fund flows are also used as control. The coefficient of interest, δ, on the interaction $\Delta I/R_{t-1} * ETF_f$, measures the differential behavior of ETF investors. Table 6 shows the results of these tests.

{Insert Table 6}

The coefficient on $\Delta I/R_{t-1}$ show that mutual fund and ETF flows are generally do not respond to changes in interest rates, controlling for other factors. Meanwhile, the coefficient on the ETF dummy suggest that this investment vehicle has larger inflows over the 2010 to 2015 period, likely the result of the significant growth in ETF assets over the time period. Interestingly, the coefficient on our interaction is negative and significant for both one-year and five-year interest rate changes suggesting that ETF investors are more likely to demand liquidity when interest rates increased in the previous month. In particular, a one-standard deviation in the one-year Treasury rate leads to 0.09% higher outflows for ETFs than for mutual funds. These results show that ETF investors are more likely to trade in response to interest rate changes, suggesting they are unlikely to be long-term investors. The results of this regression support our hypothesis that ETFs attract shorter-term investors.

Overall, this section documents the presence of short-term liquidity traders in ETFs. The presence of these traders, who as suggested by Allen, Morris, and Shin (RFS 2006), may overweight a public signal leading to prices deviating from fundamental values. Furthermore, the results combined with the main findings that ETF outflows led to higher yield spreads for exposed bonds suggest that ETFs may have introduced a noise trader risk to the corporate bond market (De Long et al. (1990)).

4.1.4 Role of ETF Arbitrageurs

Arbitrage is the foundation not only of modern financial theory, but also of the pricing of ETFs. When the market price of the ETF diverges from the net asset value (NAV) of the underlying baskets, arbitrageurs buy the underpriced asset and short the overpriced assets. For instance, if the ETF market price is trading at a discount to the NAV of the basket the arbitrageur would sell short the basket securities in the corporate bond market and buy the ETF shares on the equity exchange. If the arbitrageur is an Authorized Participant (AP), he can accumulate enough ETF shares to exchange for the basket of underlying through the in-kind creation and redemption process. He can then use the bonds that he received through this exchange to cover his short position in the corporate bonds. While the illiquidity of the corporate bond market makes corporate bond ETF arbitrage more challenging than for most equity ETFs, Figure 5 shows that it is successful for two-thirds of corporate bond ETFs the average percentage price deviation from NAV defined as

$$Deviation = \frac{P_{ETF} - NAV_{Basket}}{NAV_{Basket}} \tag{4}$$

is less than twenty basis points immediately before the onset of the Taper Tantrum.

{Insert Figure 5}

For the most efficient ETFs, those in the lowest tercile of average price to NAV deviation, arbitrageurs are able to maintain near equality between the two prices. However, immediately after the onset of the Tantrum these ETFs see a sharp divergence between the price and NAV. The average price to NAV deviation moves sharply lower, averaging over 50 basis point, indicating that ETF investors implicitly value the basket of securities less than the bond market. It is likely that these ETFs are also the most liquid securities and are thus those used by investors to react to the change in beliefs during the Tantrum. Furthermore, the liquidity of ETFs relative to the underlying corporate bonds makes it highly probable that investors would prefer to transact in the ETF market rather than the bond market. Under these dynamics an arbitrage opportunity was created as ETF prices moved lower, but the NAV prices remained elevated or stale as fundamental investors remained in individual bond positions. The existence of these arbitrage opportunities translates into selling pressure for the individual bonds. Therefore, we hypothesize that bonds that are exposed to ETFs that experienced this sharp decline in the price to NAV relationship, were subjected to greater selling pressure by arbitrageurs. These arbitrageurs are insensitive to the fundamental price of the bond because their profit depends only on the relative price of the ETF and its component bonds.

To test this hypothesis, we use two methods to form portfolios at the end of August 2013 based on the exposure of individual bonds to arbitrage. Specifically, we measure the average monthly price to NAV deviation of an ETF during the Taper Tantrum. We then calculate the exposure of a bond as the value-weighted average deviation of all ETFs that hold the bond. The first sort method divides the entire sample of bonds into high and low exposure portfolios. The high exposure portfolio includes all bonds with a deviation measure less than the median value. We then track the yield spread of these two portfolios until the end of our sample in March 2015. Panel A of Figure 6 documents the results for the average yield spread for these two portfolios along with the 90% confidence intervals. Panel B presents the difference between the yields and the t-statistics on the difference.

{Insert Figure 6}

Figure 6 documents that there is no significant difference between the average yield spreads of these two portfolios before and during the Taper Tantrum. However, the portfolios begin to diverge at the end of the shock with the yield spread of the high arbitrage exposure portfolio moving significantly higher than of the low arbitrage exposure portfolio. These results suggest that arbitrageurs sold the high exposure bonds at prices beyond fundamental levels. The difference between the yields spreads of the two portfolios remains significant until July 2014. The timeline for the convergence of the two portfolios yields coincides with the closing of the arbitrage opportunity shown in Figure 6 supporting our hypothesis that the non-fundamental move in prices can be attributed to arbitrage activity.

One potential flaw of our initial portfolio formation strategy is that the bonds in the two portfolios may be fundamentally different. For instance, the portfolios could have differential exposure to the shock for reasons beyond their ETF arbitrage exposure. To address this concern, we take advantage of multiple issues from the same issuer. For each issuer, we put the bond with lowest weighted average deviation measure in the high arbitrage exposure portfolio and the bond with the highest deviation measure in the low arbitrage exposure portfolio. In this setting, we are implicitly comparing bonds with similar fundamental, but different arbitrage exposures. The results are documented in Panel A and Panel B of Figure 7.

{Insert Figure 7}

The results of this portfolio test confirm those of the larger sample. After the shock, the yield spread between the two portfolios widen as the high portfolio bonds are subjected to the selling pressure of arbitrageurs, before ultimately converging.

4.1.5 Robustness Tests

Our initial tests of the impact of mutual fund and ETF Tantrum outflows utilize monthly panel regressions of daily yield spreads relative to the pre-shock yield spread on a variety of controls. We use of this test because it allows for more reliable computation of t-statistics. The downside of the panel setting is that bonds that trade more frequently may drive the results. To address these issues we run equation (1) with the dependent variable set to the change in the average volume weighted yield of bond i over the maturity matched Treasury rate in month t relative to the May yield spread. Table 7 presents the results of the regression for mutual funds in Panel A and ETFs in Panel B.

{Insert Table 7}

The results are nearly identical to those of Table 2 with the same fire sale consistent pattern evident in relation to ETF outflows. In Table 7, standard errors are culstered at the issuer level. We also try clustering standard errors at the credit rating level and significance level of the results stay the same.

In another robustbess test, we also run quarterly panel regressions instead of monthly panel regressions for the regression equation (1). In quarterly panel regresssions the time series is longer since for each bond, we have 22*3=66 potential daily observations while in monthly panel regressions, we have 22 potential daily observations.[7] Running quarterly panel regressions, the results are very similar to what we report in Table 2 for monthly panel regressions.

5 Conclusion

The corporate bond market long dominated by broker-dealers and long-term investors, such as insurance companies, has seen its primary market makers withdraw and new more liquid forms of innovation emerge. This paper uses an unexpected increase in the interest rates and subsequent outflows from ETFs and mutual funds, in an event known as the Taper Tantrum,

[7] We assume there are 22 trading days in each month. Since not all bonds are traded everyday, so 66 is the maximum number of observation for a bond in a given quarter.

to cleanly identify the impact of fund outflows on bond yields. We find that ETF outflows lead to significantly higher yield spreads in the months following the shock, with the impact lasting seven months. The significance and pattern of the coefficients of our regression indicate that ETFs contribute to fire sale transactions in the corporate bond market. However, the mutual funds can handle a temporary shock to fund flows and hence, do not engage in fire sales.

We further investigate the differences between ETFs and mutual funds and show that the contrasting findings for ETFs and mutual funds can be attributed to factors. First, ETFs hold a smaller amount of liquid assets such as cash and government bonds than mutual funds. Second, ETF investors are more sensitive to the changes in the interest rates. We finally show that the activity of arbitrageurs who take advantage of the mispricing between ETF shares and the underlying basket NAV, has a significant impact of bond yields.

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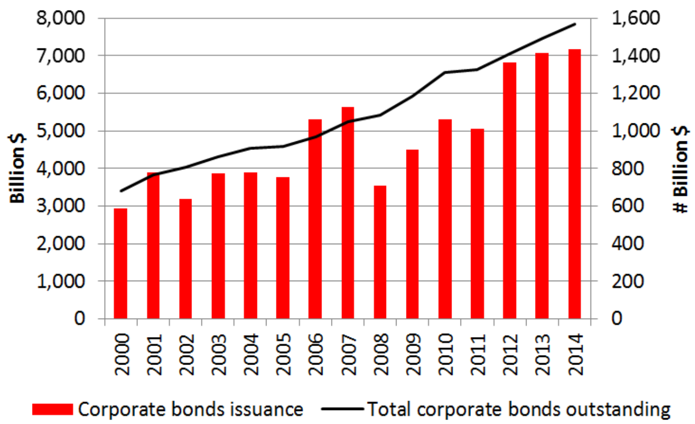
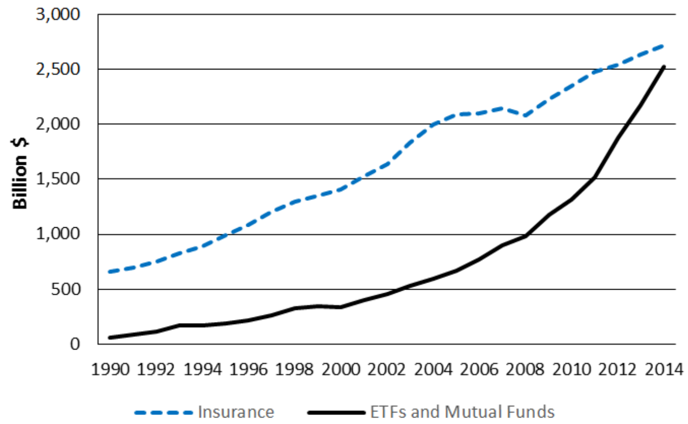
The Evolution of the Corporate Bond Market

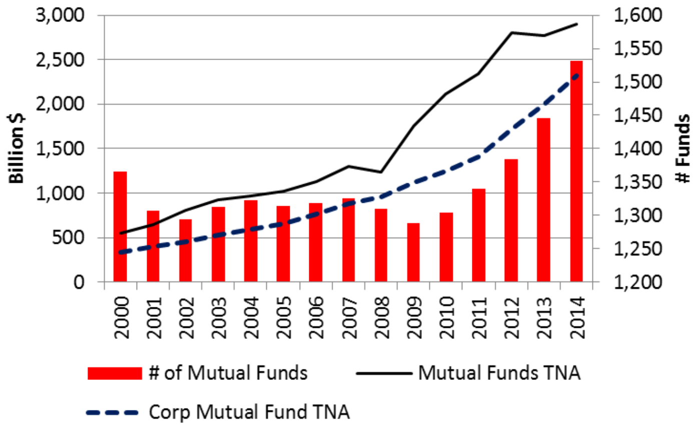
Panel A: The growth in corporate bond issuances



Panel B: Corporate Bond Holdings of Market Participants



Panel C: The Growth in Corporate Bond Mutual Funds



Panel D: The Growth in Corporate Bond ETFs

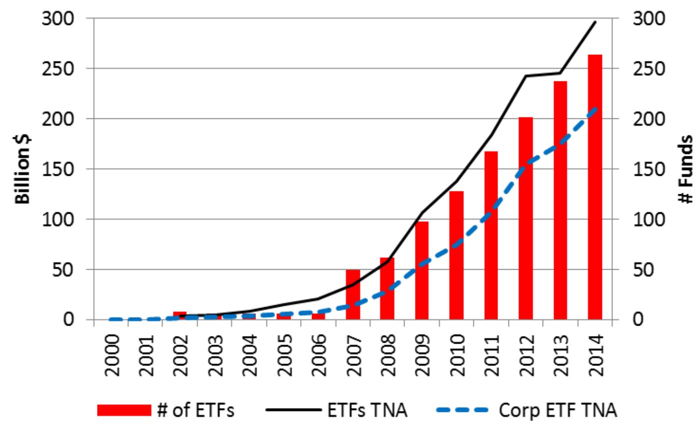


Figure 1: Panel A plots the growth of the corporate bond market since 2000. The left hand axis and black line represent the total dollar amount outstanding in corporate bonds. The right hand axis and the red bars document the total amount of new issuance each year. Panel B plots Corporate bond assets held by different market participants since 1990. The data comes from the Federal Reserve Board L.212(A) filing. Insurance assets are the sum of life and property-casualty insurers. ETFs and mutual funds include all ETFs and open-end mutual funds. Panel C plots he growth in assets under management and the number of corporate bond mutual fund alternatives. The left axis document the total assets under management. The solid line represents all taxable long-term bond fund assets from ICI Factbook, while the dashed line depicts the total corporate bond assets held by long-term open-end mutual funds from the Federal Reserve Board L.212(A) filing. The right axis and red bars plot the number of long-term taxable bond mutual fund offerings from ICI. Panel D plots the growth of assets and number of ETFs as in Panel C.

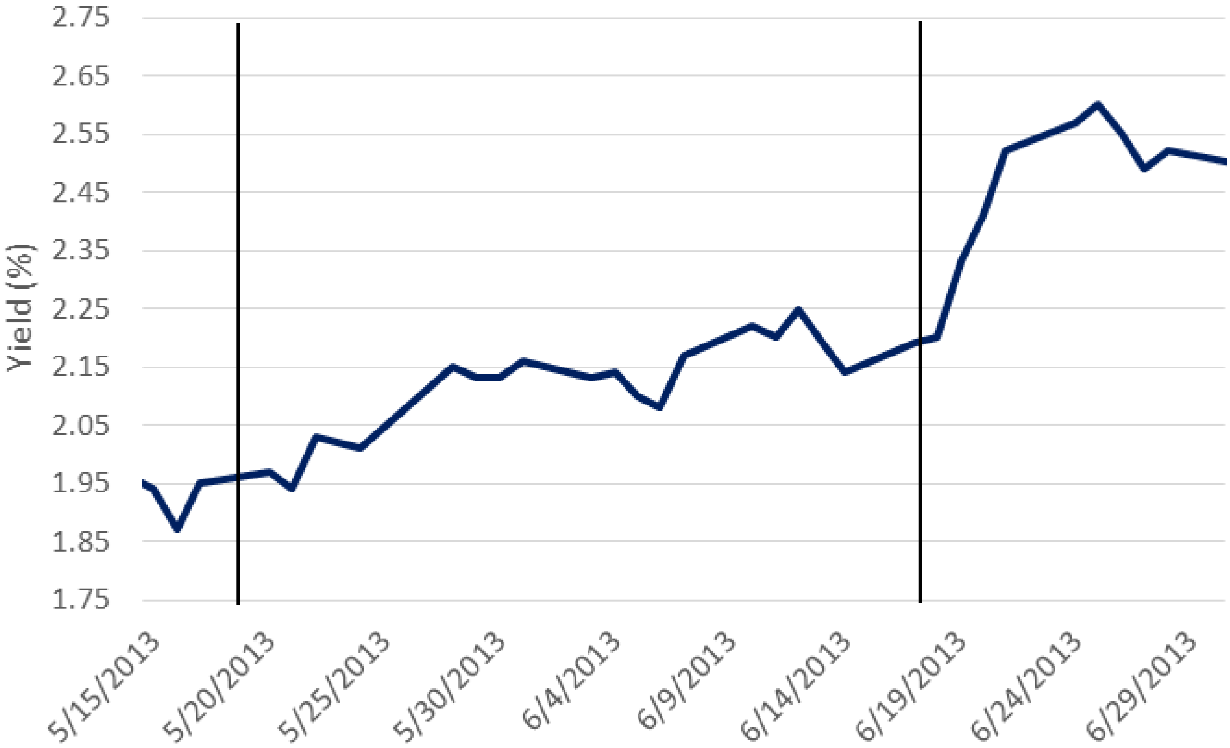


Figure 2: This figure presents the daily closing yield on the ten-year Treasury bond around Federal Reserve Chairman, Ben Bernakes first discussions concerning the slowdown in the Feds Quantitative Easing program. The first vertical line marks Bernakes testimony to Congress, while the second vertical line identifies his press conference that confirmed his initial statements.

Cumulative Yield Spread Changes for One Standard Deviation Change in ETF Tantrum Outflows

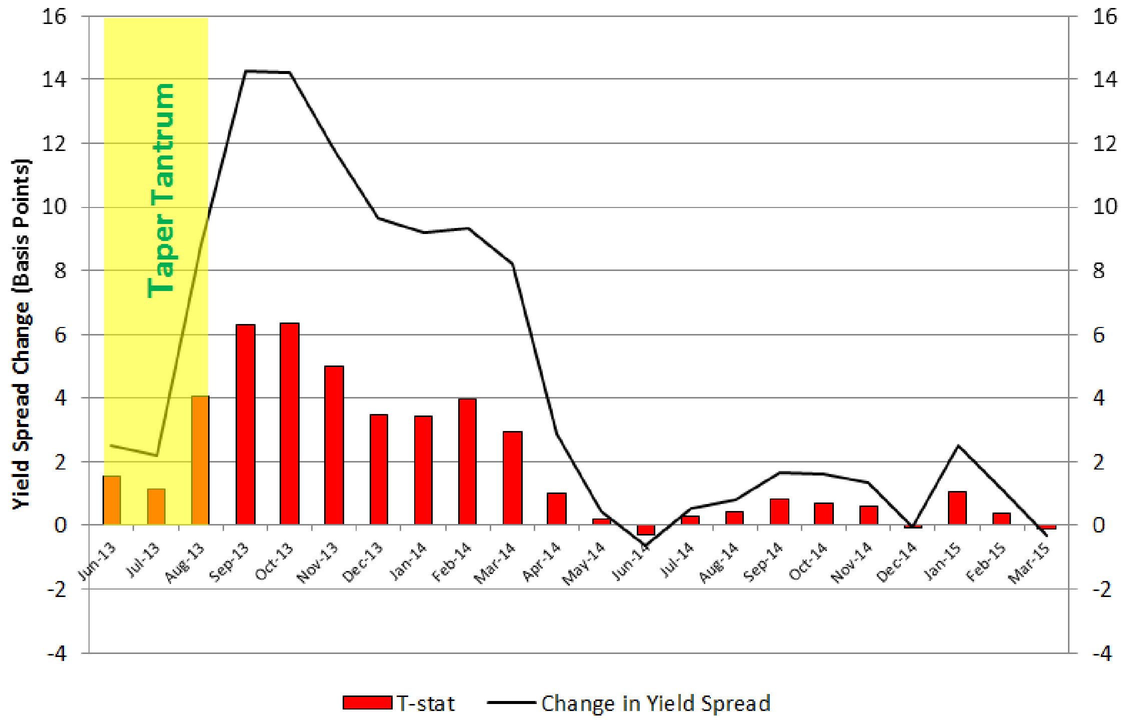


Figure 3: The figure plots the yield spread change for each month relative to pre-Tantrum levels for a one standard deviation increase in ETF outflows during the Taper Tantrum. The red-bars represent the t-statistics from the regression of the yield spread change on ETF outflows and other control variables described in Table 1.

The Volatility of Fund Flows

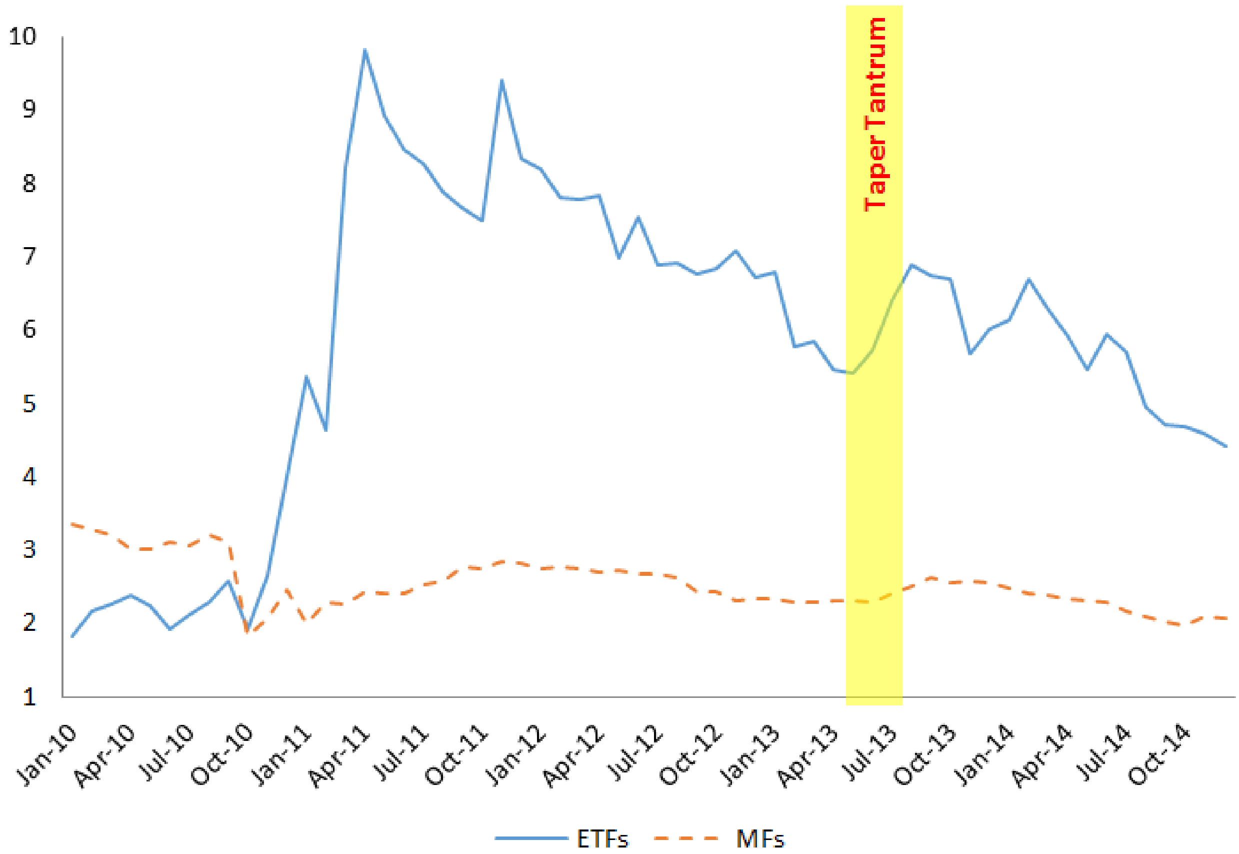


Figure 4: The figure documents the median volatility of mutual fund and ETF flows from January 2010 to December 2014. The period used as a quasi-natural experiment in this paper is highlighted by the yellow box.

Percentage Price to NAV Deviations

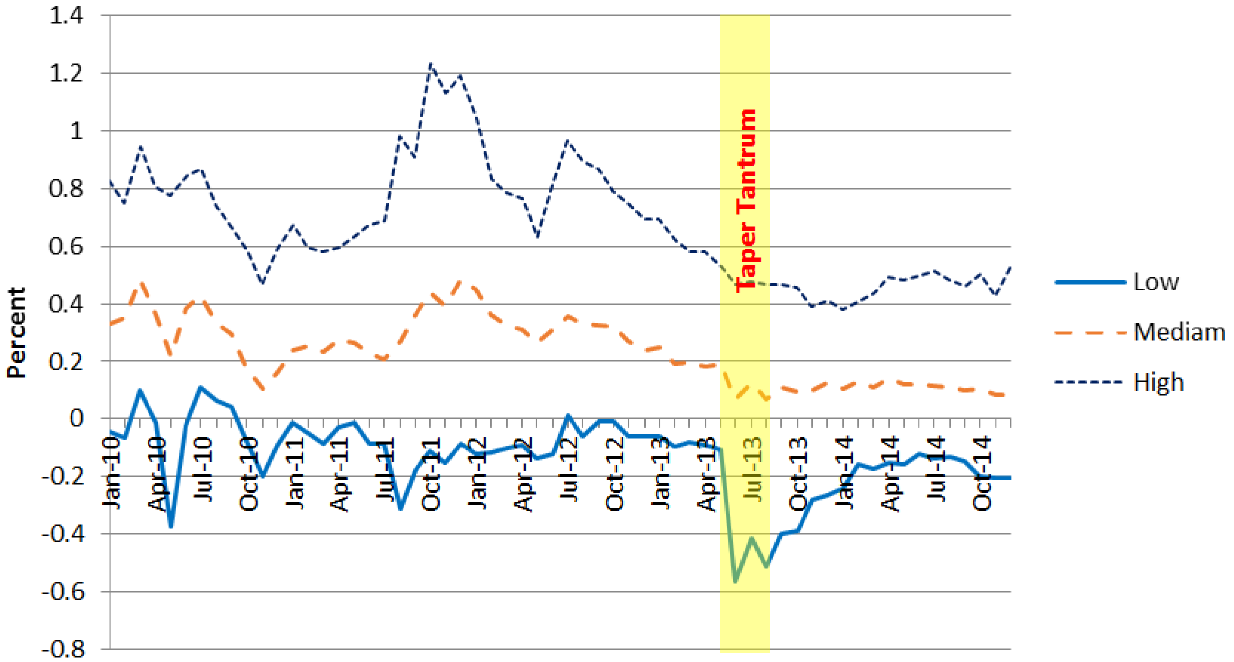
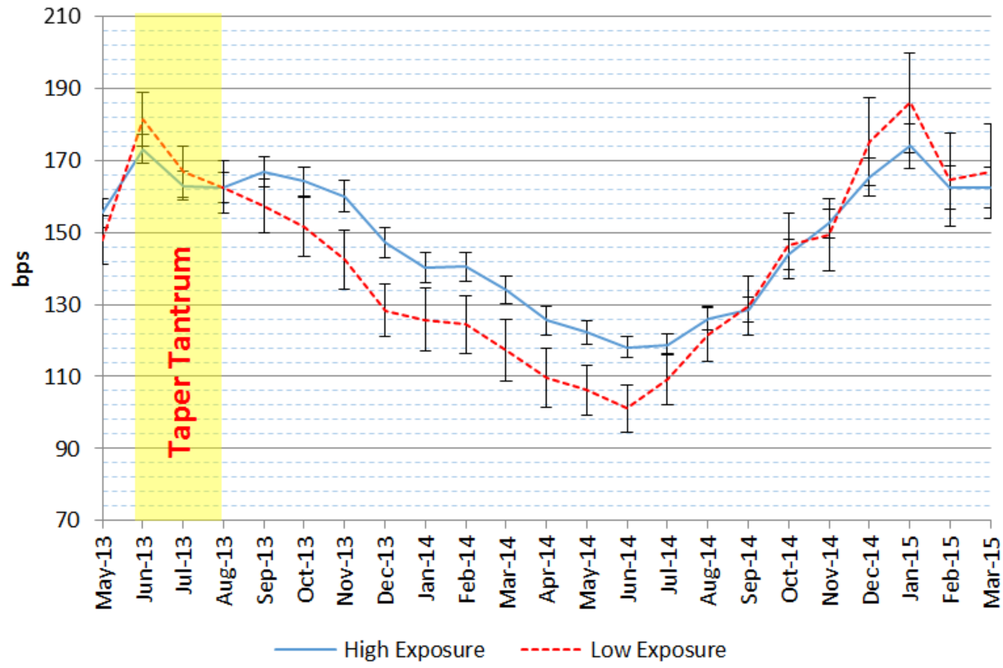


Figure 5: The time series of price deviations from NAV computed as $\frac{P_{ETF}-NAV}{NAV}$ is plotted for corporate bond ETFs. ETFs are broken into terciles for using their average deviation

Panel A: The Average Yield Spread of High and Low ETF Arbitrage Exposure Portfolios



Panel B: Portfolio Yield Difference

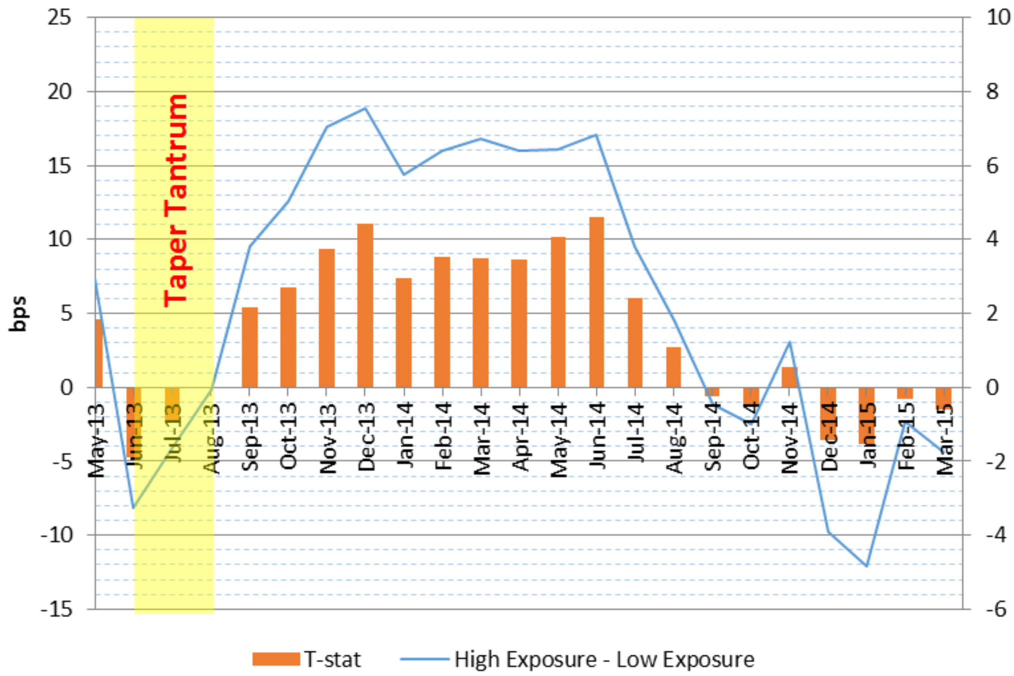
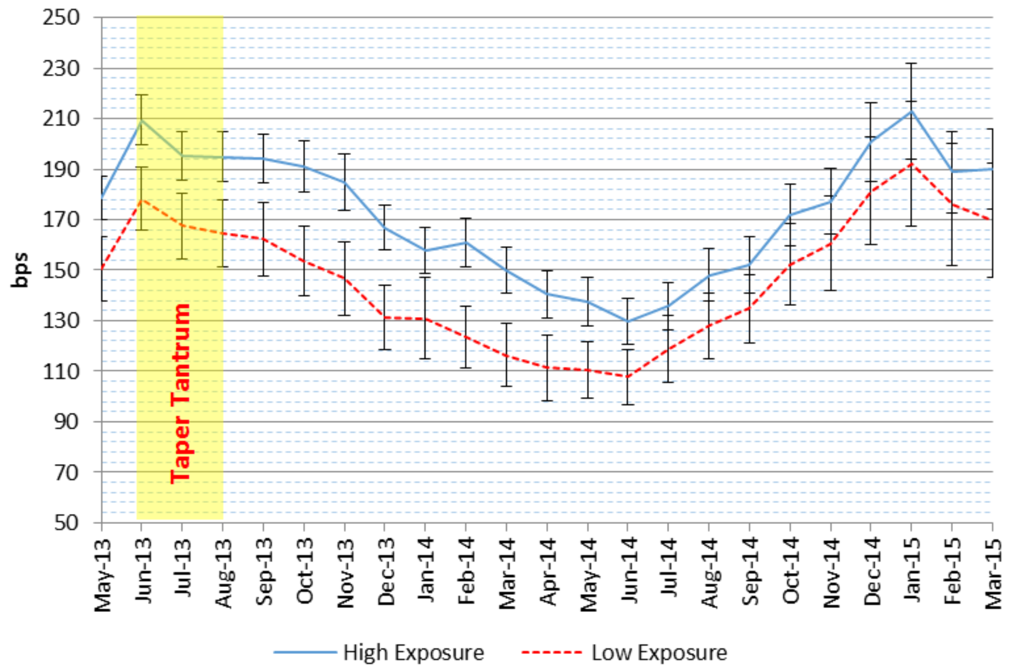


Figure 6: In Panel A corporate bonds are broken into two portfolios relative to their exposure to ETF arbitrage activities following the Taper Tantrum. The exposure of a bond is the value-weighted average deviation of all ETFs that hold the bond. We divide the entire sample of ETF bonds into high and low exposure portfolios. The high exposure portfolio includes all bonds with a deviation measure less than the median value as these are the ETFs that arbitrageurs are most likely to be active. We then track the yield spread of these two portfolios until the end of our sample in March 2015. This panels documents the results for the average yield spread for these two portfolios along with the 95% confidence intervals. Panel B presents the difference in the average yields of the two portfolios and the t-statistics of this difference.

Panel A: The Average Yield Spread of High and Low ETF Arbitrage Exposure Portfolios



Panel B: Portfolio Yield Difference

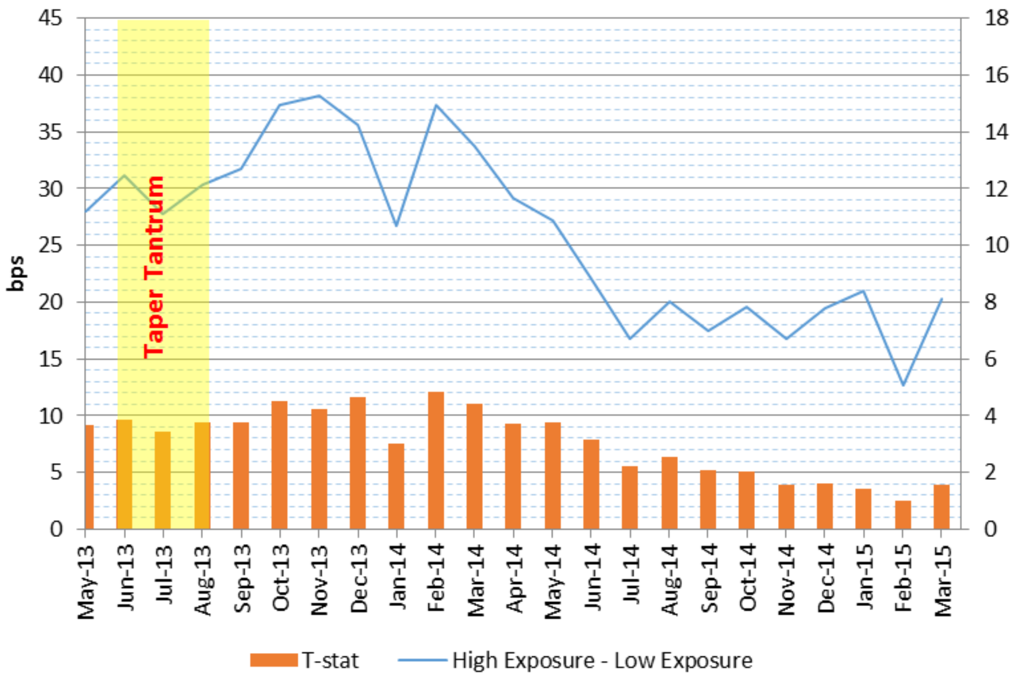


Figure 7: In Panel A corporate bonds from the same issuers are broken into two portfolios relative to their exposure to ETF arbitrage activities following the Taper Tantrum. The exposure of a bond is the value-weighted average deviation of all ETFs that hold the bond. We divide the entire sample of ETF bonds into high and low exposure portfolios. The high exposure portfolio includes all bonds with a deviation measure less than the median value as these are the ETFs that arbitrageurs are most likely to be active. We then track the yield spread of these two portfolios until the end of our sample in March 2015. This panels documents the results for the average yield spread for these two portfolios along with the 95% confidence intervals. Panel B presents the difference in the average yields of the two portfolios and the t-statistics of this difference.

Table 1: Summary Statistics

Summary statistics by investment vehicle type for the quarterly holdings data released in March 2013 immediately before the Taper Tantrum are presented below. The data is composed of corporate bond mutual fund and Exchange Traded Funds (ETFs). Panel A presents the distribution of observable summary statistics for corporate bond mutual funds, including both active and index funds. Panel B documents the distribution for ETFs. Total net assets is the dollar of value in millions for all share classes of the fund. # of holdings is the number of unique bonds held by the fund. % in top 10 holdings documents the percentage of assets concentrated in the largest holdings of the fund. Turnover is a yearly measure defined by CRSP. Expense ratio is the asset-weighted percent expense ratio of the fund for all share classes of the fund. Share of retail investors is defined as the ratio of the total assets of a fund held in retail share classes. Average duration and Average credit quality are the value-weighted characteristics of all bonds holdings.

Panel A: Mutual Funds	**Mean**	**STD**	**10%**	**25%**	**50%**	**75%**	**90%**
Total net assets ($mln)	1,751.39	5,989.49	25.80	89.80	356.10	1,209.50	3,316.30
# of holdings	430.61	822.88	20.00	85.00	263.00	494.00	918.00
% in top 10 holdings	31.40	50.50	6.45	11.04	18.89	36.48	85.34
Turnover	1.27	1.77	0.21	0.37	0.69	1.39	3.15
Expense ratio (%)	0.85	0.49	0.31	0.56	0.80	1.00	1.33
Share of retail investors	0.50	0.39	0.00	0.05	0.52	0.95	1.00
Average duration	4.05	1.89	1.50	3.08	4.23	5.12	5.89
Average credit quality	2.68	1.25	1.00	2.00	3.00	4.00	4.00
% invested in cash	12.99	14.64	1.85	4.13	8.38	15.98	28.50
% invested government bonds	17.76	18.49	0.00	0.56	13.31	28.39	43.61
% invested corporate bonds	51.52	28.16	19.83	27.60	45.44	77.62	94.77
% invested securitized bonds	14.85	15.91	0.00	0.30	9.67	26.47	38.30
% invested municipal	0.99	2.88	0.00	0.00	0.05	0.86	2.53

Panel B: ETFs	**Mean**	**STD**	**10%**	**25%**	**50%**	**75%**	**90%**
Total net assets ($ mln)	3,719.44	13,947.26	10.50	45.00	212.90	1,101.60	10,074.10
# holdings	675.43	1,840.71	43.00	104.00	232.00	760.00	1,410.00
% in top 10 holdings	21.00	20.02	4.45	8.60	15.39	24.98	43.56
Turnover	0.50	0.76	0.05	0.10	0.18	0.65	1.30
Expense ratio (%)	0.31	0.22	0.11	0.16	0.24	0.42	0.55
Average duration	4.85	3.24	0.91	2.89	4.74	6.01	7.81
Average credit quality	2.97	1.26	1.00	2.00	3.00	4.00	4.00
% invested in cash	8.90	16.29	0.00	0.60	2.40	7.41	29.88
% invested government bonds	12.12	19.57	0.00	0.00	0.34	19.11	45.25
% invested corporate bonds	74.78	29.30	23.59	50.50	93.27	98.49	99.99
% invested securitized bonds	3.49	9.81	0.00	0.00	0.01	0.45	12.77
% invested municipal	0.61	1.72	0.00	0.00	0.00	0.07	1.76

Table 2: Panel Regressions of Bond Yield Spreads and Mutual Fund and ETF Tantrum Outflow

Panel A reports results for mutual funds and Panel B for ETFs of the following monthly panel regressions.

$$(Spread_{d,t} - Spread_{May})_{i,j} = \alpha + \lambda j + \beta_1 Fund\ Outflow_{i,Tantrum} + \beta_2 Fund\ Outflow^2_{i,Tantrum} + \beta_3 Time\ to\ Maturity_{i,May} + \beta_4 Time\ to\ Maturity^2_{i,May} + \beta_5 Size_{i,May}$$
$$+ \beta_6 Amihud_{i,May} + \beta_7 Spread_{i,May} + \beta 8(Time\ to\ Maturity_{i,May} * Fund\ Outflow_{i,Tantrum}) + \beta_9(Amihud_{i,May} * Fund\ Outflow_{i,Tantrum}) + \epsilon_{ijt}$$

The dependent variable, $(Spread_{d,t} - Spread_{May})_{i,j}$, is the change in yield spread relative to the maturity-matched Treasury rate of bond i from issuer$j$. The change is measured between day d in month t and the onset of the event in May. The months t run from 1M (September 2013) to 16M (December 2014) after the end of the Tantrum. λ_j is an issuer fixed effect. $Fund\ Outflow_{i,Tantrum}$ is the weighted average monthly flow for all mutual funds or ETFs that reported bond i as a holding immediately before the Tantrum. Only bonds with negative flow exposure are included. Size (millions $), Time to Maturity (years), median Amihud illiquidity, and Spread are bond i characteristics set to their May level. Standard errors are clustered by day in each month. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Panel A: Mutual Funds						Panel B: ETFs					
	1M	**4M**	**7M**	**10M**	**13M**	**16M**	**1M**	**4M**	**7M**	**10M**	**13M**	**16M**
Fund Outflow	0.014	0.018	-0.019	-0.088*	-0.080	-0.004	0.088***	0.060***	0.051***	-0.003	0.010	0.000
	(0.64)	(0.52)	(-0.56)	(-1.73)	(-1.54)	(-0.17)	(6.29)	(3.47)	(2.95)	(-0.31)	(0.82)	(-0.02)
Fund Outflows^2	-0.003	-0.005	0.000	0.007	0.003	-0.003	-0.005***	-0.001	0.000	0.004***	0.002	0.004
	(-1.21)	(-1.01)	(0.01)	(1.37)	(0.64)	(-0.90)	(-3.64)	(-0.73)	(-0.17)	(2.60)	(1.14)	(1.40)
Log(Size)	0.058**	-0.011	0.022	-0.008	-0.002	-0.028	0.009	-0.008	0.009	0.012	0.026**	0.007
	(2.03)	(-0.44)	(0.71)	(-0.34)	(-0.16)	(-1.30)	(0.72)	(-0.58)	(0.63)	(1.17)	(2.16)	(0.39)
Time to Maturity	-0.006	0.005	0.009	0.000	0.016	0.040***	0.017***	0.021**	0.032***	0.035***	0.044***	0.042***
	(-1.25)	(0.42)	(0.99)	(-0.05)	(0.79)	(6.34)	(3.05)	(2.43)	(4.78)	(7.10)	(7.80)	(6.16)
Time to Maturity^2	0.000	0.000	0.000	0.000	0.000	0.000***	0.000*	0.000	0.000**	0.000***	0.000***	0.000***
	(-0.76)	(-1.24)	(-1.50)	(0.08)	(-0.61)	(-3.23)	(-1.83)	(-1.57)	(-2.47)	(-3.24)	(-3.05)	(-3.57)
Amihud	-1.731	-1.050	-3.169*	-4.341**	-2.409	-2.047	-0.273	-0.254	-0.318	0.707	1.474	3.796
	(-0.86)	(-0.42)	(-1.67)	(-2.07)	(-1.06)	(-1.23)	(-0.30)	(-0.16)	(-0.31)	(0.60)	(1.28)	(1.13)
Spread$_{t-1}$	0.192***	0.026	0.029	0.109	-0.164	-0.337***	-0.190***	-0.243***	-0.317***	-0.386***	-0.481***	-0.395***
	(4.36)	(0.22)	(0.33)	(0.49)	(-0.58)	(-4.78)	(-2.89)	(-2.77)	(-3.91)	(-6.12)	(-8.75)	(-4.50)
Time to Maturity * Fund Outflow	0.001	0.001	0.001	0.003	0.003*	0.001	-0.001***	-0.002***	-0.002***	-0.001***	-0.001***	0.000*
	(1.50)	(1.15)	(1.17)	(1.44)	(1.80)	(0.38)	(-5.00)	(-4.80)	(-5.72)	(-3.68)	(-3.96)	(-1.73)
Amihud * Fund Outflow	0.292	0.072	-0.015	0.239	0.356	0.062	0.239	0.191	0.170	-0.168	-0.532	-1.607
	(2.07)	(0.85)	(1.40)	(0.66)	0.000	0.000	(0.74)	(0.27)	(0.37)	(-0.35)	(-1.03)	(-0.99)
No. of obs	36,383	31,221	33,605	31,230	29,421	28,246	30,902	26,724	29,160	27,403	26,358	25,631
R^2	0.16	0.03	0.01	0.02	0.03	0.09	0.07	0.06	0.10	0.20	0.19	0.11

Table 3: Portfolio Composition

This table presents statstics on the percent of fund assets held in different investment categories by mutual funds and ETFs. Panel A shows the statistics for all funds in our study and Panel B for only funds in the lowest quartile of flows during the Taper Tantrum. In each panel the mean and median, as well as, the difference between the mutual fund and ETF statistics are presented. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

Panel A: All Funds	**Mean**				**Median**			
	Mutual Funds	ETFs	Diff	P-Value	Mutual Funds	ETFs	Diff	P-Value
Cash	12.99	8.9	4.09**	0.02	8.38	2.4	5.98***	0.00
Government bonds	17.82	12.12	5.70***	0.01	13.34	0.34	13.00***	0.00
Corporate bonds	51.52	74.78	-23.26***	0.00	45.44	93.27	-47.83***	0.00
Securitized bonds	14.81	3.495	11.32***	0.00	9.54	0.01	9.53***	0.00
Panel B: Lowest Quartile	**Mean**				**Median**			
	Mutual Funds	ETFs	Diff	P-Value	Mutual Funds	ETFs	Diff	P-Value
Cash	10.52	3.74	6.78*	0.05	5.42	1.33	4.09***	0.00
Government bonds	18.37	18.72	-0.35	0.93	14.35	6.99	7.36	0.47
Corporate bonds	53.58	74.64	-21.06***	0.00	46.4	93	-46.60*	0.10
Securitized bonds	14.65	1.82	12.83***	0.00	6.97	0.18	6.79***	0.00

Table 4: Panel Regressions of Bond Yield Spreads and Mutual Fund Tantrum Outflows for Active and Index Funds

Panel A reports results for active mutual funds and Panel B for index mutual funds of the following monthly panel regressions.

$$(Spread_{d,t} - Spread_{May})_{i,j} = \alpha + \lambda j + \beta_1 Fund\ Outflow_{i,Tantrum} + \beta_2 Fund\ Outflow^2_{i,Tantrum} + \beta_3 Time\ to\ Maturity_{i,May} + \beta_4 Time\ to\ Maturity^2_{i,May} + \beta_5 Size_{i,May} + \beta_6 Amihud_{i,May} + \beta_7 Spread_{i,May} + \beta 8(Time\ to\ Maturity_{i,May} * Fund\ Outflow_{i,Tantrum}) + \beta_9(Amihud_{i,May} * Fund\ Outflow_{i,Tantrum}) + \epsilon_{ijt}$$

The dependent variable, $(Spread_{d,t} - Spread_{May})_{i,j}$, is the change in yield spread relative to the maturity-matched Treasury rate of bond i from issuer$j$. The change is measured between day d in month t and the onset of the event in May. The months t run from 1M (September 2013) to 16M (December 2014) after the end of the Tantrum. λ_j is an issuer fixed effect. $Fund\ Outflow_{i,Tantrum}$ is the weighted average monthly flow for all mutual funds or ETFs that reported bond i as a holding immediately before the Tantrum. Only bonds with negative flow exposure are included. Size (millions $), Time to Maturity (years), median Amihud illiquidity, and Spread are bond i characteristics set to their May level. Standard errors are clustered by day in each month. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Panel A: Active Mutual Funds						Panel B: Index Mutual Funds					
	1M	**4M**	**7M**	**10M**	**13M**	**16M**	**1M**	**4M**	**7M**	**10M**	**13M**	**16M**
Fund Outflow	0.006	-0.003	-0.025	-0.060**	-0.064**	-0.019	0.020	0.000	-0.029	-0.031	-0.059*	-0.027
	(0.49)	(-0.16)	(-1.27)	(-1.97)	(-2.02)	(-1.04)	(0.93)	(-0.02)	(-1.30)	(-1.48)	(-1.89)	(-0.88)
Fund Outflows^2	-0.001	0.000	0.000	0.002	0.001	0.000	-0.013*	-0.003	0.003	0.005	0.003	-0.001
	(-1.25)	(-0.79)	(0.32)	(1.47)	(0.87)	(0.21)	(-1.94)	(-0.55)	(0.60)	(0.95)	(0.38)	(-0.15)
Log(Size)	0.052*	-0.011	0.017	-0.019	-0.011	-0.025	0.024**	0.006	0.004	0.002	0.009	0.000
	(1.95)	(-0.46)	(0.59)	(-0.88)	(-0.65)	(-1.25)	(1.99)	(0.42)	(0.38)	(0.24)	(0.84)	(-0.01)
Time to Maturity	-0.005	0.005	0.008	-0.001	0.015	0.039***	0.004	0.011	0.016***	0.025***	0.029***	0.032***
	(-1.11)	(0.44)	(0.85)	(-0.11)	(0.76)	(5.74)	(0.93)	(1.47)	(4.34)	(8.16)	(7.18)	(4.45)
Time to Maturity^2	0.000	0.000	0.000	0.000	0.000	0.000***	0.000	0.000	0.000**	0.000***	0.000***	0.000***
	(-0.85)	(-1.30)	(-1.41)	(0.22)	(-0.57)	(-2.98)	(-1.15)	(-1.27)	(-2.35)	(-3.52)	(-3.15)	(-3.34)
Amihud	-2.376	-3.151	-3.639	-5.915**	-8.173*	-2.434	0.597	3.174***	1.974***	2.243**	1.125	-2.555
	(-1.27)	(-1.12)	(-1.61)	(-2.21)	(-1.86)	(-1.34)	(0.87)	(3.13)	(2.59)	(2.04)	(1.04)	(-0.66)
$Spread_{t-1}$	0.190***	0.023	0.022	0.090	-0.169	-0.336***	-0.130***	-0.344***	-0.317***	-0.388***	-0.409***	-0.306**
	(4.33)	(0.20)	(0.25)	(0.41)	(-0.61)	(-4.73)	(-4.07)	(-4.90)	(-5.92)	(-8.88)	(-7.69)	(-2.57)
Time to Maturity * Fund Outflow	0.001	0.001	0.001	0.001	0.002**	0.001	0.001	0.002*	0.002	0.001*	0.003***	0.001
	(1.37)	(1.38)	(1.56)	(1.57)	(2.18)	(0.81)	(1.18)	(1.82)	(1.55)	(1.86)	(2.90)	(1.14)
Amihud * Fund Outflow	-0.009	0.936	1.658*	2.255**	2.041**	1.223	0.856	0.000	0.000	0.000	0.000	0.000
	(-0.01)	(0.82)	(1.79)	(2.58)	(2.10)	(1.58)	(1.11)	0.000	0.000	0.000	0.000	0.000
No. of obs	38,136	32,888	35,372	32,782	30,881	29,568	20,946	17,948	19,097	18,301	17,343	16,993
R^2	0.16	0.01	0.01	0.02	0.03	0.09	0.04	0.14	0.13	0.31	0.23	0.12

Table 5: Flows Summary Statistics
The table presents the distributions of percentage fund flows for ETFs and for the all mutual funds. The flows of active and passive funds are also shown.

	ETF	Mutual Funds		
		All	Active	Passive
Mean	4.52	0.55	0.60	-0.56
Std. Dev.	12.73	6.96	7.07	3.46
1%	-16.37	-13.07	-13.11	-10.01
5%	-9.86	-5.63	-5.63	-4.71
10%	-6.32	-4.00	-3.96	-4.20
25%	-1.77	-1.96	-1.92	-2.17
50%	0.19	-0.36	-0.35	-0.63
75%	9.58	1.49	1.52	0.60
90%	15.34	5.56	5.76	2.59
95%	26.04	10.08	10.35	5.07
99%	69.49	27.15	27.59	13.09

Table 6: Sensitivity of Fund Flows to Interest Rate Changes
This table reports the following panel regression

$$Flow_{f,t} = \alpha + \delta(\Delta I/R_{t-1} * ETF_f) + \beta_1 \Delta I/R_{t-1} + \beta_2 ETF_f + \beta_2 X_f + \epsilon_{f,t}$$

$Flow_{f,t}$ is the monthly percentage flow for fund f in month t. $\Delta I/R_{t-1}$ is the lagged change in the relevant rate (1 year Treasury or 5 year Treasury) normalized by its standard deviation. ETF_f is a dummy equal to one for ETFs and zero for mutual funds. X_f are fund level covariates including the Fund Effective Duration, one month, two month, and three month lagged flows, the average monthly fund return over the previous three months, the average rating of fund holdings, as well as, the expense ratio, the turnover ratio, and the percentage of retail investors in the fund. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Dependent Variable: Monthly Fund Flows			
	I/R= Treasury1yr		I/R= Treasury5yr	
ΔI/Rt-1 * ETF	-0.082*	-0.090**	-0.102**	-0.083*
	(-1.76)	(-2.44)	(-2.02)	(-1.82)
ΔI/Rt-1	-0.071	-0.049	-0.104	-0.033
	(-0.62)	(-0.38)	(-0.94)	(-0.36)
ETF	3.639***	1.091***	3.676***	1.142***
	(7.05)	(5.41)	(7.12)	(5.66)
Fund Eff. Duration	-0.420***	-0.208**	-0.420***	-0.208**
	(-3.15)	(-2.38)	(-3.16)	(-2.38)
$Flow_{t-1}$		1.692***		1.691***
		(9.47)		(9.49)
$Flow_{t-2}$		1.275***		1.272***
		(7.82)		(7.82)
$Flow_{t-3}$		0.893***		0.895***
		(7.93)		(7.96)
Avg Fund Rett,t-3		0.604***		0.594***
		(4.90)		(4.81)
Avg Rating		-0.028		-0.030
		(-0.30)		(-0.33)
Expense		-0.076		-0.077
		(-1.34)		(-1.36)
Turnover		-0.026		-0.026
		(-0.54)		(-0.54)
% Retail		-0.259**		-0.259**
		(-2.21)		(-2.20)
No. of obs	49,095	31,343	49,095	31,343
R^2	0.17	0.18	0.12	0.14

Table 7: Robustness - Monthly Cross-Sectional Bond Yield Spreads and Mutual Fund and ETF Tantrum Outflow

Panel A reports results for mutual funds and Panel B for ETFs of the following monthly cross-sectional regressions

$$
\begin{aligned}
(Spread_{i,j,t} - Spread_{i,j,May}) = \alpha + \lambda j + \beta_1 Fund\ Outflow_{i,Tantrum} + \beta_2 Fund\ Outflow^2_{i,Tantrum} + \beta_3 Time\ to\ Maturity_{i,May} + \beta_4 Time\ to\ Maturity^2_{i,May} \\
+ \beta_5 Size_{i,May} + \beta_6 Amihud_{i,May} + \beta_7 Spread_{i,May} + \beta 8(Time\ to\ Maturity_{i,May} * Fund\ Outflow_{i,Tantrum}) \\
+ \beta_9(Amihud_{i,May} * Fund\ Outflow_{i,Tantrum}) + \epsilon_{ijt}
\end{aligned}
$$

The dependent variable, $(Spread_{i,j,t} - Spread_{i,j,May})$ is the change in the yield spread relative to the maturity-matched Treasury rate of bond i from issuer j. The change is measured between the monthly volume weighted yield spread in month t and the volume weighted yield spread in May prior to the first Bernake testimony. The months t run from 1M (September 2013) to 16M (December 2014) after the end of the Tantrum. λ_j is an issuer fixed effect. $Fund\ Outflow_{i,Tantrum}$ is the weighted average monthly flow for all mutual funds or ETFs that reported bond i as a holding immediately before the Tantrum. Only bonds with negative flow exposure are included. Size (millions $), Time to Maturity (years), median Amihud illiquidity, and Spread are bond i characteristics set to their May level. Standard errors are culstered at the issuer level. * indicates significance at the 10% level, ** at the 5% level, and *** at the 1% level.

	Panel A: Mutual Funds						Panel B: ETFs					
	1M	**4M**	**7M**	**10M**	**13M**	**16M**	**1M**	**4M**	**7M**	**10M**	**13M**	**16M**
Fund Outflow	0.016	0.030	0.007	-0.064	-0.084*	-0.003	0.087***	0.067***	0.065***	0.007	0.015	0.014
	(0.85)	(0.89)	(0.22)	(-1.59)	(-1.92)	(-0.14)	(6.35)	(4.30)	(4.39)	(0.58)	(1.16)	(0.95)
Fund Outflows^2	-0.001	-0.006	-0.001	0.005	0.005	-0.005	-0.006***	-0.002	-0.003**	0.001	0.001	0.001
	(-0.79)	(-1.20)	(-0.41)	(1.09)	(1.13)	(-1.61)	(-4.09)	(-1.57)	(-2.06)	(0.89)	(0.46)	(0.43)
Log(Size)	0.047*	0.014	0.021	-0.009	0.025	-0.011	0.004	-0.010	-0.014	0.007	0.017	0.003
	(1.86)	(0.44)	(0.68)	(-0.25)	(0.65)	(-0.61)	(0.34)	(-0.71)	(-1.07)	(0.66)	(1.32)	(0.20)
Time to Maturity	-0.010***	0.003	0.003	0.000	0.012	0.034***	0.006*	0.012**	0.020***	0.028***	0.034***	0.039***
	(-3.14)	(0.30)	(0.49)	(-0.05)	(0.80)	(8.60)	(1.96)	(2.05)	(4.82)	(5.78)	(8.62)	(8.50)
Time to Maturity^2	0.000	0.000	0.000	0.000	0.000	0.000***	0.000	0.000	0.000*	0.000**	0.000***	0.000***
	(1.01)	(-0.53)	(-0.48)	(0.50)	(-0.54)	(-3.64)	(0.46)	(-0.56)	(-1.88)	(-2.14)	(-3.38)	(-3.81)
Amihud	-0.712	-1.841	-1.431	-2.686	-1.659	-2.180**	-0.542	0.145	-0.863	0.454	0.731	-0.046
	(-0.30)	(-1.17)	(-1.14)	(-1.32)	(-0.80)	(-2.04)	(-0.49)	(0.15)	(-1.31)	(0.71)	(1.12)	(-0.03)
Spread$_{t-1}$	0.181***	-0.042	-0.006	0.072	-0.153	-0.339***	-0.180***	-0.239***	-0.296***	-0.382***	-0.409***	-0.428***
	(7.95)	(-0.45)	(-0.08)	(0.39)	(-0.63)	(-6.52)	(-3.16)	(-3.04)	(-4.50)	(-6.71)	(-7.15)	(-5.95)
Time to Maturity * Fund Outflow	0.001	0.000	0.000	0.002	0.003**	0.001	-0.001***	-0.001***	-0.001***	0.000*	0.000***	0.000**
	(0.70)	(0.24)	(0.34)	(1.50)	(2.25)	(0.87)	(-4.33)	(-4.75)	(-4.11)	(-1.93)	(-2.95)	(-1.97)
Amihud * Fund Outflow	-1.499	0.932	0.760	1.499	0.676	1.273**	0.360	-0.067	0.374	-0.150	-0.239	0.029
	(-0.86)	(0.92)	(0.91)	(1.28)	(0.62)	(2.10)	(0.73)	(-0.15)	(1.25)	(-0.55)	(-0.82)	(0.04)
No. of obs	3,687	3,558	3,436	3,333	3,203	3,163	2,952	2,891	2,850	2,826	2,753	2,744
R^2	0.82	0.78	0.83	0.85	0.85	0.94	0.77	0.80	0.85	0.90	0.93	0.96

ESSAY THREE

Flight to illiquidity and corporate bond returns*

Saeid Hoseinzade Ronnie Sadka

Abstract

In market distress, corporate bond investors tend to sell liquid assets and hold onto illiquid ones, a phenomenon which we call flight to illiquidity. We study the impact of flight to illiquidity on corporate bond prices/yields in cross-section as well as corporate bond returns in time-series. First, we show that liquidity price premium disappears in market distress, meaning that liquid bonds are not more expensive than illiquid bonds in distress times. Second, we show that illiquiduity return premium which exists during normal times, not only does not change sign or disappears, but also widens in market distress. In other words, liquid bonds deliver a lower return both on average and during market distress. This pattern is limited to investment grade corporate bonds. Our findings suggest that keeping the credit risk fixed, liquid bonds do not provide safety during the time it is needed the most.

JEL classifications: G12, G01, G23

Keywords: Corporate Bonds, Liquidity Premium, Return

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1 Introduction

The impact of liquidity on corporate bond price/yield has been widely studied in the literature. (see, for example, Longstaff, Mithal, & Neis (2005), Chen, Lesmond & Wei (2007), Bao, Pan & Wang (2011), Dick-Nielsen et al. (2012), Friewald, Jankowitsch & Subrahmanyam (2012), Huang, Sun, Yao, & Yu (2013) and Helwege, Huang & Wang (2014)). Since corporate bond market is a fairly illiquid market, liquidity has been shown to be a significant factor in explaining corporate bond yield spread. Investors are willing to pay a premium to hold more liquid bonds expecting that those assets can be sold-off easier and at a lower discount when investors need liquidity. On the other hand, Manconi, Massa, & Yasuda (2012) and Hoseinzade (2015) document that during market distress, some corporate bond investors prefer to sell more liquid assets first. This translates into higher selling pressure on more liquid assets in distress time. These two facts together lead to the following questions: 1) Are liquid bonds still more expensive than illiquid bonds during market distress? In other words, is there still liquidity premium in corporate bond prices? 2) How do liquid bonds perform relative to illiquid bonds during market distress? Does the liquidity premium that investors pay to hold more liquid bonds pay off during market distress in the form of higher performance? We try to answer these questions in this paper.

Corporate bonds are mainly held by institutional investors such as banks, mutual funds, hedge funds, pension funds and insurance companies. Institutional investors are subject to funding liquidity depending on market conditions. Some of these investors such as pension funds and insurance companies have less volatile funding liquidity which makes them long-term buy and hold investors. Manconi et al. (2012) show that even in market distress, for instance during the recent sub-prime crisis, they did not have to sell assets in significant amounts. On the other hand, mutual funds and hedge funds have much more volatile funding liquidity. These institutional investors are subject to investor redemptions. Therefore, when investors start pulling money, they have to sell some assets to meet investor redemptions. Hoseinzade (2015) and Manconi et al. (2012) show that mutual funds facing investor redemptions prefer to sell more liquid assets first. In addition, Huang et al. (2013) show that portfolio choice of different investors is endogenous, meaning that investors with higher liquidity needs tend to invest in more liquid assets and vice versa.

During market distress, high-liquidity need investors demand liquidity (they become asset sellers), while low-liquidity need investors provide liquidity (they become asset buyers). Therefore:

1) During market distress, there is a higher selling pressure on liquid assets because sellers mostly hold liquid assets and they also tend to sell more liquid parts of their portfolio. We call this phenomenon "Flight to illiquidity" because investors sell liquid assets and hold onto illiquid ones.

2) Buyers of the liquid assets do not need to hold liquid assets and hence, they are not willing to pay for the liquidity premium. Therefore they buy the assets at a discount.

Given these two points, in this paper we show that during market distress, in cross-section, liquid bonds are not more expensive than less liquid bonds, holding credit risk and interest rate risk fixed. Moreover, in time series, liquid bonds underperform illiquid bonds during market distress.

We first show that liquidity premium exists in corporate bond yields. This confirms what has already been shown in the literature. However in market distress, because buyers of liquid assets are not willing to pay for the liquidity premium, the liquidity premium disappears and they are not more expensive anymore. We approach this problem in a different way than most of the literature. Corporate bond yield spread consists of two main parts: credit risk and liquidity risk. Following Hoseinzade (2015) and Helwege et al. (2014), to hold the credit risk fixed and isolate the impact of liquidity on yield spread, we compare various bond issues of the same issuer-firm. We implement this identification strategy by including issuer-month fixed effects in the regressions.

We then use the same identification strategy to study the performance of liquid versus illiquid bonds. We compare the performance of liquid and illiquid bond issues of the same issuer-firm during normal times and also in market distress. We show that liquid issues have on average a lower return which is consistent with the fact that investors are willing to pay a premium to hold them. However, in market distress when they are supposed to pay off by outperforming illiquid issues, they actually deliver a lower return than illiquid issues. Our finding is consistent with Lou & Sadka (2011) in the equity market. This finding suggest that if investors hold liquid corporate bonds solely because they expect liquid bonds to pay off during market distress, that is not the case.

We finally test the hypothesis that liquid bonds underperform in market distress because liquidity providers are mainly insurance companies and pension funds who are not willing to pay for liquidity premium. Insurance companies and pension funds are mainly active in investment grade corporate bond market. Therefore if our hypothesis is true, we should only see the underperformance of liquid issues for investment grade corporate bonds. We approach this problem by splitting our sample to investment grade and speculative grade corporate bonds. We show that underperformance of liquid issues only happen in investment grade corporate bonds which confirms what our hypothesis predicts.

2 Data

In this section, we present the data that we use in this study. Our data are drawn from several sources:

1. Corporate bond transaction data from TRACE.
2. Corporate bond characteristics along with credit ratings from Mergent FISD.
3. Treasury rates from the Federal Reserve website.

Our time period starts from October 1, 2004 and ends on June 30, 2014. We choose October 1, 2004 because TRACE database became fully implemented on that date and transactions of almost all corporate bond trades were reported to TRACE.

We use the filtration proposed by Dick-Nielsen (2009) to eliminate potentially erroneous transaction records on TRACE. In addition, following Edwards, Harris, and Piwowar (2007) we apply a median filter and a reversal filter to eliminate further potential data errors. In the median filter we eliminate any corporate bond transaction for which the recorded price deviates the daily median or the nine-day median more than 20%. In the reversal filter, we eliminate every transaction for which the recorded price moves more than 10% and this price movement is followed by a reversal. Applying these preliminary filtrations leaves us with 21,500,770 corporate bond transaction records that could be matched with corporate bond data in Mergent FISD. These trade transactions are for 61,988 corporate bond issues by 5,347 distinct issuers.

In most of our analysis in the paper, we compare different bond issues of the same issuer. Therefore we want the corporate bonds to be as similar as possible to eliminate any potential problem stemming from differences in bond characteristics other than the ones that are of our interest. To make our corporate bond sample more homogeneous, we remove corporate bonds that are callable, puttable, convertible, sinking fund, variable coupon rate and finally bonds whose coupon payment is not semi-annual. After applying this secondary filtration, we have 6,132,862 transaction records for 10,015 bond issues by 1,448 distinct issuers.

In this paper, we use end of the month yield spread of corporate bonds. We use the yield reported for recorded transactions in TRACE. End of the month yield is then calculated as the volume weighted average of the yields for a given bond issue on the last day of each month when there is a recorded trade in TRACE for that issue. Deducting the treasury rate with the closest maturity, we calculate the yield spread of each bond issue at the end of each month. In total we have 214,510 bond/month observations.

We use Mergent FISD to obtain credit ratings of corporate bonds. We use the most recent credit rating by their of the credit rating agencies, Moodys, S&P or Fitch. We assign a number to each credit rating, starting from 1 for AAA and Aaa, 2 for AA+ or Aa1 and so on. We eliminate bond issues for which credit rating is not available. Bond issues with rating number greater than 10 (BBB- or Baa3) are considered speculative grade bonds whereas bond issues with rating number lower than 10 are considered investment grade bonds. Table 1 presents a summary statistics of the bonds in our sample.

{Insert Table 1}

3 Liquidity proxies

This section presents the various liquidity proxies that we use in our analyses. We use three liquidity proxies that have been widely used in the literature for corporate bonds. These proxies are Amihud (Amihud 2002), Roll (Roll 2984) and imputed round trip cost (IRC) (Feldhutter 2012). In addition, following Dick-Nielsen, Feldhtter & Lando (2012) we conduct principal component analysis of the three mentioned liquidity proxies and five additional liquidity proxies. These additional liquidity proxies are: Amihud Risk, IRC Risk, Turnover, Bond Zero Trading Days and Firm Zero Trading Days. Following is how we calculate each liquidity proxy.

Amihud and Amihud Risk:

Amihud measures the price impact of each trade. For each corporate bond, the measure is the daily average of absolute returns divided by the trade size.

$$Amihud_t = \frac{1}{N_t}\sum_{j=1}^{N_t}\frac{|r_j|}{Q_j}, \tag{1}$$

where N_t is the number of returns on day t, Q_j is the trading volume in million USD. We need at least two trades on a given day to be able to calculate Amihud measure.

We define the monthly Amihud measure by taking the average of daily Amihud measures within a month. Amihud Risk for a given bond issue is then defined as the standard deviation of daily Amihud measures within a month.

Roll measure

The intuition behind the Roll measure is that the bond price moves back and forth between the bid and ask price. Therefore lower liquidity in terms of a higher bid-ask spread translates into a higher negative return covariance between two consecutive trades. If the covariance turns out positive, that observation is discarded. Therefore Roll measure is defined as:

$$Roll_t = 2\sqrt{-cov(r_i, r_{i-1})}, \tag{2}$$

where t is the day on which we calculate the measure. The covariance is calculated using trades in the past 21 trading days. Roll measure is well-defined only if there are at least four observations for calculating the covariance. Monthly Roll measure is then defines as the average daily Roll measures within a month.

Imputed roundtrip cost (IRC)

The idea behind IRC is that sometimes dealers match buyers and sellers and collect a fee in the form of buying with a lower price and immediately selling the same bond at a higher price. Feldhutter (2012) calls them Imputed Roundtrip Trades (IRT). Therefore if we observe two or three trades of the same bond with the same trading volume on the same day, they are considered as part of an IRT. For an IRT, Imputed Roundtrip Cost (IRC) is defined as:

$$\frac{P_{max} - P_{min}}{P_{max}}, \tag{3}$$

where P_{max} is the largest and P_{min} is the smallest price in the IRT. Daily IRC measure is then calculated as an average of IRCs with different trade sizes on the same day. Monthly IRC measure and IRC Risk are calculated as an average and standard deviation of daily IRC measures within a month respectively.

Turnover

Monthly turnover is defined as the total trading volume within a month normalized by the amount outstanding of the bond issue.

$$Turnover = \frac{Total\ trading\ volume_t}{Total\ amount\ outstanding}, \tag{4}$$

where t is the month. Note that unlike other measures, turnover a measure of liquidity.

Zero trading days

We calculate Bond Zero Trading Days as the number of days in a month where the bond issue is not being traded. Firm Zero Trading Days is the number of days where none of the bond issues of a firm is being traded. Bond Zero Trading Days is a bond issue level liquidity measure whereas Firm Zero Trading Days is a firm level liquidity measure.

γ measure

Following Dick-Nielsen et al. (2012), we use principal component analysis to capture the most relevant information in various liquidity measures. Table 2 shows the results of PCA. As we can see the first principal component explains 45% of the variation in the liquidity measures. The loadings are almost equally distributed between *Amihud*, *Amihud Risk*, *Roll*, *IRC* and *IRC Risk*. Loadings of Turnover, Bond Zero Trading Days and Firm Zero Trading Days are almost zero in the first principal component. The second principal component explains 21% with positive loadings on *Bond Zero Trading Days* and *Firm Zero Trading Days* and negative and smaller loading on *Turnover.* The 3rd and 4th PC explain 12% and 7% respectively and the last four PCs together explain less than 15%. Our results are very similar to Dick-Nielsen et al. (2012) except that we find a higher loading *Roll measure* on the first PC.

Using the first PC, we define anther liquidity measure, γ as the equally weighted average of Amihud, Amihud Risk, Roll, IRC and IRC Risk. Before calculating γ, we normalize each liquidity measure by subtracting the mean and dividing by standard deviation across all bonds and all months.

{Insert Table 2}

4 Liquidity price premium in corporate bonds

In this section we present two findings:

1. There is a liquidity price premium for corporate bonds during normal times. In other words, everything else being equal, more liquid bonds are more expensive in cross-section.

2. During the time of distress, the liquidity price premium disappears. In other words, everything else being equal,more liquid bonds are NOT more expensive in cross-section.

The first finding is not new to the literature. Many papers have already shown that liquidity is priced in corporate bonds, Longstaff, Mithal, & Neis (2005), Chen, Lesmond & Wei (2007), Bao, Pan & Wang (2011), Dick-Nielsen et al. (2012), Friewald, Jankowitsch & Subrahmanyam (2012) and Helwege et al. (2014). The second finding, however is new and is an evidence of flight to illiquidity during market distress.

4.1 Empirical methodology

The main challenge in capturing the impact of liquidity on corporate bond price/yield is to properly control for credit risk. Because quality of the underlying firm and the liquidity of its bond issues are correlated, Chen et al. (2007), Covitz & Downing (2007), Rossi (2009), and Kalimipalli & Nayak (2012), if not properly controlled for, credit risk is partially attributed to liquidity risk. Some papers in the literaturesuch as Dick-Nielsen et al. (2012) and Friewald et al. (2012) use credit rating to control for credit risk. It means that two bond issues with the same credit rating have exactly the same credit risk hence, the difference in the yield spread can be attributed to differences in liquidity. There are various problems with this assumption. The main problem is that credit ratings are not always up-to-date showing the most recent information about the credit risks associated with firms. Longstaff et al. (2005) use CDS spread and try to explain how liquidity impacts the non-default portion of corporate bond yield spread. Dick-Nielsen et al. (2012) explains in detail the potential problems with this method.

Following Helwege et al. (2014) Hoseinzade (2015), to control for credit risk, we use various issues of the same firm in our identification strategy. We argue that bonds issued by the same firm have the same credit risk but may have different liquidity. To eliminate any factor that potentially impact credit risk of a bond issue, we eliminate all bond issues with embedded options such as call option, put option, convertible and sinking fund. To make bond issues even more homogeneous and hence more comparable, we also eliminate bond issues with variable coupon rates and also issues whose coupon payment is not semi-annual.

To implement this identification strategy, we use issuer-specific time fixed effects in our regressions. In other words, we only compare various bond issues of the same issuer-firm on same time (month) to see if liquidity has any impact on bond yield spread. We also control for other factors that potentially impact yield spread such as, *time to maturity*, $(time\ to\ maturity)^2$, *age* and *issuesize*. We define the distress months are March 2008 and September 2008 when Bear Sterns and Lehman Brothers collapsed respectively. Figure 1 shows that these two events were associated with huge spikes in the illiquidity of the corporate bond market.

We run the following regression to study the liquidity premium of corporate bonds during normal times and distress times.

$$Yield\,spread_{ijt} = \alpha + \beta_1 Liquidity_{ijt} + \beta_2 Liquidity_{ijt} * crisis + \lambda' controls + \mu_{jt} + \epsilon_{ijt} \tag{5}$$

where i indicates bond issue, j indicates issuer-firm and t indicates month. The liquidity measure for bond i from issuer j on month t is the 6 month moving average of that measure calculated between month $t-1$ and $t-7$. As explained before we use four different liquidity proxies. Standard errors are clustered on each month.

Table 3 presents the results. Columns 1 to 4 use *Amihud*, *Roll*, *IRC* and λ as the liquidity measure respectively. Note that these measures by definition are measures of illiquidity. We multiply these measures by minus one to make them measures of liquidity for the ease of interpreting the results. As we can see in the first row, using all four measures of liquidity, during normal times there is liquidity premium in bond yield spreads. However, as the second row shows, during market distress liquidity premium disappears. It means that liquid bonds are not more expensive than illiquid bonds anymore.[1]

{Insert Table 3}

It is worth mentioning that other control variables such as *time to maturity*, *age* and *issuesize*. are also proxies for bond liquidity. We can see that sign of their coefficients are as expected. For instance, it has been shown by Hotchkiss & Jostova (2007) that when bonds age, they end up sitting in long-term investors portfolios and hence become less liquid. It has also been shown that larger issues are more liquid and time-to-maturity has in inverse relation with liquidity.

5 Corporate bonds performance

This section studies the performance of liquid bond issues relative to the illiquid issues in time-series. It is well documented in the literature that investors are willing to pay a premium to hold more liquid corporate bonds. Our results in Table 3 confirm this phenomenon too. The liquidity premium then translates to higher price and lower expected return for liquid bonds. The reason that investors are willing to pay the liquidity premium is that they expect not to get hit by liquidity shocks as much as if they held illiquid bonds. In other words, investors accept earning a lower return for holding liquid bonds, on average over time, because they expect liquid assets to perform better during a liquidity shock.

However, we show that due to flight to illiquidity during market distress which coincides with a liquidity shock, liquid bonds actually underperform. This translate into that investors not only get compensated for holding liquid bonds during market distress but also get punished.

[1]Depending on the liquidity measure we use, illiquid bonds may become even more expensive than liquid bonds.

To compare the performance of liquid bonds to illiquid bonds, we have to control for credit risk and interest rate risk. To hold the credit risk fixed, we limit ourselves to comparing various issues of the same issuer firm. We also use various control variables that capture any differential interest rate risk among those issues. Our measure of performance is the change in yield spread.

5.1 Empirical methodology

Our measure of bond performance is the change in yield spread. In each month we group bond issues of each issuer-firm into two groups. The ones with the liquidity measure greater than median liquidity measure for that issuer on that month fall into the liquid group and the rest fall into the illiquid group. For the first group, the dummy variable *Liq_dummy* is equal to one and for the second group the dummy variable is zero. We limit ourselves to comparing various issues of the same issuer-firm because we want to hold the credit risk fixed. We also use various control variables that capture any differential interest rate risk among those issues. As in the previous section, we use four different liquidity measures: *Amihud*, *Roll*, *IRT* and λ. The regression that we run is the following:

$$\Delta Yield\, spread_{ijt} = \alpha + \beta_1 Liq\_dummy_{ijt} + \beta_2 Liq\_dummy_{ijt} * crisis + \lambda' controls + \mu_{jt} + \epsilon_{ijt} \quad (6)$$

The dependent variable, $\Delta Yield\, spread_{ijt}$ is calculated as the difference between the yield spread at the end of the current month, t minus the yield spread at the end of previous month, $t-1$. We also control for $time\ to\ maturity$, $(time\ to\ maturity)^2$, age, $issuesize$, interaction between $time\ to\ maturity$ and $crisis$, and interaction between $(time\ to\ maturity)^2$ and $crisis$. The last two control for any first and second order polynomial of time-to-maturity on interest rate risk and hence yield spread. Results are reported in Table 4.

{Insert Table 4}

As we can see in Table 4 first row, columns 1,3,5,7, on average liquid bond issues return less than illiquid issues of the same firm. (Positive change in yield spread means lower return.) This result is consistent with previous literature; liquid bonds are more expensive and generate lower return on average. The results in the second row, however, are surprising. Holding liquid bond issues and receiving less return should pay off during liquidity crisis. If that is the case, β_2 should be negative and significant; yield spread of liquid bonds declines which means increase in price and a positive return. However, we see exactly the opposite, β_2, using various liquidity measures, is positive and significant (except using Amihud as the liquidity measure where the t-stat is 1.48). It shows that liquid bonds not only do not perform better, but also perform worse during the crisis months when there is huge liquidity shock to the market.

This finding confirms what we call flight to illiquidity. In one hand, during market distress many investors tend to unload their more liquid assets to prevent huge price impact. On the other hand, liquidity providers are mostly institutions who do not need liquidity and as a result are not willing to pay for the liquidity premium. Therefore, liquidity providers buy liquid securities at a discount which leads to underperformance of those securities. In the next section we formally test this hypothesis.

6 Liquidity providers during market distress

In sections 4 and 5 we show that during market distress liquidity premium disappears in cross section and liquid bonds underperform in time series. We claim that the reason to observe these phenomena is flight to illiquidity. It means that many investors have to unload some of their more liquid assets and those assets are sold at a discount. Hoseinzade (2015) and Manconi et al. 2012 have shown that during the recent financial crisis when mutual funds experienced large outflows, they sold their more liquid assets. However, if there are enough buyers who are willing to pay for liquidity premium, the liquidity premium does not disappear and the performance of liquid bonds is not necessarily lower.

In this section we want to test the hypothesis that buyers of liquid assets during market distress are institutions such as pension funds and insurance companies who are not willing to pay for the liquidity premium simply because they do need to hold liquid assets. Because we do not have the detailed holdings and trades by pension funds and insurance companies, we cannot directly test this hypothesis.

However, we use the fact that due to capital requirements, pension funds and insurance companies do not hold speculative grade corporate bonds, and as a result, they are not active in providing liquidity to the speculative grade corporate bond market. Following is out testable hypothesis:

Hypothesis: underperformance of liquid bonds is only limited to investment grade bonds where insurance companies and pension funds are active.

To test this hypothesis we run regression equation (6) for speculative grade and investment grade bonds separately. Results are shown in Table 5. As we expect, only investment grade liquid bonds deliver a lower return during market distress. We do not see any significant change in the return of the speculative grade liquid bonds. These results confirm our conjecture that at least one reason that we observe a drop is corporate bond prices during market distress is the fact that potential buyers of those securities are long term investors without liquidity needs. These buyers are not willing to pay for liquidity premium which results in trading corporate bonds at a discount.

{Insert Table 5}

7 Conclusion

This paper provides new evidences about the impact of liquidity on corporate bond yields in normal times and in market distress, both in cross section and in time-series. We show that the liquidity premium attached to corporate bond prices in normal times disappears in market distress. It means that liquid bonds are not more expensive than illiquid bonds in market distress. We further study the performance of liquid bond issues versus the illiquid bond issues of the same firm, holding credit risk fixed. We show that liquid bond issues not only underperform illiquid ones during normal times, but also during market distress when they are supposed to outperform.

We attribute these two findings to flight to illiquidity during market distress. Previous literature has shown that corporate bond investors with higher liquidity needs such as mutual funds hold more liquid assets. These investors get highest hit at distress time and have to sell-off assets. Moreover, they tend to unload the most liquid part of their portfolio first. This leads to a high selling pressure of liquid corporate bonds. On the other hand, liquidity providers (buyers of corporate bonds) in market distress are long-term investors such as insurance companies and pension funds. These investors do not need liquidity and hence, are not willing to pay for liquidity premium and buy liquid bonds at a discount.

Finally we test the hypothesis that one potential reason that liquid corporate bonds underperform illiquid ones during market distress is the fact that liquidity providers, insurance companies and pension funds in this our setting, are not willing to pay for liquidity premium simply because they do not need to hold liquid assets. We show that underperformance of liquid bonds only happens in investment grade corporate bonds where insurance companies and pension funds are active.

Shleifer and Vishny (1992 & 2010) argue that one reason that a forced sale becomes a fire sale at a dislocated price is that the potential buyers of those assets are themselves are financially constrained and cannot buy those assets. Therefore those assets are sold to investors who do not have expertise with those assets and are willing to buy at valuations that are much lower. Our finding however introduces a new channel which leads to selling assets at a dislocated price. In our setting, buyers do not necessarily have less expertise with the assets they buy. They simply are not willing to pay for liquidity premium because they have low liquidity needs and do not have to invest in liquid assets.

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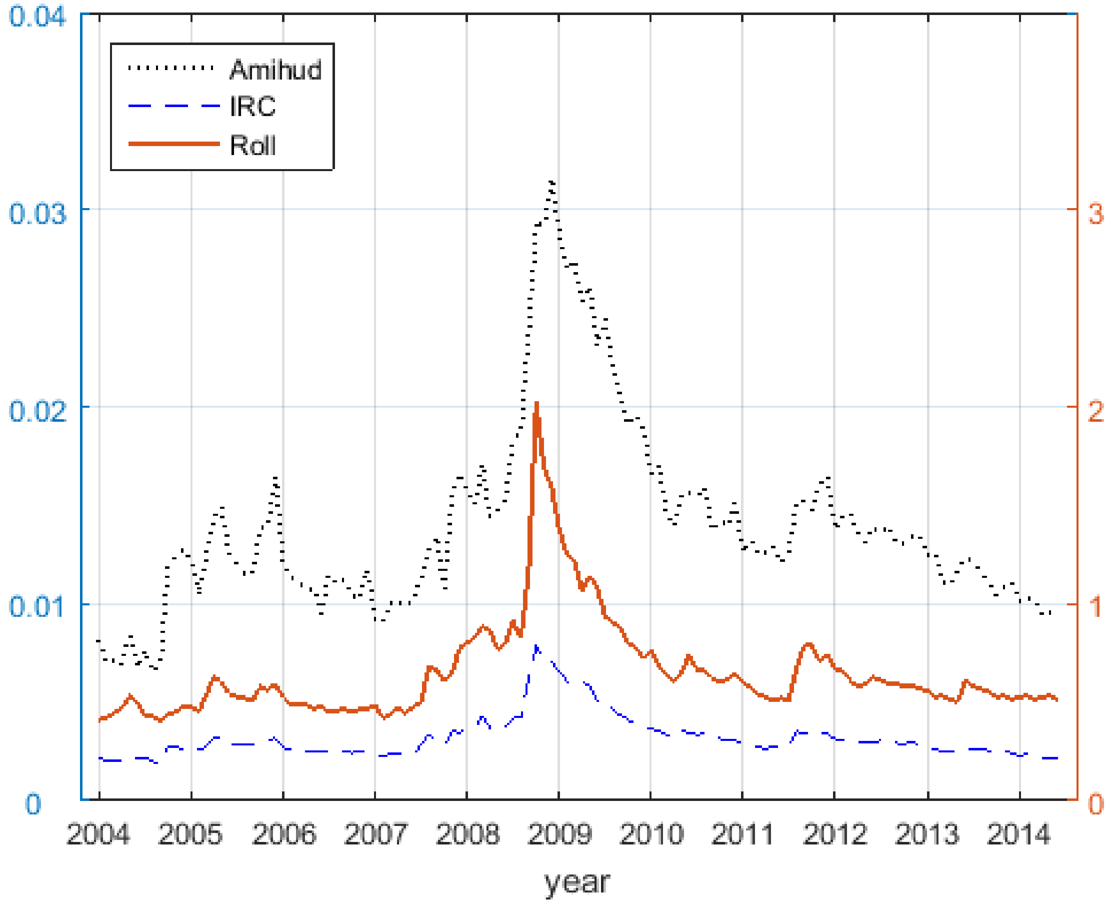

Figure 1: Amihud liquidity measure is calculated in each day based on Amihud (2002). At least two transactions are required in on a given day to calculate daily Amihud liquidity measure. Then I define monthly Amihud measure by taking the median of daily measures over a month. Roll measure, base on Roll (1984), is calculated for the days when there is at least one transaction available. Following Dick-Nielsen et al. (2012), I use a rolling window of 21 days with at least 4 transactions in the window, to calculate the daily Roll measure. I define the monthly Roll measure by taking the median of daily measures over a month. Imputed roundtrip cost (IRC) is a daily liquidity measure based on Feldhtter (2011). Monthly IRC is the median of daily measures within a month.

Table 1: Summary statistics

	Mean	STD	$Q_{0.05}$	$Q_{0.25}$	$Q_{0.50}$	$Q_{0.75}$	$Q_{0.95}$
Yield spread(%)	2.09	2.50	0.26	0.64	1.29	2.54	6.62
Yield spread change (%)	0.00	0.99	-0.93	-0.21	-0.03	0.17	0.97
Time to maturity (years)	6.58	8.27	0.33	1.75	3.75	8.17	22.75
Age (years)	7.27	5.10	1.33	3.25	5.83	10.25	17.67
Log(size) (milion USD)	5.73	1.62	2.53	5.30	5.86	6.80	7.82
Credit rating number	7.02	3.99	2	5	6	9	15

Table 2: Principal component analysis of liquidity measures

	1PC	2PC	3PC	4PC	5PC	6PC	7PC	8PC
Amihud	0.91	-0.03	-0.09	0.10	0.30	-0.06	-0.18	0.16
Amihud risk	0.88	-0.07	-0.12	0.16	0.34	-0.13	0.19	-0.13
Roll	0.68	0.15	0.13	-0.70	-0.02	-0.08	0.04	0.00
IRC	0.91	-0.01	0.09	0.10	-0.25	0.13	-0.25	-0.13
IRC risk	0.86	-0.12	0.04	0.17	-0.38	0.10	0.23	0.09
Turnover	-0.04	-0.46	0.87	0.04	0.15	0.09	0.01	0.00
Bond zero	0.08	0.87	0.10	0.02	0.18	0.43	0.05	0.00
Firm zero	0.03	0.82	0.36	0.18	-0.12	-0.40	-0.01	0.01
Cumulative % explained	0.45	0.66	0.78	0.85	0.91	0.96	0.99	1

Table 3: Liquidity premium of corporate bonds

This table presents the results of the following regression:

$$Yield\,spread_{ijt} = \alpha + \beta_1 Liquidity_{ijt} + \beta_2 Liquidity_{ijt} * crisis + \lambda' controls + \mu_{jt} + \epsilon_{ijt}$$

where i indicates bond issue, j indicates issuer-firm and t indicates month. The dependent variable, $Yield\,spread$ is the end-of-month yield spread. The liquidity measure for bond i from issuer j on month t is the 6 month moving average of that measure calculated between month $t-1$ and $t-7$. Market distress is a dummy variable which is equal to one on March 2008 and September 2008, when Bear Sterns and Lehman Brothers collapsed respectively, and zero otherwise. $Time\ to\ maturity$ and Age are in years and $size$ is in million USD. μ_{jt} issuer-time fixed effect. All liquidity measures are normalized by deducting the mean and dividing by standard deviation across all bonds and all months. Therefore the coefficients are changes in the dependent variable for one standard deviation change in the liquidity measure. All standard errors are clustered by month. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Dependent variable: Yield spread			
	Liquidity measure			
	Amihud (1)	Roll (2)	IRC (3)	γ (4)
Liquidity	-0.151***	-0.135***	-0.144***	-0.170***
	(-10.11)	(-9.29)	(-14.50)	(-12.53)
Liquidity * Market distress	0.293***	0.699***	0.299***	0.418***
	(4.42)	(22.75)	(6.17)	(14.59)
Time to maturity	0.0386***	0.0398***	0.0375***	0.0354***
	(9.74)	(11.94)	(9.51)	(8.91)
Time to maturity^2	-0.000351***	-0.000400***	-0.000356***	-0.000327***
	(-8.07)	(-10.97)	(-8.49)	(-7.77)
Age	0.00585***	0.00619***	0.00643***	0.00586***
	(3.56)	(3.32)	(3.88)	(3.49)
Log(size)	-0.0335***	-0.0335***	-0.0386***	-0.0333***
	(-3.59)	(-3.78)	(-4.38)	(-3.75)
Constant	2.034***	2.012***	2.069***	2.054***
	(33.96)	(33.93)	(35.11)	(35.17)
No. obs	164,517	156,160	162,796	165,124
Adjusted R-square	0.892	0.893	0.892	0.892
Issuer-month FE	YES	YES	YES	YES

Table 4: Liquidity and corporate bond performance

This table presents the results of the following regression:

$$\Delta Yield\ spread_{ijt} = \alpha + \beta_1 Liq\_dummy_{ijt} + \beta_2 Liq\_dummy_{ijt} * crisis + \lambda' controls + \mu_{jt} + \epsilon_{ijt}$$

where i indicates bond issue, j indicates issuer-firm and t indicates month. The dependent variable, $\Delta Yield\ spread$ is calculated as the difference between the yield spread at the end of the current month minus the yield spread at the end of previous month. Liq_dummy_{ijt} is equal to one if liquidity measure of a bond issue i on month t is greater the median liquidity measures of all bond issues of issuer j on month t, and zero otherwise. Market distress is a dummy variable which is equal to one on March 2008 and September 2008, when Bear Sterns and Lehman Brothers collapsed respectively, and zero otherwise. *Time to maturity* and *Age* are in years and *size* is in million USD. μ_{jt} issuer-time fixed effect. All standard errors are clustered by month. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Dependent variable: Change in yield spread							
	Liquidity measure							
	Amihud (1)	Amihud (2)	Roll (3)	Roll (4)	IRC (5)	IRC (6)	γ (7)	γ (8)
Liq_dummy	0.0104	0.00763	0.0164**	0.0123*	0.0116	0.00914	0.0152*	0.0130
	(1.26)	(0.98)	(2.15)	(1.89)	(1.57)	(1.28)	(1.84)	(1.62)
Liq_dummy * Market distress		0.174		0.273**		0.158***		0.137**
		(1.48)		(2.34)		(21.57)		(2.15)
Time to maturity	0.00121	0.00111	0.00163	0.00141	0.00134	0.00123	0.00158	0.00148
	(0.77)	(0.71)	(1.09)	(0.95)	(0.87)	(0.80)	(1.01)	(0.95)
Time to maturity^2	-0.00000942	-0.00000817	-0.0000127	-0.0000100	-0.0000111	-0.00000982	-0.0000137	-0.0000124
	(-0.49)	(-0.42)	(-0.69)	(-0.55)	(-0.61)	(-0.54)	(-0.72)	(-0.65)
Market distress * Time to maturity	-0.0986***	-0.0930***	-0.102***	-0.0864***	-0.0974***	-0.0906***	-0.0982***	-0.0916***
	(-3.82)	(-4.14)	(-4.02)	(-4.52)	(-3.89)	(-3.53)	(-3.78)	(-3.96)
Market distress * Time to maturity^2	0.00109***	0.00101***	0.00118***	0.000979***	0.00108***	0.000993***	0.00109***	0.00100***
	(3.81)	(4.28)	(3.49)	(3.69)	(3.90)	(3.52)	(3.77)	(4.05)
Age	0.00196	0.00196	0.00176	0.00178	0.00187	0.00188	0.00201	0.00202
	(1.26)	(1.26)	(1.10)	(1.11)	(1.20)	(1.20)	(1.30)	(1.30)
Log(size)	0.0105	0.0107	0.00267	0.00292	0.0102	0.0104	0.0104	0.0106
	(1.54)	(1.56)	(0.35)	(0.38)	(1.49)	(1.52)	(1.54)	(1.56)
Constant	-0.0805*	-0.0813*	-0.0337	-0.0356	-0.0795*	-0.0806*	-0.0853*	-0.0862*
	(-1.83)	(-1.84)	(-0.66)	(-0.70)	(-1.80)	(-1.83)	(-1.95)	(-1.97)
No. obs	143,676	143,676	140,058	140,058	142,795	142,795	143,954	143,954
Adjusted R-square	0.485	0.485	0.492	0.493	0.486	0.486	0.485	0.485
Issuer-month FE	YES	YES	YES	YES	YES	YES	YES	YES

Table 5: Liquidity and corporate bond performance

This table presents the results of the following regression for investment grade and speculative grade corporate bonds separately. Investment grade bonds have credit rating better than or equal to "BBB-" according to S&P and Fitch or "Baa3" according to Moody's.

$$\Delta Yield\,spread_{ijt} = \alpha + \beta_1 Liq\_dummy_{ijt} + \beta_2 Liq\_dummy_{ijt} * crisis + \lambda' controls + \mu_{jt} + \epsilon_{ijt}$$

where i indicates bond issue, j indicates issuer-firm and t indicates month. The dependent variable, $\Delta Yield\,spread$ is calculated as the difference between the yield spread at the end of the current month minus the yield spread at the end of previous month. Liq_dummy_{ijt} is equal to one if γ measure of a bond issue i on month t is greater the median liquidity measures of all bond issues of issuer j on month t, and zero otherwise. Market distress is a dummy variable which is equal to one on March 2008 and September 2008, when Bear Sterns and Lehman Brothers collapsed respectively, and zero otherwise. *Time to maturity* and *Age* are in years and *size* is in million USD. μ_{jt} issuer-time fixed effect. All standard errors are clustered by month. The symbols *, **, *** denote statistical significance at the 10%, 5% and 1% levels, respectively.

	Dependent variable: Change in yield spread	
	Credit rating	
	Investment grade (1)	Speculative grade (2)
Liq_dummy	0.0131	0.00373
	(1.56)	(0.11)
Liq_dummy * Market distress	0.143***	-0.0425
	(4.50)	(-0.15)
Time to maturity	0.00149	-0.000232
	(0.92)	(-0.05)
Time to maturity^2	-0.00000909	0.000000120
	(-0.43)	(0.00)
Market distress * Time to maturity	-0.103***	-0.0431***
	(-3.96)	(-3.74)
Market distress * Time to maturity^2	0.00129***	0.000421***
	(3.74)	(3.62)
Age	0.00160	0.00465
	(1.18)	(0.68)
Log(size)	0.00703	0.0379
	(1.22)	(1.06)
Constant	-0.0554	-0.290
	(-1.51)	(-1.35)
No. obs	125,146	18,808
Adjusted R-square	0.479	0.443
Issuer-month FE	YES	YES