

Investor Flows and Fragility in Corporate Bond Funds*

Itay Goldstein
The Wharton School

Hao Jiang
Michigan State University

David T. Ng
Cornell University

First Draft: March 2015
This Version: April 2016

* We are grateful for helpful comments and suggestions from Roger Aliaga-Diaz, Susan Christoffersen, Doug Diamond, Mark Flannery, Ken French, Byoung-Hyoun Hwang, Wei Jiang, Kathryn Judge, Pete Kyle, Yan Li, Pamela Moulton, David Musto, Stefan Nagel, Hyun Song Shin, Luke Taylor, Yongxiang Wang, Russ Wermers, and seminar and conference participants at Cornell University, Federal Reserve Bank of Atlanta Conference on “The Role of Liquidity in the Financial System”, Federal Reserve Board of Governors, Financial Economics and Accounting conference, ICI-University of Virginia conference on Mutual Funds and ETFs, NBER Summer Institute on Risk in Financial Institutions, Office of Financial Research, Penn NYU Law and Finance Conference, Penn State University, Securities and Exchange Commission, Shanghai Advanced Institute of Finance, University of Georgia, University of Maryland and Clearing House Conference on “the Intended and Unintended Consequences of Financial Reform”, University of Miami, and University of Toronto Conference on “Liquidity Risk in Asset Management”. Goldstein is at the Wharton School of Business at the University of Pennsylvania (phone: (215)746-0499; email: itayg@wharton.upenn.edu); Jiang is at the Eli Broad College of Business at Michigan State University (phone: (517)353-2920; email: jiangh@broad.msu.edu); and Ng is at the College of Business at Cornell University (phone: (607)255-0145; email: dtn4@cornell.edu).

Investor Flows and Fragility in Corporate Bond Funds

Abstract

Investment in bond mutual funds has grown rapidly in recent years. With it, there is a growing concern that they are a new source of potential fragility. While there is a vast literature on flows in equity mutual funds, relatively little research has been done on bond mutual funds. In this paper, we explore flow patterns in corporate-bond mutual funds. We show that their flows behave quite differently than those of equity mutual funds. While we confirm the well-known convex shape for equity funds' flow-to-performance over the period of our study, we show that during the same time, corporate bond funds exhibit a concave shape: their outflows are sensitive to bad performance more than their inflows are sensitive to good performance. Moreover, corporate bond funds tend to have greater sensitivity of outflows to bad performance when they have more illiquid assets and when the overall market illiquidity is high. These and other results we provide point to the possibility of fragility: The illiquidity of corporate bonds may generate a first mover advantage (or strategic complementarities) among investors in corporate-bond funds, amplifying their response to bad performance. We show that this behavior appears also in aggregate and explore some potential consequences for the real economy.

1. Introduction

The landscape of the financial industry is constantly changing, as new financial innovation and regulation shift activities across different financial institutions and vehicles. One of the dominant trends of recent years is the growth of assets under management by fixed income mutual funds, i.e., mutual funds investing in corporate or government bonds. Data reported by Feroli, Kashyap, Schoenholtz, and Shin (2014) show that from January 2008 to April 2013, fixed income funds have attracted multiple times more inflows compared to equity, money market, allocation and other funds combined. Data reported by the Investment Company Institute (ICI 2014) show bond-fund assets roughly doubling over this period.¹

Observing this trend, several commentators have argued that bond funds pose a new threat to financial stability. What will happen when the current trend of loose monetary policy changes or upon mounting concerns of corporate defaults? Will massive flows out of bond funds and massive sales of assets by these funds destabilize debt markets with potential adverse consequences for the real economy? Feroli, Kashyap, Schoenholtz, and Shin (2014) use evidence from the dynamics of bond funds to show that flows into and out of funds seem to aggravate and be aggravated by changes in bond prices. They conclude that this suggests the potential for instability to come out of this industry. They analyze the market “tantrum” around the announcement of the possible tightening of monetary policy in 2013, and suggest that events like this can put the bond market under stress due to amplification coming from bond mutual funds.

In order to get a better understanding of the potential threats to stability posed by bond mutual funds, we need more research on the flows into and out of these funds. By now, there is a vast literature on flows in equity mutual funds. This literature has been reviewed recently by Christoffersen, Musto, and Wermers (2014). However, as they note, there is little research on flows in bond mutual funds. In this paper, we try to fill the gap. We focus on actively managed corporate bond funds in the period between January 1992 and December 2014. This is because, as we show in Figures 1 and 2, the growth in assets held by these funds has been particularly large, even compared to other bond funds, and because these funds present a particularly strong concern for stability due to the illiquidity of their assets (corporate bonds).

¹ See Section 2.1 for details on the developments in the bond fund industry.

A pervasive result in the empirical literature on equity mutual funds is that the flow-to-performance relation tends to have a convex shape, that is, inflows to equity funds tend to be very sensitive to good past performance, but outflows are overall not that sensitive to bad past performance. Papers documenting this pattern, discussing its origins and consequences include: Ippolito (1992), Brown, Harlow, and Starks (1996), Chevalier and Ellison (1997), Sirri and Tufano (1998), Lynch and Musto (2003), Huang, Wei and Yan (2007), among others. Considering the context of fragility, a convex flow-to-performance curve suggests that fragility is not a pressing concern. If investors do not rush to take their money out of funds following negative developments, then one should not worry so much about outflows depressing prices and leading to negative consequences for the real economy.

Our evidence, however, shows that corporate bond funds exhibit quite a different pattern from equity funds when it comes to the sensitivity of flow to performance. While we confirm a convex shape for equity funds' flow-to-performance over the period of our study, we show that during the same time, corporate bond funds exhibit a concave shape: Their outflows are sensitive to bad performance more than their inflows are sensitive to good performance. Moreover, the sensitivity of flows in corporate bond funds in the negative (positive) region is greater (smaller) than that in equity funds.² Various subsample analyses within the sample of corporate-bond funds show that the concave flow-performance relation is pervasive across young and old funds, present in periods with high and low aggregate fund flows, and robust to controlling for the fund fixed effect. This is in contrast to findings in the literature on equity mutual funds, where Spiegel and Zhang (2013) showed that the convexity is an artifact of heterogeneity and that it disappears within subsamples.

The greater sensitivity of outflows to bad performance in corporate bond funds is consistent with the arguments in Chen, Goldstein, and Jiang (2010). They compare the sensitivity of outflows to bad performance between equity funds that hold illiquid assets and equity funds that hold liquid assets. They show that outflows are more sensitive to bad performance in illiquid funds and relate the result to strategic complementarities and financial fragility. In illiquid funds,

² These results are obtained under our main specification, where performance is measured relative to the bond market and equity market. As we discuss in the paper, we conduct several robustness tests with different performance measures and find that the flow-performance relationship for corporate bond funds is never convex, whereas for equity funds it is always convex.

outflows impose greater liquidation costs on the fund when readjusting the portfolio. Since portfolio readjustments typically happen in the days after the actual redemption and investors get the net asset value as of the day of redemption, withdrawing money out of the fund leads to negative externalities on other investors who keep their money in the fund. This creates a first-mover advantage in the redemption decision, amplifying the flows out of illiquid funds following bad performance.³

Indeed, corporate bond funds tend to hold illiquid assets. Unlike equity, which typically trades many times throughout the day, corporate bonds may not trade for weeks and trading costs in them can be very large. Despite the illiquidity of their holdings, corporate bond funds quote their net asset values and prices to investors on a daily basis. As a result, there is a mismatch between the illiquidity of the fund's holdings and the liquidity that investors holding the fund get: they are able to redeem their shares at any business day and get the quoted net asset value based on prices of fund assets as of the market close. This implies that when investors' outflows lead to costly liquidation by the funds, the costs would be borne to a large extent by remaining investors. This creates a first-mover advantage in redemptions which amplifies the reaction of outflows to bad performance.

To further support the idea that asset illiquidity creates strategic complementarities among corporate-bond-fund investors in their redemption decisions, we conduct many more tests on various dimensions of the data. First, the liquidation costs imposed on funds due to massive outflows are expected to be more severe during periods of higher illiquidity, when bonds trade even less, trading is more costly, and there is more uncertainty about bond valuation. We use several measures to proxy for aggregate uncertainty and illiquidity. These include the Volatility Index (VIX) and the Merrill Lynch Option Volatility Estimate (MOVE) index, measuring implied volatilities in stock and bond markets, the TED spread, measuring the difference between the interest rates on interbank loans and on treasury bills, and a corporate bond illiquidity measure by Dick-Nielsen, Feldhutter and Lando (2012), measuring illiquidity based on bond trading data. Consistent with our hypothesis, we find that outflows are more sensitive to

³ Chen, Goldstein, and Jiang (2010) develop a model of runs in the tradition of the global-games literature – e.g., Morris and Shin (1998) and Goldstein and Pauzner (2005) – and show how complementarities will generate this amplification of outflows following bad performance. Such complementarities are in the spirit of the bank-run literature going back to Diamond and Dybvig (1983); albeit they are not as strong as in banks.

bad performance of corporate bond funds during periods when the corporate bond market is less liquid.

Second, we show that among corporate bond funds, those with lower asset liquidity tend to experience greater sensitivity of outflows to bad performance. To measure liquidity at the fund level, we use the level of cash holdings, since funds with more cash suffer lower liquidation costs in case of massive outflows, and expose their investors to weaker strategic complementarities. As additional measures of fund liquidity, we use a fund's holdings of cash and government bonds, and compute two holding-based liquidity measures using the Roll (1984) measure based on the serial covariance of bond returns and the interquartile price range based on the dispersion of intraday bond prices. We find similar results using these different measures of fund liquidity.

Third, we provide direct evidence for the first mover advantage, by calculating the impact of outflows on fund returns in funds that hold illiquid assets when the market is less liquid. We find that for funds with illiquid asset holdings, a one standard deviation increase in outflows is associated with a decline in fund returns by 29 to 36 basis points in the same month when the corporate bond market is less liquid. In contrast, for funds with liquid asset holdings, a one standard deviation increase in outflows is associated with a decline in fund returns by only 4 to 7 basis points in the same month when the corporate bond market is liquid. Hence, rational investors clearly have a greater incentive to take their money out when they think others take their money out in the face of illiquid conditions. As we discuss in the paper, we think the effect of illiquidity estimated here is only a lower bound on the true effect. Hence, the actual incentives to redeem should be stronger.

Fourth, to further identify the effect of first mover advantage on outflows, we use tax-loss selling at the turn of a year as an exogenous reason to redeem, and evaluate how it is amplified due to illiquidity. It is known that tax considerations will cause investors to take their money out of losing funds just before the end of the year. The first-mover advantage studied in our paper implies that these outflows will be amplified by illiquidity. Indeed, we find that, conditional on a fund having bad performance in the past year, funds with more illiquid assets tend to experience larger outflows towards the end of the year.

Fifth, following the model in Chen, Goldstein, and Jiang (2010), we expect that strategic complementarities will be less important in determining fund outflows if the fund ownership is mostly composed of institutional investors. This is because institutional investors are large and so are more likely to internalize the negative externalities generated by their outflows. Indeed, consistent with this hypothesis, we find that the effect of illiquidity on the sensitivity of outflows to bad performance diminishes when the fund is held mostly by institutional investors.

Sixth, the difference in flow-performance relation between equity and corporate-bond funds could be attributed to the difference in payoff structure between the different types of securities: corporate bond investors may feel they are more exposed to the downside risk than to the upside potential compared with stock investors. Of course, this story will have a hard time explaining all the other results we provide, as summarized above. In addition, we examine the flow-performance relation for Treasury bond funds and municipal bond funds. Both also have limited upside potential, but have different levels of liquidity, whereby Treasury bonds are very liquid, as equity, and municipal bonds are illiquid, as corporate bonds. Consistent with the liquidity story, we find a convex flow-performance relation for Treasury funds and a concave flow-performance relation for municipal-bond funds.

As a case study, we examine the outflows from PIMCO's Total Return funds in October 2014, shortly after the announcement of Bill Gross' departure on September 26, 2014. Dubbed as the "Bond King" by *Fortune* magazine in 2002, Bill Gross clearly had an enormous effect on these funds, being the manager and the one that many investors identified these funds with. Hence, one would expect significant flows out of these funds following his resignation. Moreover, following the main theme of our paper, one would expect outflows to be amplified by illiquidity of the funds' assets. An interesting case study is offered by the fact that three of the funds – Total Return Fund, Total Return Fund II, and Total Return Fund III – were very different in nature than the fourth one – Total Return Fund IV. This last one had significantly higher amounts of cash and other liquid assets. Indeed, consistent with our hypothesis, it is the only one out of the four funds that did not see sharp withdrawals following Gross' resignation, despite the fact that up until then it had returns that were very highly correlated with those of the other three funds.

The strategic complementarities and first-mover advantage we discuss here are very familiar from the banking context, and recently were on display in the run on money market mutual funds following the collapse of Lehmann Brothers.⁴ One thing that distinguishes banks and money market funds from other mutual funds (including bond funds) is that the latter have a floating net asset value, such that investors are not guaranteed to get a fixed amount when they withdraw. Indeed, this feature is often thought to prevent the emergence of strategic complementarities in mutual funds. However, this argument is incomplete. Even with a floating net asset value, the structure of funds gives rise to complementarities and fragility, since investors can take their money out at any trading day based on the most recently updated net asset value, and the consequences of their redemptions will be reflected to a large extent in future net asset values. Hence, investors impose a negative externality on others when they redeem their shares, creating the first-mover advantage. This problem arises mostly when the assets held by the fund are illiquid, which is the case for corporate bond funds.

The potential fragility from fund flows does not necessarily call for regulatory intervention. Funds can take measures to reduce the extent of the first mover advantage and so reduce the amplification of outflows in illiquid funds. Indeed, we show here that the amplification is reduced when funds hold more liquid assets. Other measures funds can take include putting restrictions on redemptions or factoring the future liquidation costs into the net asset value that investors can take out of the fund. The practice of swing pricing, whereby the net asset value investors can redeem depends on aggregate flows, is based on similar logic.⁵

Still, regulators should be aware of the behavior of flows in the mutual fund industry. First, attempts to regulate other players in the financial system are likely to push more activity into mutual funds (as happened in the last few years for bond funds), potentially increasing their fragility. Second, if the effect of flows goes beyond the fund itself and is not internalized by the fund, then mutual funds will not fully implement the desired measures. Our paper does not attempt to answer the question of whether outflows in bond funds have significant implications on market prices and/or the real economy. We only conduct some exploratory tests in this direction.

⁴ For an empirical study of the run on money market funds, see Schmidt, Timmerman, and Wermers (2014).

⁵ Hanson, Scharfstein, and Sunderam (2014) discuss some solutions for money-market funds, noting that a floating net asset value will not completely solve the problem.

First, we examine the flow-performance relation for the aggregate corporate bond fund sector. Interestingly, we find that it is also concave just like at the fund level, exhibiting strong sensitivity of outflows to negative performance. This is in contrast to the equity fund sector, where the flow-performance relation is essentially flat at the aggregate level, as was previously found by Warther (1995). Hence, in corporate-bond funds, there is a case to worry about massive redemptions out of the sector as a whole.

Second, we explore some implications for the real economy. The mechanism that could be at work is that massive outflows from corporate bond funds force the funds to sell large amounts of bonds, putting downward pressure on corporate bond prices. Even though these bonds are traded in secondary markets, one would expect lower bond prices to make it more difficult for firms to raise new debt, so that the real effect on their operations and investments will follow. Gilchrist and Zakrajsek (2012) study the relationship between corporate bond credit spreads and economic activity. Following Gilchrist and Zakrajsek (2012), we examine how corporate bond outflows are associated with future credit spreads and macroeconomic outcomes based on a vector autoregression (VAR) framework. We find that shocks to the corporate bond fund outflows lead to economically and statistically significant increases in credit spread. Such shocks to the corporate bond fund outflow that are orthogonal to the current state of the economy lead to economically and statistically significant declines in consumption, investment and GDP. Our evidence complements existing evidence on the price pressure imposed by mutual-fund outflows (e.g., Coval and Stafford (2007), Manconi, Massa, and Yasuda (2012), and Ellul, Jotikasthira, and Lundblad (2012)) and on the real effect of these outflows (e.g., Edmans, Goldstein, and Jiang (2012) and Hau and Lai (2013)).

The remainder of the paper is organized as follows. Section 2 presents the institutional background and hypothesis development. Section 3 presents the data and methodology. Section 4 shows the empirical results. Section 5 explores some implications of aggregate outflows from corporate bond funds on prices and the real economy. Section 6 describes the case study based on Bill Gross' departure from PIMCO funds. Section 7 concludes.

2. Institutional background and hypothesis development

2.1. Institutional background: valuations, redemptions and liquidity management

Our paper focuses on actively managed corporate bond mutual funds. Compared with the voluminous research on the equity counterparts, relatively little academic research has been conducted on corporate bonds funds. This deficiency has to be addressed because of the large size of the corporate bond market as well as the increasingly important presence of mutual funds in this market segment.⁶ At the end of 2013, the amount of corporate bonds outstanding was \$7.46 trillion, almost half the size of the equity market. The corporate bond market is particularly important as a funding vehicle for U.S. companies. According to the Securities Industry and Financial Markets Association (SIFMA), corporate bond issuances in the U.S. reached \$1.4 trillion dollars in 2014. Many non-US firms also issue corporate bonds in the U.S., as documented by Bruno and Shin (2015). In the same year, the initial public offerings of equity in the U.S. raised only \$92 billion dollars.⁷

Traditional players in the corporate bond market include long-horizon investors such as insurance companies, pension funds, and trusts.⁸ In the recent decade, mutual funds have become increasingly important in corporate bond markets. According to ICI, the geometric average annual growth rate of assets under management by corporate bond funds is 14% from 2000 to 2013, which leads the aggregate size of corporate bond funds to more than quintuple. Combining data from ICI (\$1.72 trillion holdings of corporate bonds by bond funds) and SIFMA (\$7.46 trillion corporate bonds outstanding), we estimate that corporate bond funds owned about 23% of corporate bonds outstanding in 2013. As Moneta (2015) documents, the average turnover rate of corporate bond funds is much higher than that of equity funds. For instance, from 1996 to 2007 the average turnover rate of general corporate bond funds is approximately twice as large as that

⁶ There is some other research on flows in bond funds, such as Zhao (2005) and Chen and Qing (2016), but they are not looking at the effects of liquidity and fragility, which are the focus of our paper.

⁷ This is an estimate from Ernst and Young. See: [http://www.ey.com/Publication/vwLUAssets/ey-q4-14-global-ipo-trends-report/\\$FILE/ey-q4-14-global-ipo-trends-report.pdf](http://www.ey.com/Publication/vwLUAssets/ey-q4-14-global-ipo-trends-report/$FILE/ey-q4-14-global-ipo-trends-report.pdf).

⁸ As Bessembinder and Maxwell (2008) explain, most bond issues are often absorbed into stable “buy-and-hold” portfolios of insurance companies and pension funds soon after issuance. The reason is that corporate bonds are a favored investment for insurance companies and pension funds, since their long-horizon obligations can be matched reasonably well to the relatively predictable, long-term stream of coupon interest payments from bonds.

of equity funds, which suggests more active trading and relatively shorter investment horizons of corporate bond funds. Considering the relatively low liquidity in corporate bond markets, the high trading activities of corporate bond funds are likely to generate substantial market impact.

It should be noted that fixed income funds in general have expanded substantially during this period. For instance, the average annual growth rates for Treasury bond funds and Municipal bond funds from 2000 to 2013 are approximately 5%. Their growth, however, is dwarfed by that of corporate bond funds. As shown in Figure 1, the share of corporate bond fund assets in the universe of fixed income funds has trended up steadily. With a total net asset value reaching \$1.86 trillion in 2013, corporate bond funds comprise 57% of all bond fund assets. Due to their dominant position in bond funds and their illiquidity, we choose to focus on corporate bond funds in our study. To make our analysis of flow-performance relation comparable with the literature on equity funds, we exclude passively managed corporate bond funds.

Corporate bond funds are prone to strategic complementarities in redemption decisions among their investors due to the mismatch between the illiquidity of their assets and the liquidity they offer to their investors. Below, we elaborate on four related features that contribute to these forces: infrequent corporate bond trading; uncertain pricing of corporate bonds; high costs associated with investor outflows; and negative externality arising from costly outflows.

First, in contrast to equities which trade frequently on the exchange, corporate bonds trade primarily in the over-the-counter dealer market relatively infrequently. Prior to 2002, the corporate bond market was particularly opaque, without readily available information on transaction prices and volume. The introduction of the Transaction Reporting and Compliance Engine (TRACE) in July 2002 required bond dealers to report all trades in publicly issued corporate bonds to the National Association of Security Dealers (NASD) which in turn released these transaction data to the public. Using these data, Edwards, Harris, and Piwowar (2007) find that individual bond issues do not trade on 48 percent of days in their sample. They find that the average number of daily trades in an issue, conditional on trading, is only 2.4. Bessembinder and Maxwell (2008) suggest that despite the improved ex-post transparency in the corporate bond market, it remains relatively illiquid compared with other bonds. This remains true in recent years. In 2014 corporate bonds comprise a sizeable (20.1%) percentage of U.S. bond market

outstanding, but account for only a miniscule 3.7% of trading volume, according to figures from SIFMA. In contrast, U.S. Treasury securities represent 32.1% of the U.S. bond market outstanding but their trading volume account for a lion's share (69.2%) of the trading volume for all bonds.

Second, partially due to the fact that corporate bonds trade infrequently, accurate price information of corporate bonds may not be readily available, which leads to ambiguity in the pricing of corporate bonds. According to the Investment Company Act of 1940, bonds not traded should be priced at "fair value" made "in good faith." Cici, Gibson and Merrick (2011) find that in practice, bond fund managers usually comply with this mandate by marking their bond positions at the prices provided by one or more pricing service companies and/or securities dealers. However, different pricing services can mark the prices differently, and managers of bond funds have the discretion to override the third-party pricing using their own judgements. This creates room for large dispersions and uncertainty of bond valuations.

Indeed, Cici, Gibson and Merrick (2011) document substantial dispersions of month-end valuations placed on identical corporate bonds by different mutual funds. Their tests reveal that such dispersion of valuations is consistent with returns smoothing behavior by managers, which involves marking positions such that the net asset value is set above or below the true value of fund shares, resulting in wealth transfers across existing, new, and redeeming fund investors. They find that the returns smoothing is particularly serious for corporate bond funds with hard-to-mark assets and not as much for Treasury bond funds; furthermore, when a fund's return is low, the fund is more likely to mark the bond positions higher than the true value. Under this situation, existing shareholders would have particularly high incentives to withdraw their money while the mark is good.

Third, the trading cost associated with outflows can be high for corporate bond funds. Although substantial disagreement exists in the literature, the estimates of trading costs in corporate bonds indicate that they are generally large. For instance, Bessembinder, Maxwell, and Venkataraman (2006) estimate round-trip (purchase and sale) trading costs during the first half of 2002 to be approximately 25 basis points, or \$6,750 on an average-sized transaction. After the introduction of TRACE in 2002, this figure decreased to about half. Edwards, Harris and

Piowar (2007) estimate that the round-trip transaction costs in corporate bonds range from approximately 150 basis points for the smallest trade size to about three bps for the largest trade size. Bao, Pan and Wang (2011) use the covariance in corporate bond returns to estimate the trading costs and find that the median implied bid-ask spread is 1.50%. These results support the view that it is costly to trade corporate bonds. In times of distress or low liquidity, we expect trading costs of corporate bonds to be much larger.

Finally, the structure of corporate bond funds that hold illiquid assets but provide withdrawal rights to their investors on a daily basis would give rise to payoff complementarities. Like other open-end mutual funds, the costs imposed by investors' liquidation in corporate bond funds are not fully reflected in the price these investors get when they redeem the shares, but are shared by investors who keep their money in the fund. The NAV at which investors can buy and sell their shares in the funds is calculated using the same-day market close prices of the underlying securities but the trades made by the funds in response to redemptions are most likely to happen after the day of the redemptions. Given the three preceding features of the corporate bond fund market – infrequent corporate bond trading, uncertain pricing of corporate bonds, and high costs associated with investor outflows – the negative externality of redeeming investors on remaining shareholders can be particularly high for corporate bond funds, which could intensify the run risk.

Given the high potential and large costs of financial fragility in corporate bond funds, we would expect mutual fund managers to take measures to mitigate this risk. For instance, under the Investment Company Act, a fund may impose fees on redemptions of fund shares held for a short period, i.e., redemption fees. On March 3, 2005, the Securities and Exchange Commission voted to adopt a rule concerning voluntary redemption fees, which allows a mutual fund to adopt a redemption fee of no more than 2 percent of the amount of the shares redeemed to discourage short-term trading. In practice, however, redemption fees do not appear to be popular among mutual funds. For example, our reading of fund prospectuses indicates that despite a wide range of fixed income mutual funds offered, PIMCO charges a 1% redemption fee only for investors in shares of the PIMCO Senior Floating Rate Fund (invested mainly in floating-rate high yield bank loans) on redemptions and exchanges made by the investor within 30 calendar days after the shares' acquisition. Clearly, even for this fund, the redemption fee is far from being adequate in

eliminating the strategic complementarities that we stress in our paper. Such reluctance of open-end mutual fund managers to impose tighter redemption fees on shareholders, however, is consistent with the excessive open ending among funds competing aggressively to attract investors' money (Stein, 2005).

2.2. Hypothesis development

The main hypotheses we have going into the data are based on the idea that strategic complementarities exist among investors in corporate bond mutual funds driven by the illiquidity of their assets. When they redeem their shares, they get the net asset value as of the day of redemption. The fund then has to conduct costly liquidation that hurts the value of the shares for investors who keep their money in the fund. Hence, strategic complementarities emerge, such that the expected redemption by some investors increases the incentives of others to redeem. Chen, Goldstein, and Jiang (2010) provide a model, based on the global-games literature, which clarifies this point formally regarding the difference between illiquid and liquid equity funds. They show how strategic complementarities driven by illiquidity amplify the sensitivity of outflows to bad performance. A similar model should apply for corporate bond funds and for the comparison between corporate bond funds and equity funds. We now describe the four main hypotheses that follow from such a model.

A key distinction between corporate bond funds and equity funds is that the former hold much more illiquid assets, due to the features of the corporate bond markets as mentioned earlier. Hence, the strategic complementarities for investors when redeeming shares will be stronger in corporate bond funds than in equity funds. When they take their money out of the fund, investors impose greater costs on those who stay in the fund due to the greater illiquidity. This leads to the first hypothesis.⁹

Hypothesis 1: Corporate bond funds exhibit a stronger sensitivity of outflows to bad performance than equity funds, leading to a more concave flow-to-performance relation.

⁹ In a different context, Getmansky (2012) shows that hedge funds feature greater sensitivity of flows to performance on the downside than on the upside. But, this is most likely due to the restrictions that prevent new investors from coming into the funds.

Focusing on corporate bond funds, the same logic should extend to changes in liquidity over time. When illiquidity in the corporate bond market is higher, strategic complementarities among mutual fund investors should strengthen leading to greater sensitivity of outflows to bad performance.

Dick-Nielsen, Feldhutter and Lando (2012) document that corporate bond illiquidity varies over time and contributes substantially to bond yield spread during the financial crisis. As Cici, Gibson and Merrick (2011) note, returns smoothing is particularly serious for corporate bond funds with hard-to-mark assets. During periods of high illiquidity, corporate bonds trade less and are harder to mark. As a result, corporate bond fund managers have more latitude to mark their positions, resulting in more uncertainty in the true NAV of the funds. Moreover, during these periods liquidation costs are higher. For all these reasons, redeeming investors impose stronger negative externalities on remaining investors in periods of high illiquidity, and so outflows are expected to respond more strongly to underperformance in such periods. This leads to the second hypothesis.

Hypothesis 2: During periods of higher illiquidity, corporate bond funds exhibit greater sensitivity of outflows to low past performance.

While the previous hypothesis deals with the time series, similar forces are expected to operate in the comparison across different funds. Greater illiquidity at the level of the fund is expected to generate stronger strategic complementarities among investors when deciding to redeem their shares. The reason is that funds with more liquid assets will not have to bear high costs liquidating their positions in short notice to meet redemption requests, mitigating the negative externalities following redemptions. Funds may thus choose to hold more liquidity to alleviate the tendency of investors to run. Following the logic of hypothesis 2, the outflows from illiquid funds are then expected to respond more strongly to low past performance. This leads to the third hypothesis.

Hypothesis 3: Corporate bond funds with more illiquid assets exhibit greater sensitivity of outflows to low past performance.

Finally, we expect strategic complementarities to be weaker in funds that are held mostly by institutional investors. These investors are large and hold a large proportion of the funds'

assets; their holdings are not as affected by other investors' actions. By holding on to their own shares rather than selling them, they guarantee that their holdings do not suffer from the price decline arising from their own selling. In other words, these investors internalize the externalities they impose and are less prone to strategic complementarities. Other investors, knowing that the institutional investors provide strategic stability, are also less inclined to withdraw. This point is made formally in the model of Chen, Goldstein, and Jiang (2010). This leads to the last hypothesis.

Hypothesis 4: The effect of illiquidity on the sensitivity of outflows to bad performance is weaker in funds that are held mostly by institutional investors.

Our empirical tests will focus on these four hypotheses and also provide many robustness tests to check whether illiquidity is indeed an important force in amplifying withdrawals out of mutual funds and creating 'run' dynamics. We now turn to describe the data and empirical measurements.

3. Sample construction and empirical measurements

3.1. Sample construction

Data on corporate bond funds come from the Center for Research in Security Prices (CRSP). Our sample period is January 1992 to December 2014. Prior to 1991, there are few corporate bond funds in the CRSP database. Since we use one year of data to estimate the alpha of individual bond funds, our flow-performance tests start from January 1992. A bond fund typically issues several share classes with different bundles of expense ratios, management fees, front-end and/or back-end sales charges (loads), minimum investment requirements, and restrictions on investor types to attract investors with different wealth levels, investment horizons, and investment mandates. Since these fund share-level characteristics can influence the investment and redemption decisions of mutual fund investors, we use individual fund share classes as our unit of observations.

We select corporate bond funds based on the objective codes provided by CRSP. Specifically, to be classified as a corporate bond fund, a mutual fund must have a (1) Lipper objective code in the set ('A', 'BBB', 'HY', 'SII', 'SID', 'IID'), or (2) Strategic Insight objective

code in the set ('CGN','CHQ','CHY','CIM','CMQ','CPR','CSM'), or (3) Wiesenberger objective code in the set ('CBD','CHY'), or (4) 'IC' as the first two characters of the CRSP objective code. In the paper, we use Lipper objective code as a measure of style of a corporate bond fund. We require at least one year of fund history before a fund is included in our sample and exclude index corporate bond funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database. Our final sample includes 4,679 unique fund share classes and 1,660 unique corporate bond funds. To compare the behavior of investors in corporate bond funds and equity funds, we follow Jiang and Zheng (2014) to select the sample of equity funds.

3.2. Measurement of flow and performance

The key variables in our empirical analyses are mutual fund flows and performance. As a standard practice, we impute net fund flows from the total net assets of each fund share class between consecutive points in time and the interim net fund return. Specifically, flow for fund k in month t is defined as:

$$Flow_{k,t} = \frac{TNA_{k,t} - TNA_{k,t-1}(1 + R_{k,t})}{TNA_{k,t-1}}$$

where $R_{k,t}$ is the return of fund k during month t , and $TNA_{k,t}$ is the total net asset value at the end of month t . To mitigate the influence of outliers (a standard practice in the literature), fund flows are winsorized at the 1% and 99% levels.

To measure performance of corporate bond funds, we estimate a bond fund's average alpha in the past year by performing rolling-window time-series regressions for each fund using past 12 months of data. One issue that merits a special discussion is the benchmark relative to which performance is measured. Given the scarcity of studies on the investment and redemption decisions of corporate bond fund investors, we resort to both theory and prior empirical studies on flows and performance of equity funds for guidance. Our primary performance measure is fund *Alpha*, which is the intercept from a regression of excess corporate bond fund returns on excess aggregate bond market and aggregate stock market returns. We use the Vanguard total

bond market index fund return and CRSP value-weighted market return to proxy for aggregate bond and stock market returns.

Several reasons prompt the choice of this simple measure of fund *Alpha*. First, a positive (negative) intercept from this regression for a given mutual fund over a particular period indicates that investors holding passive stock and bond market portfolios would have improved their mean-variance performance had they tilted their portfolios towards (away from) the fund. Therefore, the measured *Alpha* can, a priori, be an important determinant of the investment and redemption decisions of bond fund investors if they expect future alphas to be persistent. Second, a growing number of studies find that alpha from the Capital Asset Pricing Model (CAPM) drives flows into and out of equity mutual funds, and the explanatory power of CAPM alpha for fund flows is higher than alternative, multifactor models (see Berk and Van Binsbergen, 2014; Barber, Huang, and Odean, 2014). Although for equity funds it may be reasonable to approximate the wealth portfolio using the aggregate stock market return following the spirit of CAPM, for corporate bond funds, it seems natural to include both bond and stock markets to approximate fluctuations in the wealth portfolio.¹⁰ Third, from an asset pricing perspective, a growing literature establishes common risk factors driving both stock and bond returns (e.g., Fama and French, 1993; Kojien, Lustig, and Van Nieuwerburg, 2014). Therefore, it is reasonable to adjust for the exposures to bond and stock market risks when computing corporate bond fund alpha.

Given that there is no established consensus on measuring performance for corporate bond funds, we consider several robustness tests with different measures of performance. First, instead of using both stock and bond market factors, we use a more parsimonious, one-factor model with the aggregate bond market return to compute the corporate bond fund alpha. Second, to improve the precision of beta estimates, we first estimate fund beta using past two or three years of return data, and then compute the alpha of the bond fund over the next month. Third, we use fund returns in excess of the cross-sectional average of all corporate bond fund returns as

¹⁰ Earlier tests of CAPM approximate returns on the wealth portfolio using the value-weighted returns to stock and bond markets (e.g., Friend, Westerfield, and Granito, 1978). Since our objective is not to literally test if the aggregate wealth portfolio is mean-variance efficient, and for the benefit of mitigating measurement errors in the relative value of stocks and bonds, we adopt a more flexible approach of including both stock and bond market returns in the regression. Another advantage of our approach is that it allows individual funds to have different exposures to stock and bond markets.

alternative measure of fund performance. Fourth, we use raw fund returns in excess of the risk-free rates. The results of these robustness tests, unreported to conserve space, show that our main findings are robust to the choice of performance measure. We come back to this point in the next section.

3.3. Measurement of liquidity

Our empirical analysis incorporates both aggregate and fund-level measures of liquidity. We use four measures of the aggregate corporate bond market liquidity. First, Bao, Pan, and Wang (2011) find that increase in the aggregate stock market volatility, as proxied by the VIX index, strongly and positively impacts the illiquidity of corporate bonds. We therefore use the VIX index (from the Chicago Board Options Exchange (CBOE)) as one measure of aggregate corporate bond illiquidity. Second, Brunnermeier and Pedersen (2009) show that asset market liquidity co-moves with the funding liquidity of financial institutions that supply liquidity to asset markets. We use the TED spread (difference between the three-month London Interbank Offered Rate (LIBOR) and the three-month Treasury-bill interest rate, from the St. Louis Fed data) to capture funding liquidity to financial institutions, which in turn determines the liquidity of corporate bond markets. Third, we use the index of aggregate corporate bond market illiquidity proposed by Dick-Nielsen, Feldhutter and Lando (DFL 2012). Since the DFL index is estimated using the TRACE (Trade Reporting and Compliance Engine) data, it has a shorter history, starting from July 2002 to June 2013. It shares an 86% correlation coefficient with VIX. Finally, we use the Merrill Lynch MOVE index from Bloomberg, which is the yield curve weighted index of normalized implied volatility on 1-month options. The weights are based on 2, 5, 10, and 30 year contracts. We use these four aggregate liquidity measures to capture the periods when liquidity in the corporate bond market evaporates, strengthening the concern of fund investors about the negative externality arising from other investors' redemption decisions.

Concerning the liquidity of assets held by individual corporate bond funds, as a first approximation, we use an elementary but powerful proxy, namely the fund's cash holdings (the fraction of fund assets held in cash). To accommodate redemption requests from clients, fund managers may have multiple means, e.g., disposal of undesired holdings, selling liquid assets, using the proceeds from new clients (inflows), and loans from financial markets or other

institutions such as the fund family. When faced with large, abrupt net redemptions, however, cash provides fund managers with the most reliable source of liquidity (see Chernenko and Sunderam, 2015). Moreover, while adverse market events (e.g., the failure of Lehman Brothers) can render the liquidity of previously liquid financial assets (e.g., shares of money market funds) suddenly illiquid, the liquidity of cash is largely insulated from these movements. These considerations prompt us to use the pre-determined level of cash holdings to proxy for the liquidity of a fund's assets, which, according to our hypothesis, will influence the redemption decisions of fund investors.

Of course, the level of cash holdings can reflect fund managers' anticipation of the fund's foreseeable liquidity needs, and therefore could be endogenous, which may reverse the direction of causality. This concern of endogeneity, however, implies that conditional on poor past performance, funds with higher cash holdings should experience large subsequent redemptions, due to fund managers' anticipation effect. This predicted direction is opposite to that of our hypothesis and, if relevant, could potentially bias us against finding evidence that supports our hypothesis. In addition to the level of cash holdings, we use the holdings of cash and government bonds as another proxy for liquidity of the funds' holdings. We get data on cash and government-bond holdings of mutual funds from CRSP mutual fund database. As a second measure of cash, we also collect cash holdings data for corporate bond mutual funds from the SEC N-SAR filings.¹¹

Finally, we also estimate the fund holdings-based liquidity based on the corporate bonds held by the fund. For this, we use the TRACE data which is a publicly available dataset that contains corporate bond transactions level data. We take average of the daily liquidity over each month to create two monthly liquidity measures (Roll and Interquartile Range) for each bond. We merge the CRSP funds' bond holdings with the monthly bond liquidity measures, and then aggregate over each corporate bond fund's bond holdings to create fund-level liquidity measures.

¹¹ The paper by Chernenko and Sunderam (2015) uses this source as well.

3.4. Summary statistics

Figure 2 shows the total net assets and dollar flows of actively managed corporate bond funds in our sample. The total net assets in this segment have been trending up in our sample period, particularly since the onset of the recent financial crisis. As of 2008, there was \$649 billion under management. From 2008 to 2014, this figure has almost tripled to more than \$1.8 trillion. Such a steady increase in corporate bond fund assets, however, masks increasingly volatile fund flows. For instance, corporate bond funds attracted net inflows of approximately \$190 billion in 2009 but experienced net redemptions of nearly \$60 billion from existing funds in 2013. The massive growth of the corporate bond funds sector naturally raises the concern of potential instability; what would be the consequences if corporate bond fund performance and the direction of flows are to reverse in the future.

Table 1 presents the summary statistics for the funds in our sample from January 1992 to December 2014. Over this sample period, active corporate funds record returns of 0.42% and an inflow of 0.82% per month on average. The median fund share-class size is \$59 million, with a median age of 6.89 years. On average these funds have annual expense of 1.04% and approximately 29% of them charge rear-end loads. The funds hold 3.5% of their assets in cash on average, but the cash holding practices vary substantially across funds with a standard deviation of 10%. The top one percent of funds holds as much as 46.7% of their assets in cash, while the bottom one percent has negative cash holding (i.e. leverage) of 36.72%. Fewer than 20% of the funds have negative cash holdings. On average, 23% of the fund share-classes are institutional.

4. Results

4.1. Flow-performance relation for corporate bond funds

In this section, we report that outflows are more sensitive to underperformance of corporate bond funds than are inflows to outperformance. To begin, we follow Chevalier and Ellison (1997) and Robinson (1988) to estimate a semi-parametric regression of fund flows on past fund

performance, where the relation between fund flows and performance has a flexible functional form. Our semi-parametric regression is specified as follows:

$$Flow_{i,t} = \alpha + f(Alpha_{i,t-12 \rightarrow t-1}) + \gamma \times Controls_{i,t} + \varepsilon_{i,t}, \quad (1)$$

where $Flow_{i,t}$ is corporate bond fund i 's net flow in month t , and $Alpha_{i,t-12 \rightarrow t-1}$ is fund i 's alpha estimated as the intercept from a regression of excess fund returns on excess aggregate bond market and aggregate stock market returns in the past one year. $Controls_{i,t}$ includes a battery of fund characteristics: Lagged Flow (the fund's net flow in month $t-1$), Log(TNA) (the natural log of fund assets), Log(Age) (the natural log of fund age in years), Expense (the fund's expense ratio), and Rear Load (an indicator variable equal to one if the fund charges back-end loads and zero otherwise). To compare our results with the literature on equity funds, we also estimate the same regression for stock funds in the same period. To make the results comparable between the corporate bond funds and stock funds, we use the same two-factor model to estimate equity fund alpha. The results, however, are similar if we use a one-factor model including only the aggregate stock market return to estimate alpha for equity mutual funds.

Figure 3 shows the results. Among underperforming funds, the response of outflows to a decline in the alpha of corporate bond funds is highly sensitive, which stands in stark contrast to the low sensitivity of flows out of equity funds to a decrease in their alpha. Among outperforming funds, however, investors tend to reward winning equity funds by switching disproportionately more money to their managers, but show only a tepid response to the performance of winning corporate bond funds. These results provide initial support for Hypothesis 1 that corporate bond funds exhibit a stronger sensitivity to underperformance than equity funds.

Due to the flexible functional specification, the semi-parametric approach has relatively low statistical power. To formally test Hypothesis 1, we perform the following parametric regression that captures a potential kink in the flow-performance relation:

$$Flow_{i,t} = \alpha + \beta_1 Alpha_{i,t-12 \rightarrow t-1} + \beta_2 Alpha_{i,t-12 \rightarrow t-1} \times I(Alpha_{i,t-12 \rightarrow t-1} < 0) + \beta_3 I(Alpha_{i,t-12 \rightarrow t-1} < 0) + \gamma \times Controls_{i,t} + \varepsilon_{i,t}, \quad (2)$$

where $I(Alpha_{i,t-12 \rightarrow t-1} < 0)$ is an indicator variable equal to one if the fund achieves a negative alpha in the past year and zero otherwise, and the dependent and other independent variables are defined as in Equation (1). To control for the aggregate flows into and out of the corporate bond fund sector, we include the month fixed effect. To allow for intertemporal dependence of regression residuals at the level of fund share class, we cluster standard errors by fund share class.

Table 2 shows the results. We find a concave flow-performance relation for corporate bond funds: the sensitivity of flows out of corporate bond funds to bad performance is much higher than that of flows into those funds to good performance. The slope coefficient for *Alpha* is 0.238, and the slope coefficient for *Alpha* interacted with the negative alpha dummy is 0.621 and is statistically significant. In other words, the sensitivity of outflows to negative alpha is 0.859 (= 0.238+0.621), which is 3.6 times that of the sensitivity of inflows to positive alpha (0.238).

Such a concave flow-performance relation for corporate bond funds is markedly different from the convex flow-performance relation documented in the stock fund literature. In the second column, we confirm the existence of such a convex flow-performance relation for stock funds during our sample period. For stock funds with positive alpha, a one percent increase in alpha is associated with 0.994 percent increase in fund flows. But for stock funds with negative alpha, a one percent decrease in alpha is associated with a 0.419% (=0.994-0.575) decrease in fund flows. The sensitivity of outflows to negative alpha is therefore 58% lower than that of inflows to positive alpha, which implies a convex flow-performance relation for stock funds, as consistent with prior literature.

In the context of fragility, the effect of outflows is particularly important. The sensitivity of outflows in corporate bond funds to decreases in alpha (0.859%) is approximately twice that of equity funds (0.419%). We also find that the difference between the two coefficients on the negative alpha indicator variable is statistically significant at the 1% level when we run a regression that pools the corporate bond and equity funds together.

So far, our results are based on the performance measure of alpha calculated using a two-factor model, i.e., fund alpha is measured as the intercept from a regression of excess corporate bond fund returns on excess Vanguard total bond market returns and excess CRSP value-weighted stock market returns. Despite the reasons outlined previously that lead us to favor this

proxy for corporate bond fund alpha, we also construct alternative measures of fund performance: alpha from a one-factor model with the aggregate bond market return, alpha based on predetermined fund betas, style-adjusted fund returns, and fund returns in excess of the risk-free rate. These results, unreported to conserve space, show that the flow-performance relation for corporate bond funds is either concave or linear, but never convex. In contrast, equity funds consistently exhibit a convex flow-performance relation in all specifications. These results lend support to our Hypothesis 1.

Recently, Spiegel and Zhang (2013) suggest that the heterogeneity among equity funds may lead to a spurious convex flow-performance relation. In Table 3, we perform various subsample analyses on our corporate bond funds to examine if the flow-performance relation is pervasive across young and old funds, present in periods with low and high aggregate fund flows, and robust to controlling for the fund fixed effect. Young and old funds correspond to the funds with below- and above-median fund age, respectively. High and low flow periods correspond to months with below- and above-median aggregate corporate bond fund flows. The dependent and independent variables in the regressions are as defined in Equation (2).

Columns (1) and (2) of Table 3 indicate that the higher sensitivity of outflows to underperformance than inflows to outperformance is robust across both young and old funds. On average, flows are more sensitive to past performance for young funds than for old funds, which is consistent with Chevalier and Ellison (1997). The incremental sensitivity of outflows to underperformance relative to that of inflows to outperformance is also quantitatively larger and statistically stronger for young funds than for old funds.

Columns (3) and (4) show that the shape of the flow-performance relation is similar in periods with high and low aggregate corporate bond fund flows. Column (5) shows that the stronger response of outflows to underperformance is robust to controlling for the fund share class fixed effect. These results suggest that the shape of the flow-performance relation in corporate-bond funds that we report in this paper should not be spurious, as suggested by Spiegel and Zhang (2013) in the context of equity funds. In the next subsection, we investigate how liquidity might shape the redemption decisions of corporate-bond fund investors in response to low past fund performance.

4.2. Illiquidity and sensitivity of redemptions to poor performance

4.2.1. Illiquidity of corporate bond markets

Why do corporate bond funds experience greater sensitivities of outflows to negative performance than stock funds? One natural explanation is the presence of first-mover advantage, which is exacerbated by the illiquidity of the assets held by the corporate bond funds. As discussed previously, because of the illiquidity of corporate bonds, investors' outflows from corporate bond funds may lead to costly liquidation, where the costs would be borne to a large extent by the remaining investors. This creates a first-mover advantage, which amplifies the reaction of outflows to bad performance. Under this explanation, outflows should be more sensitive to bad performance during periods when the corporate bond market is more illiquid, which is our Hypothesis 2.

To test this hypothesis based on the time-series variation in the corporate bond market liquidity, we perform the following regression:

$$Flow_{i,t} = \alpha + \beta_1 Alpha_{i,t-12 \rightarrow t-1} + \beta_2 Alpha_{i,t-12 \rightarrow t-1} \times IlliqPeriod_{i,t} + \beta_3 IlliqPeriod_{i,t} + \gamma Controls_{i,t} + \varepsilon_{i,t}, \quad (3)$$
$$\forall Alpha_{i,t-12 \rightarrow t-1} < 0$$

where $Flow_{i,t}$ is fund i 's net flow in month t , $Alpha_{i,t-12 \rightarrow t-1}$ is fund i 's alpha in the past one year, $IlliqPeriod_t$ is an indicator variable that equals to one if the particular illiquid period proxy is above the sample mean and zero otherwise, and $Controls_{i,t}$ remains the same as before. We use four proxies to capture illiquid periods in the corporate bond market, which are based on the VIX, TED spread, DFL Illiquidity index, and Merrill Lynch MOVE index. For this test, we conduct regressions based on the subsample of funds with negative alpha.

Table 4 shows that the high sensitivity of investor redemptions to poor fund performance is driven mostly by periods when the corporate bond market is illiquid based on these four proxies. In particular, during liquid periods with low VIX, the effect of performance on flows essentially disappears for underperforming funds. But, during illiquid periods with high VIX, a 1% decrease in alpha is associated with 0.622% incremental outflows. Similarly for the TED spread, the DFL index and the MOVE index, during liquid periods, there is a relatively flat relation between funds' flows and past performance. During illiquid periods with a high TED

spread, high DFL index, or high MOVE index, a 1% decrease in alpha is associated with a 0.628%, 0.666%, and 0.548% increase in outflows, respectively. The difference in the sensitivity of flows to past alpha between high and low liquidity periods is statistically significant in all the four cases.

Overall, we find that corporate bond funds have a higher outflow-to-poor-performance sensitivity during periods when the corporate bond market is less liquid. This evidence supports the idea of strategic complementarities driven by the illiquidity of the corporate bond market. Since periods with illiquid corporate bond markets tend to coincide with those of market stress, the more severe redemptions from underperforming funds in those periods can impose particularly high costs on these funds.

4.2.2. Illiquidity of fund assets

Next, we test Hypothesis 3 by exploring the impact of asset liquidity on the flow-performance relation for corporate bond funds. To measure asset liquidity at the fund level, we use five different measures. We start with a fund's cash balances. Specifically, using CRSP data, we measure a fund's most recent level of cash holdings prior to month t , to ensure that the level of cash holdings is not simply the outcome of flows in month t and that the information of cash holdings is available to fund investors. Second, also using CRSP, we measure a fund's cash and government bond holdings as an alternative measure of asset liquidity. Third, we measure a fund's holdings of cash and cash equivalents, collected from the SEC N-SAR filings. In particular, from the semi-annual N-SAR forms for all corporate bond mutual funds available through the EDGAR website, we extract their holdings of cash (item 74A), repurchase agreements (item 74B), and short-term debt other than repurchase agreements (item 74C). We sum up these three items and create an alternative measure of cash holdings based on the N-SAR filings. For each of the three cash-related measures of asset liquidity, we construct a corresponding indicator variable for illiquid funds, *IlliqFund*, which equals one if the fund has cash holdings lower than the average fund in the same style and zero otherwise, to control for the possibility that the level of cash holdings may be systematically different across corporate bond funds with different investment styles and to mitigate the influence of potential outliers.

The fourth and fifth measures are based on the illiquidity of individual corporate bonds held by corporate bond funds. We use two measures of corporate bond illiquidity: the Roll (1984) measure and the interquartile range of bond prices. The Roll measure captures the serial covariance of intraday bond returns and is commonly used in the bond literature as a proxy for the bid-ask spread. Intuitively, bond prices bounce back and forth between the bid and ask prices, and hence higher bid-ask spreads would lead to higher negative covariance between consecutive returns. We collect intraday transaction data from TRACE for all corporate bonds and compute the Roll measure for each bond, following Dick-Nielsen, Feldhutter and Lando (2012):

$$\begin{aligned} Roll_j &= 2\sqrt{-\text{cov}(r_j, r_{j-1})}, \text{ if } \text{cov}(r_j, r_{j-1}) < 0; \\ &= 0, \text{ if } \text{cov}(r_j, r_{j-1}) \geq 0. \end{aligned}$$

To compute a daily Roll measure for individual corporate bonds, we require at least four transactions on a given trading day. The monthly Roll measure for each bond is the median of daily Roll measure within the month. The CRSP mutual fund database reports the corporate bond holdings for each fund in each quarter, which we assume to remain the same over the next three months until the next reporting date. In each month, we aggregate the bond-level Roll measure into a fund-level Roll measure by taking value-weighted averages using the fund's bond holdings, where the weights are based on the fraction of fund assets invested in the bond. This fund-level Roll measure is our fourth measure of bond fund asset illiquidity.

The fifth measure is based on the interquartile range of the prices of corporate bonds held by bond funds. The intuition of this measure is that in the corporate bond market, a large fraction of intraday bond price volatility is driven by the bid-ask spread (see, e.g., Pu (2009), Han and Zhou (2015) and Schestag, Schuster, and Uhrig-Homburg (2015)). As a result, corporate bonds with a larger bid-ask spread tend to have more dispersed transaction prices on a given day. To estimate the interquartile range, we follow Schestag, Schuster, and Uhrig-Homburg (2015), using transactions data from TRACE. Specifically, for each corporate bond, we divide the difference between the 75th percentile and 25th percentile of intraday prices on day t by the average trade price of that day to obtain the daily interquartile range. We compute the daily interquartile range with at least three observations and calculate the monthly measure as the mean of the daily measures. We then calculate the value-weighted average of interquartile range for each corporate bond fund to obtain our fifth measure of fund-level asset liquidity.

To mitigate the concern that corporate bond funds holding more illiquid bonds may choose to hold more cash as a liquidity buffer, we construct the indicator variable *IlliqFund* that combines information on holdings of illiquid corporate bonds and cash. Specifically, *IlliqFund* equal to one if the fund has below-average style-adjusted cash holdings and above-average holdings of illiquid corporate bonds based on the Roll measure (or the interquartile range), and zero if the fund has above-average cash holdings and below-average holdings of illiquid corporate bonds. Otherwise, the observation is excluded.

As N-SAR data start in 2003, and the coverage for government bond holdings data in CRSP improve significantly after 2003, we use data from 2003 to 2014 as our baseline sample for the tests of Hypothesis 3.¹² For the two bond holdings-based measures, we merge the TRACE data with the CRSP mutual fund holdings data. To obtain sufficient data coverage, we further limit the data sample for bond holdings-based analyses to the period 2008 to 2014 for these two measures.

To test Hypothesis 3, we use the following regression specification:

$$Flow_{i,t} = \alpha + \beta_1 Alpha_{i,t-12 \rightarrow t-1} + \beta_2 Alpha_{i,t-12 \rightarrow t-1} \times IlliqFund_{i,t} + \beta_3 IlliqFund_{i,t} + \gamma Controls_{i,t} + \varepsilon_{i,t}, \quad (4)$$

$$\forall Alpha_{i,t-12 \rightarrow t-1} < 0$$

where $Flow_{i,t}$ is fund i 's net flow in month t , $Alpha_{i,t-12 \rightarrow t-1}$ is fund i 's alpha in the past one year. Across specifications, $IlliqFund_{i,t}$ is an indicator variable for an illiquid fund based on each of the five measures described previously, and $Controls_{i,t}$ includes the same set of control variables as in the earlier tables. We conduct regressions based on the subsample of funds with negative alpha.

Panel A of Table 5 shows the results. Column (1) presents the results where we include the interaction term between low cash holdings and the performance variable. For funds with high cash holdings, a 1% decrease in alpha results in a 0.554% increase in outflows. In contrast, for funds with low cash holdings, a 1% decrease in alpha results in a 1.368% (=0.554+0.814%)

¹² In the previous version of our paper, we use the CRSP cash holdings for our full sample from 1992 to 2014 to test the effect of asset liquidity on the sensitivity of outflows to underperformance of corporate bond funds. The results provide a similar support to Hypothesis 3. For consistency with other measures based on cash and government bond holdings, we use the period from 2003 to 2014 to test the effect of asset liquidity on the sensitivity of investor redemptions to underperformance in this version.

increase in outflows. Hence, among illiquid funds, negative fund alpha results in a significantly higher flow-performance sensitivity. Column (2) confirms the results when we include Treasury bond holdings along with cash as a measure of a bond fund's liquidity. Column (3) shows similar results with low cash holdings obtained from N-SAR filings.

Next we examine the results for funds with more illiquid bond holdings. Column (4) shows that bond funds with more illiquid corporate bond holdings based on the Roll measure tend to have a higher sensitivity of outflows to bad performance than their more liquid peers. Column (5) demonstrates the same effect for funds with more illiquid corporate bond holdings based on the Interquartile Range.

In summary, we show that among corporate bond funds, those with lower asset liquidity tend to experience a greater sensitivity of outflows to bad performance, i.e., their flow-performance relation is more concave. Consistent with Hypothesis 3, the evidence supports the idea that asset illiquidity exacerbates strategic complementarities among corporate-bond-fund investors in their redemption decisions.

4.2.3. Interpreting lower cash holdings

So far, we have used a variety of proxies for asset liquidity of individual corporate bond funds, with a central focus on their holdings of cash and other liquid assets such as government bonds. Now we consider two issues that could confound the interpretation of the role played by cash holdings in driving the results.

First, funds with lower cash holdings may be more actively investing in their core return-generating assets. In other words, they may simply be more active asset managers. If investors perceive the past fund performance as more revealing of the managers' skill for more active funds, it could lead to the observed relation between lower cash holdings and stronger sensitivities of outflows to past underperformance. To mitigate this concern, we use a fund's R^2 (the proportion of the variance in fund returns explained by their exposure to the passive market portfolios) to capture how active a fund is, and include the interaction between the fund's R^2 and past alpha as a further control variable.

Second, since fund flows tend to be persistent, i.e., periods with high redemptions may foreshadow further redemptions, if a lower level of cash holdings of a fund results from large prior redemptions, the effect of the interaction between low cash holdings and low past performance on future fund flows may be driven by the possibility that fund flows are more persistent among losers. To address this concern, we use the interaction between flows in the past year and past fund alpha as an additional control variable.

Panel B of Table 5 shows the results. For all our three cash-related variables, funds with a lower level of cash holdings have a significantly higher sensitivity of outflows to bad performance than their cash-abundant peers. The results is robust even after we control for the influence of a fund's R^2 and flows in the past year: The results also indicate that funds with a higher R^2 tend to have a stronger flow-performance relation, which may be due to the more precise alpha estimate for high R^2 funds.

4.2.4. Illiquidity of fund assets during illiquid periods

Building on the preceding results on the liquidity of the corporate bond market and fund assets, we proceed to examine whether the sensitivity of outflows to underperformance of corporate bond funds is particularly high for illiquid corporate bond funds during illiquid time periods. To examine this conjecture, we estimate the following regression involving the three-way interaction including fund performance, illiquid time period dummy and illiquid fund dummy:

$$Flow_{i,t} = \alpha + \beta_1 Alpha_{i,t-12 \rightarrow t-1} + \beta_2 Alpha_{i,t-12 \rightarrow t-1} \times IlliqPeriod_t \times IlliqFund_{i,t} + \beta_3 Alpha_{i,t-12 \rightarrow t-1} \times IlliqPeriod_t + \beta_4 Alpha_{i,t-12 \rightarrow t-1} \times IlliqFund_{i,t} + \gamma Controls_{i,t} + \varepsilon_{i,t}, \quad (5)$$

$$\forall Alpha_{i,t-12 \rightarrow t-1} < 0$$

where we include the three-way interaction of $Alpha_{i,t-12 \rightarrow t-1}$, $IlliqPeriod_t$ and $IlliqFund_{i,t}$. The dependent and other independent variables are defined as in Equations (2) and (3).

Table 6 shows the result. As conjectured, we find that the high sensitivity of investor redemptions to poor fund performance is particularly severe for illiquid funds during periods

when the corporate bond market is less liquid. The slope coefficient for the three-way interaction of fund performance, illiquid period and illiquid fund is positive and statistically significant at the 1% level. The economic magnitude is also large. For instance, for funds with below-average cash and government bond holdings during illiquid periods with high VIX, a 1% decrease in fund alpha is associated with a 1.444% ($=2.705+0.345+0.159-1.765\%$) increase in outflows.

These results show that the impact of liquidity on the strength of the association between past fund alpha and outflows is robust. Illiquid corporate bond funds have a significantly higher sensitivity of outflows to bad performance than liquid funds, especially when the corporate bond market is less liquid.

4.3. Tax-loss selling and outflows from illiquid funds

U.S. tax laws offer incentives for investors to harvest capital losses before the end of the year to offset potential tax liability, which provides an interesting natural experiment to study how liquidity influences investor redemption decisions. The idea is that if the underperformance of corporate bond funds induces tax-motivated redemptions from certain investors, the payoff of remaining shareholders would be adversely influenced since they have to partially bear the redemption-related liquidation costs. The resulting strategic complementarities will be aggravated if the corporate bond fund holds illiquid assets. As a result, the response of redemptions to underperformance can be particularly strong before the end of the year for corporate bond funds holding illiquid assets.

To exploit tax-loss selling as an exogenous event that aggravates the first mover advantage in investor redemptions, we test whether the difference in the outflow-underperformance sensitivity between liquid and illiquid funds is stronger before the end of the year. This is essentially a difference-in-differences approach. In Figure 4, we examine the seasonality in aggregate flows of corporate bond funds with negative alpha. It shows that flows out of underperforming corporate bond funds tend to be particularly large in November and December. The finding that large flows out of underperforming corporate bonds tend to start in November is consistent with the idea that the anticipation of tax-motivated selling in December, which is associated with costly asset liquidation, provides incentives for certain fund investors to

take money out earlier in November. We therefore use an indicator variable *YearEnd* that equals one for November or December and zero otherwise, to capture the turn of the year.¹³

To identify the impact of tax-loss selling, we estimate the following regression:

$$Flow_{i,t} = \alpha + \beta_1 Alpha_{i,t-12 \rightarrow t-1} + \beta_2 Alpha_{i,t-12 \rightarrow t-1} \times IlliqFund_{i,t} \times YearEnd_t + \beta_3 Alpha_{i,t-12 \rightarrow t-1} \times IlliqFund_{i,t} + \beta_4 Alpha_{i,t-12 \rightarrow t-1} \times YearEnd_t + \gamma Controls_{i,t} + \varepsilon_{i,t}, \quad (6)$$

$$\forall Alpha_{i,t-12 \rightarrow t-1} < 0$$

where we include $Alpha_{i,t-12 \rightarrow t-1}$, $YearEnd_t$, $IlliqFund_{i,t}$, and the pairwise and three-way interactions of the three variables together with the control variables in the regression. Table 7 reports the results. We find that among underperforming corporate bond funds, illiquid funds tend to experience larger outflows during the turn of a year than their liquid peers. As a placebo test, we perform similar analyses for outperforming corporate bond funds, which indicate no such effects. Our results remain similar, whether we use holdings of cash or cash plus government bonds to capture illiquid corporate bond funds.

4.4. Direct evidence of first mover advantage

We have presented evidence consistent with the presence of payoff complementarities in driving the redemption decisions of mutual fund investors when the funds hold illiquid assets and/or in illiquid times. In this subsection, we seek to provide more direct evidence of the gains for investors from redeeming before others in these circumstances. In particular, we estimate the impact of outflows on fund returns and how this is affected by illiquidity. A higher effect of outflows on returns implies that investors lose more if they stay in the fund when others redeem. The approach is similar in spirit to Amihud (2002) which gauges the effect of investor order flows on stock returns.

In particular, we perform the following regression:

¹³ When we define the end of the year only as December, we find a weaker but still consistent effect of liquidity on investor redemptions. We attribute the stronger result based on November and December to the inclusion of early redemptions occurring in November, which increases the power of our tests.

$$R_{i,t} = \alpha + \beta_1 Flow_{i,t} + \beta_2 Flow_{i,t} \times IlliqPeriod_t \times IlliqFund_{i,t} + \beta_3 Flow_{i,t} \times IlliqPeriod_t + \beta_4 Flow_{i,t} \times IlliqFund_{i,t} + \gamma Controls_{i,t} + \varepsilon_{i,t}, \forall Alpha_{i,t-12 \rightarrow t-1} < 0 \quad (7)$$

where $R_{i,t}$ and $Flow_{i,t}$ denote fund i 's net return and flow in month t , respectively, $IlliqPeriod_t$ is an indicator variable equal to one if the particular illiquidity proxy (the VIX, TED spread, DFL, or MOVE index) is above the sample mean and zero otherwise, and $IlliqFund$ is an indicator variable equal to one if the fund has cash and government bond holdings below the average fund in the same style and zero otherwise. We include $Flow_{i,t}$, $IlliqPeriod_t$, $IlliqFund_t$, and the pairwise and three-way interactions of the three variables in the regression. The other variables are defined as earlier.

Table 8 presents the results. The slope coefficients for fund flows measure the impact of flows on contemporaneous fund returns. In particular, β_2 is an estimate of the three-way interaction coefficient for how fund flow affects returns for an illiquid fund during illiquid time. Table 8 reports positive and statistically significant coefficient estimates for β_2 across the four proxies of illiquid corporate bond markets. This result suggests that the incentive to redeem shares in month t after observing fund underperformance during the period from $t-12$ to $t-1$ is especially strong for illiquid funds when the corporate bond market is less liquid.

The sum of the four beta coefficients $\beta_1 + \beta_2 + \beta_3 + \beta_4$ represents the impact of flows on returns to illiquid corporate bond funds when the corporate bond market is illiquid. To get a sense of the magnitude of the overall impact of fund flows on fund returns, a one standard deviation (8.79%) increase in flows out of an illiquid corporate bond fund in a given month is associated with a decline in fund returns by 33, 31, 36, and 29 basis points in the same month when the corporate bond market is less liquid as measured by the VIX, TED spread, DFL, and MOVE index, respectively.

Since part of fund flows in month t may result from fund returns in month t (intra-month response of fund investors to fund performance) and fund managers may engage in costly trades in month $t+1$ to partially accommodate redemption requests received in month t , these measures tend to underestimate the negative impact of outflows on fund performance. We therefore view our estimates as providing a lower bound on the adverse impact of outflows on fund performance,

which generates incentives for investors to run. Considering that these estimates of the negative impact of fund flows on fund returns represent only a lower bound of the actual costs, the incentives to run can indeed be large for investors in illiquid corporate bond funds when the corporate bond market is illiquid.

4.5. The effect of large investors

Turning to Hypothesis 4, strategic complementarities should be less important in determining fund outflows if the fund ownership is mostly composed of institutional investors. The reason is that large institutional investors hold larger positions in the funds and so they are more likely to internalize the negative externalities generated by their outflows. Hence, they serve to reduce coordination problems that lead to runs on funds. For funds with large investors, we expect the effect of illiquidity on the flow-performance relation to be mitigated.

In Table 9, we examine the effect of complementarities in the case of institutional investors. Following Chen, Goldstein, and Jiang (2010), we classify bond funds into institutional-oriented funds and retail-oriented funds. A fund is classified as an institutional-oriented (retail-oriented) fund if more than 80% (less than 20%) of fund assets are owned by institutional investors through institutional share class.

Panel A of Table 9 shows that the effect of asset illiquidity on the sensitivity of outflows to bad performance is not statistically significant among institutional-oriented funds but statistically significant among retail-oriented funds. The first two specifications show the results for institutional-oriented funds. The coefficient of interest is the interaction term between alpha and low cash. The presence of strategic complementarity implies that illiquid funds would have a higher sensitivity of fund flows to underperformance, hence a larger coefficient in the interaction term. However, the dominance of institutional investors would serve as a constraining force and reduce such an effect. The results indicate that, indeed, among institutional-oriented funds, the sensitivity of fund flows to low past performance has no significant relation to the asset liquidity (cash holdings) of corporate bond funds. The coefficient on the interaction term between alpha and low cash is statistically insignificant in both specifications (1) and (2) with different control variables.

When we turn to the last two specifications (3) and (4) which show the results for retail-oriented funds, the effect is very different from that of the institutional-oriented funds. In such cases, the sensitivity of outflows to low performance is significantly larger for low-cash, illiquid funds. The coefficient for the interaction between alpha and low cash is positive and statistically significant for both specifications. Hence, consistent with hypothesis 4, we find that the effect of asset illiquidity on the sensitivity of outflows to bad performance diminishes when the fund is held mostly by institutional investors. For retail-oriented funds where coordination failures are more likely to be a problem, the sensitivity of outflows to bad performance is substantially exacerbated when the fund's cash holdings fall below average.

Panel B of Table 9 shows how the illiquidity of corporate bond markets impacts the sensitivity of outflows to bad performance for institutional- and retail-oriented funds. Throughout the four proxies for the periods when corporate bond markets are illiquid, retail-oriented funds tend to experience more severe outflows when fund performance declines than their institutional-oriented counterparts. For instance, when the VIX or DFL index is high, the sensitivity of outflows to low fund performance does not rise for institutional-oriented funds but sharply increases for retail-oriented funds. When the TED spread or MOVE index is high, there is evidence of an increase in the sensitivity of outflows to low fund performance for institutional-oriented funds.¹⁴ The increase, however, is larger for retail-oriented funds.

The results in this subsection point to another measure that can reduce the fragility in fund outflows; namely, concentrated fund ownership. Internalizing the externality, large shareholders reduce the sensitivity of outflows to bad performance. The retail-oriented funds, however, can still create significant problems, as retail investors are more affected by strategic complementarities and rush to the exit.

¹⁴ It is possible that in times of market stress, institutional investors may have other incentives to liquidate their positions in funds investing in illiquid asset classes, e.g., due to their own liquidity constraints or risk management practices that curtail losses in the presence of adverse market shocks.

4.6. Treasury and Municipal bond funds

So far in the paper, we have focused on corporate bond funds. As a comparison, in this subsection, we examine the flow-performance relations for Treasury and Municipal bond funds. Treasury bonds are traded in more liquid secondary markets than are Muni bonds (Harris, 2015). Due to the enhanced liquidity, we would expect the force of strategic complementarity to be weaker for Treasury bond funds, and thus the flow-performance relation for Treasury bond funds to be less concave than for Muni bond funds.

We estimate the flow-performance relation for Treasury and Municipal bond funds in Table 10. The results indicate that, similar to equity funds, Treasury bond funds tend to exhibit a convex flow-performance relation; but similar to corporate bond funds, Muni bond funds tend to exhibit a concave flow-performance relation. Column (1) shows a negative and statistically significant coefficient for $Alpha \times (Alpha < 0)$ among Treasury bond funds, which indicates that outflows are less sensitive to underperformance than are inflows to outperformance. Column (2) shows a positive and statistically significant coefficient for $Alpha \times (Alpha < 0)$ among Municipal bond funds, which indicates that outflows are more sensitive to underperformance than are inflows to outperformance. These results provide further support for the role of liquidity in driving the redemption decisions of mutual fund investors.

One alternative explanation for the greater concavity of the flow-performance relation for corporate bond funds than for equity funds is that investors in corporate bond funds may perceive corporate bonds as an asset class with limited upside potential but large downside risk. Perhaps as a result, their investment decisions may be more sensitive to underperformance of corporate bond funds. The results on Treasury funds provide some evidence against this hypothesis, since Treasuries have a payoff structure similar to corporate bonds with limited upside potential.¹⁵ Instead, they are consistent with the idea that liquidity of the assets held by the funds drives the asymmetric flow-performance relation. In addition, it should be noted that the alternative explanation based on the payoff structure will have a hard time explaining the various evidence presented so far concerning the effect of market liquidity, fund liquidity, investor clientele, etc. on the sensitivity of flow to performance in corporate-bond funds.

¹⁵ One additional problem with this story is that equity returns are negatively skewed, but equity mutual funds tend to exhibit a convex flow-performance relation.

5. Economic impact of aggregate corporate bond fund flows

So far, we analyzed the flows into and out of individual funds and their interaction with performance, liquidity, investor clientele, and so on. As we discussed, we think the collection of results is mostly consistent with a first-mover advantage amplifying redemptions out of mutual funds following bad performance in case of illiquidity. From a policy point of view, one would like to know the behavior and consequences of aggregate corporate bond fund flows. In this section, we build on the previous analyses and examine aggregate flows. We first report the flow-performance relation for corporate bond funds as a sector, and then examine whether shocks to flows into and out of the aggregate corporate bond fund sector would affect subsequent macroeconomic activities.

5.1. Flow-performance relation for the aggregate corporate bond fund sector

We consider the flow-performance relation for corporate bond funds as one sector, using equity funds as a comparison. The goal is to assess if the fund-level flow-performance relation reported previously may be washed out in the process of aggregation. Specifically, we perform semi-parametric regressions of aggregate fund flows in a given month on fund returns in the previous month with lagged fund flows as a control variable.

Figure 5 presents the results, which show that the aggregate redemption decision by corporate bond fund investors is more sensitive to lower corporate bond fund returns in the preceding month than is the aggregate purchase decision to higher corporate bond fund returns in the previous month. Hence, the concavity in the flow-performance relationship for corporate-bond funds is maintained in the aggregate. For equity funds, however, aggregate fund flows have no significant relations to past aggregate fund returns, after we control for the persistence in fund flows. This finding is similar to Warther (1995), who finds no evidence to support feedback trading by equity mutual fund investors in aggregate.

These results shed interesting new light on the corporate-bond fund sector when it comes to considering the implications for systemic stability. It appears like investors tend to leave the sector as a whole when its performance declines, and so there is a concern for the effect on prices

overall. This is very different from the behavior of the equity-fund sector where investors just shift money across funds in response to past performance but there are no significant shifts in and out of the sector.

5.2. Economic impact of corporate bond fund flows

In this subsection, we provide some exploratory analysis of the potential impact of shocks to flows into and out of the aggregate corporate bond fund sector on subsequent macroeconomic activity. A potential mechanism goes as follows: to accommodate large unexpected flows, bond fund managers often have to trade corporate bonds in the relatively illiquid secondary market. The resulting demand shocks can have significant impact on corporate bond prices and the credit risk premium. This then affects firms' cost of capital, and can then affect investments and other macroeconomic variables.

The analysis we provide here builds on the recent work by Gilchrist and Zakrajsek (2012). They find that variation in credit risk premiums has substantial predictive power for measures of macroeconomic activity. Their specific measure of credit risk premiums is computed in two steps. They first compute a credit spread index based on the prices of individual corporate bonds traded in the secondary market. They then decompose the credit spread into a component that is due to expected defaults and another component that is due to credit risk premium, which they refer to as the excess bond premium (EBP). Through a vector autoregression (VAR) framework, they show that shocks to the EBP lead to substantial fluctuations in macroeconomic variables.

Gilchrist and Zakrajsek (2012) attribute changes in EBP to shocks to financial intermediaries in credit markets, such as leveraged broker-dealers. Instead, we focus here on demand shocks arising from unexpected flows out of and into the corporate bond fund sector as a force leading to fluctuations in EBP. We first evaluate how corporate bond fund flows are related to Gilchrist and Zakrajsek (2012)'s excess bond premium measure. Specifically, we conduct a bivariate VAR with quarterly corporate bond fund outflows (fund flows times -1) and excess bond premium on a quarterly basis, and estimate the response of EBP to shocks to the corporate

bond fund outflow. For this and subsequent VAR analysis, our sample period is from 1991Q1 to 2010Q3 with two lags of the endogenous variables.¹⁶

Figure 6 shows that in response to a one percent increase in corporate bond fund outflows during a quarter, the excess bond premium rises during the contemporaneous quarter, and jumps up further by 9.2 basis points during the next quarter and another 7.6 basis points subsequently. All these responses are statistically significant and economically meaningful, which supports our conjecture that demand shocks to corporate bonds, induced by fund flows, impact bond prices and the credit risk premium in a meaningful way.

We proceed to estimate the macroeconomic consequences of shocks to the corporate bond funds. To this end, we estimate a VAR model in the spirit of Gilchrist and Zakrajsek (2012), replacing the EBP with fund outflows. Specifically, the VAR includes (1) log-difference of real personal consumption expenditure; (2) log-difference of real business fixed investment; (3) log-difference of real GDP; (4) inflation as measured by the log-difference of the GDP price deflator; (5) the quarterly corporate bond fund outflow; (6) the quarterly value-weighted excess stock market return from CRSP; (7) the ten-year nominal Treasury yield; and (8) the effective nominal federal funds rate.

Figure 7 shows the impulse response functions of the endogenous variables to the shock to the corporate bond fund outflow. An unanticipated increase in the outflow leads to substantial reductions in future consumption, investment and output growth rates over the next several quarters. For instance, in response to an unexpected one percent increase in fund outflows, the GDP growth rate declines by 0.084, 0.067, and 0.065 percentage points in the subsequent three quarters, reaching an accumulated decline of 0.22 per cent. These results indicate the impact of the variation in flows out of and into the corporate bond fund sector on future macroeconomic activities, possibly through the credit risk premium channel.

¹⁶ The data on EBP and other macroeconomic variables are available through <https://www.aeaweb.org/articles.php?doi=10.1257/aer.102.4.1692>.

6. Event study: The departure of the “Bond King” and investor redemptions

In this section, we study the effect of the departure of Bill Gross on the flows of the funds he managed. Bill Gross, known on Wall Street as the Bond King, is the co-founder of PIMCO, a large fund management company, and one of the most celebrated bond fund managers.¹⁷ On September 26, 2014, Bill Gross abruptly quit PIMCO and joined Janus, a much smaller firm. By all accounts, his departure came as a big surprise to the market and to the PIMCO senior management.¹⁸

In PIMCO, Bill Gross managed the Total Return Fund, a giant bond fund with assets under management of \$221 billion as of June 2014. In October, the first full month after his surprise departure, clients pulled \$27.5 billion. Half of those redemptions from the Pimco Total Return Fund occurred in the first five trading days of October; redemptions then slowed sharply.¹⁹

The Total Return Fund consists of four different funds: Total Return Fund I, Total Return Funds II, Total Return Fund III, and Total Return Fund IV.²⁰ Total Return Fund IV was founded in 2011; it places more restrictions on the use of derivatives and leverage, forgoes high-yield debt, and may not invest in options.²¹

Being more conservative, Total Return Fund IV has higher cash holdings than the first three funds. As of June 2014, Total Return Fund IV holds cash that equals 2.5% of the total asset under management, while Total Return Fund, Total Return Fund II, and Total Return Fund III hold cash below 0.5% of the total asset under management, as shown in Figure 8. In addition to

¹⁷ He was named by Morningstar as the Fixed Income Manager of the Year for 1998, 2000, and 2007, the first person to receive this award more than once, and was recognized for his "excellent investment skill, the courage to differ from consensus, and the commitment to shareholders necessary to deliver outstanding long-term performance." Wall Street Journal, <http://topics.wsj.com/person/G/bill-gross/52>

¹⁸ According to the New York Times, the surprising exit “came after Mr. Gross learned in recent weeks that top executives at Pimco and Allianz, the German insurer that owns it, had grown tired of his leadership and were weighing a change.” Despite these, “the timing of the departure of Mr. Gross even seemed to catch Pimco and Allianz off guard, despite the behind-the-scenes planning to remove him. By late afternoon Friday, photographs of Mr. Gross, his biography and well-read monthly investment letters still appeared prominently displayed on the Pimco website.” See http://dealbook.nytimes.com/2014/09/26/william-gross-leaves-pimco-to-join-janus/?_r=0

¹⁹ <http://www.bloomberg.com/news/articles/2014-11-04/pimco-total-return-lost-27-5-billion-after-gross-s-exit>

²⁰ The original Total Return Fund I was founded in 1987. Subsequently, in 1991, to accommodate clients’ needs, Gross founded Total Return Fund II, which is barred from investing in high yield bonds, and Total Return Fund III, which is barred from investing in gaming, tobacco and spirits industries.

²¹ <http://www.bloomberg.com/news/articles/2011-03-11/gross-starts-derivative-lite-version-of-pimco-total-return-as-rally-ends>

the typical cash holdings, PIMCO has been holding a substantial amount of assets in the form of commingled cash vehicles, which serve the purpose of liquidity management. At the end of September 2014, Total Return Fund IV holds the highest fraction of assets in commingled cash vehicles (29.3%), which is substantially higher than the rest of the three funds: TRF (16.2%), TRF II (25.5%), and TRF III (20.9%). Following the main theme of our paper, we would expect outflows to be amplified by the illiquidity of the funds' assets. Hence, we would expect Total Return Fund IV to have lower outflows than the other three funds following the departure.

Figure 8 also shows the pattern of investment outflows of the four Total Return Funds in October 2014, the first full month after Gross' departure. There are outflows in Total Return Funds I, II, and III that amount to 15%, 22% and 30% of the funds' assets, respectively. In contrast, Total Return Fund IV benefits from a modest *inflow*. This result is particularly interesting, since the pairwise correlations between returns on Total Return Fund IV and the other three funds exceed 99% during the two-year period before the departure of Bill Gross.

7. Conclusion

Corporate bond funds have grown tremendously in recent years. They hold a large fraction of corporate bonds outstanding in the US, and play an important role in the financing of firms' investments and operations. Despite their importance in the marketplace, there is very little research to date studying their flows patterns. We provide such a study in this paper and show that the familiar convex relationship between flows and performance in equity funds does not hold in corporate bond funds. The relationship in corporate bond funds is much more concave, indicating a stronger sensitivity of outflow to poor performance.

We also show that the sensitivity of outflows to bad performance in corporate bond funds is much stronger in times of aggregate illiquidity and among funds that hold more illiquid assets. Moreover, the effect of illiquidity on the sensitivity of outflows to bad performance is driven mostly by retail-oriented funds and not by institutional-oriented funds.

These findings are all consistent with the presence of payoff complementarities among corporate-bond-fund investors driven by the illiquidity of their assets. Investors know that the

redemption by others will impose liquidation costs on the fund that will reduce the return for those staying in the fund, and so there is a tendency to redeem with others, which acts to amplify the effect of negative performance on outflows.

Funds can take different measures to alleviate the amplification of outflows. These include holding a cash buffer, putting restrictions on redemptions, or changing the formula for net asset value calculation in the case of redemptions. Regulators should also be aware of the pattern of outflows in corporate bond funds in thinking about the stability of the financial system as a whole and in cases where there are externalities from funds to market prices and real economic activity.

References

- Bao, J., Pan, J. and Wang, J. (2011). The Illiquidity of Corporate Bonds, *The Journal of Finance* 66 (3), 911–946.
- Barber, B. M., Huang, X., and Odean, T. (2014). Which risk factors matter to investors? Evidence from mutual fund flows, working paper, University of California at Berkeley.
- Berk, J. B., and Van Binsbergen, J. H. (2014). Assessing Asset Pricing Models Using Revealed Preference. National Bureau of Economic Research working paper no. 20435.
- Bessembinder, H., and Maxwell, W. (2008). Markets: Transparency and the corporate bond market. *The Journal of Economic Perspectives*, 217-234.
- Bessembinder, H., Maxwell, W., and Venkataraman, K. (2006). Market transparency, liquidity externalities, and institutional trading costs in corporate bonds. *Journal of Financial Economics*, 82(2), 251-288.
- Brown, K. C., Harlow, W. V., and Starks, L. T. (1996). Of tournaments and temptations: An analysis of managerial incentives in the mutual fund industry. *The Journal of Finance*, 51(1), 85-110.
- Brunnermeier, M., and Pedersen, L. (2009) Market Liquidity and Funding Liquidity, *Review of Financial Studies*. 22 (6), 2201-2238.
- Bruno, V., and Shin, H. (2015) Global Dollar Credit and Carry Trades: A Firm-Level Analysis, working paper, Bank of International Settlements.
- Chen, Q., Goldstein, I., and Jiang, W. (2010). Payoff complementarities and financial fragility: Evidence from mutual fund outflows. *Journal of Financial Economics*, 97(2), 239-262.
- Chen, Y., and Qin, N. (2016) The Behavior of Investor Flows in Corporate Bond Mutual Funds. *Management Science*, forthcoming.
- Chernenko, S. and A. Sunderam. (2015) Liquidity Transformation in Asset Management: Evidence from the Cash Holdings of Mutual Funds, working paper, Harvard Business School.
- Chevalier, J., and Ellison, G. (1997). Risk Taking by Mutual Funds as a Response to Incentives. *Journal of Political Economy*, 105(6), 1167-1200.
- Christoffersen, S. E., Musto, D. K., and Wermers, R. (2014). Investor Flows to Asset Managers: Causes and Consequences. *Annual Review of Financial Economics*, 6(1), 289-310.
- Cici, G., Gibson, S., and Merrick, J. J. (2011). Missing the marks? Dispersion in corporate bond valuations across mutual funds. *Journal of Financial Economics*, 101(1), 206-226.

- Coval, J., and Stafford, E. (2007). Asset fire sales (and purchases) in equity markets. *Journal of Financial Economics*, 86(2), 479-512.
- Diamond, D. W., and Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *The journal of political economy*, 401-419.
- 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(3), 471-492.
- Edmans, A., Goldstein, I., and Jiang, W. (2012). The real effects of financial markets: The impact of prices on takeovers. *The Journal of Finance*, 67(3), 933-971.
- Edwards, A. K., Harris, L. E., and Piwowar, M. S. (2007). Corporate bond market transaction costs and transparency. *The Journal of Finance*, 62(3), 1421-1451.
- Ellul, A., Jotikasthira, C., and Lundblad, C. (2011). Regulatory pressure and fire sales in the corporate bond market. *Journal of Financial Economics*, 101(3), 596-620.
- Fama, E. F., and French, K. R. (1993). Common risk factors in the returns on stocks and bonds. *Journal of financial economics*, 33(1), 3-56.
- Feroli, M., Kashyap, A. K., Schoenholtz, K. L., and Shin, H. S. (2014). Market tantrums and monetary policy. Chicago Booth Research Paper, (14-09).
- Friend, I., Westerfield, R., and Granito, M. (1978). New evidence on the capital asset pricing model. *The Journal of Finance*, 33(3), 903-917.
- Getmansky, M. (2012). The life cycle of hedge funds: Fund flows, size, competition, and performance. *The Quarterly Journal of Finance*, 2(01).
- Gilchrist, S. and E. Zakrajsek (2012). Credit Spreads and Business Cycle Fluctuations. *American Economic Review*, 102(4), 1692-1720.
- Goldstein, I., and Pauzner, A. (2005). Demand–deposit contracts and the probability of bank runs. *The Journal of Finance*, 60(3), 1293-1327.
- Goldstein, M., Hotchkiss, E., and Sirri, E. (2007). Transparency and liquidity: A controlled experiment on corporate bonds. *The Review of Financial Studies*, 20(2), 235-273.
- Han, Song, and Hao Zhou. (2015). Effects of Liquidity on the Nondefault Component of Corporate Yield Spreads: Evidence from Intraday Transactions Data. Forthcoming, *Quarterly Journal of Finance*.
- Hanson, S. G., Scharfstein, D. S., and Sunderam, A. (2014). An evaluation of money market fund reform proposals. Working paper Harvard Business School.

- Harris, L. (2015). When will Bond Markets join the 21st century? *The Wall Street Journal*, June 4.
- Hau, H., and Lai, S. (2013). Real effects of stock underpricing. *Journal of Financial Economics*, 108(2), 392-408.
- Huang, J., Wei, K. D., and Yan, H. (2007). Participation costs and the sensitivity of fund flows to past performance. *The Journal of Finance*, 62(3), 1273-1311.
- Ippolito, R. A. (1992). Consumer reaction to measures of poor quality: Evidence from the mutual fund industry. *Journal of Law and Economics*, 45-70.
- Jiang, H., and Zheng, L. (2014). Active fundamental performance. Unpublished manuscript, Michigan State University and UC Irvine.
- Koijen, R. S., Lustig, H. N., and Van Nieuwerburgh, S. (2013). The cross-section and time-series of stock and bond returns. NYU working paper
- Lynch, A. W., and Musto, D. K. (2003). How investors interpret past fund returns. *The Journal of Finance*, 58(5), 2033-2058.
- 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(3), 491-518.
- Moneta, F. (2015). Measuring bond mutual fund performance with portfolio characteristics. Forthcoming, *Journal of Empirical Finance*.
- Morris, S., and Shin, H. S. (1998). Unique equilibrium in a model of self-fulfilling currency attacks. *American Economic Review*, 587-597.
- Nagel, S. (2014). The Liquidity Premium of Near-Money Assets. University of Michigan working paper.
- Pu, X. (2009). Liquidity Commonality Across the Bond and CDS Markets. *Journal of Fixed Income*, 19, 26-39.
- Robinson, P. M. (1988). Root N-Consistent Semiparametric Regression. *Econometrica* 56, 931-954.
- Roll, R. (1984). A simple implicit measure of the effective bid-ask spread in an efficient market, *Journal of Finance* 39, 127-1139.
- Schestag, R., Philipp Schuster, and Marliese Uhrig-Homburg. (2015). Measuring Liquidity in Bond Markets. Forthcoming, *Review of Financial Studies*.

Schmidt, L., Timmerman, A., and Wermers, R. (2014). Runs on Money Market Mutual Funds. University of Maryland working paper.

Sirri, E. R., and Tufano, P. (1998). Costly search and mutual fund flows. *The journal of Finance*, 53(5), 1589-1622.

Spiegel, M. and Zhang, H. (2013). Mutual Fund Risk and Market Share-Adjusted Fund Flows. *Journal of Financial Economics*, 108, 506-528.

Stein, J. (2005). Why are most mutual funds open-end? Competition and the limits of arbitrage. *Quarterly Journal of Economics*, 120, 247-272.

Warther, V. (1995). Aggregate Mutual Fund Flows and Security Returns. *Journal of Financial Economics*, 39, 209-236.

Zhao, X. (2005). Determinants of Flows into Retail Bond Funds. *Financial Analyst Journal*, 61, 47-59.

Figure 1 Distribution of Bond Fund Assets across Investment Objectives

This figure plots the share in net fund assets for fixed income mutual funds grouped by their investment objectives over the period 2000 to 2013. The source of data is the 2014 Investment Company Institute Fact book.

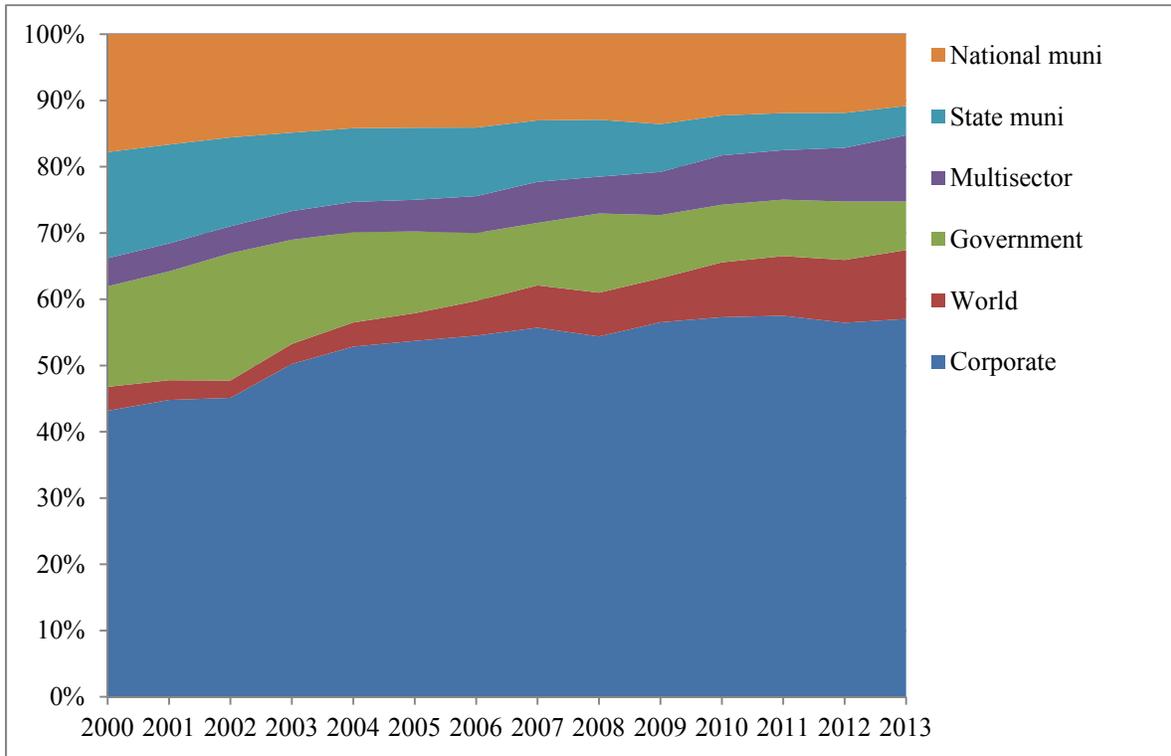


Figure 2 Total Net Assets and Dollar Flows of Active Corporate Bond Funds

This figure shows total net assets (TNA) and dollar flows of actively managed corporate bond funds from 1991 to 2014. We exclude index corporate bond funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

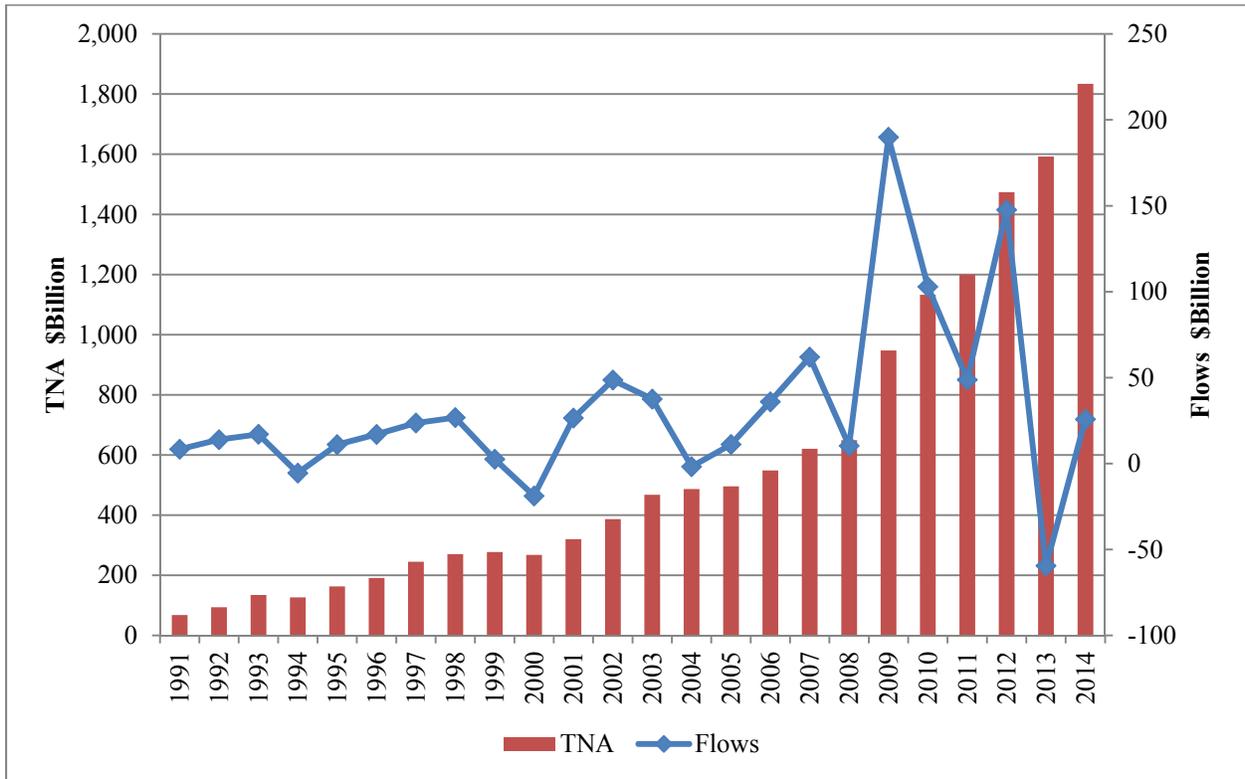


Figure 3 Flow Performance Relations for Individual Corporate Bond Funds

This figure shows the flow-performance relation for corporate bond funds and stock funds using a semi-parametric regression of monthly fund flows on past fund alpha and fund characteristics including fund size, fund age, expenses, back-end loads and lagged flows. The estimation uses the method developed by Robinson (1988) and applied in Chevalier and Ellison (1997). The red and green lines represent the 90% confidence intervals.

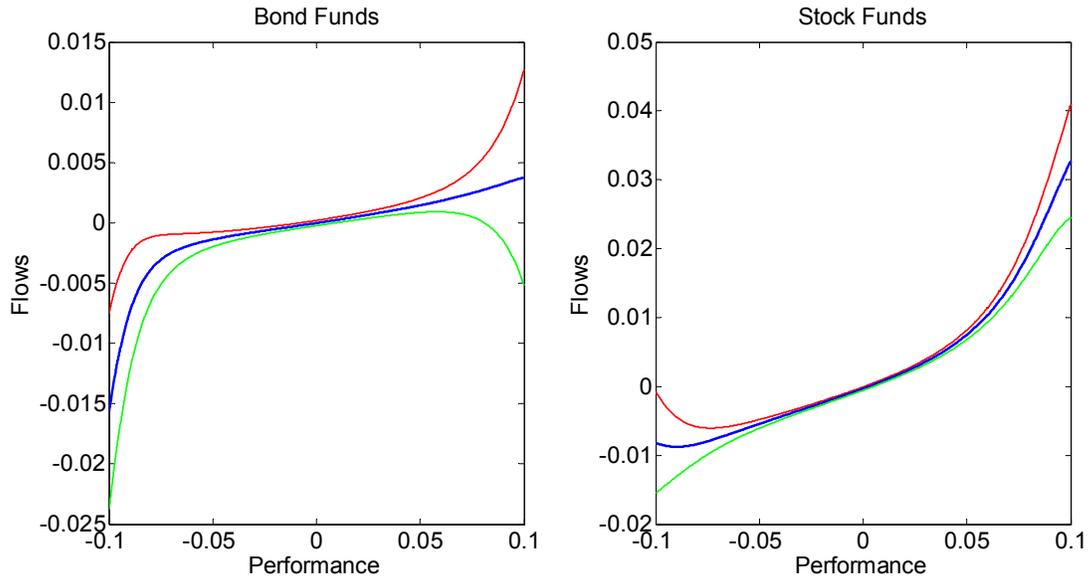


Figure 4 Seasonality of Monthly Flows for Underperforming Corporate Bond Funds

This figure plots the slope coefficients for eleven dummy variables that capture February to December, respectively, for our sample of corporate bond funds with negative alpha in the past year during the period from July 2003 to December 2014. The dependent variable is monthly percentage flows of corporate bond funds. With standard errors clustered across funds, the coefficients for November and December are statistically significant with t -statistics of -4.92 and -6.45, respectively.

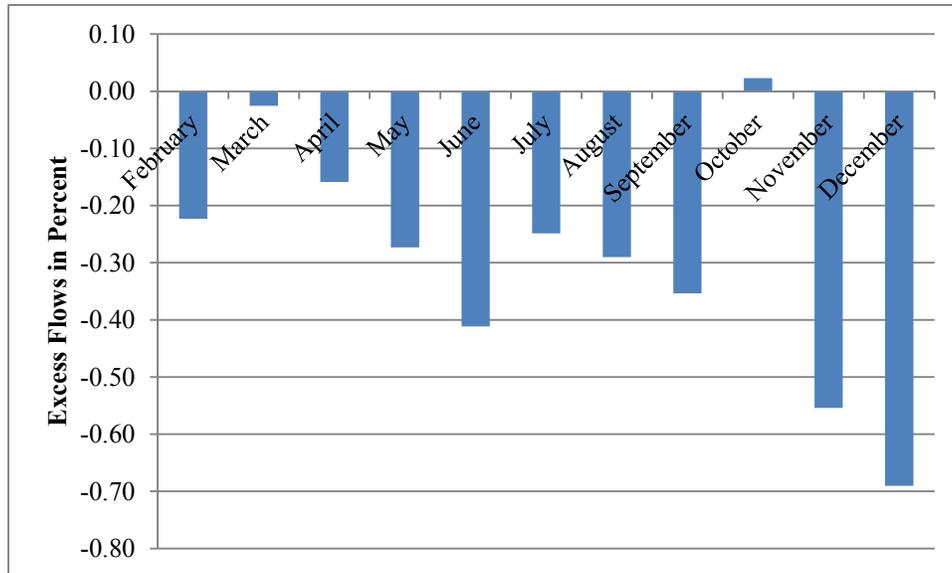


Figure 5 Flow Performance Relations for Aggregate Corporate Bond Funds

This figure shows the flow-performance relation for aggregate corporate bond funds and stock funds using a semi-parametric regression of monthly fund flows on past fund returns and lagged fund flows. The estimation uses the method developed by Robinson (1988) and applied in Chevalier and Ellison (1997). The red and green lines represent the 90% confidence intervals.

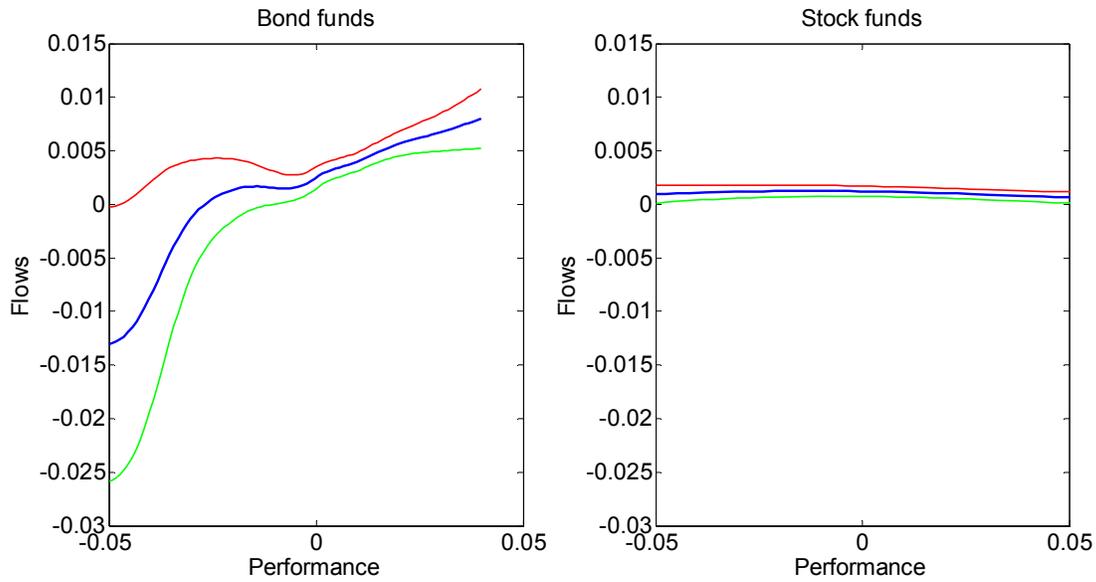


Figure 6 Impact of Corporate Bond Fund Outflows on Excess Bond Premium

This figure depicts the response of Excess Bond Premium (EBP), as proposed by Gilchrist and Zakrajrop (2012), to a one percent shock to the corporate bond fund outflows. The impulse response function is estimated from a vector autoregression (VAR) that consists of the average monthly fund outflows in a given quarter and the quarterly average of the EBP, as available from Gilchrist and Zakrajšek (2012). The band error bands represent the 95th percent confidence interval based on 2000 bootstrap replications.

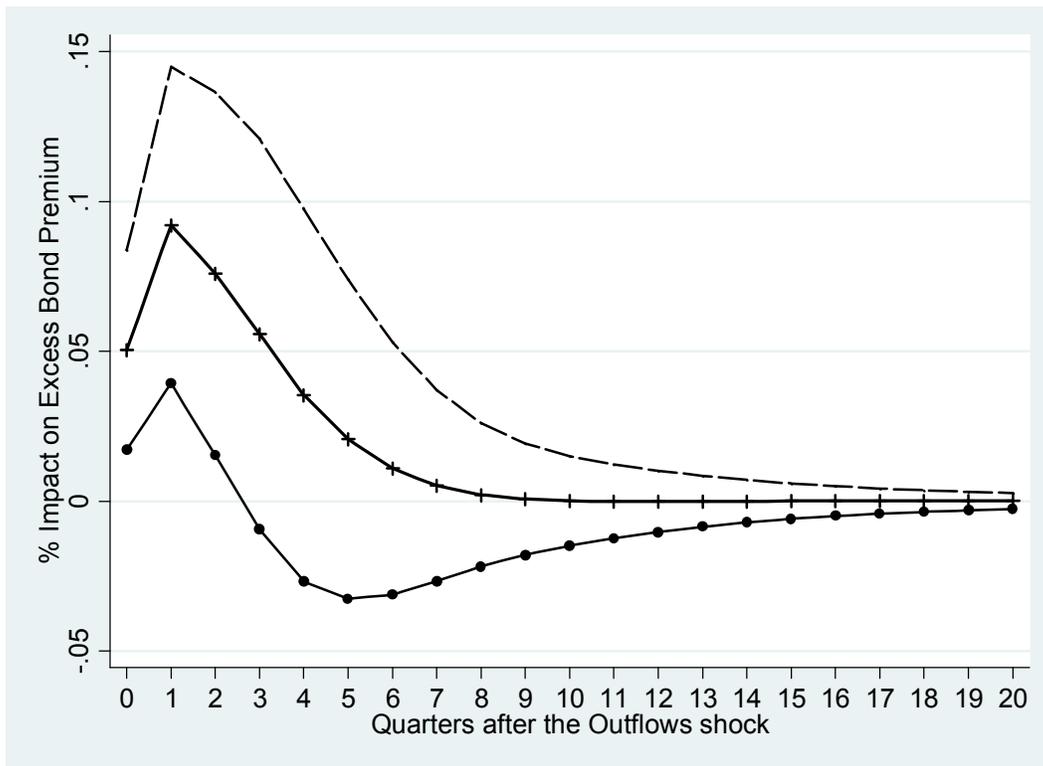
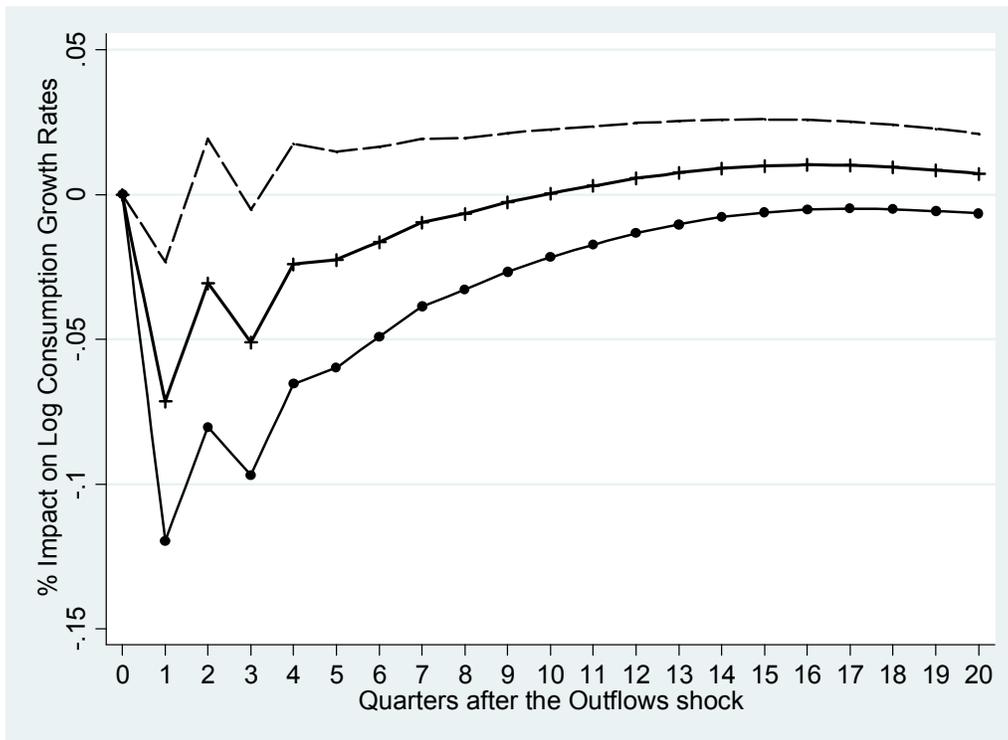


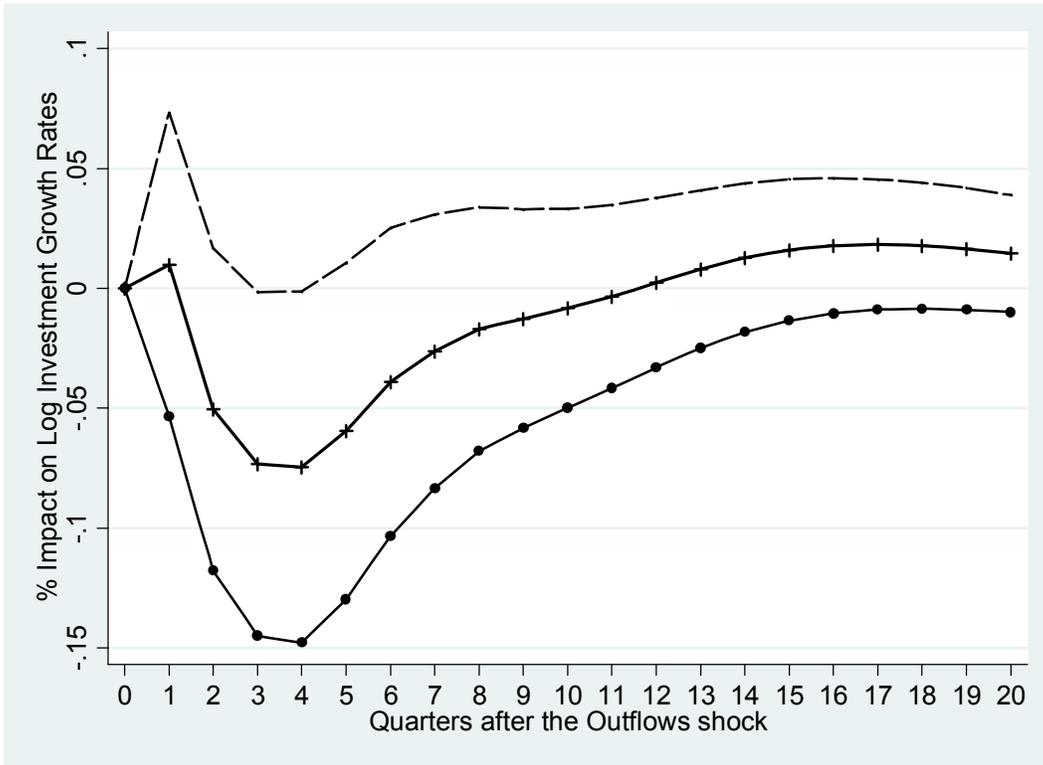
Figure 7 Impact of Corporate Bond Fund Outflows on Macroeconomic Activity

This figure depicts the response of macroeconomic growth rates (consumption in Panel A; investment in Panel B; and GDP in Panel C) to a one percent shock to the corporate bond fund outflows. The impulse response function is estimated from a vector autoregression (VAR) that consists of log-difference of real personal consumption expenditures, log-difference of real business fixed investment, log-difference of real GDP, inflation as measured by the log-difference of the GDP price deflator, the average monthly fund outflows in a given quarter, quarterly value-weighted excess stock market return from CRSP, the ten-year (nominal) Treasury yield; and the effective nominal federal funds rate. Data on macroeconomic variables come from Gilchrist and Zakrajšek (2012). The error bands represent the 95th percent confidence interval based on 2000 bootstrap replications.

Panel A: Consumption Growth



Panel B: Investment Growth



Panel C: GDP Growth

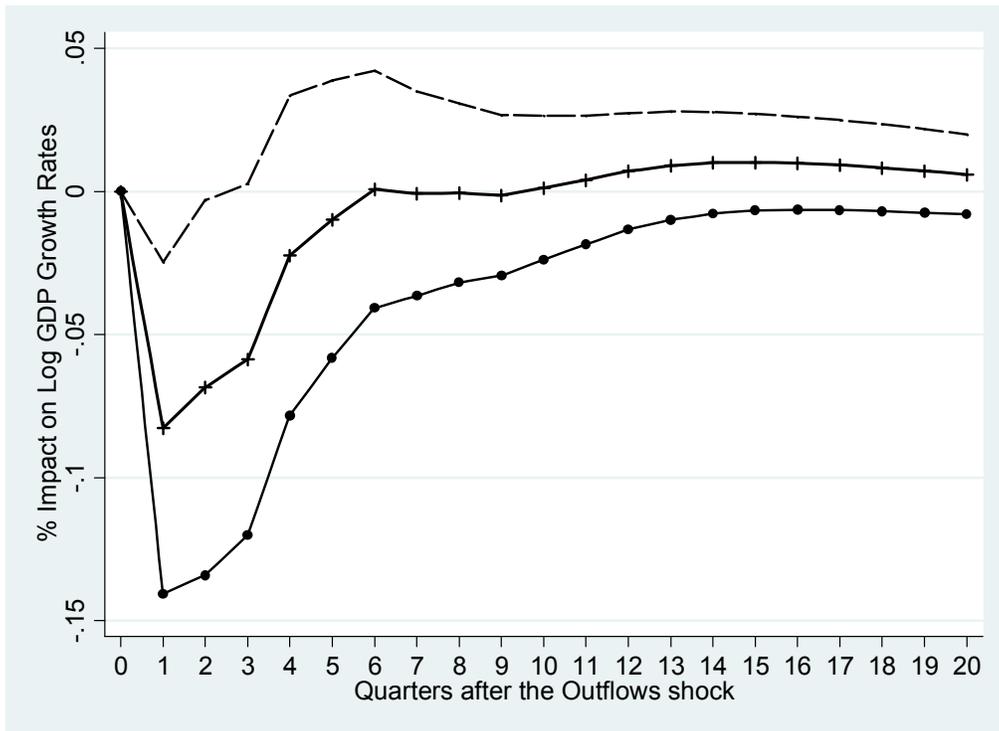


Figure 8 Exiting Total Return Funds following the Departure of Bill Gross

This figure shows the fraction of fund assets withdrawn in October 2014 from PIMCO’s Total Return Fund, Total Return Fund II, Total Return Fund III, and Total Return Fund IV following the resignation of the funds’ manager, Bill Gross, announced on 26 September 2014. The vertical axis on the left shows proportional fund flows in October 2014 and the vertical axis on the right shows the percentage of fund assets held in cash for these four funds in June 2014.

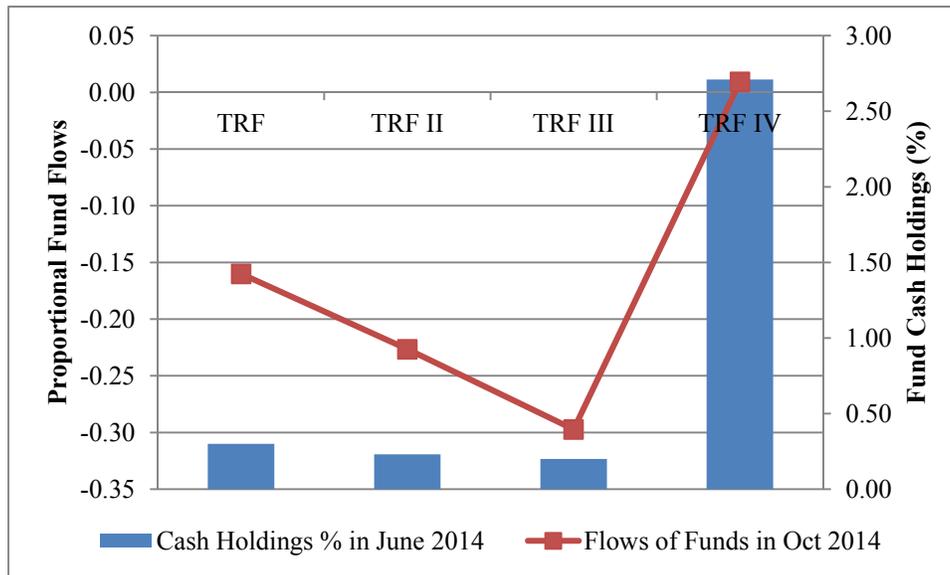


Table 1 Summary Statistics

This table shows the summary statistics for characteristics of active corporate bond funds in our sample from January 1992 to December 2014. Flow (%) is the percentage fund flow in a given month, Fund return (%) is the monthly net fund return in per cent, Log(TNA) is the natural log of total net assets (TNA), Log(Age) is the natural log of fund age in years since its inception in the CRSP database, Expense (%) is fund expense ratio in per cent, Rear load is an indicator variable that equals one if the fund share charges rear loads and zero otherwise, Cash Holdings is the proportion of fund assets held in cash in per cent, Institutional is an indicator variable that equals one if it is an institutional share class, and zero otherwise. The unit of observations is share class-month. The sample includes 4,679 unique fund share classes and 1,660 unique funds. We exclude index corporate bond funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

	Mean	Std Dev	P1	P5	P10	P20	P30	P40	P50	P60	P70	P80	P90	P95	P99	N
Flow (%)	0.82	8.79	-23.83	-7.27	-4.26	-2.27	-1.33	-0.72	-0.20	0.34	1.15	2.54	5.87	11.13	44.09	326035
Fund Return (%)	0.42	1.86	-4.90	-1.93	-1.03	-0.38	0.00	0.25	0.47	0.72	0.99	1.34	1.91	2.54	5.17	326036
Log(TNA)	3.88	2.38	-2.30	-0.51	0.64	1.97	2.84	3.51	4.08	4.64	5.22	5.89	6.72	7.39	8.79	326076
Log(Age)	1.90	0.76	0.22	0.61	0.85	1.20	1.49	1.72	1.93	2.14	2.35	2.58	2.85	3.08	3.56	326871
Expense (%)	1.04	0.48	0.14	0.40	0.50	0.63	0.74	0.82	0.93	1.05	1.26	1.57	1.77	1.90	2.13	326035
Rear Load	0.29	0.46	0	0	0	0	0	0	0	0	0	1	1	1	1	326871
Cash Holdings (%)	3.50	10.04	-36.72	-10.52	-2.54	0.00	1.08	1.97	2.81	3.81	5.00	6.90	11.40	18.31	46.69	326035
Institutional	0.23	0.42	0	0	0	0	0	0	0	0	0	1	1	1	1	326871

Table 2 Flow-Performance Relations: Corporate Bond Funds versus Stock Funds

This table shows flow-performance relations for active corporate bond funds and stock funds from January 1992 to December 2014. It indicates the asymmetry in investor responses to outperformance and underperformance (positive versus negative alpha). Flow is the proportional fund flow in a given month, Alpha is the average monthly alpha for a given fund in the past year, Log(TNA) is the natural log of total net assets, Log(Age) is the natural log of fund age in years since its inception in the CRSP database, Expense is fund expense ratio, Rear load is an indicator variable that equals one if the fund share charges rear loads and zero otherwise. For all funds, alpha is the intercept from a regression of excess fund returns on excess aggregate bond market and aggregate stock market returns. We use the Vanguard total bond market index fund return and CRSP value-weighted market return to proxy for aggregate bond and stock market returns. The unit of observations is share class-month. We include month fixed effects and cluster standard errors by fund share class. We exclude index funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

	(1)	(2)
	Corporate Bond Funds	Stock Funds
Alpha	0.238*** (2.71)	0.994*** (34.23)
Alpha× (Alpha<0)	0.621*** (4.34)	-0.575*** (-14.70)
Alpha<0	-0.00979*** (-18.45)	-0.00723*** (-25.06)
Lagged Flow	0.152*** (21.47)	0.118*** (29.90)
Log(TNA)	0.000728*** (5.74)	0.000459*** (5.46)
Log(Age)	-0.0157*** (-32.08)	-0.0183*** (-70.95)
Expense	-0.200*** (-2.59)	-0.0522 (-0.77)
Rear Load	-0.00280*** (-3.68)	-0.134*** (-5.51)
Observations	307,242	1,578,506
Adj. R^2	0.0646	0.0583

Table 3 Subsamples of Corporate Bond Funds

This table shows flow-performance relations for subgroups of active corporate bond funds from January 1992 to December 2014. It indicates that the asymmetry in investor responses to outperformance and underperformance (positive versus negative alpha) is pervasive across young and old funds, present in periods with both aggregate inflows and outflows, and robust to controlling for the fund share class fixed effect. The variables are defined as in Table 2. Young and old funds correspond to the funds whose age falls below and above median respectively. High and low flows correspond to periods with aggregate corporate bond fund flows above and below median, respectively. The unit of observations is share class-month. We include month fixed effects and cluster standard errors by fund share class. We exclude index funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

	(1)	(2)	(3)	(4)	(5)
	Young	Old	Low Flows	High Flows	Fund Fixed Effects
Alpha	0.411*** (2.58)	0.0630 (0.72)	0.0193 (0.15)	0.299*** (2.94)	0.166* (1.85)
Alpha×(Alpha<0)	1.046*** (4.23)	0.534*** (4.04)	0.860*** (4.14)	0.531*** (3.68)	0.658*** (4.51)
(Alpha<0)	-0.0118*** (-12.87)	-0.00717*** (-13.51)	-0.00977*** (-14.97)	-0.0104*** (-14.20)	-0.00971*** (-17.11)
Lagged Flow	0.153*** (17.53)	0.136*** (14.20)	0.123*** (15.02)	0.177*** (19.53)	0.0951*** (13.33)
Log(TNA)	0.000222 (1.21)	0.00120*** (7.22)	0.000317** (2.18)	0.00121*** (6.74)	0.00506*** (13.26)
Log(Age)	-0.0208*** (-19.37)	-0.00788*** (-11.73)	-0.0148*** (-27.84)	-0.0168*** (-26.24)	-0.0349*** (-26.39)
Expense	0.232* (1.93)	-0.578*** (-6.46)	-0.511*** (-6.13)	0.129 (1.26)	1.639*** (7.11)
Rear Load	-0.00299** (-2.41)	-0.00193** (-2.38)	-0.00322*** (-4.00)	-0.00238** (-2.33)	0.00202** (2.05)
Observations	145,739	161,503	163,258	143,984	307,242
Adj. R^2	0.0566	0.0507	0.0503	0.0695	0.101

**Table 4 Flow-Performance Relations of Underperforming Corporate Bond Funds
during Illiquid Periods**

This table shows time-varying flow-performance relations for active corporate bond funds with negative alpha from January 1992 to December 2014. The fund characteristics are defined as in Table 2. We use four indicator variables to capture illiquid period (IlliqPeriod) of corporate bond markets, high VIX, high TED, high DFL, and high MOVE. IlliqPeriod equals to one if the corresponding time-series variable is above the sample average. VIX is the CBOE's VIX index, TED is the difference between the three-month London Interbank Offered Rate (LIBOR) and the three-month T-bill interest rate, DFL is the corporate bond market illiquidity index proposed by Dick-Nielson, Feldhutter, and Lando (2012), and MOVE is the Merrill Lynch Option Volatility Estimate. The unit of observations is share class-month. We cluster standard errors by fund share class, and exclude index funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

Alpha<0	(1) VIX	(2) TED	(3) DFL	(4) MOVE
Alpha	-0.131 (-0.77)	-0.121 (-1.11)	-0.746*** (-3.22)	-0.0909 (-0.73)
Alpha×IlliqPeriod	0.753*** (3.89)	0.749*** (5.37)	1.412*** (5.21)	0.639*** (4.58)
IlliqPeriod	0.00690*** (9.81)	0.00148** (2.44)	0.00745*** (8.11)	0.00252*** (4.19)
Lagged Flow	0.121*** (15.37)	0.123*** (15.47)	0.152*** (14.90)	0.123*** (15.50)
Log(TNA)	0.000552*** (3.78)	0.000558*** (3.82)	0.000533*** (2.98)	0.000544*** (3.75)
Log(Age)	-0.0134*** (-26.78)	-0.0136*** (-26.70)	-0.0124*** (-17.88)	-0.0135*** (-26.70)
Expense	-0.175** (-1.98)	-0.185** (-2.10)	-0.284** (-2.45)	-0.183** (-2.08)
Rear Load	-0.00294*** (-3.40)	-0.00285*** (-3.29)	-0.00611*** (-5.87)	-0.00291*** (-3.36)
Observations	171,006	171,006	100,215	171,006
Adj. R^2	0.0339	0.0330	0.0429	0.0329

**Table 5 Flow-Performance Relations of Underperforming Corporate Bond Funds
with Illiquid Assets**

This table shows flow-performance relations for active corporate bond funds with negative alpha from July 2003 to December 2014. In Panel A, we use five indicator variables to capture an illiquid fund, IlliqFund. For Columns 1, 2 and 3, IlliqFund is an indicator variable equal to one if the fund has cash, cash and government bond holdings, and holdings of cash, short-term securities and repos reported in the fund's NSAR filings below the average fund in the same style and zero otherwise, respectively. For Column 4 (5), IlliqFund is an indicator variable equal to one if the fund has below-average style-adjusted cash holdings and above-average holdings of illiquid corporate bonds based on the Roll measure (interquartile range), and zero if the fund has above-average cash holdings and below-average holdings of illiquid corporate bonds. Other variables are defined as follows: Flow is the proportional fund flow in a given month, Alpha is the intercept from a regression of excess corporate bond fund returns on excess aggregate bond market and aggregate stock market returns, Log(TNA) is the natural log of total net assets (TNA), Log(Age) is the natural log of fund age in years since its inception in the CRSP database, Expense is the fund expense ratio, Rear load is an indicator variable that equals one if the fund share charges rear loads and zero otherwise. Variables joined by \times represent the interaction terms. For example $\text{Alpha} \times \text{IlliqFund}$ is the interaction term between Alpha and IlliqFund. Panel B shows the results with additional interaction terms between Alpha and R^2 and between Alpha and PastFlow. R^2 is the adjusted R^2 from a regression of excess fund returns and excess stock and bond market returns in the past year. PastFlow is net fund flow in the past year. For both panels, we use the Vanguard total bond market index fund return and CRSP value-weighted market return to proxy for aggregate bond and stock market returns. The unit of observations is share class-month. We include month fixed effects and cluster standard errors by fund share class. We exclude index funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

Panel A Asset Liquidity and Flow-Performance Relation

Alpha<0	Low Cash	Low (Cash + Government Bonds)	Low NSAR Cash	Illiquid Holdings (Roll)	Illiquid Holdings (Interquartile Range)
Alpha	0.554*** (6.42)	0.567*** (6.17)	0.631*** (6.09)	0.688*** (3.20)	0.662*** (3.16)
Alpha×IlliqFund	0.814*** (3.21)	0.647*** (2.74)	0.767*** (3.82)	1.305*** (3.02)	1.174*** (2.82)
IlliqFund	-0.000288 (-0.38)	0.00113 (1.51)	0.00211* (1.73)	0.00472*** (2.89)	0.00435*** (2.74)
Lagged Flow	0.131*** (12.50)	0.132*** (12.52)	0.121*** (7.15)	0.180*** (10.67)	0.179*** (11.11)
Log(TNA)	0.000561*** (3.18)	0.000555*** (3.15)	0.000470* (1.80)	0.000831*** (2.58)	0.000928*** (2.86)
Log(Age)	-0.0140*** (-20.26)	-0.0140*** (-20.22)	-0.0142*** (-14.61)	-0.0153*** (-12.59)	-0.0157*** (-12.95)
Expense	-0.443*** (-3.99)	-0.449*** (-4.02)	-0.521*** (-3.10)	-0.0281 (-0.14)	-0.0158 (-0.08)
Rear Load	-0.00485*** (-4.78)	-0.00482*** (-4.74)	-0.00221 (-1.45)	-0.00474** (-2.49)	-0.00482** (-2.50)
Observations	108,745	108,745	49,759	25,389	25,370
Adj. R^2	0.0500	0.0498	0.0473	0.0732	0.0750

Panel B Interpreting Lower Cash Holdings

	Cash Holdings			Cash and Government Bond Holdings			NSAR Cash Holdings		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Alpha	0.420*** (5.98)	0.471*** (3.01)	0.279* (1.88)	0.415*** (5.75)	0.479*** (2.98)	0.276* (1.85)	0.478*** (5.61)	0.505*** (4.22)	0.337*** (3.11)
Alpha×IlliqFund	0.582** (2.28)	1.209*** (3.76)	0.840*** (2.91)	0.417* (1.67)	1.040*** (3.44)	0.658** (2.36)	0.471** (2.43)	1.035*** (3.80)	0.818*** (2.73)
Alpha×R ²	0.543*** (2.61)		0.730*** (3.13)	0.643*** (2.95)		0.817*** (3.40)	0.538 (1.52)		0.516 (1.15)
Alpha×PastFlow		-0.440*** (-3.15)	-0.454*** (-3.07)		-0.434*** (-3.10)	-0.449*** (-3.04)		-0.331*** (-3.08)	-0.329*** (-2.81)
IlliqFund	7.72e-05 (0.10)	0.000848 (1.03)	0.000561 (0.70)	0.00181** (2.42)	0.00209*** (2.64)	0.00218*** (2.82)	0.00152 (1.27)	0.00232* (1.84)	0.00215* (1.70)
R ²	0.0174*** (8.57)		0.0178*** (8.85)	0.0181*** (8.96)		0.0186*** (9.25)	0.0199*** (6.43)		0.0198*** (6.23)
Lagged Flow	0.131*** (12.63)	0.130*** (12.60)	0.129*** (12.51)	0.131*** (12.64)	0.131*** (12.62)	0.129*** (12.53)	0.120*** (7.19)	0.120*** (7.22)	0.119*** (7.16)
Log(TNA)	0.000632*** (3.69)	0.000520*** (3.03)	0.000602*** (3.52)	0.000638*** (3.72)	0.000520*** (3.03)	0.000610*** (3.56)	0.000549** (2.07)	0.000507* (1.90)	0.000537** (2.04)
Log(Age)	-0.0137*** (-20.68)	-0.0128*** (-18.44)	-0.0130*** (-18.81)	-0.0137*** (-20.68)	-0.0128*** (-18.44)	-0.0130*** (-18.84)	-0.0138*** (-14.56)	-0.0133*** (-13.99)	-0.0133*** (-14.09)
Expense	-0.495*** (-4.58)	-0.516*** (-4.83)	-0.494*** (-4.62)	-0.499*** (-4.60)	-0.521*** (-4.86)	-0.497*** (-4.64)	-0.563*** (-3.31)	-0.559*** (-3.29)	-0.563*** (-3.34)
Rear Load	-0.00412*** (-4.18)	-0.00411*** (-4.22)	-0.00389*** (-4.00)	-0.00408*** (-4.14)	-0.00408*** (-4.17)	-0.00385*** (-3.95)	-0.00195 (-1.29)	-0.00184 (-1.21)	-0.00171 (-1.14)
Observations	104,198	104,198	104,198	104,198	104,198	104,198	48,537	48,537	48,537
Adj. R ²	0.0509	0.0509	0.0523	0.0509	0.0507	0.0522	0.0474	0.0467	0.0481

**Table 6 Flow-Performance Relations of Underperforming Corporate Bond Funds
with Illiquid Assets during Illiquid Periods**

This table shows the effect of illiquid corporate bond markets and illiquid corporate bond fund assets on the flow-performance relation for underperforming funds with negative alpha from July 2003 to December 2014. Flow is the proportional flow for a given fund in month t . IlliqFund is an indicator variable equal to one if the fund has cash and government bond holdings below the average fund in the same style and zero otherwise. Other variables are defined as in Table 4. The unit of observations is share class-month. We cluster standard errors by fund share class. We exclude index funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

Alpha<0	(1) VIX	(2) TED	(3) DFL	(4) MOVE
Alpha	0.345 (1.22)	-0.394 (-1.03)	0.00548 (0.01)	-0.0873 (-0.22)
Alpha×IlliqPeriod×IlliqFund	2.705*** (6.38)	1.410** (2.51)	2.191*** (4.00)	1.682*** (3.19)
Alpha×IlliqPeriod	0.159 (0.52)	0.921** (2.35)	0.517 (1.23)	0.556 (1.33)
Alpha×IlliqFund	-1.765*** (-5.12)	-0.564 (-1.37)	-1.377*** (-2.87)	-1.020** (-2.29)
IlliqPeriod×IlliqFund	0.00339** (2.09)	-0.000202 (-0.13)	0.00292* (1.67)	0.00187 (1.20)
IlliqPeriod	0.00689*** (5.65)	0.00710*** (5.97)	0.00625*** (4.65)	0.00353*** (2.91)
IlliqFund	-0.00213*** (-2.60)	-0.000331 (-0.39)	-0.00220** (-2.30)	-0.00162* (-1.81)
Lagged Flow	0.138*** (12.99)	0.138*** (13.01)	0.150*** (14.12)	0.139*** (13.05)
Log(TNA)	0.000607*** (3.51)	0.000582*** (3.37)	0.000555*** (2.99)	0.000558*** (3.24)
Log(Age)	-0.0132*** (-19.59)	-0.0130*** (-19.34)	-0.0125*** (-17.17)	-0.0129*** (-19.27)
Expense	-0.497*** (-4.43)	-0.506*** (-4.52)	-0.371*** (-3.05)	-0.526*** (-4.71)
Rear Load	-0.00570*** (-5.71)	-0.00580*** (-5.79)	-0.00667*** (-6.22)	-0.00552*** (-5.53)
Observations	108,745	108,745	94,640	108,745
Adj. R^2	0.0411	0.0406	0.0431	0.0400

Table 7 Tax-Loss Selling and Outflows from Illiquid Funds

This table uses the turn of a year which tends to be associated with tax-loss selling as an exogenous event to identify the effect of liquidity on outflows from underperforming funds from July 2003 to December 2014. We use an indicator variable that equals one for November or December and zero otherwise to capture the turn of the year. IlliqFund is an indicator variable equal to one if the fund has cash or cash and government bond holdings lower than the average fund in the same style, and zero otherwise. Other variables are as defined in Table 5. As a placebo test, we perform similar analyses for funds with positive alpha.

	Low Cash		Low (Cash + Government Bonds)	
	Alpha <0	Alpha >=0	Alpha <0	Alpha >=0
Alpha	0.357*** (5.56)	0.502*** (3.25)	0.400*** (6.08)	0.516*** (3.21)
Alpha×IlliqFund×YearEnd	1.001*** (2.76)	-0.139 (-0.63)	1.386*** (3.64)	-0.152 (-0.63)
Alpha×IlliqFund	-0.383* (-1.90)	-0.106 (-0.63)	-0.637*** (-3.26)	-0.144 (-0.79)
IlliqFund×YearEnd	0.000206 (0.15)	0.000722 (0.45)	0.000568 (0.42)	0.00200 (1.16)
Alpha×YearEnd	0.0955 (0.87)	-0.292 (-1.59)	0.0178 (0.17)	-0.288 (-1.41)
YearEnd	-0.00325*** (-3.41)	-0.000545 (-0.47)	-0.00309*** (-3.24)	-0.00136 (-0.99)
IlliqFund	-0.00340*** (-4.50)	-0.00407*** (-4.63)	-0.00129* (-1.71)	-0.00315*** (-3.34)
Lagged Flow	0.139*** (13.14)	0.203*** (19.07)	0.140*** (13.18)	0.203*** (19.11)
Log(TNA)	0.000623** *	0.000202	0.000598** *	0.000183
Log(Age)	-0.0130*** (-19.27)	-0.0154*** (-22.33)	-0.0130*** (-19.15)	-0.0154*** (-22.12)
Expense	-0.486*** (-4.36)	-0.772*** (-6.94)	-0.493*** (-4.40)	-0.773*** (-6.90)
Rear Load	-0.00549*** (-5.48)	-0.00426*** (-4.09)	-0.00556*** (-5.53)	-0.00442*** (-4.23)
Observations	108,745	105,288	108,745	105,288
Adj. R^2	0.0400	0.0696	0.0398	0.0693

**Table 8 Impact of Flows on Returns to Underperforming Funds:
Evidence of First Mover Advantage**

This table shows the impact of fund flows on contemporaneous returns for underperforming funds with negative alpha from July 2003 to December 2014. Flow is the proportional flow for a given fund in month t . IlliqFund is an indicator variable equal to one if the fund has cash and government bond holdings below the average fund in the same style and zero otherwise. Other variables are defined as in Table 4. The unit of observations is share class-month. We cluster standard errors by fund share class. We exclude index funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

Alpha<0	(1) VIX	(2) TED	(3) DFL	(4) MOVE
Flow	0.00559*** (6.01)	0.00774*** (4.95)	0.00532*** (5.72)	0.00535*** (5.30)
Flow×IlliqPeriod×IlliqFund	0.0127*** (3.13)	0.0135*** (3.12)	0.0146*** (3.36)	0.00503 (1.24)
Flow×IlliqPeriod	0.0167*** (6.57)	0.0114*** (4.00)	0.0180*** (6.74)	0.0180*** (6.50)
Flow×IlliqFund	0.00310** (2.51)	0.00273 (1.49)	0.00249* (1.93)	0.00498*** (3.77)
IlliqPeriod×IlliqFund	-0.00175*** (-5.25)	-4.74e-05 (-0.16)	-0.00116*** (-3.46)	-0.000935*** (-3.28)
IlliqPeriod	-0.00238*** (-9.20)	-0.00213*** (-10.62)	-0.00370*** (-14.58)	-0.00419*** (-20.36)
IlliqFund	0.000897*** (8.25)	0.000475*** (4.76)	0.000817*** (7.06)	0.000726*** (6.93)
Past Alpha	0.657*** (7.52)	0.687*** (8.75)	0.638*** (7.02)	0.641*** (7.31)
Lagged Flow	0.00367*** (5.37)	0.00314*** (4.64)	0.00450*** (5.94)	0.00328*** (4.81)
Log(TNA)	0.000175*** (5.96)	0.000187*** (6.59)	0.000192*** (5.75)	0.000163*** (5.73)
Log(Age)	0.000239*** (2.59)	0.000157* (1.78)	0.000339*** (3.11)	0.000142 (1.62)
Expense	0.0273 (1.54)	0.0357** (2.10)	0.0564*** (2.80)	0.0175 (1.00)
Rear Load	-0.000264 (-1.56)	-0.000196 (-1.19)	-0.000938*** (-5.00)	-8.01e-05 (-0.48)
Observations	108,745	108,745	94,640	108,745
Adj. R^2	0.0467	0.0416	0.0519	0.0532

Table 9 Institutional Investors and the Impact of Liquidity on Outflows of Underperforming Corporate Bond Funds

This table shows how the presence of large institutional investors influences the impact of liquidity on the outflows of corporate bond funds with negative alpha. Panel A shows the effect of fund liquidity, i.e., their cash holdings and Panel B shows the effect of liquidity in the corporate bond market. A fund is classified as an institutional-oriented (retail-oriented) fund if more than 80% (less than 20%) of fund assets are owned by institutional investors through institutional share class. Flow is the proportional fund flow in a given month, Alpha is the intercept from a regression of excess corporate bond fund returns on excess aggregate bond market and aggregate stock market returns, Low Cash is an indicator variable equal to one if the fund has cash holdings below the average fund in the same style and zero otherwise, Inst is an indicator variable equal to one if the fund class is an institutional share class and zero otherwise, Log(TNA) is the natural log of total net assets (TNA), Log(Age) is the natural log of fund age in years since its inception in the CRSP database, Expense is fund expense ratio, Rear load is an indicator variable that equals one if the fund share charges rear loads and zero otherwise. Inst is an institutional dummy that equals 1 if the particular fund share-class is institutional, and zero otherwise. We use the Vanguard total bond market index fund return and CRSP value-weighted market return to proxy for aggregate bond and stock market returns. The unit of observations is share class-month. We include month fixed effects and cluster standard errors by fund share class. We exclude index funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

Panel A Liquidity of Corporate Bond Funds

Alpha<0	Institutional-Oriented Funds		Retail-Oriented Funds	
	(1)	(2)	(3)	(4)
Alpha	2.056*** (3.61)	2.042*** (3.58)	0.958** (2.28)	1.024** (2.44)
Alpha×LowCash	-0.906 (-1.17)	-0.898 (-1.17)	1.268*** (2.90)	1.236*** (2.83)
Low Cash	-0.00304 (-1.57)	-0.00301 (-1.56)	-0.000683 (-0.52)	-0.00100 (-0.76)
Lagged Flow	0.108*** (5.35)	0.108*** (5.34)	0.106*** (4.86)	0.105*** (4.82)
Log(TNA)	0.000324 (0.89)	0.000391 (1.03)	0.000489 (1.40)	0.000822** (2.22)
Log(Age)	-0.0163*** (-9.70)	-0.0164*** (-9.58)	-0.0132*** (-10.57)	-0.0124*** (-9.96)
Expense	0.0469 (0.14)	-0.0168 (-0.05)	-0.543*** (-3.02)	-0.331* (-1.81)
Rear Load	-0.00340 (-1.21)	-0.00352 (-1.25)	-0.00639*** (-4.11)	-0.00619*** (-3.99)
Inst		-0.00123 (-0.48)		0.00766*** (4.03)
Observations	19,331	19,331	37,367	37,367
Adj. R ²	0.0398	0.0398	0.0490	0.0500

Panel B Liquidity of Corporate Bond Markets

Alpha<0	Institutional-Oriented				Retail-Oriented			
	(1) VIX	(2) TED	(3) DFL	(4) MOVE	(5) VIX	(6) TED	(7) DFL	(8) MOVE
Alpha	1.207 (1.40)	0.680 (1.16)	0.817 (1.09)	0.724 (1.05)	0.473 (1.04)	0.527 (1.26)	0.682* (1.71)	0.588 (1.31)
Alpha×IlliqPeriod	0.478 (0.68)	1.715** (2.24)	0.801 (1.22)	1.298** (1.98)	1.996*** (3.38)	2.443*** (3.80)	1.704*** (3.09)	1.950*** (3.20)
IlliqPeriod	-0.0104 (-0.46)	-0.0287 (-1.36)	-0.0550* (-1.87)	-0.0185 (-0.32)	0.0180 (1.26)	0.0238*** (3.59)	0.0181 (1.26)	-0.0646* (-1.88)
Lagged Flow	0.108*** (5.35)	0.108*** (5.33)	0.116*** (5.43)	0.108*** (5.34)	0.106*** (4.86)	0.106*** (4.84)	0.126*** (6.01)	0.106*** (4.87)
Log(TNA)	0.000282 (0.78)	0.000240 (0.66)	0.000630 (1.60)	0.000254 (0.70)	0.000466 (1.33)	0.000466 (1.34)	0.000376 (1.02)	0.000462 (1.33)
Log(Age)	-0.0162*** (-9.61)	-0.0161*** (-9.57)	-0.0152*** (-8.74)	-0.0162*** (-9.61)	-0.0133*** (-10.54)	-0.0133*** (-10.57)	-0.0133*** (-10.11)	-0.0133*** (-10.56)
Expense	0.00547 (0.02)	-0.0268 (-0.08)	0.120 (0.34)	-0.0201 (-0.06)	-0.564*** (-3.15)	-0.555*** (-3.10)	-0.483** (-2.48)	-0.560*** (-3.14)
Rear Load	-0.00346 (-1.23)	-0.00315 (-1.12)	-0.00318 (-1.08)	-0.00335 (-1.19)	-0.00659*** (-4.19)	-0.00652*** (-4.17)	-0.00693*** (-4.22)	-0.00662*** (-4.21)
Observations	19,331	19,331	16,514	19,331	37,367	37,367	32,600	37,367
Adj. R ²	0.0397	0.0401	0.0407	0.0399	0.0489	0.0492	0.0529	0.0489

Table 10 Flow-Performance Relations for Treasury and Muni Bond Funds

This table shows flow-performance relations for Treasury and Muni bond funds from December 2000 to December 2014 (when the two samples overlap). It indicates that the asymmetry in investor responses to outperformance and underperformance (positive versus negative alpha) is present for Muni bond funds but absent for Treasury bond funds. Flow is the proportional fund flow in a given month, Alpha is the average monthly alpha for a given fund in the past year, Log(TNA) is the natural log of total net assets, Log(Age) is the natural log of fund age in years since its inception in the CRSP database, Expense is the fund expense ratio, and Rear load is an indicator variable that equals one if the fund share charges rear loads and zero otherwise. For all funds, alpha is the intercept from a regression of excess fund returns on excess aggregate bond market and aggregate stock market returns. We use the Vanguard total bond market index fund return and CRSP value-weighted market return to proxy for aggregate bond and stock market returns. The unit of observations is share class-month. We include month fixed effects and cluster standard errors by fund share class. We exclude index funds, exchange traded funds, and exchange traded notes from the CRSP mutual fund database.

	(1)	(2)
	Treasury Bond Funds	Muni Bond Funds
Alpha	2.432*** (3.65)	0.186** (2.05)
Alpha× (Alpha<0)	-2.062** (-2.24)	0.711*** (4.75)
Alpha<0	-0.00509*** (-3.97)	-0.00657*** (-16.27)
Lagged Flow	0.109*** (6.20)	0.204*** (26.51)
Log(TNA)	0.000489* (1.78)	0.00117*** (10.75)
Log(Age)	-0.0171*** (-16.32)	-0.0138*** (-35.89)
Expense	-0.282* (-1.65)	-0.373*** (-5.44)
Rear Load	-0.00442** (-2.40)	-0.000973* (-1.87)
Observations	79,594	288,373
Adj. R^2	0.0825	0.126