Is There Flow-Driven Price Impact in Corporate Bond Markets?

Jaewon Choi
University of Illinois at Urbana-Champaign
jaewchoi@illinois.edu

Seunghun Shin
Korea Advanced Institute of Science and Technology
shshin610@business.kaist.ac.kr

This Draft: April 2016

Is There Flow-Driven Price Impact in Corporate Bond Markets?

Abstract

We document the extent to which mutual fund flows drive price pressure in the corporate bond markets. In contrast to well-documented evidence reported in equity fund studies, fund flows have only limited impact on corporate bond prices. We attribute this puzzling finding to liquidity-sensitive trading conducted by corporate bond funds. Funds on average maintain 14% of their net assets in cash and selectively trade high liquidity bonds. They sell only 66 to 78 basis points of their bond holdings for one percent outflows of their total assets, instead of selling one-to-one. However, during market stress episodes such as the 2008 financial crisis and the Taper Tantrum, we observe significant flow-driven price pressure. Flows to low cash holding funds also exert temporary price pressure at the aggregate market level. Our results suggest that significant flows during market stress can potentially have destabilizing impact on the corporate bond markets despite funds' liquidity management.

JEL Classification: G11, G12, G14

Keywords: Price pressure on corporate bonds; Flow-induced trading; Corporate bond funds; Financial stability

1. Introduction

There is a wide consensus in the finance literature that mutual fund trading driven by investor flows results in significant price pressure in equity markets.[1] A natural corollary to this observation is that flow-driven trading by funds could exert even greater price pressure in corporate bond markets. Corporate bonds are highly illiquid; they are traded over the counter and search costs can be particularly high.[2] As such, scholars and regulators are increasingly interested in understanding the potential implications of these funds' flow-driven asset sales for financial stability.[3]

There are, however, several possible explanations of the difficulty of deriving flow-driven price pressure on corporate bonds from the available equity market evidence. Knowing that liquidation costs can be substantial, corporate bond funds can take precautionary measures to buffer investor redemptions and choose to hold more cash or shift to relatively liquid securities such as Treasuries. Thus, funds can internally absorb liquidity demand from investors by seeking less liquidity provision from market makers. Also, although average transaction costs are higher for corporate bonds, institutional trades, including trades by mutual funds, incur much lower transaction costs (Edwards, Harris, and Piwowar 2007). Furthermore, liquidity providers in corporate bond markets are typically dealer banks and the effect of price pressure caused by liquidity demand from mutual funds will depend on the capacity of liquidity provision by dealer banks.

In this paper, we examine flow-induced trading behaviors on the part of corporate bond mutual funds and gauge their impact on returns, employing a detailed holdings database for the period running from 2002 through 2014. Our key message is

---

[1] See, e.g., Coval and Stafford (2007), Frazzini and Lamont (2008), Lou (2012), Edmans, Goldstein, and Jiang (2012), Khan, Kogan, and Serafeim (2012), among many others.

2 See, for example, de Jong and Driessen (2005), Longstaff, Mithal, and Neis (2005), Chen, Lesmond, and Wei (2007), Bao, Pan, and Wang (2011), and Feldhutter (2012), among many others.

3 See, e.g., Goldstein, Jiang, and Ng (2015), Chernenko and Sunderam (2012) and also the rule proposal from the Securities and Exchange Commission (http://www.sec.gov/news/pressrelease/2015-201.html)

that there is only limited evidence of flow-induced price pressure in the cross section of corporate bonds, although there is substantial market-wide price pressure especially during market distress episodes. We attribute this finding in the cross section to liquidity management on the part of mutual funds. Given investor flows, these funds selectively trade relatively liquid bonds, which contrasts with proportional expansion or reduction of existing holdings documented in equity mutual fund studies (e.g., Lou 2012). Dealers' liquidity provision also helps; corporate bond funds tend to trade more actively when bond liquidity provision is strong. In consequence, bond trading driven by flows does not impose a significant price impact in the cross section. During market distress, however, we find significant temporary market-wide price impact lasting for weeks, which suggests that funds' management of liquidity is not substantial enough to absorb severe redemption demand from investors.

Studying flow-driven trading by corporate bond funds is particularly interesting in light of recent developments in financial markets. Since the great recession, unprecedented volumes of liquidity have poured into corporate bond markets. Anecdotally termed "reaching for yield," asset managers and retail investors following this trend are increasingly shifting their portfolios towards riskier securities (Rajan 2013 and Stein 2013). Eventually, easy monetary policies will turn the tide, as the Fed has been repeatedly signaling a "tapering down" period. When interest rates start rising significantly, investors may collectively start redeeming cash from corporate bond funds, as they did during the "Taper Tantrum" episode, which can pose a threat to financial stability and can also be exacerbated by potentially high liquidation costs and strategic complementarity among fund investors (e.g., Goldstein, Jiang, and Ng 2015). Moreover, with stricter capital requirements and the Volcker Rule being enforced, anecdotal evidence suggests that liquidity has "dried up" in corporate bond markets due to the now-limited capacity of dealer banks to provide liquidity. Thus, whether mutual funds maintain adequate liquidity cushions and reduce the potential market impact of investor flows is a critical issue. However, little empirical evidence is available yet in the academic literature pertaining to this issue perhaps due to the limited availability of relevant data.

Our main findings are as follows. We find that corporate bond funds do not shrink their investments proportionally, or dollar-for-dollar, in response to investor outflows. Instead, these funds trade disproportionately fewer corporate bonds. For example, for every one percent of investor outflows relative to net asset values, funds decrease their corporate bond holdings by only 62 to 78 basis points. This result contrasts with those found in other studies indicating that equity funds shrink their holdings almost proportionately to meet investor redemption (Lou 2012). Furthermore, cash holdings, market liquidity, and dealers' liquidity provision all matter for the trading behaviors of corporate bond funds. Specifically, flow-driven sales are more pronounced for liquid corporate bonds, especially when those funds have lower liquidity buffers. Also, flow-driven trading (both buy and sell) is stronger for bonds for which liquidity provision conducted by corporate bond dealers is strong. Thus, funds' trading in response to flows is sensitive to both the liquidity of corporate bond markets and liquidity buffers. Funds absorb liquidity demand from investors through both internal liquidity and liquidity management.

Although funds maintain relative high cash holdings (on average 14% of their assets) and selectively trade liquid bonds with strong liquidity provision from dealers, corporate bond markets are inherently illiquid. Thus, we conduct a thorough empirical examination of the cross-sectional effects of flow-driven price pressure on corporate bonds. In contrast to well-documented evidence found in studies of flow-driven sales on the part of equity funds, we find no significant evidence of cross-sectional flow-driven price impacts on corporate bonds. Specifically, in quarters during which flow-driven asset sales actually take place, we do not find any significant negative price effects on portfolios with extreme outflow-driven trading. Rather, prices of these bonds even rise during some quarters in which outflow-driven trading occurs, which shows that these bond sales are far from fire sales, in contrast to the results documented in equity mutual fund studies (Coval and Stafford 2007). Overall, these pieces of evidence suggest that both mutual funds' provision of liquidity for fund investor redemption and selective trading in response to market liquidity tend to dampen price pressure and lower redemption costs.

We further investigate flow-induced price impacts by narrowing our data to a subsample of funds with relatively poor liquidity buffers, low cash holding funds, since the liquidity management story suggested so far implies that the effects of price pressure are more likely to be present among such funds. We find evidence consistent with flow-induced price pressure. Returns on sell minus buy portfolios sorted on flow-driven trading are lower during quarters are negative during quarters with extreme flows, followed by return reversals. Overall, our results contrast with those found in equity mutual fund studies. Equity funds hold much less cash, partly because their holdings are liquid. However, their trades can have significant price impacts in a relatively liquid market, since these funds also engage in proportional asset sales to meet investor outflows. In comparison, corporate bond funds on average hold substantial amounts of their assets in cash and also selectively trade relatively liquid bonds, which enable them to mitigate liquidity shocks from investors.

Although we provide strong evidence that there is price impact only for low cash holding funds, this result does not necessarily imply that there is no market-wide pressure induced by aggregate fund flows. This issue is important, because aggregate fund flows can pose threats to financial stability of corporate bond markets. Thus, we first focus on the two recent episodes of credit market distress: the 2008 financial crisis and the 2013 Taper Tantrum. Indeed, our data show that investors withdrew substantially from corporate bond funds during these two episodes: aggregate oflows were more than 6% and 4% for 2008 Q3/Q4 and 2013 Q2/Q3, respectively. The lowest flow decile funds experienced approximately 20% of outflows. We find these significant negative flows are associated with substantial negative price pressure. Cumulative abnormal bond returns on bonds held by the most severe flow-driven sell pressure were up to negative 3% from the week of Aug 29, 2008 through the week of Oct 10, 2008 and reverted almost to zero by the week of 2008, Nov 7. For low cash holding funds, price decrease and reversal was even more pronounced (up to -5% during the week of Oct 10). During the recent Taper Tantrum, we also find a price pattern consistent with temporary price pressure and reversal, although the economic magnitudes are not as large. For low cash holding funds, cumulative abnormal return reached up to negative

0.6% on June 28, 2013 (the week after the Fed press conference on tapering), which reverted to a normal level by the week of July 19, 2013. These results show that significant fund flows due to market distress can dislocate prices from fundamentals in the corporate bond markets. Also, we find that the corresponding market disruption lasts for a few weeks.

We further investigate price impact at the aggregate level by using impulse response analyses from vector autoregressions (VAR). We find significant temporary price impact at the market level. For example, we find that in response to a one-standard-deviation shock of flows, abnormal returns on the bond portfolio held by aggregate funds increase by approximately 60% of a one-standard-deviation change in abnormal returns in the aggregate bond portfolio. This price increase is followed by subsequent reversal over the next two months period. This price impact in the aggregate level is especially pronounced among portfolios held by low cash holding funds. These results suggest that even though funds tend to engage in liquidity management, such liquidity management is not substantial enough to mitigate market-wide price pressure arising from aggregate flows and also that aggregate fund flows potentially have a destabilizing effect on the corporate bond markets

Our results have important implications for the recent debate among regulators and policymakers over financial stability in the post–financial crisis period. Recently, the SEC proposed new liquidity management rules for mutual funds.[4] Notably, mutual funds now have to disclose asset illiquidity and also maintain substantial holdings in relatively liquid securities to prevent significant disruption of financial markets. Our cross-sectional results do not necessarily imply that collective outflows from corporate bond funds will not threaten financial stability. Rather, our aggregate-level results show that market-wide shocks to mutual fund flows have a substantial price impact, despite individual funds' liquidity management. Indeed, our results are consistent with those in Feroli et al (2014), who show that shocks to monetary policies have lasting (although weak) impacts on aggregate bond prices.

[4] http://www.sec.gov/news/pressrelease/2015-201.html

This paper contributes to the literature on asset fire sales (Shleifer and Vishny 1992, Pulvino 1998, Mitchell, Pulvino, and Stafford 2004, Coval and Stafford 2007, Mitchell, Pedersen, and Pulvino 2007, Campbell, Giglio, and Pathak 2011, Ellul, Jotikasthira, and Lundblad 2011, Jotikasthira, Lundblad, and Ramadorai 2012, Ben-David, Franzoni, and Moussawi 2012). There is also a growing body of literature on fire sales in corporate bond markets. Manconi, Massa, and Yasuda (2012) show that investors sell more liquid corporate bonds when they are exposed to liquidity shocks in their securitized bond holdings. Ellul, Jotikasthira, and Lundblad (2011) document price pressure in corporate bonds driven by regulatory capital requirements for insurance companies.

A couple of contemporaneous studies are related to ours. Based on the idea that mutual funds provides liquidity transformation service to end investors, Chernenko and Sunderam (2016) show that mutual funds' cash holdings play a key role in providing liquidity transformation service to investors. Our paper differs from their study because our focus is on funds' trading of corporate bonds and its impact on prices, while both the studies provide consistent implications for market-wide financial stability. In a closely related study, Hoseinzade (2015) examines contemporaneous yield changes due to selling pressure from mutual funds through a comparison of bonds issued by the same firms and concludes that investor runs do not destabilize corporate bond markets, based only on cross-sectional evidence. Our paper is different from this study because our key purpose is to show contemporaneous price changes followed by subsequent return reversal, which is an indication of temporary price pressure. More importantly, our paper makes a different conclusion that aggregate fund flows can pose a threat to financial stability by thoroughly documenting the extent to which flow-induced trading exerts price pressure in both the cross section and the aggregate levels.

2. Data and Variables

Our sample consists of US corporate bond mutual funds between July 2002 and December 2014. We obtain data on mutual fund quarterly holdings from the Morningstar database and returns and other fund characteristics from the Center for Research in Security Prices (CRSP) survivorship-bias-free mutual fund database. There can be several share classes within one fund and each share class has different returns, management fees etc. While the Morningstar database consists of portfolio-level observations, the CRSP mutual fund database consists of share class-level observations. We use portfolio level observations in our empirical studies by value-weighting share class level variables within the same funds using net asset values.

We classify mutual funds as corporate bond funds according to Lipper objective codes obtained from the CRSP. Specifically, we classify as corporate bond funds when the Lipper objective code is one of (A, BBB, HY, SII, SID, IID), CRSP objective code starts with 'IC'. In addition, we require corporate bond holdings to be at least 10% of their total net assets. We exclude index funds, exchange trade funds, and exchange trade notes from the CRSP mutual fund database. We require fund size to be at least \$1M with at least one year holdings data available and having more than 10 different holdings in Morningstar at some point in the past and also require $0.5 < \frac{TNA_{j,t}}{TNA_{j,t-1}} < 3$ for fund j in month t to eliminate funds with too extreme changes in TNA. As a result, 803 unique corporate bond funds remain in our final sample.[5]

We obtain bond pricing as well as terms and conditions information from several data sources. The data source for corporate bond pricing is Trade Reporting and Compliance Engine (TRACE) database. We use the enhanced historical TRACE corporate bond data instead of the standard TRACE corporate bond data. Compare to

[5] We exclude two funds (MorningStar fundid = "FSUSA001ZG" and "FSUSA001ZF") from our sample because their cash ratios are too extreme, probably due to data errors. For example, FSUSA001ZF funds held -98% of their TNA as cash and cash-like holdings at the end of 2010:Q1, but held 79% of their TNA as cash and cash-like holdings. However, inclusion of these two funds does not affect our empirical results.

the standard TRACE database, the enhanced TRACE provides actual (uncapped) trade volumes and historical buy-sell side information. The enhanced data also contains more detailed information like reporting date and time which allows us to better filter known errors. (e.g., Dick-Nielsen, 2014) We use bond pricing data from 2005, since the coverage of the TRACE becomes comprehensive after February 2005. Our bond pricing data ends the first quarter of 2014, since the enhanced TRACE has 18 month lags in availability of the data. To filter reporting errors in TRACE, we follow the filtering procedures described in Dick-Nielsen (2009, 2014).[6] In addition, we obtain terms and conditions information from the Mergent Fixed Income Securities Database (FISD) including coupons, ratings, maturity, amounts outstanding, and other characteristics. To be included in our sample, the bonds must be non-convertible U.S. fixed coupon bonds.[7] Our final bond-level sample after merging TRACE, FISD, and MorningStar consists of 256,869 bond-quarter observations between 2005 and 2014.

Our measure of mutual fund flows is constructed based on monthly total net assets (TNA) and returns from the CRSP. Specifically, the monthly net flow of funds is defined as:

$$flow_{j,t} = \frac{TNA_{j,t} - TNA_{j,t-1} * (1 + r_{j,t})}{TNA_{j,t-1}} \quad (1)$$

where $TNA_{i,t}$ is the total net assets for fund j at the end of month t and $r_{j,t}$ is the monthly returns for fund j over month t. The quarterly flows are defined as the sum of monthly flows during the quarter. We use quarterly flows in the our empircal analyses to match with the quarterly holdings data.

The monthly return on corporate bond i during month t is computed as

[6] We also use the SAS codes available on Dick-Nielsen's website. We also add price sequence based filters (reversal and median filters) as suggested in Dick-Nielsen (2014) and Edwards, Harris, and Piwowar (2007). About 0.2% of observations are removed from the reversal and median filters.

[7] To be classified as corporate bonds, we require Mergent FISD bond type is in (CCOV, CDEB, CLOC, CMTN, CMTZ, CP, CPAS, CPIK, CS).

$$r_{i,t} = \frac{P_{i,t}+AI_{i,t}+Cpn_{i,t}}{P_{i,t-1}+AI_{i,t-1}} - 1 \quad (2)$$

where $P_{i,t}$ is a clean price, $AI_{i,t}$ is an accrued interest, and $Cpn_{i,t}$ is a coupon payment, if any. Since most bonds do not trade on the daily basis, we define the month-end price $P_{i,t}$ as the last available daily price within 5 days from the end of month t where the daily price is a trading volume weighted price for each day, following the procedures described in Bessembinder, Kahle, Maxwell, and Xu (2009). Definitions for other variables used in this study are also detailed in Appendix A.

2.1 Summary Statistics

Using our data, we provide a few interesting statistics on corporate bond funds at both the time-series and cross-sectional levels, because most existing studies focus primarily on equity fund statistics.

Figure 1 plots our sample funds' average holdings in corporate bonds (Panel A) and cash (Panel B). Note that these funds, although they are classified as corporate bond funds, on average hold approximately only 50% in corporate bonds. This shows that, although corporate bonds are the dominant asset class in corporate bond funds' holdings, these funds have much leeway in terms of what asset classes to hold, because their investment mandates are only loosely defined. In Panel B, we find that corporate bond funds in our sample hold substantially higher cash holdings (hovering around 15% of net assets) compared with equity funds' cash holdings, for example, reported in Simutin (2014).[8] We also find that cash ratios dip during the 2008 financial crisis and also during 2013 Q3 and Q4 (the Taper Tantrum), suggesting that aggregate outflows might have been huge during those periods.

Table 1 provides descriptive statistics for fund-level (Panel A) and bond-level (Panel B) variables for our sample. Corporate bond mutual funds hold U.S. corporate

[8] Simutin (2014) reports that average cash held by equity mutual funds are approximately 3% of total assets, as of 2010.

bonds only about 50.47% of their total net assets (see *Corp Ratio*), although it is still the largest asset class in funds' holdings. Also, our sample funds maintain relative high cash reserves on average (14.26% of total net assets in cash and cash-like securities). At the same time, the standard deviation of cash holdings is quite substantial (13.39%), which also suggests that there exist funds with low cash holdings. The U.S. Treasury bonds accounts for a large portion of the cash holdings (10.40% of total net asset).[9] Panel B reports bond-level statistics including bond illiquidity measured as percentiles of zero trading days (*ZTD*) in a quarter as in Chen, Lesmond, and Wei (2007). The average of *ZTD* is 62.05% and the 75th percentile is 100%. This indicates that bonds held by mutual funds are traded for approximately 38% days in a quarter, and more than 25% of the bonds are not traded in a quarter. These statistics show that corporate bonds held by mutual funds are quite illiquid.

3. Mutual Fund Trading in Response to Flows

In response to capital flows, fund managers should adjust their holdings. In a market with no wealth effect or liquidity constraint, mutual funds' portfolio trading decision generally does not depend on investor flows. Funds would scale up or down their portfolios proportionally in response to investor flows, since funds can respond to investor liquidity demand (i.e., redemption requests) by resorting to market liquidity (i.e., selling existing portfolios). In addition, funds would not need to pile up cash holdings to satisfy investor liquidity needs, since holding cash can be costly and hurt fund performance. Existing studies indeed find that equity funds' cash holding is not significant (Simutin 2014). It is also well-documented that equity mutual funds proportionally sell their position, or dollar-for-dollar, for investor outflows, hence the cash buffers play only limited role (e.g., Lou 2012).

[9] We categorize Treasury bonds, money market funds, and short-term maturity less than three months as cash holdings. See the Appendix B for the detailed description of cash items.

In contrast, trading behaviors of corporate bond funds will not necessarily be similar to those of equity funds. Corporate bonds are highly illiquid and liquidation costs can be substantial. Thus, these funds have incentives to selectively trade relative liquid corporate bonds and also buffer investor redemptions using cash holdings. In fact, corporate bond funds maintain relatively high cash holdings, as shown in the previous section, and actively employ cash buffers to mitigate redemption requests from end investors. These considerations imply that corporate bond funds might not engage in proportional scaling of their holdings given redemption requests. In this section, we examine trading behaviors by corporate bond funds given investor flows with a special focus on market liquidity and the liquidity provision of dealers in the corporate bond markets.

3.1. The Effect of Market Liquidity on Flow-Induced Trading

We conduct cross-sectional regressions of funds' corporate bond trades on flows and their interaction with liquidity measures including zero trading days and the Roll measure of illiquidity as in Bao, Pan, and Wang (2011). Bond trades can be driven by time variation in issuing firm characteristics (e.g., default risk) and thus we control for issuer times time fixed effects.[10] We include only bonds with time to maturity longer than one year.[11] We divide our sample into low and high cash funds to examine the extent to which fund liquidity buffers affect flow-induced trading. We classify a fund as low (high) cash fund if they hold cash less (more) than 5% of their total net assets.

Table 2A Column (1) reports that the estimated coefficient on outflows, *Flow(-)*, is 0.78 (a t-statistic of 18.36), whereas in Column (4) the coefficient is 0.66 (a t-statistic of 17.74). These results indicate that corporate bond funds liquidate only 66 to 78 basis points of their corporate bond holdings for 1 percent flows. Corporate bond fund sales are far from proportional scaling unlike equity mutual trades, suggesting that these funds sell other assets (presumably cash-like securities) instead of selling corporate

[10] Our results remain quantitatively and qualitatively similar when we control for bond times time fixed effects.
[11] Results are robust to different maturity cutoffs of, e.g., three years.

bond. In addition, low-cash funds are more sensitive to outflows in reducing their position than the high-cash funds.[12] This is consistent with the idea that funds employ cash holdings to absorb liquidity demand from investors.

The estimated coefficient on inflows *Flow(+)* is 0.57 (t-statistic of 8.34) in Column (1), whereas in Column (4) the coefficient on inflows is 0.45 (t-statistic 12.68). Similar to outflow results, funds expand only 45 to 57 basis points of their current corporate bond holdings for 1 percent inflows. They can open new positions in other corporate bonds (in many time newly-issued bonds) or in other assets. For example, they may "park" new capital inflows in liquid and safe assets such as Treasury, and then purchase corporate bonds slowly over time to manage transaction costs. Kolokolova, Lin, and Poon (2015) documents similar behaviors by hedge funds.

In Column (2) of Panel A, we examine the effect of market liquidity by including the interaction of flows with zero trading days. The estimated coefficient on the interaction term between outflows (*Flow(-)*) and bond illiquidity (*ZTD*) is -0.27 with a t-statistic of -5.68 and the coefficient estimate on the interaction between inflows (Flow(+)) and *ZTD* is -0.01 with a t-statistic of -0.33. This indicates that outflow-induced trading by low-cash funds is more sensitive to bond illiquidity. Holding everything else constant, for a one standard deviation increase in *ZTD,* outflow-induced trading by low-cash funds decreases by about 13% compare with the unconditional results (Column 1). The effect of liquidity is both statistically and economically significant, especially for low-cash funds that are experiencing outflows. We use Roll (1984) measure as an alternative measure of bond illiquidity as a robustness check (columns 3 and 6). The results are similar.

In sum, the impacts of outflows on trading are both economically and statistically more pronounced in low-cash funds than in high-cash funds. These results indicate that the internal liquidity plays important role, especially in low-cash funds. Furthermore, these results are consistent with the liquidity management story that funds with low

[12] In unreported results, we use interacted terms for lagged cash ratio instead of dividing groups and find significant results within outflow funds.

cash cushions selectively trade liquid securities to absorb redemption requests from investors.

3.2. The Effect of Dealer Liquidity Provision on Flow-Induced Trading

Panel B of Table 2 reports the extent to which flow sensitivity of bond trading depends on dealer liquidity provision. We split the sample into outflow (columns one through three) and inflow samples (columns four through six) and separately examine the effects of dealers' buy liquidity provision and sell liquidity provision. As explanatory variables, we include the interactions of flows with *DealerBuyAmihud* and *DealerSellAmihud*, which are the measures of price changes per volume when dealers provide liquidity to their clients, estimated using dealer-buy and dealer-sell transactions, respectively. These variables measure how weak dealers' liquidity provision is, since they represent price impacts driven by clients. See the Appendix A for the detailed definitions of these variables.

In Column (1) of Table 2B, the estimated coefficient of *Flow*DealerBuyAmihud* is -0.84 (t-statistics of -3.05). This indicates that decreases in dealer-buy liquidity provision (hence increases in *DealerBuyAmihud*) are associated with decreases in outflow-induced trading. Holding everything else constant, a one standard deviation increase in *DealerBuyAmihud* reduces flow-induced trading by 6%. In contrast, *DealerSellAmihud* is not relevant to the relationship between outflows and trades, as can be seen from Column (2). This result is consistent with the story that mutual fund managers consider the liquidity provision capacity of dealers when they liquidate.

For the inflow sample (columns four through six), we find that the both dealers' selling and buying liquidity provision becomes statistically significant. In other words, mutual funds buy bonds with stronger dealers' liquidity provision, given inflows. Compare to outflow samples where funds consider only dealer buying provision, this is consistent with the liquidity management story that when funds buy more bonds, they consider not only the liquidity costs at the moment but also the liquidation costs in case of redemption happens. In sum, the results provided in Table 2 panel B also present

strong evidence that mutual funds' trading behavior depends on the market liquidity of corporate bonds.

4. Is There Flow-Driven Price Pressure on Corporate Bonds?

The results provided in Table 2 show that, unlike evidence documented in previous studies for equity, corporate bond mutual funds do not engage in proportional scaling of investment holdings given investor flows but selectively trade bonds with abundant market liquidity. These funds also tend to pile up cash and cash-like securities and thus tend to absorb liquidity demand from end investors through selective trading and liquidity management. An interesting and important question that follows is that whether the liquidity management of mutual funds is sufficient enough to mitigate price impact given large fund flows. Corporate bond markets are inherently illiquid. Thus, whether investor flows can exert sufficient price pressure is ultimately an open, empirical question.

In this section, we thoroughly examine the extent to which fund flows temporarily impact corporate bond prices both in the cross section and time series. Our empirical analyses are important in the following sense. First, in our cross-sectional analysis, we closely follow the approaches done in the equity studies, e.g., Coval and Stafford (2007), Frazzini and Lamont (2008), and Lou (2012), and document the extent to which flow-induced trading has price impact on corporate bonds. In particular, we contrast price impact driven by low liquidity versus high liquidity funds, since our results documented in the previous section suggest that funds might not necessarily be forced to trade given flows because of their high cash holdings. Second, we examine flow-driven price pressure during market distress episodes, e.g., the 2008 financial crisis and the Taper Tantrum. The price impact analyses during these distress episodes will be particularly informative with respect to the recent debate on the financial stability.

4.1. Cross-Sectional Evidence on Price Pressure: Full Sample Analysis

4.1.1 Characteristics of mutual funds sorted on investor flows

In Table 3, we first report the various characteristics of funds sorted on investor flows. Columns (2) and (3) show that corporate bond and cash ratios out of total assets are stable across decile sorts. For example, funds experiencing most severe inflows and outflows have on average 51.28% and 51.16% of their assets in corporate bonds (see *Corp Ratio*) and their difference is not statistically significant with a t-statistics of only -0.12. In contrast, we find a weak pattern in cash holdings (see *Cash Ratio*) across flow decile buckets. Funds experiencing most severe outflows (inflows) have on average 13.06% (15.03%) of corporate bond holdings per funds. This is probably due to the fact that fund flows are persistent with an AR(1) coefficient of 0.38. Funds with large outflows also experienced outflows in previous quarters and used their cash buffers to meet investor redemption.

Changes in corporate bond (Column 5) and cash ratios (Column 6) allow us to understand how our sample funds trade corporate bonds and use cash holdings. If funds do the proportional scaling, their holding composition would not change due to flows. However, funds experiencing large outflows liquidate relatively less corporate bonds and use cash buffers instead. As a result, the ratio of corporate bond holdings increases after experiencing severe outflows, while the cash ratio decreases after experiencing severe outflows. (See Columns 5 and 6) Furthermore, the ratio of corporate bond holdings decreases after experiencing severe inflows, while the cash ratio increases after experiencing severe inflows. This indicates that funds experiencing large inflows purchase relatively less corporate bonds and accumulate cash buffers instead. Among funds in most severe outflows and inflows groups, those changes are statistically significant at the 1% level.

4.1.2. Full Sample Results

In this section, we examine the extent to which flow-driven trading exerts price pressures on corporate bonds. To identify which bonds are under flow-induced trading, we use the *Pressure* measure of Coval and Stafford (2007):

$$Pressure_{i,t} = \frac{\sum_j \left(\max\left(0, \Delta Holdings_{j,i,t}\right) \middle| Flow_{j,t} > 90^{th} percentile\right)}{AmountOutstanding_{i,t-1}} - \frac{\sum_j \left(\max\left(0, -\Delta Holdings_{j,i,t}\right) \middle| Flow_{j,t} < 10^{th} percentile\right)}{AmountOutstanding_{i,t-1}} \quad (3)$$

where $Flow_{j,t}$ is the quarterly capital flows of mutual fund j during the quarter t, $AmountOutstanding_{i,t-1}$ is the lagged amount outstanding of bond i, and $\Delta Holdings_{j,i,t}$ estimates the holding changes during quarter t for bond i held by fund j. Thus, $Pressure_{i,t}$ is purchases by funds under severe inflows minus sales by funds under severe outflows. At each quarter end, we then classify bonds with $Pressure_{i,t}$ below the 10th percentile *bonds under flow-induced selling* and bonds with $Pressure_{i,t}$ above the 90th percentile as *bonds under flow-induced buying*.

Using this classification, we form hedge portfolios by taking a long position in bonds under flow-induced selling and a short position in bonds under flow-induced buying. We form value-weighted (VW) portfolios, rebalance them quarterly, and examine performance of these portfolios from four quarters before the portfolio sorting quarter through eight quarters after the sorting quarter. Since we track long-horizon performances of quarterly sorted portfolios, we follow the approach of Jegadeesh and Titman (1993) by examining monthly returns of portfolios formed in different time points. We estimate abnormal returns by following the matching portfolios approach (by rating and maturity) of Bessembinder et al. (2008). Specifically, we subtract from bond returns the returns on the value-weighted portfolios that are formed using other bonds

with the same rating and maturity buckets.[13] We expect the prices of bonds under flow-induced selling (buying) will drop (rise) in the portfolio sorting quarter and be reversed in following periods, if there exists substantial flow-induced price pressure, as documented in previous studies of equity mutual funds.

Table 4 Panel A reports monthly abnormal returns on the flow-induced buy and sell portfolios as well as the sell-minus-buy hedge portfolios from two quarters before (Q-2) and through six quarters after (Q6) the portfolio sorting quarter (Q0). If flow-induced fund trading has price impacts, we should observe significant price decreases for the sell portfolios and price increases for the buy portfolios during the portfolio sorting quarter (Q0). The results indicate otherwise. Returns during Q0 are all statistically insignificant at the conventional levels. We do not view that these are due to power issues, since the economic magnitudes are tiny (-1.3 and 5.9 basis points per month for the sell and buy portfolios, respectively). Moreover, we only observe modest post-flow-quarter price rebound, i.e., continuous price increases for the sell portfolios or price decreases for the buy portfolios after Q0. These results provide no strong evidence for flow-driven price pressure on corporate bonds.

In Panel B, we provide returns of the flow-induced sell and buy portfolios for four-quarter periods to increase the statistical power. The results are similar to those in Panel A. We do not find significant price reversal after the event quarter Q0. Overall, the results provided in Table 4A and 4B present only limited and weak price impact driven by mutual fund flows.

13 First, we divide bonds by five groups based on the S&P's major rating categories. (AAA, AA, A, BBB, and others) We exclude bonds if their S&P ratings are not available. Then we assign bonds to three time-to-maturity groups. For investment grade bonds, we segment bonds by time-to-maturity of 0 to 5 years, 5 to 10 years, and 10+ years. For noninvestment grade bonds, the cutoffs are 0 to 6 years, 6 to 9 years, and 9+ years. Since AAA bonds are too small to split into three maturity groups, we instead split them into two groups, 0 to 7 years and 7+ years.

4.2. Cross-Sectional Evidence on Price Pressure: Low Cash Funds

The results in the previous section show that there is no significant evidence for price impacts on corporate bonds. Most likely, the results are due to the fact that these funds trade relatively liquid corporate bond given flows and also hold substantial liquidity buffers. In some sense, it is difficult to call "flow-induced trading" due to high liquidity buffers. Figure 1 Panel B and also Table 3 show that corporate bond funds hold around 15% of their net assets in cash, while average outflows are approximately negative 15% for the lowest fund flow decile, as shown in Figure 2 Panel B. Thus, funds in our sample have liquidity cushions large enough to cover substantial outflows.

In this section, we focus on funds with lower cash holdings and relatively high corporate bond holdings. This way, we can better identify flow-induced trading in corporate bonds and thus gauge the extent to which fund flows might exert price pressure.

4.2.1. Price Impact Due to Low Cash Funds: Results

Table 5 provides the analysis of price impact for bonds held by low cash funds. We define low cash funds as funds with less than 5% of their net assets in cash and cash-like securities and also more than 50% of their assets in corporate bonds. Using only these funds, we recalculate the Pressure measure following Equation 3 to form buy and sell pressure portfolios.

In Panel A, we find evidence consistent with price pressure. Although Q0 returns are not statistically significant in the sell or buy portfolios separately, the sell minus buy portfolio returns are negative and statistically significant at the 5% level. There is pre-price decrease in the portfolio for Q-2 and Q-1, similar to what is found in equity fund studies. Recovery is not particularly pronounced, although we find a significantly positive return of 0.292% monthly (0.292% * 3 during the quarter).

To increase statistical power and also investigate longer term response, we report in Panel B four-quarter period return results. We find a clearer pattern of price pressure.

There is pre-event price decrease in Column (1) (Q-4 to Q-1), contemporaneous price decrease in Q0, and continuation of price decrease in Column (3) (Q1 to Q4), followed by strong reversal in Column (4) (Q5 to Q8). In sum, Table 5 shows evidence for flow-induced price impact for bonds held by low cash holding funds.

4.2.2. Total Amounts of Bonds Held by Low Cash Funds

We found evidence consistent with flow-induced price pressure for low cash funds. An important question that follows is how important these low cash funds are in the corporate bond markets. If they account for only a small fraction of the entire corporate bond mutual fund space or hold small fraction of corporate bonds, any price pressure that their flow might exert is not a serious concern for financial stability.

In Figure 3, we graphically illustrate the total face value of corporate bonds held by low cash funds. Panel A shows that low cash funds have substantial amounts of corporate bonds. Towards the latter part of the sample period (late 2014), these funds hold more than 40% of the total amounts held by all the corporate bond funds in our sample. Given that mutual funds are one of the major institutional investors in the U.S. corporate bond markets,[14] these holdings by low cash funds are substantial. Moreover, we find the holdings of the low cash funds steadily increase in the latter part of the sample except for late 2013, which might be due to liquidity concerns following the Taper Tantrum, while the holdings of all sample funds do not increase (rather decrease) after late 2013. This trend suggests increasing possibility of market destabilization.

In Panel B, we further plot how large a fraction of these low cash funds account for the corporate bond fund universe over time. Our earlier results show that the average holdings of cash among corporate bond mutual funds are substantially high, i.e., 14% on average. In Figure 3 Panel B, however, we find that substantially high fractions of these funds have cash ratios lower than 10%. Moreover, low cash funds increasingly account for higher fractions over time, potentially due to excessive risk taking by

[14] Mutual funds hold approximately 20% of the total corporate bonds outstanding in the U.S. as of 2014, according toFlow of Funds Accounts from the Federal Reserve.

funds ,e.g., reaching for yield as documented in Choi and Kronlund (2015), during the post financial crisis period.

Overall, Figure 3 illustrates that funds are increasingly holding less cash. Low cash funds with less than 5% of net assets in cash account for more than 40% of total corporate bond holdings by corporate bond mutual funds. Combined with our previous results for price pressure due to low cash funds, Figure 3 suggests that potential risk posed by corporate bond mutual funds to financial stability is increasing.

5. Flow-Driven Price Pressure During Market Distress Episodes

We further analyze price impact exerted by mutual fund flows during market distress episodes. The analyses will have particularly important implications for financial stability of the post-crisis corporate bond markets.

As a preview, Figure 4 shows weekly aggregate bond returns (not abnormal returns) held by all corporate bond mutual funds along with fund flows to the top and bottom flow deciles as well as the monthly aggregate fund flows during both the 2008 financial crisis period and the mid 2013 period, a.k.a. the Taper Tantrum. A few preliminary observations are in order. We see substantial aggregate outflows in 2008 Q3 and 2013 Q2 both around the 2%-4% range. The bottom flow decile funds experience significantly negative flows larger than 10% for the both periods, which suggests that these funds are under the significant pressure of fire sales.

4.1. Flow-Driven Price Impact During the 2008 Financial Crisis

We examine weekly *abnormal* return on the sell portfolio formed in 2008 Q4. We use weekly returns instead of monthly returns in order to detect price pressure lasting shorter than a monthly horizon. Indeed, as our results show later, large price movement during the market distress episodes dissipates within a month.

Table 6 shows weekly abnormal returns on the sell portfolio form using *Pressure* in 2008Q4 for all funds and also for low cash funds. We find substantial negative returns in the week of October 3rd and 10th followed by strong reversal in subsequent weeks, suggesting flow-driven price pressure. For the low cash funds (Panel B) in particular, abnormal returns are -0.88% and -2.11% for the first and second weeks of October, respectively, which are statistically significant at the 10% and 5% levels. Note that these are abnormal returns, measures in excess of matching portfolio returns. These negative returns are followed by substantial positive returns in the next two weeks (1.47% and 1.08%), indicating that the price pressure during the first two weeks have mostly disappeared in the following two weeks. In sum, we find evidence consistent with substantial price pressure lasting less than a month.

Figure 5 plots cumulative abnormal returns on the sell portfolio for both all sample funds and low cash funds during the period from Aug 29 through Nov 7. We find that price dips and reversals are much more pronounced for low cash funds, also consistent with fire-sale driven price pressure under significant outflows. The economic magnitudes are also quite significant. The abnormal cumulative returns are more negative than 5% in the week of Oct 10. Recovery occurs for the next four week period, showing that cumulative abnormal returns revert back to the late August level in early November.

4.2. Price Impact During the Taper Tantrum

In this section, we examine flow-driven price impact during the recent Taper Tantrum episode in the summer of 2013. During this period, the Fed announced that it would tighten the monetary policy and substantial amounts of investor money flew out

of risky corporate bond fund markets.[15] Anecdotally, price impact on the corporate bond market due to investor outflow was significant.

Did aggregate fund flows also have a market-wide impact during the Taper Tantrum episode? In Figure 4B, we plot raw returns on the aggregate-level portfolio of corporate bonds held by all mutual funds in our sample along with the aggregate flows. We find that around the end of June, aggregate outflows from corporate bonds were substantial, around -2.1%. During the month of June, bond returns were approximately -0.8% per week, implying that aggregate bond price decreased around -3.2% for the month, which is quite a substantial change in bond prices. However, this price decrease did not last long. As we can see from the graph, the price quickly rebounded in the next month (July).

In Table 7, we examine weekly abnormal returns on the sell portfolio formed in 2013 Q2 for all sample funds and also for low cash funds. We find continual negative returns throughout June. The abnormal returns are -0.17% and -0.24% (both are statistically significant at the 5% level) in the last week of June for the all fund sample and the low cash sample, respectively. Note that in the previous week (the week of June 21th) the Fed held a press conference regarding tapering down,[16] which might explain the significant low abnormal returns. These negative returns tend to revert in July. The returns in the week of July 19th are 0.19% and 0.45% for the all fund sample and the low cash fund sample, both of which are highly statistically significant.

In Figure 6, we plot cumulative abnormal bond returns during the period. We find a cumulative return pattern consistent with price pressure from May 17th to June 28th. The cumulative abnormal return reaches approximately -0.6% at June 28th and recovers next three weeks. These results show that, although funds tend to engage in selective trading in liquid bonds, there existed short-term flow-driven price impacts in the cross section of bonds. This is consistent with our short-term analyses on the crisis

15 June 19th 2013, Federal Reserve Chairman Ben Bernanke had press conference in which Fed might be tapering down the monthly pace of purchases later that year.
16 See http://www.federalreserve.gov/mediacenter/files/FOMCpresconf20130619.pdf.

period. Note, however, that the economic magnitudes are not substantial. In part, this is because we examine returns in excess of matching portfolio returns. Although in Figure 4B the market wide returns were quite substantially negative in June 2013 (the aggregate returns are around -1% for the month) and there were subsequent large positive returns in July, it is difficult to conclude from the aggregate returns that how much is due to price pressure. For this reason, we employ abnormal returns on the sell portfolio and potentially purge out substantial portion of market-wide price impact. Although the economic magnitudes of the abnormal returns are not substantial, we find evidence consistent with flow-driven price impact during the periods of severe market-wide outflows.

6. Aggregate Level Evidence: Impulse Response Analyses

In this section, we examine market-wide price impact driven by aggregate flows to corporate bond mutual funds. We first pool corporate bond holdings of all sample funds into an aggregate bond portfolio and perform impulse response analyses using the vector autoregression model with two lags. [17] [18] Our VAR model consists of monthly aggregate flows and value-weighted monthly *abnormal* returns of the aggregate bond portfolio. Both variables are standardized (mean 0 and standard deviation 1). Through impulse response analyses, we examine the effect of flow shocks orthogonalized to contemporaneous returns on the aggregate portfolio. For this reason, we impose the Cholesky ordering of three variables to be (1) flows and (2) abnormal returns. We obtain aggregate flows by calculating average monthly flows in percentage weighted by

17 To be included to the portfolio, we require a bond to have time-to-maturity longer than three years. When a bond holding is eliminated from all funds' holdings due to the selling (not due to retirement), we hold the bond in the portfolio for additional two quarters with last available holding size as a weight to capture any following price impact after the large selling.

18 We choose this particular model based on the Akaike information criteria (AIC). If we use one lag instead of two, the results are qualitatively and quantitatively similar except slightly less temporary effects in the all sample analysis.

fund size (TNA). We weight abnormal returns by sum of market values of bonds held by our sample funds by using last available holding data before the return month.

Figure 7 shows the cumulative impulse response of abnormal bond returns to a shock in fund flows. The plot in Panel A indicates that a one-standard-deviation shock to market-wide fund flows corresponds to approximately 60% of a one-standard-deviation increase in abnormal returns on the aggregate bond portfolio, which decays to approximately 40% over the next two months. Thus the temporary effect is approximately 20% of a one standard deviation of abnormal returns. Note that we employ abnormal returns on the aggregate bond portfolio using the approaches of Bessembinder, Kahle, Maxwell, and Xu (2009), which implies that the economic magnitude should be interpreted as abnormal returns in excess of rating-maturity matching returns.

In Panel B we plot the price impact of the aggregate bond portfolio held by low-cash funds ($< 5\%$). For the aggregate bond portfolios held by these firms, we anticipate a stronger price impact and decay. We find that although initial price reaction is not particularly greater, subsequent decay in prices tends to be much faster. At month 0, the abnormal return on the portfolio jumps up by approximately 27%. After three months, less than 9% of one-standard-deviation shock on return remains. In summary, we find evidence consistent with flow-driven price pressure at the aggregate level.

5. Conclusion

In this paper, we examine the extent to which fund trading in response to investor flows affects corporate bond price. Surprisingly, we find only limited evidence for flow-induced price pressure. Knowing that corporate bond markets can be highly illiquid, corporate bond mutual funds on average maintain substantial cash holdings. In addition, these funds trade bonds with high market liquidity and also bonds for which liquidity provision by market makers is strong. Overall, our evidence suggests that

corporate bond mutual funds actively employ internal liquidity and trade bonds with relatively high liquidity to dampen liquidity shocks from fund investors.

Appendix A. Variable Definitions

Variables	Definitions
	Fund Characteristics
Flow	Fund flows during the quarter. First, we estimate monthly flow using monthly return from CRSP mutual fund database as $Flow_{j,t} = \frac{TNA_{j,t} - TNA_{j,t-1}(1+R_{j,t})}{TNA_{j,t-1}}$, where $TNA_{j,t}$ is the total net asset of fund and $R_{j,t}$ is the monthly return of fund j at time t. And then we define quarterly *Flow* as aggregated monthly flow during the quarter t.
Fund ZTD	Value-weighted average of zero-trading days (ZTD) of bonds held by the mutual fund. (See below for *ZTD*)
CashRatio	Percentage amounts of cash holdings scaled by total net assets at the end of each quarter. Cash is cash and cash-like securities in MorningStar (typecode in C, CH, CL, CP, CR, CT, FM, FV) plus government treasury holdings in MorningStar (typecode in BT, TP). The definitions of typecodes are detailed in Appendix B.
CorpRatio	Percentage amounts of US corporate bond holdings scaled by total net assets at the end of each quarter. Holding information is from MorningStar and we merge Mergent FISD database to get bond information. We require Mergent FISD bond type in (CCOV, CDEB, CLOC, CMTN, CMTZ, CP, CPAS, CPIK, CS).
Δ*CorpRatio*	Change in *CorpRatio* between quarters.
Δ*CashRatio*	Change in *CashRatio* between quarters.
	Bond Characteristics
Trade	Trading in the bond by the mutual fund in the quarter, in percentage. Specifically, $$Trade_{i,j,t} = \frac{Amt\ Hold_{i,j,t}}{Amt\ Hold_{i,j,t-1}} - 1$$ where $Amt\ Hold_{i,j,t}$ is the amount (in par value) of bond i held by fund j at the end of quarter t, obtained from the Morningstar database.

ZTD	Ratio of zero-trading days in a quarter for the bond, used in Chen, Lesmond, and Wei (2007) and Dick-Nielsen et al. (2012). If there is no transaction recorded in TRACE for the bond during the day, we call it zero trading day.
Roll	Roll (1984) illiquidity measure. $\text{Roll}_{i,t} = 2\sqrt{-cov(\Delta p_{i,s}, \Delta p_{i,s-1})}$ where $p_{i,s}$ is the natural logarithm of price for bond i on day s. We calculate daily price as trading volume weighted price at each day. We require volume to be at least \$100k to exclude retail transaction. Each day, we calculate the Roll measure with rolling window of 21 days. To be well-defined, we require at least 4 observations available within the rolling window and discard positive covariance observations. We define quarterly *Roll* as the median of daily Roll measure within the quarter.
DealerBuyAmihud	The Amihud (2002) illiquidity measure of dealer-buy liquidity provision. We first calculate daily $\text{DealerBuyAmihud}_t = (-1) * \frac{1}{N_t}\sum_{j=1}^{N_t}\frac{r_j}{\lvert Q_j \rvert}$ where N_t is number of dealer-buy-and-customer-sell transaction for the bond on that day. We do not include inter-dealer transactions. We obtain dealer transaction information from the enhanced TRACE. r_j is the return of the dealer-buy-and-customer-sell-transaction price to preceding transaction price. This preceding transaction is the previous transaction in TRACE, sorted by time of transaction of the bond within that day. Thus the preceding price is not necessarily to be from a dealer-buy transaction. The reports in TRACE have a unit time interval of a second. We leave r_j to be signed to capture the liquidity provision from the customer's (like mutual funds) perspective. Holding everything else constants, more negative r_j means more cost of liquidation for the customer. Also, positive r_j means dealers are willing to pay more and this makes customer easier to liquidate their holding. Therefore, we multiply -1 to make this to the illiquidity measure. Q_j is a transaction volume in million dollars. We require volume to be at least \$100k to exclude retail transaction. We define quarterly *DealerBuyAmihud* measure as the median of daily measures within the quarter.
DealerSellAmihud	Amihud (2002) style illiquidity measure of dealer-sell liquidity provision. The definition is similar to *DealerBuyAmihud*. There are two differences. First, we use dealer-sell-and-customer-buy transaction instead of dealer-buy transaction. Second, we do not multiply -1, since now the situation is opposite. Holding everything else constants, more positive r_j means more cost of transaction for the customer. (i.e., daily

$\text{DealerSellAmihud}_t = \frac{1}{N_t}\sum_{j=1}^{N_t}\frac{r_j}{|Q_j|}$) We define quarterly *DealerSellAmihud* measure as the median of daily measures within the quarter.

Monthly Return

Monthly total return of corporate bond. Price information is obtained from TRACE and other bond characteristics to calculate accrued interests and coupon payments are obtained from Mergent FISD database. We similarly follow procedures in Bessembinder et. al. (2008). We calculate daily price as trading volume weighted price at each day. We require volume to be at least \$100k to exclude retail transaction. To calculate monthly return, we use the last daily price within 5 days to the end of each month. Since TRACE price is 'clean' price, we calculate return as following:

$$\text{Return}_{i,t} = \frac{P_{i,t} + AI_{i,t} + Cpn_{i,t}}{P_{i,t-1} + AI_{i,t-1}} - 1$$

where $P_{i,t}$ is the price, $AI_{i,t}$ is accrued interest, and $Cpn_{i,t}$ is coupon payment, if any, in month t.

Pressure

$$\text{Pressure}_{i,t} = \frac{\begin{pmatrix} \sum_j \left(\max\left(0, \Delta Holdings_{j,i,t}\right) \middle| Flow_{j,t} > 90^{th} percentile\right) \\ -\sum_j \left(\max\left(0, -\Delta Holdings_{j,i,t}\right) \middle| Flow_{j,t} < 10^{th} percentile\right) \end{pmatrix}}{AmountOutstanding_{i,t-1}}$$

where $\Delta Holdings_{j,i,t}$ is the change in holding amounts of bond i for fund j from time t – 1 to time t. The quarterly holding amounts are obtained from MorningStar.

* All variables except returns are winsorized at the 1st and 99th percentile.

Appendix B. Morningstar Typecodes for Cash Holdings

Morningstar Typecode	Definitions
BT	Bond - US Treasury
C	Cash
CD	Cash - CD/Time Deposit
CL	Cash - Currency Future
CP	Cash - Commercial Paper
CR	Cash - Repurchase Agreement
CT	Cash - T-Bill
FM	Mutual Fund -MMkt
FV	Mutual Fund -VA
TP	Bond - TIPS

References

Amihud, Y., 2002. Illiquidity and Stock Returns: Cross-section and Time-series Effects. *Journal of Financial Markets* 5:31-56.

Bao, J., Pan, J., and Wang, J., 2011. The Illiquidity of Corporate Bonds. *Journal of Finance* 66:911-946.

Ben-David, I., Franzoni, F., and Moussawi, R., 2012. Hedge Fund Stock Trading in the Financial Crisis of 2007–2009. *Review of Financial Studies* 25:1-54.

Bessembinder, H., Kahle, K. M., Maxwell, W. F., and Xu, D., 2009. Measuring Abnormal Bond Performance. *Review of Financial Studies* 22: 4219-4258.

Campbell, J. Y., Giglio, S., and Pathak, P. 2011. Forced Sales and House Prices. *American Economic Review* 101:2108-31.

Chen, L., Lesmond, D. A., and Wei, J., 2007. Corporate Yield Spreads and Bond Liquidity. *Journal of Finance* 62:119-149.

Chernenko, S., and Sunderam, A., 2012. The Real Consequences of Market Segmentation. *Review of Financial Studies* 25:2041-2069.

Chernenko, S., and Sunderam, A., 2016. Liquidity Transformation in Asset Management: Evidence from the Cash Holdings of Mutual Funds. Working Paper.

Choi, J. and Kronlund, M., 2015. Reaching for Yield by Corporate Bond Mutual Funds. University of Illinois Working Paper.

Coval, J., and Stafford, E., 2007. Asset Fire sales (and Purchases) in Equity Markets. *Journal of Financial Economics* 86:479-512.

Dick-Nielsen, J., Feldhütter, P., and Lando, D., 2012. Corporate Bond Liquidity Before and After the Onset of the Subprime Crisis. *Journal of Financial Economics* 103:471-492.

Dick-Nielsen, J., 2009. Liquidity Biases in TRACE. *Journal of Fixed Income* 19:43-55.

Dick-Nielsen, J., 2014. How to Clean Enhanced TRACE data. Copenhagen Business School Working Paper.

Driessen, J., 2005. Is Default Event Risk Priced in Corporate Bonds? *Review of Financial Studies* 18:165-195.

Edmans, A., Goldstein, I., and Jiang, W., 2012. The Real Effects of Financial Markets: The Impact of Prices on Takeovers. *Journal of Finance* 67:933-971.

Edwards, A. K., Harris, L. E., and Piwowar, M. S., 2007. Corporate Bond Market Transaction Costs and Transparency. *Journal of Finance* 62:1421-1451.

Ellul, A., Jotikasthira, C., and Lundblad, C. T., 2011. Regulatory Pressure and Fire Sales in the Corporate Bond Market. *Journal of Financial Economics* 101:596-620.

Feldhütter, P., 2012. The Same Bond at Different Prices: Identifying Search Frictions and Selling Pressures. *Review of Financial Studies* 25:1155-1206.

Feroli, M., Kashyap, A. K., Schoenholtz, K. L., and Shin, H. S., 2014. Market Tantrums and Monetary Policy. *Chicago Booth Research Paper* 14-09.

Frazzini, A., and Lamont, O. A., 2008. Dumb Money: Mutual Fund Flows and the Cross-section of Stock Returns. *Journal of Financial Economics* 88:299-322.

Friewald, N., and Nagler, F., 2015. Dealer Inventory and the Cross-Section of Corporate Bond Returns. Norwegian School of Economics Working Paper.

Goldstein, I., Jiang, H., and Ng, D. T., 2015. Investor Flows and Fragility in Corporate Bond Funds. Wharton School Working Paper.

Hoseinzade, S., 2015. Do Bond Mutual Funds Destabilize the Corporate Bond Market?, Working Paper.

Jegadeesh, N., and Titman, S., 1993. Returns to Buying Winners and Selling Losers: Implications for Stock Market Efficiency. *Journal of Finance* 48:65-91.

Jotikasthira, C., Lundblad, C., and Ramadorai, T., 2012. Asset Fire Sales and Purchases and the International Transmission of Funding Shocks. *Journal of Finance* 67:2015-2050.

Khan, M., Kogan, L., and Serafeim, G., 2012. Mutual Fund Trading Pressure: Firm-Level Stock Price Impact and Timing of SEOs. *Journal of Finance* 67:1371-1395.

Kolokolova, O., Lin, M. T., and Poon, S. H., 2014. Too Big to Ignore? Hedge Fund Flow and Bond Yields. University of Manchester Working Paper.

Longstaff, F. A., Mithal, S., and Neis, E., 2005. Corporate Yield Spreads: Default Risk or Liquidity? New Evidence from the Credit Default Swap Market. *Journal of Finance* 60:2213-2253.

Lou, D., 2012. A Flow-based Explanation for Return Predictability. *Review of Financial Studies* 25:3457-3489.

Mahanti, S., Nashikkar, A., Subrahmanyam, M., Chacko, G., and Mallik, G., 2008. Latent Liquidity: A New Measure of Liquidity, with an Application to Corporate Bonds. *Journal of Financial Economics* 88:272-298.

Manconi, A., Massa, M., and Yasuda, A., 2012. The Role of Institutional Investors in Propagating the Crisis of 2007–2008. *Journal of Financial Economics*, 104:491-518

Mitchell, M., Pedersen, L. H., and Pulvino, T., 2007. Slow Moving Capital. American *Economic Review* 97:215-220.

Mitchell, M., Pulvino, T., and Stafford, E., 2004. Price Pressure Around Mergers. *Journal of Finance* 59:31-63.

Pulvino, T. C., 1998. Do Asset Fire Sales Exist? An Empirical Investigation of Commercial Aircraft Transactions. *Journal of Finance* 53:939-978.

Rajan, R. G., 2013, A Step in the Dark: Unconventional Monetary Policy after the Crisis. Andrew Crockett Memorial Lecture, Bank for International Settlements.

Roll, R., 1984. A Simple Implicit Measure of the Effective Bid - ask Spread in an Efficient Market. *Journal of Finance* 39:1127-1139.

Sahay, R., Arora, V., Arvanitis, T., Faruqee, H., N Diaye, P., and Griffoli, T. M., 2014. Emerging Market Volatility: Lessons from the Taper Tantrum. IMF Staff Discussion Note, International Monetary Fund.

Shleifer, A., and Vishny, R. W., 1992. Liquidation Values and Debt Capacity: A Market Equilibrium Approach. *Journal of Finance* 47:1343-1366.

Simutin, M., 2014. Cash Holdings and Mutual Fund Performance. *Review of Finance* 18:1425-1464

Stein, J. C., 2013, Overheating in Credit Markets: Origins, Measurement, and Policy Responses, Speech at the "Restoring Household Financial Stability after the Great Recession: Why Household Balance Sheets Matter" Research Symposium Sponsored by the Federal Reserve Bank of St. Louis, St. Louis, Missouri.

Table 1. Summary Statistics

This table provides descriptive statistics for fund- and bond-level. The sample consists of actively managed corporate bond mutual funds and bonds held by these funds in both the MorningStar and TRACE databases. Variables are defined in Appendix A. All variables are measured in quarterly frequency except *Monthly Return* which is in monthly frequency. We report the number of observations (N), mean, standard deviation (Std.), 5%, 25%, median (50%), 75%, and 95% quantiles. The sample period is from 2002Q3 and 2014Q4.

Panel A. Fund-Level Variables

VARIABLES	N	Mean	Std.	5%	25%	50%	75%	95%
TNA ($ mil.)	21,566	1,573	8,062	19.58	99.14	322.5	1,020	5,823
Quarterly Flow (%)	21,566	1.26	12.03	-12.96	-3.97	-0.25	4.28	19.51
Corporate Bond Ratio (%)	21,566	50.37	27.38	15.14	26.24	42.97	77.85	94.31
Cash Ratio (%)	21,566	14.17	13.67	0.02	4.10	11.03	22.37	39.20
Treasury Ratio (%)	21,566	10.40	11.54	0	0	6.91	16.97	33.21
Agency Bond Ratio (%)	21,566	16.75	17.09	0	0	12.75	29.63	48.12
ABS Ratio (%)	21,566	9.29	11.46	0	0	4.67	15.31	33.48
Equity Ratio (%)	21,566	1.12	2.48	0	0	0.12	1.10	5.33
Other (%)	21,566	7.94	9.61	0	2.10	5.41	11.24	26.29

Panel B. Bond-Level Variables

	N	Mean	Std.	5%	25%	50%	75%	95%
TTM	356,097	7.93	8.79	0.38	2.76	5.42	8.85	26.82
Age	356,112	4.81	4.26	0.42	1.69	3.66	6.77	13.37
Rating [19]	329,836	12.64	4.08	5	10	13	16	18
Amount Outstanding	355,574	496,788	555,550	4,000	200,000	320,000	600,000	1,500,000

[19] We assign 21 to AAA rating.

($M)								
Zero Trading Days(ZTD)	290,234	62.05	35.27	3.125	29.23	69.84	100	100
Roll	110,387	0.0117	0.0147	0.00154	0.00399	0.00746	0.0139	0.0351
DealerBuyAmihud	192,727	0.0168	0.0542	0.0000	0.0002	0.0019	0.0139	0.0703
DealerSellAmihud	200,271	0.0180	0.0531	0.0000	0.0002	0.0023	0.0160	0.0780
Monthly Return (%)	309,142	0.70	4.75	-4.10	-0.63	0.61	1.89	5.51
Weekly Return (%)	998,082	0.18	2.50	-2.49	-0.52	0.15	0.85	2.88

Table 2. Flow-Driven Trading: Impact of Liquidity

This table provides the regression of mutual fund corporate bond trading on contemporaneous fund flows. The dependent variable $Trade_{i,j,t}$ is the percentage trading in bond i by mutual fund j in quarter t:

$$Trade_{i,j,t} = \frac{Amt\ Hold_{i,j,t}}{Amt\ Hold_{i,j,t-1}} - 1$$

where $Amt\ Hold_{i,j,t}$ is the amount (in par value) of bond i held by fund j at the end of quarter t, obtained from the Morningstar database. In Panel A, we report the regression results for low ($< 5\%$) and high ($>= 5\%$) cash funds. The independent variables include positive and negative components of quarterly investor flows (*Flow(-)* and *Flow(+)*), zero trading days of bonds in a quarter (*ZTD*), the bond illiquidity measure of Roll (1994) (*Roll*). The liquidity variables are lagged by one quarter. For the visibility of coefficients, in the regression *ZTD* is not in percentage scale. We also include as independent variables the interactions of investor flows with these zero-trading-day and Roll measures. Through Column 1 to 3, the sample consists of funds with low cash ratio ($< 5\%$), and through Column 4 to 6, the sample consists of funds with high cash ratio ($>= 5\%$) at the end of last quarter (t-1). The sample consists of bond-fund-quarter observations from 2002Q2 through 2014Q4. In the regressions using liquidity variables (Column 2, 3, 5, and 6) the sample period is restricted to the period between 2005Q1 and 2014Q2 due to the availability of enhanced TRACE. In Panel B, we report the regression of fund trading on dealer liquidity provision for outflow and inflow samples. The outflow sample consists of bond-fund-quarter observations of negative fund flows. The inflow sample is defined similarly. The independent variables include investor flows (*Flow*), Amihud (2002) measures constructed using dealer buy transactions (*DealerBuyAmihud*), Amihud measures constructed using dealer sell transactions (*DealerSellAmihud*). We also include as independent variables the interactions of investor flows with these variables. The sample consists of bond-fund-quarter observations between 2005Q1 and 2014Q1, where the enhanced TRACE database is available. In both panels, we exclude bonds with maturity less than 1 year. All regressions include the issuer*time fixed effect. The values in parentheses are t-statistics using standard errors clustered at the fund level. ***, **, and * denote statistical significant at the 1%, 5%, and 10% levels, respectively.

Panel A: Interaction with Market Liquidity Measures

	Low Cash Funds			High Cash Funds		
	(1)	(2)	(3)	(4)	(5)	(6)
	$Trade_{i,j,t}$	$Trade_{i,j,t}$	$Trade_{i,j,t}$	$Trade_{i,j,t}$	$Trade_{i,j,t}$	$Trade_{i,j,t}$
$Flow(-)_{j,t}$	0.778***	0.912***	0.936***	0.661***	0.716***	0.739***
	(18.36)	(14.93)	(13.91)	(17.74)	(14.38)	(14.20)
$Flow(+)_{j,t}$	0.570***	0.579***	0.628***	0.446***	0.524***	0.506***
	(8.336)	(6.162)	(5.500)	(12.68)	(10.49)	(10.08)
$Flow(-)_{j,t} * ZTD_{i,t-1}$		-0.272***			-0.0983**	
		(-5.678)			(-2.465)	
$Flow(+)_{j,t} * ZTD_{i,t-1}$		-0.0140			-0.149***	
		(-0.325)			(-3.011)	
$ZTD_{i,t-1}$		-1.542***			-1.736***	
		(-3.137)			(-3.376)	
$Flow(-)_{j,t} * Roll_{i,t-1}$			-5.493***			-3.300*
			(-2.939)			(-1.902)
$Flow(+)_{j,t} * Roll_{i,t-1}$			-3.453			-0.924
			(-1.354)			(-0.758)
$Roll_{i,t-1}$			81.20***			51.07***
			(3.448)			(3.272)
Constant	-10.89***	-10.09***	-12.01***	-10.55***	-9.501***	-11.43***
	(-24.55)	(-17.43)	(-17.14)	(-28.17)	(-22.76)	(-22.06)
Issuer * Time FE	Y	Y	Y	Y	Y	Y
Observations	1,149,441	899,340	428,986	2,070,925	1,663,044	948,266
Adj. R^2	0.130	0.128	0.110	0.101	0.102	0.0868

Panel B: Interaction with Dealer Liquidity Provision Measures

	Outflow Sample			Inflow Sample		
	(1)	(2)	(3)	(4)	(5)	(6)
	$Trade_{i,j,t}$	$Trade_{i,j,t}$	$Trade_{i,j,t}$	$Trade_{i,j,t}$	$Trade_{i,j,t}$	$Trade_{i,j,t}$

$Flow_{j,t}$	0.735***	0.730***	0.738***	0.502***	0.504***	0.508***
	(19.35)	(19.66)	(19.59)	(10.76)	(10.51)	(10.48)
$Flow_{j,t}$ *$DealerBuyAmihud_{i,t-1}$	-0.838***		-0.694**	-0.548***		-0.382**
	(-3.045)		(-2.557)	(-2.593)		(-2.008)
$DealerBuyAmihud_{i,t-1}$	8.192***		7.113***	14.32***		12.43***
	(3.251)		(2.757)	(6.189)		(5.240)
$Flow_{j,t}$ *$DealerSellAmihud_{i,t-1}$		-0.479	-0.242		-0.766**	-0.578*
		(-1.365)	(-0.600)		(-2.361)	(-1.713)
$DealerSellAmihud_{i,t-1}$		8.726***	9.284***		14.16***	11.75***
		(3.315)	(3.214)		(4.063)	(3.107)
Constant	-10.58***	-10.54***	-10.72***	-10.98***	-10.95***	-11.14***
	(-29.14)	(-29.65)	(-29.50)	(-21.81)	(-21.60)	(-21.58)
Issuer * Time FE	Y	Y	Y	Y	Y	Y
Observations	976,232	991,060	965,932	954,536	969,910	944,649
Adj. R^2	0.104	0.104	0.104	0.0960	0.0956	0.0960

Table 3. Mutual Funds' Holdings in Corporate Bonds and Internal Liquidity

This table provides quarterly fund flows during a quarter t ($Flow_t$), corporate bond holdings (*Corp Ratio*), cash holdings (*Cash Ratio*), value-weighted averages of zero trading days of bonds at the fund-level (*fund ZTD*) at the end of quarter *t-1*, changes in *Corp Ratio* ($\Delta CorpRatio$), changes in *Cash Ratio* ($\Delta CashRatio$) from the quarter *t-1* to t for decile groups of funds sorted on quarterly fund flows. We report averages and standard deviations (in parentheses) for each decile group. In the bottom two rows, we report the mean difference and t-statistics (in parentheses) based on t-test between extreme outflow (flow rank 1) groups and extreme inflow (flow rank 10) groups. The sample period is from 2002Q3 to 2014Q4, except for *fund ZTD* which is available between 2005Q1 to 2014Q1 through TRACE database.

	(1)	(2)	(3)	(4)	(5)	(6)
$Flow_t$ rank	$Flow_t$	$Corp\ Ratio_{t-1}$	$Cash\ Ratio_{t-1}$	$fund\ ZTD_{t-1}$	$\Delta CorpRatio_t$	$\Delta CashRatio_t$
Outflow 1	-15.48	51.16	13.06	46.52	0.77***	-0.90***
	(6.75)	(28.44)	(14.30)	(20.09)	(6.31)	(7.50)
2	-6.93	54.31	12.70	46.30	0.40***	-0.48***
	(2.37)	(28.56)	(12.99)	(18.11)	(5.41)	(6.31)
3	-4.23	50.96	13.60	45.92	0.02	-0.22*
	(1.82)	(27.44)	(12.89)	(18.32)	(4.94)	(5.38)
4	-2.49	48.82	14.68	46.17	0.17	-0.34***
	(1.68)	(27.1)	(13.01)	(18.22)	(5.31)	(6.25)
5	-1.05	49.45	14.41	45.85	-0.04	0.05
	(1.56)	(27.09)	(13.31)	(18.18)	(5.27)	(5.87)
6	0.44	50.10	14.36	46.92	-0.29***	0.25*

	(1.7)	(27.06)	(13.18)	(18.22)	(4.96)	(6.44)
7	2.27	50.16	14.55	46.68	-0.36***	0.37***
	(1.9)	(26.92)	(13.18)	(18.93)	(4.84)	(5.98)
8	5.01	50.07	14.65	47.52	-0.36***	0.40***
	(2.47)	(27.23)	(13.46)	(18.21)	(4.14)	(6.25)
9	9.86	50.56	14.34	48.43	-0.61***	0.51***
	(3.93)	(27.08)	(13.12)	(18.52)	(4.98)	(6.08)
Inflow 10	28.82	51.28	15.03	50.41	-1.22***	1.34***
	(19.68)	(27.02)	(13.66)	(19.58)	(6.8)	(7.75)
Mean difference (1-10)	-44.29***	-0.12	-1.97***	-3.89***	1.99***	-2.24***
t-value	(-92.23)	(-0.13)	(-4.23)	(-5.28)	(9.14)	(-8.83)

Table 4. Average Abnormal Returns on Portfolios Sorted on Flow-Driven Trading by Corporate Bond Funds

This table provides monthly (Panel A) and weekly (Panel B) abnormal returns (in percentages) on corporate bond portfolios sorted on flow-driven trading. Each quarter end, we sort corporate bonds into sell portfolios (Sell) if the price pressure variable (*Pressure*) is below the 10th percentile. We sort corporate bonds into buy portfolios (Buy) if *Pressure* is above the 90th percentile. We form value-weighted buy and sell portfolios as well as hedge portfolios (Sell-Buy), which long the sell portfolios and short the buy portfolios. In Panel A, we report monthly average abnormal returns on these portfolios quarter-by-quarter from two quarters before (Q-2) through six quarters after (Q6) the portfolio formation quarter (Q0). In Panel B, we report monthly average abnormal returns on these portfolios year-by-year from one year before (Q-4 to Q-1) through two years after (Q1 to Q4 and Q5 to Q8) the portfolio formation quarter (Q0). The abnormal returns are estimated following the matching-portfolio approach (by rating and maturity) of Bessembinder et al. (2008). We rebalance portfolios each quarter and to increase the power we follow the procedures of Jegadeesh and Titman (1993) by taking equal-weight averages of portfolio returns formed in different quarters. We exclude months that have available observations less than 20. In all panels, we require bonds to have at least three years before maturing in formation quarters to be included in the portfolios. In Panel A, the values in parentheses are t-statistics based on the Newey-West standard errors with three lags (Panel A) or twelve lags (Panel B). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Panel A. Monthly Abnormal Returns (Quarter-by-Quarter)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Q-2	Q-1	Q0	Q1	Q2	Q3	Q4	Q5	Q6
Sell	-0.015	-0.007	-0.013	-0.006	-0.017	0.020	-0.085	-0.045	0.081**
	(-0.352)	(-0.144)	(-0.250)	(-0.168)	(-0.508)	(0.324)	(-1.434)	(-0.797)	(2.152)
Buy	0.079	0.103	0.059	-0.049	-0.033	0.012	0.026	0.022	0.002
	(1.458)	(1.540)	(0.965)	(-0.907)	(-0.780)	(0.271)	(0.426)	(0.443)	(0.061)
Sell-Buy	-0.094**	-0.109*	-0.073	0.043	0.016	0.008	-0.111	-0.067	0.079
	(-2.063)	(-1.677)	(-1.043)	(0.787)	(0.302)	(0.170)	(-1.249)	(-0.754)	(1.563)
Obs.	102	105	108	108	105	102	99	96	93

Panel B. Monthly Abnormal Returns

	(1)	(2)	(3)	(4)
	Q-4 to Q-1	Q0	Q1 to Q4	Q5 to Q8
Sell	-0.012	-0.013	-0.015	0.018
	(-0.428)	(-0.250)	(-0.442)	(0.890)
Buy	0.075	0.059	-0.007	0.005
	(1.477)	(0.965)	(-0.221)	(0.216)
Sell-Buy	-0.087*	-0.073	-0.008	0.013
	(-1.781)	(-1.043)	(-0.226)	(0.427)
Obs.	105	108	108	96

Table 5. Average Abnormal Returns on Portfolios Sorted on Flow-Driven Trading by Low Cash Corporate Bond Funds

This table provides monthly abnormal returns (in percentages) on corporate bond portfolios sorted on flow-driven trading of low cash funds with concentrated holdings. We classify a corporate bond fund as a low cash fund if they hold cash and cash-like securities less than 5% and corporate bond more than 50% of their total assets under managements. Each quarter end, we sort corporate bonds into sell portfolios (Sell) if the price pressure variable (*Pressure*) estimated from low cash funds subsample is below the 10th percentile. We sort corporate bonds into buy portfolios (Buy) if *Pressure* estimated from low cash funds subsample is above the 90th percentile. We form value-weighted buy and sell portfolios as well as hedge portfolios (Sell-Buy), which long the sell portfolios and short the buy portfolios. In Panel A, we report monthly average abnormal returns on these portfolios quarter-by-quarter from two quarters before (Q-2) through six quarters after (Q6) the portfolio formation quarter (Q0). In Panel B, we report monthly average abnormal returns on these portfolios year-by-year from one year before (Q-4 to Q-1) through two years after (Q1 to Q4 and Q5 to Q8) the portfolio formation quarter (Q0). The abnormal returns are estimated following the matching-portfolio approach (by rating and maturity) of Bessembinder et al. (2008). We rebalance portfolios each quarter and to increase the power we follow the procedures of Jegadeesh and Titman (1993) by taking equal-weight averages of portfolio returns formed in different quarters. We exclude months that have available observations less than 20. In all panels, we require bonds to have at least three years before maturing in formation quarters to be included in the portfolios. In Panel A, the values in parentheses are t-statistics based on the Newey-West standard errors with three lags (Panel A) or twelve lags (Panel B). ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels.

Panel A. Monthly Abnormal Returns (Quarter-by-Quarter)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Q-2	Q-1	Q0	Q1	Q2	Q3	Q4	Q5	Q6
Sell	-0.032	0.049	-0.024	-0.173**	0.052	-0.034	-0.095	0.059	-0.073
	(-0.565)	(0.800)	(-0.568)	(-2.611)	(0.581)	(-0.498)	(-1.090)	(0.975)	(-1.094)
Buy	0.171**	0.093	0.108	0.047	0.077	0.007	-0.044	-0.232**	-0.047
	(2.111)	(0.996)	(1.602)	(0.697)	(1.258)	(0.091)	(-0.594)	(-2.182)	(-0.645)
Sell-Buy	-0.203***	-0.044	-0.132**	-0.220**	-0.025	-0.040	-0.050	0.292**	-0.025
	(-3.439)	(-0.519)	(-2.073)	(-2.596)	(-0.245)	(-0.392)	(-0.422)	(2.258)	(-0.216)
Obs.	102	105	108	108	105	102	99	96	93

Panel B. Monthly Abnormal Returns

	(1)	(2)	(3)	(4)
	Q-4 to Q-1	Q0	Q1 to Q4	Q5 to Q8
Sell	-0.036	-0.024	-0.067	-0.001
	(-0.902)	(-0.568)	(-1.643)	(-0.047)
Buy	0.110	0.108	0.023	-0.149*
	(1.561)	(1.602)	(0.727)	(-1.838)
Sell-Buy	-0.146*	-0.132**	-0.090**	0.148**
	(-1.815)	(-2.073)	(-2.156)	(2.159)
Obs.	105	108	108	96

Table 6. Weekly Average Abnormal Returns of *Sell* Portfolio around the Bankruptcy of Lehman Brothers in 2008

This table provides weekly average abnormal returns (in percentages) on corporate bond portfolios sorted on price pressure around the Bankruptcy of Lehman Brothers in 2008. We sort corporate bonds into sell portfolios (*Sell*) if the price pressure variable (*Pressure*) is below the 10th percentile at the end of quarters following the bankruptcy of Lehman Brothers. Specifically the *Pressure* is estimated during 2008:Q4 and sorted at the end of 2008:Q4. In Panel A, the *Pressure* is estimated by using all sample funds. In Panel B, we use subsample of low cash funds. We classify a corporate bond fund as a low cash fund if they hold cash and cash-like securities less than 5% and corporate bond more than 50% of their total assets under managements. We form the value-weighted *Sell* portfolios. We report weekly average abnormal returns (*E[R]*) on bonds in these portfolios from the week of September 5th to the week of November 7th. The weekly returns on bonds are calculated based on prices obtained from TRACE. The abnormal returns are estimated following the matching-portfolio approach (by rating and maturity) of Bessembinder et al. (2008). Variables are detailed in Appendix A. The t-statistics are based on the standard error of the mean.

	Panel A		Panel B	
	All Funds		Low Cash Funds	
End of Week	E[R] (%)	t-statistic	E[R] (%)	t-statistic
September 5th	-0.10	-1.09	-0.55***	-3.30
September 12th	-0.53*	-1.86	-0.49	-0.90
September 19th	-1.12	-1.30	-1.20	-1.17
September 26th	-0.90*	-2.03	0.18	0.30
October 3th	0.30	0.83	-0.88*	-1.80
October 10th	-0.71*	-1.66	-2.11**	-2.36
October 17th	0.52	0.83	1.47	1.61
October 24th	0.86***	2.62	1.08*	1.83
October 31th	-0.18	-0.58	1.20	1.58
November 7th	0.83***	3.75	0.67	1.53

Table 7. Weekly Average Abnormal Returns of *Sell* Portfolio around the Taper Tantrum in 2013

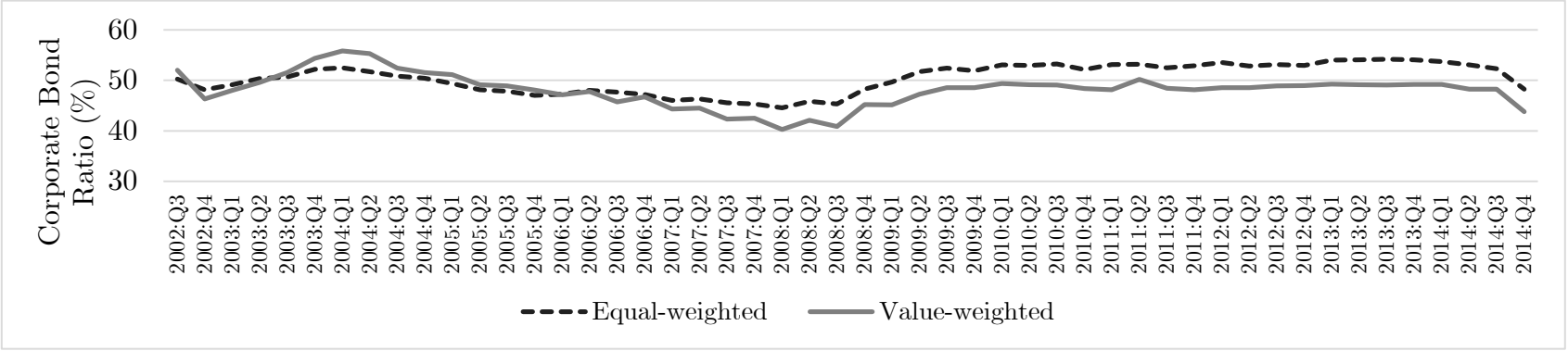
This table provides weekly average abnormal returns (in percentages) on corporate bond portfolios sorted on price pressure around the Taper Tantrum (May to June 2013). In Panel A, the *Pressure* is estimated by using all sample funds. In Panel B, we use subsample of low cash funds. We classify a corporate bond fund as a low cash fund if they hold cash and cash-like securities less than 5% and corporate bond more than 50% of their total assets under managements. At the end of Taper Tantrum quarter (2013:Q2), we sort corporate bonds into sell portfolios (*Sell*) if the price pressure variable (*Pressure*) is below the 10th percentile. We form the value-weighted *Sell* portfolio. We report weekly average abnormal returns (*E[R]*) on bonds in these portfolios from the week of May 10th to the week of July 19th. The weekly returns on bonds are calculated based on prices obtained from TRACE. The abnormal returns are estimated following the matching-portfolio approach (by rating and maturity) of Bessembinder et al. (2008). Variables are detailed in Appendix A. The t-statistics are based on the standard error of the mean. The date represents the last business day of each week during which returns are calculated

	Panel A		Panel B	
	All Funds		Low Cash Funds	
End of Week	E[R] (%)	t-statistic	E[R] (%)	t-statistic
May 17th	-0.10*	-1.80	-0.27***	-3.67
May 24th	-0.09	-1.49	0.07	0.81
May 31th	-0.11*	-1.88	-0.09	-1.19
June 7th	-0.09	-1.72	-0.03	-0.46
June 14th	-0.02	-0.45	-0.08	-1.23
June 21th	0.00	-0.01	0.00	0.04
June 28th	-0.17**	-2.25	-0.24**	-2.45
July 5th	0.06	0.80	0.20	1.64
July 12th	0.26**	2.07	0.16	1.04
July 19th	0.19***	2.78	0.45***	5.39

Figure 1. Average Corporate Bond and Cash Ratios Over Time

Panel A plots the time series of equal- and total-net-assets-weighted average corporate bond ratios ($CorpRatio_{i,t}$) of corporate bond funds. Panel B plots the time series of equal- and total-net-assets-weighted average cash ratio ($CashRatio_{i,t}$) of corporate bond funds. The equal-weighted averages are denoted by dashed lines and value-weighted averages are denoted in solid lines. Variables are detailed in Appendix A. The sample period is from 2002:Q2 to 2014Q4 and denoted in x-axis.

Panel A. Corporate Bond Holdings



Panel B. Cash Holdings

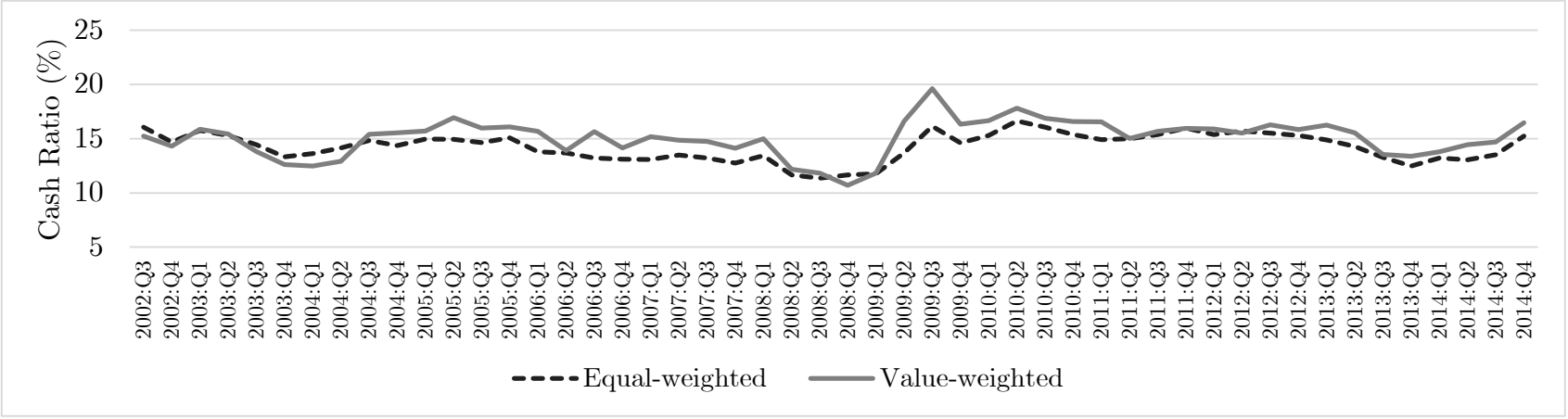
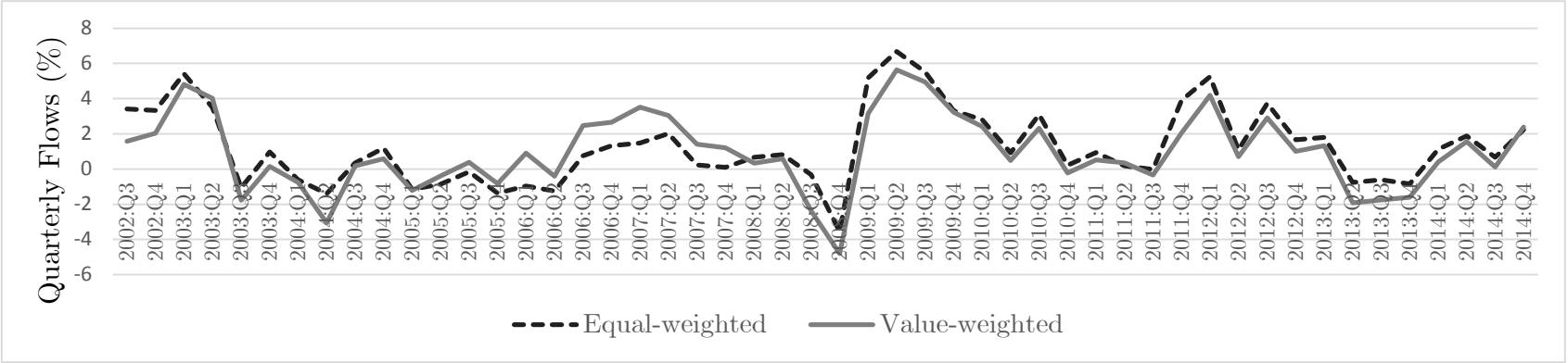


Figure 2. Average Fund Flows

Panel A plots the time series of equal- and total-net-assets-weighted average capital flows to corporate bond mutual funds. Panel B plots the time-series average of flows for decile groups sorted on fund flows. In Panel B, numbers in x-axis denote the decile groups from the lowest (1) to highest (10) fund flow deciles. The sample period is from 2002:Q3 to 2014:Q4. In Panel A, the equal-weighted averages are denoted by dashed lines and value-weighted averages are denoted in solid lines. In Panel B, black bars (in the left) denote results from all sample period and grey bars denote sub-period results during the market distress periods (2008:Q3, 2008:Q4, and 2013:Q2).

Panel A. Average Quarterly Fund Flows over Times



Panel B. Average Quarterly Flows across Fund Flow Deciles

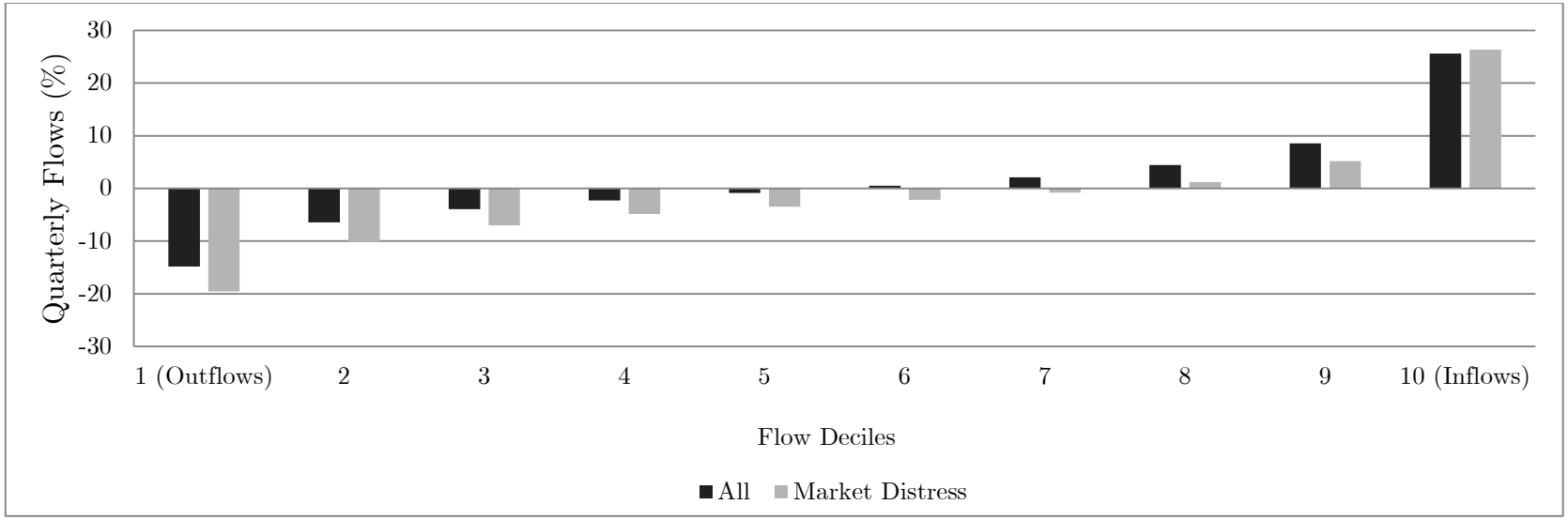
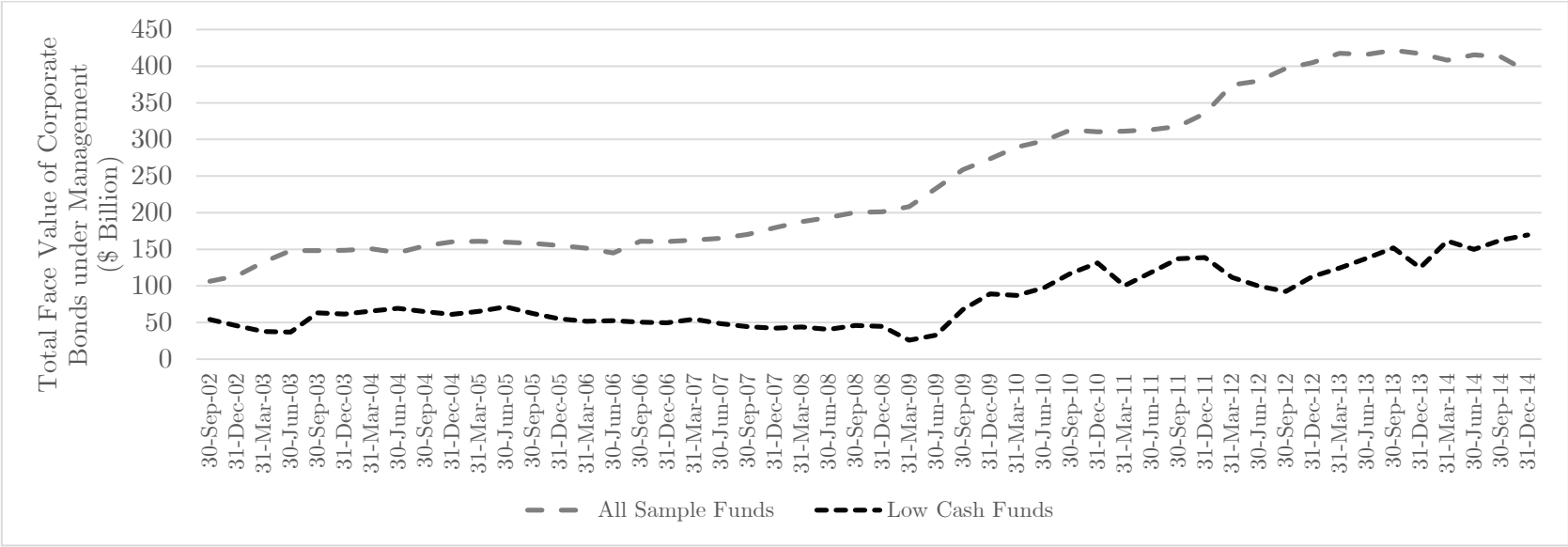

30
20
10
0
-10
-20
-30
Quarterly Flows (%)
1 (Outflows)
2
3
4
5
6
7
8
9
10 (Inflows)
Flow Deciles
All
Market Distress

Figure 3. How Many Low Cash Funds?

This figure provides descriptive graphs about low cash funds in our sample. We classify a corporate bond fund as a low cash fund if they hold cash and cash-like securities less than 5% and corporate bond more than 50% of their total assets under managements. Panel A shows the total face values of corporate bonds under managements for all sample funds and subsample of low cash funds in each quarter-end from 2002Q2 to 2014Q4. We sum face values of all U.S. corporate bonds with fixed coupon held by our sample funds at the end of each quarter. The holding information is obtained from Morningstar. Panel B shows distribution of sample funds across the cash ratio. The cash ratio is a ratio of dollar amounts of cash holdings to dollar amounts of total net assets of the fund and estimated at the end of each quarter from 2002Q2 to 2014Q4. Each quarter we divide our sample into eight groups, from cash ratio less than 5% to more than 35% by 5% level. We plot percentage shares of number of funds for each group.

Panel A. Total Face Values of Corporate Bonds under Managements ($ Billion)



Panel B. Distribution of Sample Funds across Cash Ratio

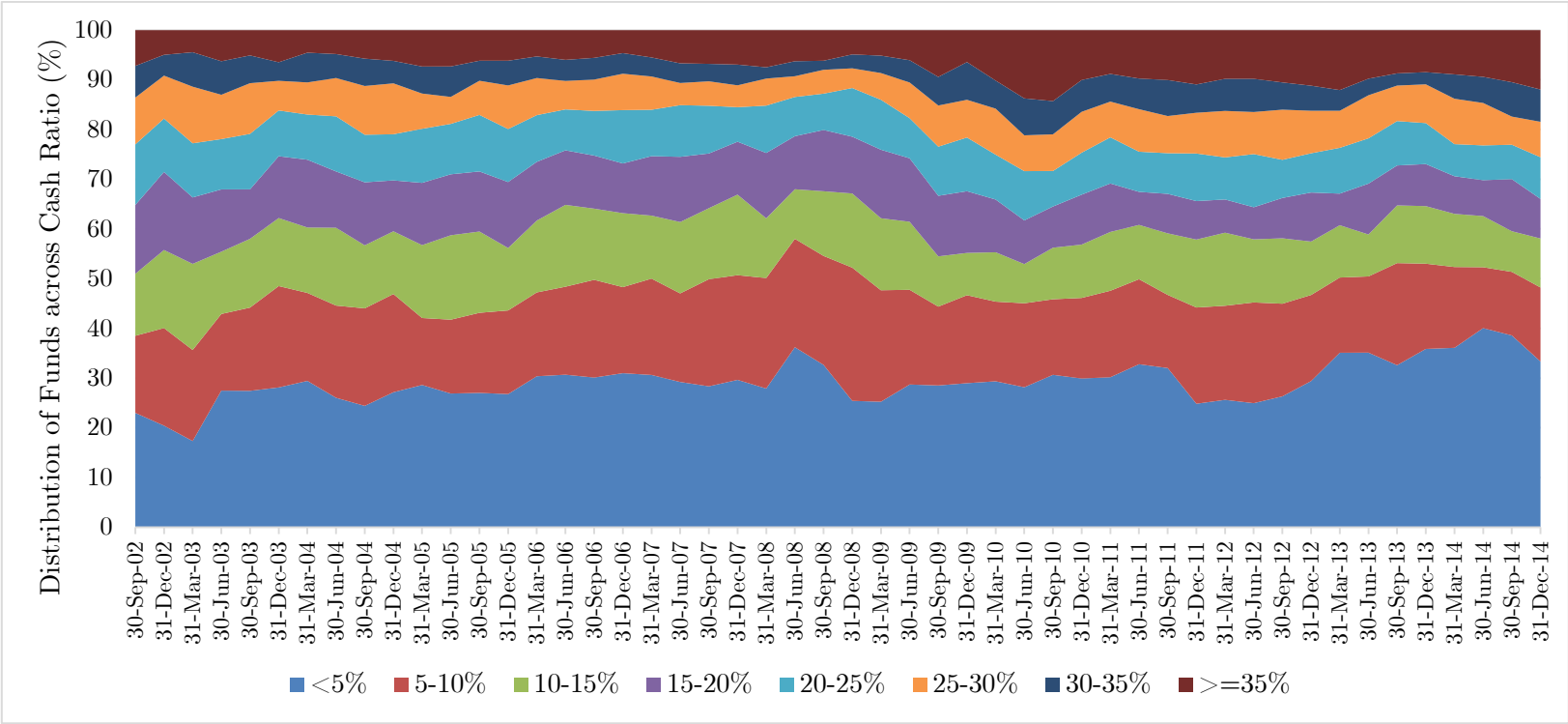
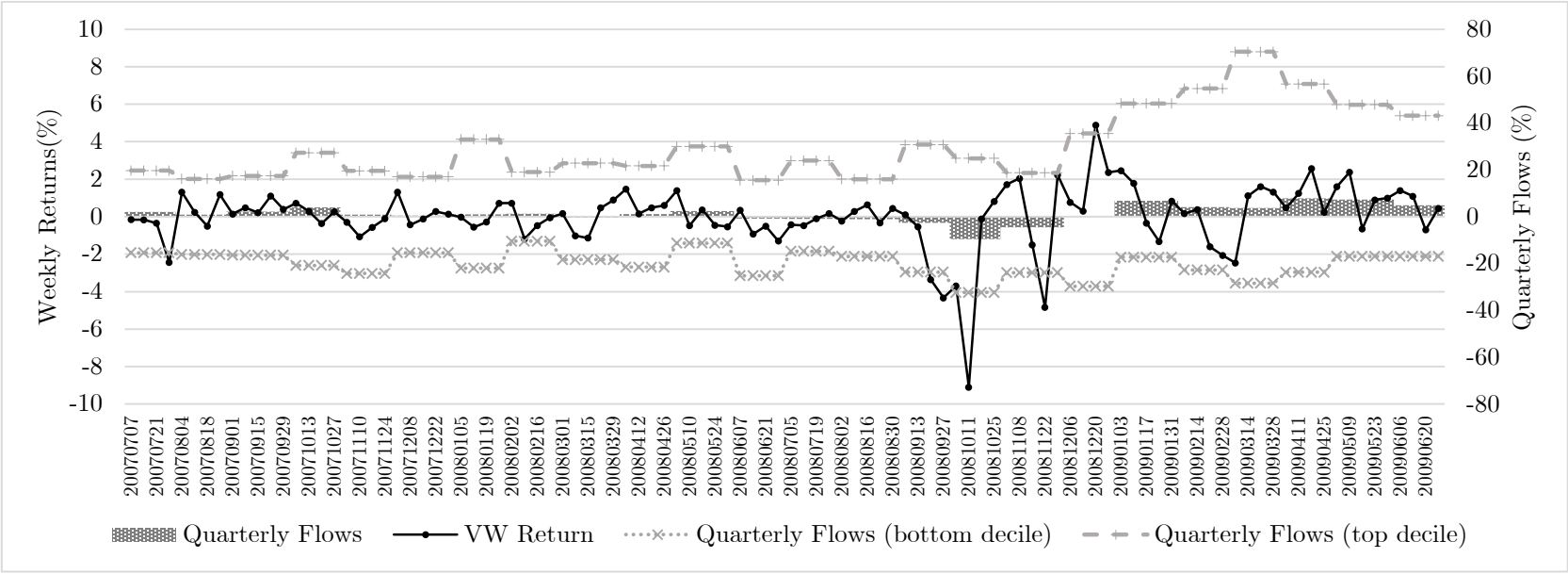


Figure 4. Aggregate Fund Flows and Corporate Bond Returns around Market Stressed Conditions

This figure provides aggregate-level flows to corporate bond mutual funds in percentage and value-weighted weekly raw returns in percentages on the aggregate portfolio of corporate bond mutual funds around the 2008 financial crisis (Panel A) and 2013 Taper Tantrum (Panel B). Each month the average of percentage monthly flows to corporate bond mutual funds weighted by their total net assets is calculated. Then we rescale the aggregate monthly flows to quarterly flows by multiplying 3. We also report the average flows within its top and bottom decile (sorted on flows at the end of each month). The aggregate portfolio is formed and rebalanced quarterly, based on quarterly holding information obtained from the Morningstar. The weekly returns on bonds in the aggregate portfolio is calculated based on prices obtained from TRACE. Each week we calculated the portfolio returns by taking value-weighted average. The weight is estimated by multiplying TRACE price at the end of previous week and total amounts held by corporate bond mutual funds at the closest quarter end before the week. Variables are detailed in Appendix A. The first y-axis (on the left) represents the weekly returns in percentage and the second y-axis (on the right) represents the quarterly flows in percentage. The x-axis represents the ends of weeks during which returns are calculated. Panel A covers from the end of first week in 2007Q3 to the end of last week in 2009Q2 and Panel B covers from the end of first week to the end of last week in 2013.

Panel A. Financial Crisis (2007Q3 – 2009Q2)



Panel B. Taper Tantrum (2013Q1 – 2013Q4)

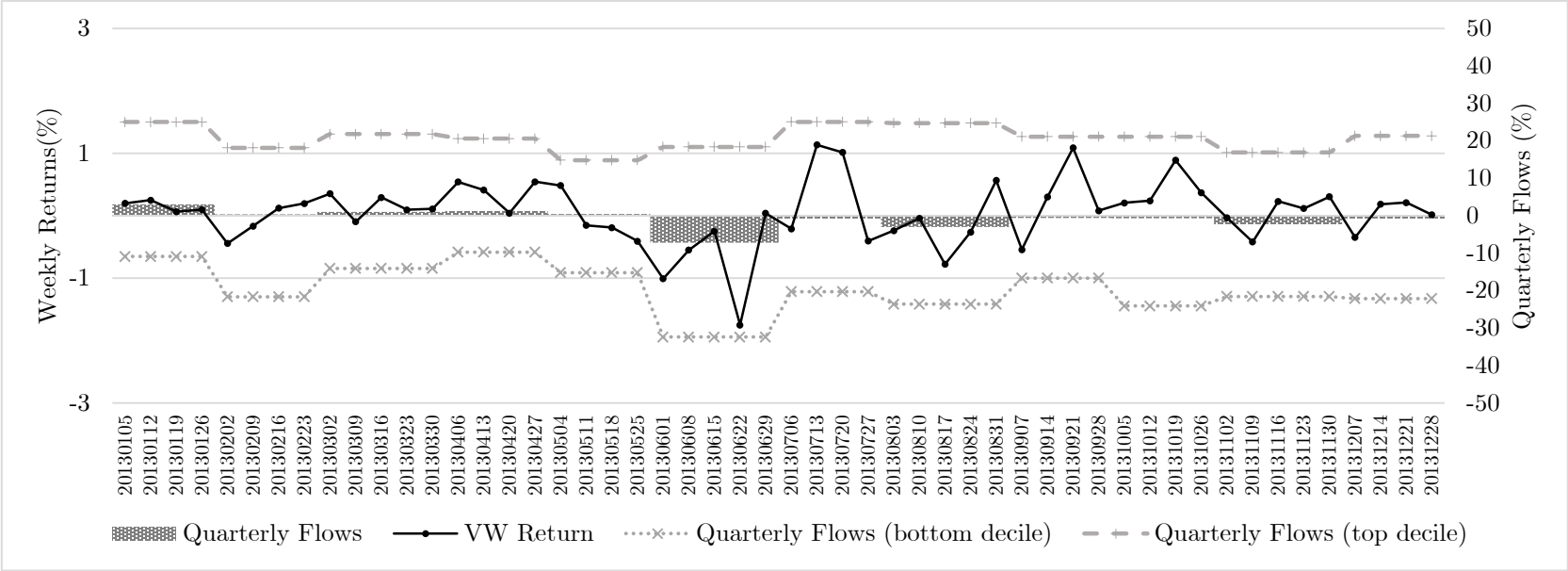


Figure 5. Weekly Cumulative Average Abnormal Returns on Flow-induced Selling Portfolio around the bankruptcy of Lehman Brothers in 2008

This figure provides value-weighted cumulative average weakly abnormal returns (CAARs) in percentages on the *Sell* corporate bond portfolio sorted on price pressure following the Lehman Brothers bankruptcy in 2007-2008 financial crisis. We report CAARs of two portfolios. First, we use all sample funds to estimate the price pressure measure (*Pressure*). The definition of *Pressure* is detailed in Appendix A. Second, we use the subsample of low cash funds. We classify a corporate bond fund as a low cash fund if they hold cash and cash-like securities less than 5% and corporate bond more than 50% of their total assets under managements. For each sample, we sort corporate bonds into sell portfolios (*Sell*) if the price pressure variable (*Pressure*) is below the 10th percentile at the end of quarters following the bankruptcy of Lehman Brothers. Specifically, the *Pressure* is estimated during 2008:Q4 and sorted at the end of 2008:Q4. The weekly returns on bonds are calculated based on prices obtained from TRACE. The abnormal returns are estimated following the matching-portfolio approach (by rating and maturity) of Bessembinder et al. (2008). Variables are detailed in Appendix A. We report weekly CAARs on the *Sell* portfolio from the week of August 29th to the week of November 7th. The y-axis represents CAARs in percentage. Dates in x-axis denote the last business day of each week.

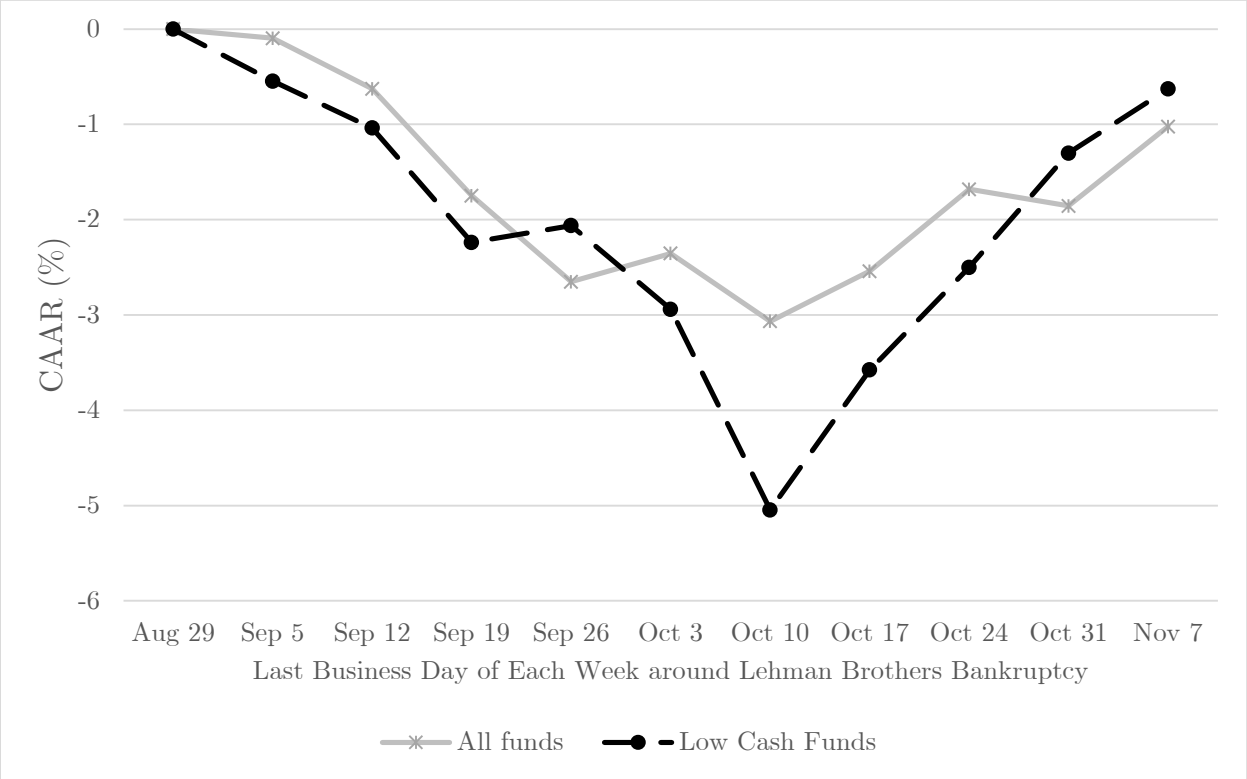


Figure 6. Weekly Cumulative Average Abnormal Returns on Flow-induced Selling Portfolio around the Taper Tantrum in 2013

This figure provides value-weighted cumulative average weakly abnormal returns (CAARs) in percentages on the *Sell* corporate bond portfolio sorted on price pressure around the 2013 Taper Tantrum. We report CAARs of two portfolios. First, we use all sample funds to estimate the price pressure measure (*Pressure*). The definition of *Pressure* is detailed in Appendix A. Second, we use the subsample of low cash funds. We classify a corporate bond fund as a low cash fund if they hold cash and cash-like securities less than 5% and corporate bond more than 50% of their total assets under managements. For each sample, we sort corporate bonds into sell portfolios (*Sell*) if the price pressure variable (*Pressure*) is below the 10th percentile at the end of 2013:Q2. The weekly returns on bonds are calculated based on prices obtained from TRACE. The abnormal returns are estimated following the matching-portfolio approach (by rating and maturity) of Bessembinder et al. (2008). Variables are detailed in Appendix A. We report weekly CAARs on the *Sell* portfolio from the week of May 10th to the week of July 19th. The y-axis represents CAARs in percentage. Dates in x-axis denote the last business day of each week.

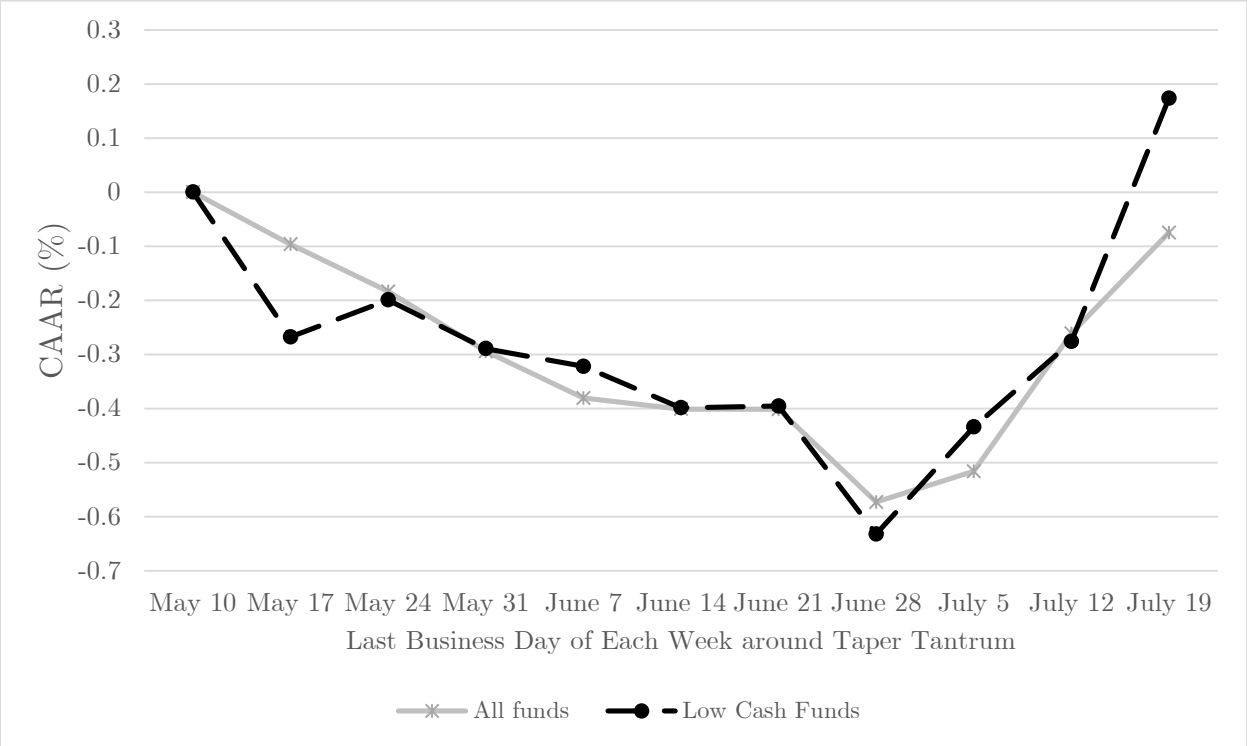
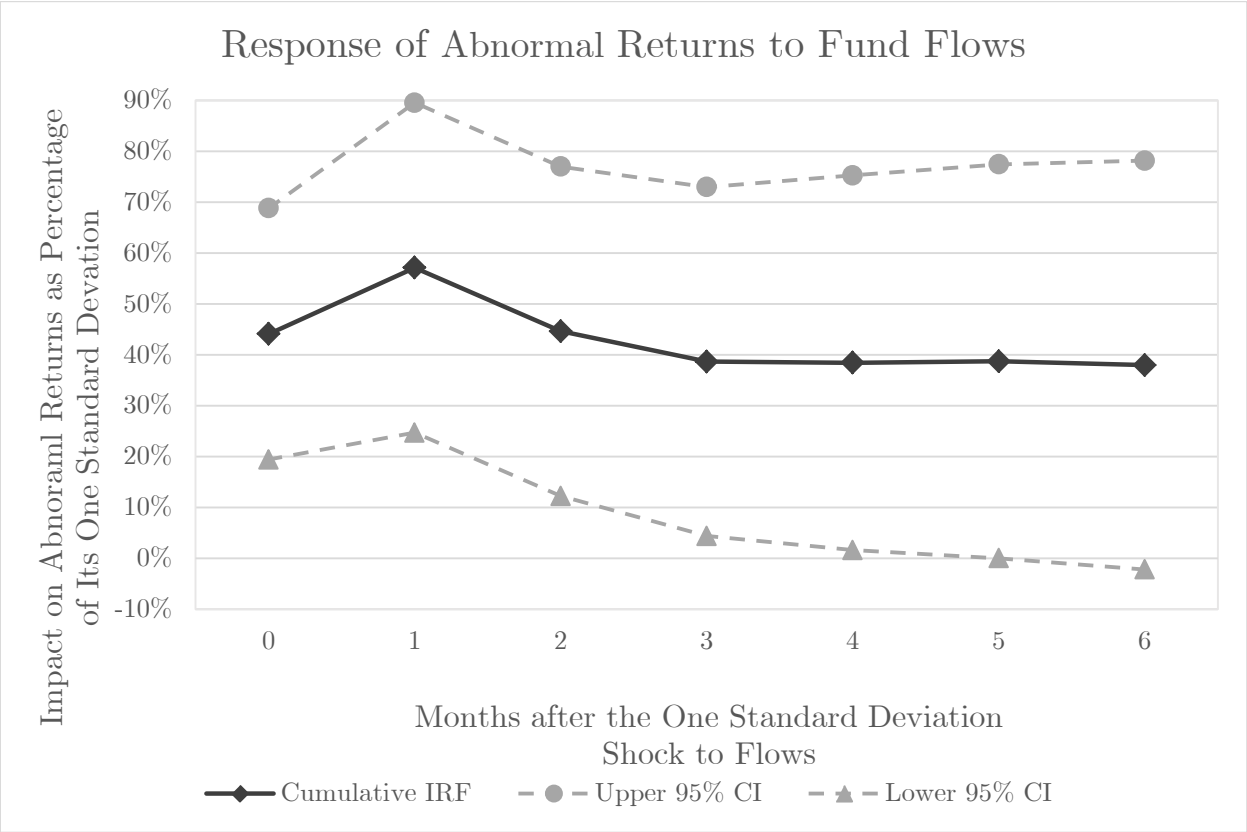


Figure 7. Cumulative Impulse Response of Corporate Bond Returns to Fund Flows

This figure provides the cumulative impulse response of returns on aggregate corporate bond portfolios held by all corporate bond mutual funds to a one standard deviation shock to aggregate corporate bond mutual fund flows. We use a vector autoregression (VAR) model with two lags. We use two monthly variables in following order; flows, and abnormal returns. Thus the shocks on flows are orthogonalized to contemporaneous shocks on abnormal returns. We calculate the aggregate monthly flows by value-weighting all funds' percentage flows by fund size (*TNA*). The monthly returns are calculated based on TRACE prices and abnormal returns are estimated following the matching-portfolio approach (by rating and maturity) of Bessembinder et al. (2008). Variables are detailed in Appendix A. All variables are standardized with mean zero and standard deviation one. In Panel A, we use all funds in our sample and in Panel B we use low cash ($< 5\%$) funds. Numbers in y-axis denote the impact on abnormal returns as percentage of its one standard deviation. Numbers in x-axis denote months after the shock to fund flows. The cumulative impulse response function (cIRF) is denoted by a solid line. The error bands denoted by dashed lines represent the 95% confidence intervals by using a bootstrap methodology (1000 bootstraps).

Panel A. All Sample Funds



Panel B. Low Cash Funds