

# Monetary Policy Amplification through Bond Fund Flows

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June 2023

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## Abstract

I show that the secular rise of bond mutual funds and ETFs (“bond funds”) amplifies the bond market transmission of monetary policy. During monetary tightening cycles, bond funds experience large outflows of return-chasing capital and scale down their corporate bond holdings significantly more than traditional corporate bond investors such as insurance companies and pension funds. In the cross section of firms, higher bond fund exposure leads to higher firm sensitivity to monetary policy – during monetary tightening cycles, more-exposed firms experience lower bond returns, issue less debt, and contract more on equity payout or real investment. To address endogeneity concerns, I use a shift-share instrument that exploits plausibly exogenous bond fund growth and sticky fund-firm relationship over long horizons. To quantify the aggregate effects, I use the granular instrumental variable approach and show that bond fund flows account for a large and growing share of the monetary sensitivity of aggregate bond yields and aggregate real investment.

Keywords: monetary policy transmission, bond fund flows, investor heterogeneity, corporate bond, relationship lending, demand elasticity

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# 1 Introduction

Corporate bonds are an important asset class and an important source of firm financing.<sup>1</sup> Over the past several decades, more and more corporate bonds are financed by a particular group of investors: bond mutual funds and ETFs (henceforth “bond funds”). As shown in Figure 1, the share of corporate bonds held by bond funds has experienced a secular rise from less than 2% in 1980 to over 20% in 2020.<sup>2</sup> This ownership shift matters because bond funds behave very differently from traditional corporate bond investors such as insurance companies and pension funds. In particular, this paper finds that bond funds’ credit supply is much more sensitive to monetary policy than other corporate bond investors. As a result, I show that the rise of bond funds amplifies the bond market transmission of monetary policy.

I have three main results. First, during monetary tightening cycles, bond funds experience large outflows of return-chasing capital and significantly scale down corporate bond holdings, much more so than other corporate bond investors such as insurance companies. Secondly, firms are differentially exposed to bond funds, and firms with higher bond fund exposure experience lower bond returns, issue less bonds, and decrease more on leverage, payout or real investment, during monetary tightening cycles. For identification, I construct a shift-share instrument that captures plausibly exogenous variation in bond fund exposure. Lastly, I use the granular instrumental variable approach to show that bond fund flows account for a large and growing share of the monetary sensitivity of aggregate bond yield and aggregate real investment.

I start with some new stylized facts on the difference in monetary sensitivity across corporate bond investors. Net flows to bond funds are highly volatile and strongly negatively correlated with monetary policy rate changes. As a result, bond funds’ corporate bond net purchases are equally sensitive to monetary policy. Using local projections with various monetary surprise measures (e.g., Gertler and Karadi, 2015) as instruments, I show that 1 p.p. increase in the two-year Treasury rate leads to 15 p.p. decrease in net flows to bond funds and 12 p.p. decrease in their corporate bond net purchases. This high sensitivity to monetary policy is common across bond funds, persistent across time periods, and robust to various macroeconomic controls as well as different monetary surprise instruments. In contrast, traditional corporate bond investors such as insurance companies and pension funds have stable flows and small corporate bond net purchase sensitivity to monetary policy.

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<sup>1</sup>As of year-end 2020, corporate bonds have a market capitalization of \$15 trillion and account for 35% of the total liabilities of nonfinancial corporate business, as shown in Figure A3 and Figure A1.

<sup>2</sup>Section 3 details the forces behind the secular rise of bond funds.

What explains bond fund flows' large sensitivity to monetary policy? I show that return chasing plays a key role. In the cross section of bond funds, return beta (i.e. Macaulay duration) is the strongest determinant of flow beta, winning horse races against rating, income yield, and yield to maturity. Across different mutual fund classes, money market funds and loan funds have the opposite return beta and also the opposite flow beta to bond funds. My findings here are consistent with the growing evidence that mutual fund investors chase returns, whether the returns are driven by skill or risk (e.g., Ben-David et al., 2021a).

I show that this investor heterogeneity in monetary sensitivity is an important state variable for monetary policy transmission. My main analysis exploits the fact that substantial heterogeneity in exposure to bond funds in the cross section of firms. A typical bond fund holds a small share of the market and near-proportionally scales up (down) existing holdings in response to inflows (outflows). As a result, flows to a bond fund disproportionately affect its portfolio firms, instead of all firms equally. Consequently, if a firm's bonds are held more by bond funds today, it is more exposed to common flows to bond funds tomorrow.

Indeed, I find that, during monetary tightening (easing), for firms whose bonds are held more by bond funds, their existing bondholders experience less (more) flows and make less (more) purchases of the firms' bonds. The difference in flow-induced trading from existing bondholders is large and stand at around 3% of firms' bond amount outstanding, creating large buying or selling pressure on these firms' bond prices.

Across corporate bonds with the same rating, the same duration and similar other characteristics, those with higher bond fund ownership have significantly higher effective duration: in response to monetary tightening, their prices decrease much more. Consistent with the price pressure interpretation, price impacts are temporary and fully revert over time, confirming that the underlying driver is discount rate news rather than changes in fundamental cash flows.

I then show that the secondary market price effects spill over to firm activities in the primary market. In response to monetary tightening, firms with higher bond fund ownership issue less bonds at higher yields. That price (bond yield) and quantity (bond issuance) move in the opposite direction further supports that the effect is driven by creditor supply instead of firm demand. For the average firm, lower bond issuance is entirely substituted with other forms of debt and also equity. However, for firms that are financially constrained ex ante, there is significant decrease in real capital expenditures and R&D.

Bond fund ownership is not randomly assigned to firms and my results are subject to en-

dogeneity concerns. After presenting additional evidence against alternative explanations, I focus on an identification strategy that exploits plausibly exogenous within-firm variation in bond fund ownership. Specifically, I construct a shift-share instrument based on initial bond fund relationships (the share) and cumulative bond fund flows (the shift). Intuitively, if a firm has more relationships with bond funds that subsequently experience large inflows of capital – due to the secular shift from defined-benefit to defined-contribution pension plans or due to better alpha, lower fees, or higher fund family market power – then the firm is going to be more exposed to bond funds over time. My main results remain largely the same, lending further credence to the causal effect of bond fund ownership on firm sensitivity to monetary policy.

My main analysis focuses on comparing near-identical bonds or firms in the cross section. This approach allows for identification but may understate the aggregate effects. To shed light on the aggregate effects, I use the granular instrumental variable approach (Gabaix and Koijen, 2020, 2021) to identify the elasticity of aggregate variables to bond fund flows. I then use the estimated elasticity to calculate counterfactual aggregate bond yields and aggregate real investment without bond fund flows. The results show that bond fund flows account for 26% (24%) of the aggregate bond yield (aggregate real investment) sensitivity to monetary policy. Moreover, bond fund flows' contribution to aggregate monetary sensitivity has increased substantially over the past 15 years, reflecting the rise of bond funds and the magnitude of their flows.

My results directly speak to the trade-offs concerning the current monetary tightening. Faced with higher inflation, central banks around the world have increased policy rates at an aggressive pace. However, many observers have cautioned for the recessionary effect of higher interest rates. My results suggest that higher interest rates may decrease bond fund flows, amplifying the increase in corporate bond yields, the decrease in corporate bond issuance, and the slowdown of real activities especially for the constrained firms. Indeed, aggregate bond fund flows have decreased by 20 p.p. since the beginning of 2022. According to my estimates, this means an additional 30 bps increase in the aggregate corporate bond yield. Moreover, according to my cross-sectional analysis, firms with higher exposure to bond fund flows are expected to face particularly severe credit crunches. These are important quantitative effects that can inform policymakers on the future course of monetary policy.

The rest of this paper is organized as follows. Section 2 summarizes this paper's contributions to the literature. Section 3 provides the relevant institutional background and describes the data used in the paper. Section 4 documents monetary sensitivity across different corporate

bond investors. Section 5 presents the main finding that higher exposure to bond funds leads to higher monetary sensitivity in the cross section of firms. Section 6 uses the GIV approach to quantify effects on aggregate bond yields and aggregate real investment. Section 7 concludes.

## 2 Literature

This paper contributes to three strands of literature. First, this paper contributes to the credit channel of monetary policy. Most of the literature focuses on bank lending, including Bernanke and Blinder (1988), Bernanke and Blinder (1992), Kashyap and Stein (2000), Drechsler et al. (2017), Ippolito et al. (2018), and Supera (2021). In contrast, I study one of the largest and fastest-growing nonbank corporate lenders – bond mutual funds and ETFs. I show that this bond fund channel matters quantitatively for the transmission of monetary policy, both in the cross section of bond-issuing firms and for the aggregate bond yields. In Section 4.4, I discuss in detail how bond fund lending is as important – if not more – for monetary policy transmission as bank lending.

Recent work such as Darmouni et al. (2020) and Fabiani et al. (2022) also studies the bond market transmission of monetary policy. Darmouni et al. (2020) studies the European bond market and focuses on the contrast between loans and bonds in terms of renegotiation cost. Fabiani et al. (2022) studies corporate debt maturity and focuses on the effect of bond mispricing due to investor reaching-for-yield. In contrast, the mechanism of my paper highlights the importance of heterogeneity across corporate bond investors, the secular rise of bond funds, and the inelasticity of investors and capital providers.

A growing literature explores heterogeneity in monetary policy transmission, including Ottonello and Winberry (2020) and Caglio et al. (2022). My paper highlights the importance of *investor* heterogeneity – bond issuers held more by bond funds are more sensitive to monetary policy than bond issuers held more by other investors such as insurance companies and pension funds. Other papers have studied the effect of investor heterogeneity for corporate bond liquidity (Li and Yu, 2022), fragility (Coppola, 2022), and valuation (Bretscher et al., 2021). Also emphasizing investor heterogeneity, Parker et al. (2020) studies the rise of target date funds and its effect on stock market dynamics.

My approach resonates with recent papers that trace monetary policy transmission to retail flows. Drechsler et al. (2017) show that monetary policy leads to large core deposit flows in

and out of the banking system, Xiao (2019) and Supera (2021) show that part of the core deposit flows come from money market funds and time deposits, and Daniel et al. (2021) show that monetary policy leads to large flows in and out of assets with high income yields. My contributions are to give a detailed analysis of flows across different corporate bond investors and across different types of mutual funds and to identify and quantify the effects of these flows on bond pricing and firm financing.

My paper also contributes to understanding the high sensitivity of long-term bond yields to monetary policy (Shiller et al, 1983; Cochrane and Piazzesi, 2002; Gürkaynak et al, 2005; Giglio and Kelly, 2018; Kroencke et al, 2021). This surprisingly large sensitivity is one reason behind the explanatory power of the level factor, which is unobserved and commonly taken as given in term structure models. Existing explanations include changes in risk-taking (Hanson and Stein, 2015; Choi and Kronlund, 2018; Lian et al., 2018; Jiang et al., 2022), duration hedging (Hanson, 2014; Domanski et al., 2017; Hanson et al., 2021; Ozdagli and Wang, 2020), and changes in liquidity sensitivity (Drechsler et al., 2018; Lagos and Zhang, 2020; Li and Yu, 2022). Along with Brooks et al. (2018) and Hanson et al. (2021), I emphasize the role of return-chasing investor flows. My contributions are on quantification. First, I provide identification of the impact of monetary-induced bond fund flows in the cross section of corporate bond yields. Then, I use the demand system approach to decompose the aggregate bond yield sensitivity to monetary policy, and show that bond fund flow channel is quantitatively important.

Secondly, this paper contributes to the growing literature on the role of flows in inelastic asset markets. Most of the papers study equity market elasticity, including Coval and Stafford (2007), Frazzini and Lamont (2008), Lou (2012), and Gabaix and Koijen (2021). A growing number of papers speak to bond market elasticity, including Choi et al. (2020), Falato et al. (2021b), Ma et al. (2022), Barbosa and Ozdagli (2022), and Coppola (2022). I show that investor elasticities are low enough to make flows a quantitatively important channel of monetary transmission in the bond market. Additionally, I identify firms as an important source of arbitrage capital in reversing the impact of flows (Ma, 2019).

In addition to asset pricing implications, I show that investor flows have real effects. Related papers include Bond et al. (2012), Massa et al. (2013), Zhu (2021), Ben-Rephael et al. (2021), Friberg et al (2022), Barbosa and Ozdagli (2022), Coppola (2022), Zhao et al. (2022), and Adelino et al. (2023). My contribution is that flows to institutional corporate bond investor are a key channel through which firms' leverage, payout, and real investment policies respond to monetary policy.

Lastly, this paper contributes to the understanding of bond mutual funds and ETFs, which have steadily grown to become one of the largest lenders to corporations. A key distinction between bond funds and other corporate bond investors such as insurance companies and pension funds is their large volatile flows, and a growing literature seeks to understand what drives fluctuations in bond fund flows, such as Chen and Qin (2017), Goldstein et al. (2017), and Falato et al. (2021a). My contribution is to identify monetary policy as a key determinant of bond fund flows both on the aggregate and in the cross section. My results also imply that part of the secular rise of bond funds can be traced to prolonged accommodative monetary policy and the secular decline in interest rates.

A few papers also study how monetary policy affects bond fund flows, including Feroli et al. (2014), Banegas et al. (2016), Brooks et al. (2018), Kuong and Zhang (2020), Hanson et al. (2021), Dannhauser and Hoseinzade (2021) and Li and Yu (2022). This paper makes the following contributions. First, I provide a rigorous documentation of the relationship between monetary policy and bond fund flows, using 30-year of time series and an instrumented local projection framework. Secondly, I show that, among the different explanations, return chasing is responsible for most of the bond fund flow sensitivity to monetary policy, both on the aggregate and in the cross section. Lastly, I show, using both reduced-form and structural approaches, how bond fund flows amplify the transmission of monetary policy to bond pricing and firm financing.

More broadly, this paper also contributes to the understanding of mutual fund flows. Most closely related to this paper are Teo and Woo (2004), Bailey et al. (2011), Barber et al. (2016), Song (2020), and Ben-David et al. (2021a), which show that mutual fund investors chase simple returns and do not distinguish between alpha vs factor-related returns. Consistent with their results, I show that bond fund investors chase realized returns driven by monetary policy (the factor) and duration (the factor loading).

This paper also contributes to the understanding of bond funds' trading behavior. A growing literature emphasizes bond funds' liquidity management, including Choi et al. (2020) and Jiang et al. (2021). I show that bond funds' liquidity management is imperfect, due to information frictions and investment mandates, and as a result there is a large pass-through from bond fund flows to bond fund trading, generating large price pressure on bonds.

## 3 Background and Data

### 3.1 Corporate bond investors

There is limited direct retail participation in the corporate bond market. Compared to stocks, corporate bonds are very illiquid and sold in large minimum quantities, making them difficult to access by retail investors. On the other hand, there is large retail participation through bond mutual funds and ETFs. According to ICI Fact Book, over 85% of the bond mutual fund shares are owned by retail investors. I use security-level holdings and verify that there is limited ownership of bond fund shares by institutions such as insurance companies (4%) and other mutual funds (6%), as shown in see Figure A5. Most of bond funds are benchmarked against the aggregate investment-grade or high-yield bond market, holding not only corporate bonds but also Treasury securities, agency securities and foreign bonds, as shown in Figure A6.<sup>3</sup>

Apart from bond funds, insurance companies have traditionally been the largest corporate bond investors. They sell life or P&C insurance policies and invest the premiums in mostly fixed-income securities, due to regulatory incentives.<sup>4</sup> Pension funds are the third largest investors of corporate bonds. Pension funds receive periodic contributions to defined-benefit pension plans (e.g. 401k) and invest in balanced portfolios (e.g., 60 equities / 40 bonds). Banks hold significant corporate bonds as market makers, although their inventory has shrunk significantly due to post-crisis bank regulation (e.g., Wu, 2022). The other corporate bond investors include hedge funds, close-end funds, and foreign institutional investors (e.g., foreign mutual funds).

Figure 1 shows the dynamics of corporate bond ownership over time. There is a secular rise of ownership by mutual funds and ETFs over time, from less than 2% in 1980 to over 20% in 2022. In contrast, pension funds have shrunk steadily over time. Indeed, one key driver of these dynamics is the secular switch from defined-benefit pension plans, where retirement assets are managed by institutional pension funds, to defined-contribution pension plans, where retirement assets are invested in mutual funds by retirees directly. Another important reason for the rise of bond funds is simply their wider adoption over time – as a financial innovation, bond ETFs have experienced particularly large growth not until 10 years ago.

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<sup>3</sup>As shown in Figure A6, most of bond funds are active and most of bond funds are categorized by Morningstar as investment-grade intermediate-term bond funds, as known as core bond funds.

<sup>4</sup>Under NAIC statutory rules, equities require significantly higher risk-based capital than bonds. See Becker and Ivashina (2015) for more details.

## 3.2 Data sources

Data on mutual funds and ETFs are primarily from the CRSP Survivor-Bias-Free US Mutual Fund Database. The database contains comprehensive information on the universe of all publicly traded mutual funds and ETFs in the United States, including returns, total net assets, distributions, expense ratios, holdings, and etc. Data are available at monthly frequency from January 1990 to December 2020, except for holdings, which only became reliable in 2010 and are generally available on a quarterly basis.<sup>56</sup> Data on Morningstar Categories, Morningstar Ratings and fund holdings from 2005 to 2010 are from Morningstar Direct. I follow Ľuboř Pástor et al. (2015) and use CUSIP and ticker (in this order) to merge CRSP and Morningstar.

I focus on bond funds with significant corporate bond holdings. Following Choi and Kronlund (2018), investment-grade bond funds are defined as by Lipper objective codes A, BBB, CPB, GB, IID, SII, SID, or USO, and high-yield bond funds ACF, FLX, HY, MSI, SFI, or SHY. I include ETFs and variable annuity funds in the sample, as they are also open-end, they often share the same underlying portfolios with mutual fund share classes, and I find their flow sensitivity to monetary policy very similar to mutual funds. My final bond fund sample contains 1,491 bond funds from 1990Q1 to 2020Q4. Panel B of Table 1 shows summary statistics.

Data on corporate bonds are from Mergent FISD and Enhanced TRACE. Mergent FISD contains information on bond characteristics, such as rating, maturity, amount outstanding, callability, and maturity.<sup>7</sup> Enhanced TRACE contains information on bond trades, which I use to construct variables such as price, yield, duration, trading volume, and bid-ask spread. I closely follow the procedure in Dick-Nielsen (2014) to clean the Enhanced TRACE data.

I focus on straight bonds issued by U.S. non-financial firms, to be defined in the next subsection. I link corporate bonds with Compustat firms by issuer CUSIP and stock ticker (in this order).<sup>8</sup> I exclude convertible bonds, bonds with variable coupons, bonds denominated in

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<sup>5</sup>Schwarz and Potter (2016) give detailed description on coverage and quality of the holdings data in CRSP.

<sup>6</sup>Holdings are generally reported on a quarterly basis but can be on the first, second, or third month of quarter. I use the month that is closest to end of quarter. For example, if a fund reports holdings in January, April, July and October, I will assign them to Q4 (of previous year), Q1, Q2 and Q3, respectively.

<sup>7</sup>For ratings, I focus on those from S&P, Moody's, and Fitch. If there are multiple ratings for a bond, I take the median.

<sup>8</sup>Many corporate bonds are issued by specialized subsidiaries. For example Shell issues most of its bonds through the subsidiary Shell International Finance BV. I use the parent-subsidiary relationship from Mergent FISD to link bonds to the ultimate parent.

foreign currencies, and bonds that are never held by any bond fund (which may reflect some unobserved intrinsic properties). I restrict to bond-quarter observations with non-missing quarter-end price, defined as the trade-weighted daily price closest to the quarter-end date and not more than five days away from the quarter-end date. My final corporate bond sample includes 11,850 corporate bonds from 2005Q1 to 2020Q4. Panel C of Table 1 shows summary statistics of my corporate bond sample.

Data on U.S. non-financial firms are from Compustat. I restrict to firms headquartered in U.S. and exclude firms with SIC codes starting with 6. I restrict to firm-quarter observations with at least \$1 million market capitalization of equity and at least \$1 million bond amount outstanding, since I control for equity characteristics (e.g., Tobin's Q) and bond characteristics (e.g., bond rating). My final firm sample consists of 1,123 firms from 2005Q1 to 2020Q4. Panel D of Table 1 shows summary statistics of my firm sample.

Data on life insurers and P&C insurers are from their regulatory filings with the National Association of Insurance Commissioners (NAIC). In particular, Schedule D filings contain detailed information on insurers' bond holdings. I obtain these filings through SNL Financial. Data on annuity sales are from Beacon Annuity Nexus.

Data on individual U.S. Treasury bonds are from CRSP US Treasury Database, which contains information on characteristics (e.g. maturity) and trading (e.g. yield). Daily data on aggregate zero-coupon treasury yield curves are from Gurkaynak et al. (2007).

Appendix B contains additional details on data cleaning (e.g., error detection) and variable construction (e.g., fund duration and firm profitability).

### 3.3 Measuring monetary policy

I measure conventional monetary policy by the two-year Treasury rate, denoted as *Rate*. One advantage of using the two-year Treasury rate is that it captures both current and the expected path of future federal fund rates. The literature suggests that two years is roughly the horizon at which the Fed's forward guidance policy operates (Bernanke et al., 2004; Gürkaynak et al., 2005; Swanson and Williams, 2014; Hanson and Stein, 2015). Forward guidance is especially important when the federal funds rates are at the zero lower bound, as was the case during 2008-2015, which constitutes a large portion of my sample (recall that my mutual fund holdings data do not start until 2005).

One disadvantage of using the two-year Treasury rate is that it contains risk premium and central bank information, as discussed in Nakamura and Steinsson (2018). For the analyses that rely on the full sample of 1990-2020 (i.e., not constrained by the mutual fund holdings data), my results are robust to using the federal funds rate.

For identification purpose, I will also use monetary surprise measures from Hanson and Stein (2015), Gertler and Karadi (2015), Nakamura and Steinsson (2018), and Swanson (2021). I will discuss the validity of these measures as instruments later in the paper.

### 3.4 Measuring flows

One key issue of this paper is to accurately measure net flows in or out of an entity and not confuse them with appreciation or depreciation of value. The primitive is dollar flows:

$$Flow^{\$} = Inflow^{\$} - Outflow^{\$}$$

Dollar flows are directly available in databases such as Financial Accounts of the United States. For mutual funds, the convention is to impute dollar flows using total net assets and returns:

$$Flow_{t,t+1}^{\$} = TNA_{t+1} - TNA_t(1 + Return_{t,t+1})$$

The underlying assumption is that there is no portfolio adjustment until the end of the period. There are a few adjustments needed for this imputation. I subtract ETF purchases by the Federal Reserve’s Secondary Market Corporate Credit Facility (SMCCF) following the COVID crisis. I account for fund mergers, which are recorded in the CRSP mutual fund headers file (“merge\_fundno”). Specifically, I subtract from the imputed flows the TNAs of acquired funds.

Instead of net flows at the fund level, I am also interested in net flows at the portfolio level, i.e. net purchases. For a portfolio where par values of bonds (or shares of stocks) are given, we can similarly assume that all portfolio adjustments occur at the end of the period and calculate dollar flows as:

$$Flow_{t,t+1}^{\$} = \sum_{n=1}^N (Par_{n,t+1} - Par_{n,t}) Price_{n,t+1}$$

where  $n$  indexes for the number of bonds.

Dollar flows cannot be studied directly, because they are not stationary. For example, in a time series of aggregate bond fund flows, dollar flows in later periods are mechanically larger than dollar flows in earlier periods because of secular growth in the size of bond funds, and they cannot be directly compared to each other. The convention is to work with percentage flows:

$$Flow_{t,t+h}^{\%} = \frac{Flow_{t,t+h}^{\$}}{Size_t}$$

where *Size* is usually the entity’s own size. Note that  $Flow^{\%}$  would simply be the net percentage change in size, or net growth, if the assets have stable value (e.g. deposits). In this paper, we will often compare flows across entities, e.g. between bond funds and other institutional corporate bond investors. To do so, it makes more sense to scale the dollar flows with a common benchmark, e.g. the size of the corporate bond market.

The focus of this paper is how flows respond to monetary policy, i.e. the flow beta:

$$FlowBeta = \frac{\partial Flow}{\partial Rate}$$

## 4 Monetary Sensitivity across Corporate Bond Investors

In this section, I document new stylized facts on the relative monetary sensitivity across different corporate bond investors. I show that bond funds are much more sensitive to monetary policy than other corporate bond investors such as insurance companies and pension funds – in response to monetary easing, bond funds’ net flows and corporate bond net purchases increase much more. I show that return chasing plays a key role in explaining the high monetary sensitivity of bond funds.

### 4.1 Time series

I begin by visually examining the aggregate time series. The red line in Panel A of Figure 2 plots the year-over-year net flows (scaled by lagged sizes) averaged across bond funds, weighted by corporate bond holdings.<sup>9</sup> It shows that bond fund flows are highly volatile, ranging from 31% in some years to -7% in others – it means that the bond fund sector

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<sup>9</sup>Since Morningstar holdings data do not become comprehensive until 2005Q1, I use the 2005Q1 holdings as weights for the periods before.

expands or contracts by as much as 30% over a one-year horizon. More importantly, there is a visibly strong negative correlation between bond fund flows and changes in two-year Treasury rates, as shown by the black dash line. The correlation coefficient is -0.53.

The blue line in Panel A of Figure 2 plots the year-over-year corporate bond net purchases (scaled by lagged corporate bond holdings) averaged across bond funds, weighted by corporate bond holdings. It shows that bond funds' corporate bond net purchases move almost one-to-one with their net flows, suggesting that bond funds near-proportionally scale their corporate bond holdings in response to flows. To confirm this, I follow Lou (2012) and Choi et al. (2020) and analyze how bond funds trade in response to flows at the asset class level:

$$AssetClassFlow_{i,t} = \beta FundFlow_{i,t} + FE + \epsilon_{i,t} \quad (1)$$

where  $AssetClassFlow_{i,t}$  denotes bond fund  $i$ 's net purchases of a particular asset class (e.g. corporate bonds) in year  $t$  (scaled by holdings in year  $t - 1$ ),  $FundFlow_{i,t}$  denotes net flows to bond fund  $i$  in year  $t$  (scaled by fund size in year  $t - 1$ ), and  $FE$  includes fund fixed effects and year fixed effects. Panel A of Table 2 shows the results. On an annual frequency, when a bond fund experiences 1% inflow (outflow), its corporate bond portfolio expands (contracts) by almost exactly 1%. This means that cash and cash equivalents (e.g. Treasury securities) play a limited role in absorbing fund flows.<sup>10</sup> This reflects the fact that there are usually targets or mandates on portfolio allocations at the asset class level, e.g. a fixed portfolio weight in investment-grade corporate bonds.

Panel B of Figure 2 highlights how different corporate bond investors react differently to monetary policy rate changes. It plots year-over-year corporate bond net purchases (scaled by lagged corporate bond holdings) for bond funds (in red), insurance companies (in green), and the average corporate bond investor (in blue). To obtain net purchases by the average corporate bond investor, I use aggregate corporate bond net issuance (scaled by lagged aggregate corporate bond outstanding), since firms are the counterparty to all corporate bond investors combined.

It is visible that bond fund net purchases are much more volatile and react to monetary policy rate changes much more than insurers and the average corporate bond investor. The correlation with monetary policy rate changes is high for all corporate bond investors (-0.53 for bond fund, -0.31 for insurers, -0.45 for the average corporate bond investor). However, the beta to monetary policy rate changes is much higher for bond funds (-5.3) than insurers

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<sup>10</sup>The results are slightly different from Choi et al. (2020) since I look at annual flows, which are more relevant to my setting than quarterly flows.

(-0.6) and the average corporate bond investor (-1.2).

The visual evidence above suggests that bond funds' net flows and corporate bond net purchases are highly responsive to monetary policy, much more so than other corporate bond investors such as insurance companies. The sub-section below provides identification and quantification.

## 4.2 Local projections

I use an instrumented variation of the local projection approach (Jorda, 2005) to identify and quantify the effect of monetary policy on flows (either total flows or corporate bond flows) to different corporate bond investors. I estimate the following regression:

$$Y_{t,t+h} = \alpha_h + \beta_h \Delta Rate_{t,t+4} + \gamma_h Controls + \epsilon_{t,t+h} \quad (2)$$

where  $Y_{t,t+h}$  refers to cumulative aggregate net flows from quarter  $t$  to quarter  $t+h$  (scaled by size in quarter  $t$ ),  $\Delta Rate_{t,t+4}$  denotes change in two-year Treasury rate from quarter  $t$  to quarter  $t+4$ , controls are specified below, and standard errors are Newey-West with automatically selected bandwidth (Newey and West, 1994). Under this specification,  $\beta_h$  identifies the effect of monetary policy on flows at the  $h$ -quarter horizon.

I use one-year change in monetary policy rate to focus on monetary cycle effects, similar to the approach in Xiao (2019) and Daniel et al. (2021). Mutual fund investors, most of whom are retail (see Section 3), are unlikely to respond to rate changes at a high frequency. As will be shown in the next sub-section, one key explanation for bond fund flow beta is return chasing, and return chasing has been shown to operate at a low frequency (Barber et al., 2016). Conveniently, the standard deviation of one-year change in two-year Treasury rate is close to one percentage point (see Table 1), which I will use as the baseline unit of rate change.

I control for observable macroeconomic variables including GDP growth, core inflation rate, and change in unemployment rate. Doing so partials out the part of flows and the part of rate changes that can be explained by observable macro news. To be clear, I do not claim that monetary policy is random. Instead, the assumption I make is that monetary policy can respond to the same macroeconomic news differently over time, and this variation is

exogenous to flows.<sup>11</sup>

I control for lags of flows, rate changes, and control variables because all of these variables could be highly persistent. I want to isolate the flows due to new rate changes, not the flows in response to past flows or past rate changes. Olea and Plagborg-Møller (2021) show that controlling for lags makes local projection inference robust to highly persistent data generating processes and obviates adjustment for serial correlation in standard error.

Despite the controls, one could still come up with endogeneity concerns – there might be some unobservable macroeconomic variables that drive both monetary policy and flows. To address these concerns, I use the monetary surprises from Gertler and Karadi (2015) as an instrument for monetary policy. The idea is to look at a narrow window (e.g. 30 minute) around an FOMC announcement and treat any rate change there as an exogenous shock to monetary policy, since there is likely no change to any macroeconomic variables over the same narrow window. Since my focus is on one-year rate changes that approximate monetary cycles, I construct the instrument as cumulative monetary surprises over one year, following the approach in Gertler and Karadi (2015). Formally, the identifying assumption is that monetary surprises are large enough and sufficiently correlated with rate changes over the one-year horizon (the relevance condition) but they are orthogonal to any unobservable factors that might drive flows (the exclusion condition).

Panel A of Figure 3 shows the cumulative responses of corporate bond net purchases by the top three corporate bond investors to monetary policy. In response to 1 p.p. drop (hike) in two-year Treasury rate, there is cumulative 15 p.p. increase in net purchases of corporate bonds by bond funds. The response is economically large, since the standard deviation of three-year bond fund net purchases is 17 p.p. In contrast, the effect is much smaller for insurers, pension funds, or the average corporate bond investor, as approximated by the aggregate corporate bond issuance.

Panel B of Figure 3 focuses on the difference between bond funds and insurers at the three-year horizon across various alternative specifications. The difference is large and: 1) robust to using the equal-weighted flow or the panel of bond funds <sup>12</sup>, 2) robust to restricting to early periods without the contamination of unconventional monetary policy, 3) similar across

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<sup>11</sup>For concreteness, suppose that there is 1 p.p. increase in inflation. In response, the Fed decides how much it should raise the interest rate. I assume that whether the Fed raises interest rate by 25 bps or 50 bps is exogenous to flows.

<sup>12</sup>To use the panel data, I use the following regression specification:  $Flow_{i,t,t+h} = \beta_h \Delta Rate_{t,t+4} + \gamma_{1,h} MacroControls + \gamma_{2,h} FundControls + FE + \epsilon_{i,t,t+h}$ , where  $FE$  includes fund fixed effects and standard errors are two-way clustered by fund and by quarter.

monetary easing ( $\Delta Rate < 0$ ) and monetary tightening ( $\Delta Rate > 0$ )<sup>13</sup>, robust to measuring monetary policy with federal funds rates, common across different styles of bond funds (passive vs active, IG vs HY), common across different share classes (retail vs institutional), robust to controlling additionally for concurrent rate changes and fund variables (expense ratio and alpha), robust to using alternative monetary surprises by Nakamura and Steinsson (2018), Swanson (2021), or Bauer and Swanson (2022).

Nakamura and Steinsson (2018) argue that monetary surprises reflect the Fed’s private information about future macroeconomic conditions instead of exogenous shocks to interest rates. I show that my results are robust to using the monetary surprise measures from Jaroćiński and Karadi (2020) and Cieslak and Schrimpf (2019) that exclude the Fed’s private information. In Figure A10 of Appendix A, I show that bond fund flows decrease in response to negative macroeconomic news. As a result, since rate drops reflect the Fed’s private information of a weaker economy and bond fund flows increase in response to rate drops, bond fund flows are not likely driven by the Fed information channel.

### 4.3 Inspecting the mechanism

Why does monetary policy have much larger effects on bond funds than traditional corporate bond investors such as insurance companies and pension funds? Return chasing is a natural explanation. There is growing evidence that mutual fund investors chase realized returns and do not distinguish between alpha vs factor-related returns (e.g., Ben-David et al., 2021a). When the Fed lowers interest rates, bond funds realize large factor-related returns (where monetary policy is the factor and duration is factor loading), which appeal to momentum traders such as retail investors. In comparison, institutional investors such as insurers should be much less subject to return chasing and other behavioral biases.<sup>14</sup>

I show two pieces of evidence in support of the return chasing channel. First, flows to bond funds largely come from the mutual fund classes that have the opposite return beta as bond funds. I apply the same time series and local projection analyses to the aggregate returns

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<sup>13</sup>Response is stronger with tightening than with easing, likely due to two reasons. First, bond fund flows are more responsive to negative returns than to positive returns, due to strategic complementarity (e.g. Goldstein et al., 2017). Secondly, bond funds scale existing portfolio more proportionally to outflows than to inflows, as shown in Panel A of Table 2.

<sup>14</sup>Return chasing may not be the only channel at play. Brooks et al. (2018) and Hanson et al. (2021) suggest that bond investors extrapolate short rate movement. Lian et al. (2018) suggest that lower interest rates induce higher investor risk-taking due to reference dependence and salience. All these behavioral biases should apply more to retail investors.

and the aggregate flows of major mutual fund classes: bond funds, equity funds, money market funds, and loan funds. Figure A7 and Figure A8 show that money market funds and loan funds have the opposite return beta as well as flow beta as bond funds.<sup>15</sup> The returns on money market instruments and bank loans are indexed to short-term interest rates that mechanically decrease during monetary easing, and return-chasing mutual fund investors pull capital away when this happens.

If return chasing is the main channel that drives bond fund flow sensitivity to monetary policy, one might expect similar flow patterns for equity mutual funds, because equities are also long duration and known to be affected by monetary policy (Bernanke and Kuttner, 2005). Figure A7 and Figure A8 show that there is little cyclical co-movement between equity fund returns or flows with monetary policy. The reason is that equity returns load on many factors other than monetary policy and these factors tend to be negatively correlated with monetary policy rate changes – when the Fed cuts interest rates, it is usually when the economy is doing well and equity returns are rising. In comparison, bond returns are much more dominated by monetary policy rate changes, the fact that the level factor drives most of bond yield changes.

The second piece of evidence comes from the cross section of bond funds, where bond funds with higher return beta have much higher flow beta. I estimate the following regression in the cross section of bond funds:

$$Flow_{i,t,t+12} = \beta \Delta Rate_{t,t+4} \times FundCharacteristics_{i,t} + FE + \epsilon_{i,t,t+12} \quad (3)$$

where  $Flow_{i,t,t+12}$  denotes cumulative flows to fund  $i$  from quarter  $t$  to quarter  $t + 12$  (scaled by fund size in quarter  $t$ ),  $\Delta Rate_{t,t+4}$  denotes changes in two-year Treasury rates from quarter  $t$  to quarter  $t + 4$ , fund characteristics include rating, duration, income yield, yield to maturity, log TNA, expense ratio, turnover, return alpha, return volatility and cash ratio, all standardized, and  $FE$  includes fund fixed effects as well as style-quarter fixed effects.<sup>16</sup>

Table A1 shows the results. Bond funds with higher return duration have significantly higher flow beta. Given a 1 p.p. decrease in two-year Treasury rate over the last year, one-standard-deviation increase in fund duration is associated with 0.41 p.p. increase in fund flow over the next quarter. The effect is not only statistically significant but also economically meaningful: it is 17% of the mean quarterly bond fund flow. In contrast, rating, income yield and yield

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<sup>15</sup>These findings are in line with the ones in Xiao (2019) and Nicola Cetorelli (2022).

<sup>16</sup>The regression includes both the interaction term as well as the components of the interaction, e.g. fund characteristics.

to maturity do not affect flow beta to the same extent.<sup>17</sup> This suggests that chasing realized returns is more important than reaching for yield for cross-sectional flow beta.<sup>18</sup>

#### 4.4 Comparison with the bank lending channel

How does the bond fund flow channel stand against other established channels of monetary policy, such as the bank lending channel? I first argue that the bond fund flow channel is as important, if not more, as the bank lending channel in terms of amount of lending. First, the amount of bond fund lending through corporate bonds (\$1.57 trillion as of 2020) is almost as large as the amount of bank lending through C&I loans (\$1.61 trillion). Based on the trajectory, bond funds are likely to soon overtake banks as the bigger lender to firms.

Secondly, in terms of funding source, bond fund flows are as sensitive to monetary policy as deposit flows. Figure A10 shows that savings deposits increase by 21 p.p. in response to 1 p.p. decrease in the two-year Treasury rate, which is higher but on a similar magnitude as the monetary sensitivity of bond fund flows.

Lastly, there is mixed evidence on the bank lending channel of monetary policy. Indeed, papers such as Greenwald et al. (2020) and Supera (2021) show that C&I loans actually contract in response to monetary easing, which I verify in Figure A10.<sup>19</sup> In contrast, bond fund lending moves almost one-for-one with flows (see Section 5.1) and significantly expands during monetary easing (see Section 4).

Apart from amount of lending, another important dimension is the accessibility of bond fund lending vs bank lending. All firms can access bank lending, but not all firms have access to the bond market. Panel A of Figure A2 shows that only about a quarter of the firms have access to the bond market. However, Panel B of Figure A2 shows that firms with

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<sup>17</sup>Yield to maturity is missing for many fund-quarter observations because I require yield to maturity to be non-missing for at least 50% of the fund's holding. On average, yield to maturity is missing for 66% of the bond fund holdings.

<sup>18</sup>The reasons that I get smaller fund flow monetary sensitivity to yield to maturity and income yield than Choi and Kronlund (2018) and Daniel et al. (2021) do are as follows. First and foremost, I include return duration in the regression, which I believe is an important omitted variable in previous specifications. Secondly, I use a bigger universe of bond funds (1,491 funds) and look at a longer time span (from 1990 to 2022). Thirdly, I conduct my analysis on the fund level, whereas previous papers analyze share-class-level flows, which may over-weight funds with many share classes. Lastly, I look at within-style flows by including style-quarter fixed effects, whereas some of the previous papers look at flows across all bond funds, which can be confounded by style-level flows.

<sup>19</sup>Supera (2021) argues that C&I loans are funded by time deposits, whose flows move in the opposite direction as demand and savings deposits.

bond market access are the largest firms and account for most of the real investment and employment. Therefore, the effects that I identify on these largest firms are important.

Also important is the substitutability of bond fund lending vs bank lending. Indeed, the original motivation of the bank lending channel is that there are significant frictions such as information asymmetry that makes bank lending more sensitive than the bond market to monetary policy. My paper, along with recent work by Barbosa and Ozdagli (2022) and Coppola (2022), shows that the corporate bond market is characterized by the frictions conventionally thought to be confined in bank lending. In Section 5, I have shown that, for the firms with one-standard-deviation higher bond fund exposure, in a monetary tightening cycle, when their bondholder net flows decrease by 3.1 p.p. more than the average firm, their net bond issuance decrease by 1.3 p.p. and their net debt issuance decrease by 0.9 p.p. The results mean that, even for the firms with bond market access, shocks to existing lending can have large impacts on their financing, as they cannot frictionlessly substitute to other bond investors or other forms of debt.

## 5 Monetary Sensitivity across Bond-Issuing Firms

I demonstrate the bond fund amplification channel of monetary transmission using the cross section of firms. I begin by showing substantial heterogeneity across firms in exposure to bond fund flows – firms whose bonds are held more by bond funds today are more exposed to future changes in bond fund flows and bond fund credit supply. I then show that higher bond fund ownership leads to higher firm sensitivity to monetary policy: during monetary tightening, firms whose bonds are held more by bond funds experience larger decrease in bond prices, issue less bonds, and contract more on leverage, payout, or real investment, depending on the the firm’s financial condition. The effects are economically large compared to the average firm sensitivity to monetary policy. I address potential endogeneity concerns and use a shift-share instrument to sharpen identification.

### 5.1 Heterogeneous exposure to bond fund flows

There is substantial heterogeneity in exposure to bond fund flows in the cross section of firms. Bond funds hold concentrated portfolios of firms and near-proportionally scale up (down) existing holdings in response to inflows (outflows). As a result, if a firm has higher

bond ownership by bond funds today, it is then more exposed to future changes in bond fund flows and bond fund credit supply. I show large variation in bond fund ownership across near-identical firms and discuss plausibly exogenous sources of this variation.

### 5.1.1 Bond fund flow-induced trading

Bond funds hold concentrated portfolios – they invest in a small fraction of the issuers and corporate bonds that are available on the market. Panel A of Figure 4 shows that, out of the total number of issuers with more than \$1 million bond outstanding conditional on a given corporate bond style (e.g. investment-grade short-term bonds), a typical bond fund holds less than 10%. Panel B of Figure 4 shows that bond funds are even less diversified at the individual bond level.

Not only are bond funds’ portfolios concentrated, the concentration is persistent over time. When a bond fund experiences inflows or outflows, it near-proportionally scales up or down its existing holdings. This scaling is more proportional at the more aggregated asset class level, but applies even at the disaggregated bond issuer level. In other words, bond funds do not respond to flows by trading the market or using cash only. To show this, I extend the exercise in Lou (2012) and Choi et al. (2020), with a different frequency focus and a new counterfactual exercise. Specifically, I run the following regression:

$$IssuerFlow_{i,j,t} = \beta FundFlow_{i,t} + FE + \epsilon_{i,j,t} \quad (4)$$

where  $IssuerFlow_{i,j,t}$  denotes flows to a bond issuer  $j$  in bond fund  $i$ ’s portfolio in year  $t$  (scaled by holdings in at year-end  $t - 1$ ),  $FundFlow_{i,t}$  denotes flows to bond fund  $i$  in year  $t$  (scaled by fund size at year-end  $t - 1$ ), and  $FE$  includes fund fixed effects and issuer-year fixed effects. By definition, I am looking at flows to portfolio issuers, i.e. those whose holdings at year-end  $t - 1$  are not zero.

Panel C of Table 2 shows the results. When a bond fund experiences 1% outflow, the holdings of its portfolio issuers contract by 0.80%. When a bond fund experiences 1% inflow, the holdings of its portfolio issuers expand by 0.70%. The results suggest that in response to flows, bond funds near-proportionally scale the holdings of its portfolio issuers. The scaling is not one for one, but far above zero, so cash plays a limited role in absorbing flows.

What would the regression coefficients look like if bond funds respond to inflows by buying not only portfolio issuers but also other issuers available on the market? To answer that,

I conduct the following counterfactual exercise: for each dollar that the bond fund spends on buying a corporate bond, I suppose that the bond instead buys all the corporate bonds with similar rating and duration, and then I calculate the counterfactual flows to each portfolio issuer. For example, suppose that a bond fund buys \$1 million of a 3-year Apple bond, I spread that \$1 million across all investment-grade short-term corporate bonds outstanding (weighted by amount outstanding). Column 3 shows the results when I run the same regression above with these counterfactual flows. If bond funds were to trade the market in response to flows, the scaling coefficient would have been substantially less, close to zero. This exercise demonstrates that bond funds allocate a disproportionate share of their inflows to issuers that are already in their existing portfolios – they do not trade the market in response to flows.

Panel D of Table 2 repeats the same exercise but at the individual corporate bond level. The results are similar with outflows: when a bond fund experiences 1% outflow, the holdings of its portfolio corporate bonds contract by 0.76%. However, when a bond fund experiences 1% inflow, the holdings of its portfolio corporate bonds expand by only 0.40% – it is still far above the market-trading counterfactual, but significantly less than the 0.70% at the issuer level. The results suggest that, when experiencing inflows, bond funds keep buying from the same bond issuers they have relationship with, but not necessarily the exact bonds that they already hold.

There are reasons to believe that portfolio concentration and portfolio scaling should be stronger in the corporate bond market, compared to other markets such as the equity market. First of all, there are on average 50,000 bond CUSIPs, which are substantially more than the number of stocks. Secondly, the most liquid corporate bonds are more illiquid than the most illiquid stocks, and therefore it is in practice very difficult to trade the entire corporate bond market. Lastly, investment-grade corporate bonds are highly substitutable to each other – holding a few number of corporate bonds can be sufficient to replicate the exposure to the broad corporate bond market.

The results here resonates with growing evidence on relationship lending in the corporate bond market (e.g., Massa et al., 2013; Zhu, 2021; Barbosa and Ozdagli, 2022). Theories on relationship lending include Williamson (1987), Sharpe (1990), Holmstrom and Tirole (1997), and van Nieuwerburgh and Veldkamp (2010), and a common theme is information asymmetry. When there is asymmetric information between lenders and borrowers – e.g., lenders need to pay a cost to acquire information on borrowers – it is optimal for lenders to form lending relationships with a small number of borrowers. Although relationship lending

is usually a theme in the banking literature, my results contribute to the growing evidence that there is significant relationship lending in the corporate bond market.

### 5.1.2 Measuring exposure to bond fund flows

I want to measure the exposure of each firm to bond fund flows in response to monetary policy. My results on bond fund portfolio scaling in the previous section suggest that this exposure can be summarized by the firm’s bond fund ownership. Flows to a bond fund do not affect all firms equally, but rather disproportionately affect the firms with high portfolio weights ex ante. Since monetary policy leads to common flows across all bond funds (as shown in Section 4), a firm’s total ownership by all bond funds summarizes its exposure to future monetary-policy-induced common bond fund flows.

For illustration, consider two firms – Firm A has 50% of its bonds held by bond funds whereas Firm B has 0%. According to my results in Section 4, bond funds would experience around 15-percentage-point outflows, in response to one-percentage-point increase in monetary policy rate. According to my results in the previous subsection, bond funds scale down holdings of Firm A’s bonds by around 12% (15% times the scaling coefficient of 0.8) whereas Firm B’s bonds are not affected. In total, Firm A’s bonds would experience a selling pressure of 6% (50% times 12%) whereas Firm B’s bonds 0%.

Concretely, firm  $j$ ’s exposure to common bond fund flows at the end of quarter  $t$  is measured by its total ownership by all bond funds:

$$BFOwnership_{j,t} = \frac{\sum_i AmountHeld_{i,j,t}}{AmountOutstanding_{j,t}} \quad (5)$$

where  $AmountHeld_{i,j,t}$  denotes bond fund  $i$ ’s holdings of firm  $j$ ’s bonds at the end of quarter  $t$  and  $AmountOutstanding_{j,t}$  denotes firm  $j$ ’s total bond amount outstanding (Ma et al., 2022).

In Appendix C, I take into account the following aspects to more precisely measure exposure to changes in bond funds’ credit supply: there is heterogeneity in flow sensitivity to monetary policy across bond funds, bond funds trade bonds differently in response to inflow vs outflow, and bond funds engage in liquidity management and prioritize trading of liquid bonds.

### 5.1.3 Understanding variation in bond fund ownership

Panel A of Figure 5 shows significant variation in bond fund ownership in the cross section of firms. Part of the variation comes from bond funds selecting firms based on certain characteristics – bond fund ownership is larger for firms with lower ratings, shorter bond duration, and larger sizes. However, Panel B of Figure 5 shows that significant variation in bond fund ownership remains even after residualized with a wide set of firm attributes:

$$BFOwnership_j = \gamma FirmAttributes_j + FE + \epsilon_j \quad (6)$$

where firm attributes include log total assets, cash holdings, profitability, Tobin’s Q, bond share, bond rating, and bond duration, and  $FE$  includes rating fixed effects and industry fixed effects.

I discuss plausibly exogenous reasons for variation in bond fund ownership. First, a typical firm has a pretty concentrated investor base for its bonds. Figure A9 in Appendix A shows that, out of the 1033 bond funds and the 953 insurers, a typical firm only has 144 bond fund or insurer holders. One interpretation is that firms do not exhaustively search for all the potential investors, e.g. due to high information cost that would be paid for each search (van Nieuwerburgh and Veldkamp, 2010). Therefore, two near-identical firms can have very different investor base, due to the randomness in their limited search process for bond investors.

Underwriters are an important aspect to understand frictions in the corporate bond market, as shown in Chakraborty and MacKinlay (2020), Zhu (2021) and Siani (2021). A typical investor keeps working with a small set of underwriters both for primary market purchases and secondary market trading, and those underwriters have sticky relationships with a small universe of firms. Therefore, a firm can have high or low bond fund ownership simply because the underwriter it works with has more or less bond fund clients.

It is worth reiterating the large general increase in bond fund ownership over time, as shown in Figure 1. I find that not all firms are equally exposed to the secular rise of bond funds. Panel A of Figure 5 shows that, from 2005 to 2020, there is not only a rightward shift but also a wider spread in the distribution of bond fund ownership. Some bond funds have grown faster than others, due to reasons such as better performance, lower expenses or larger market power. As I will detail in Section 5.6, having initial relationships with high-growth bond funds is associated with larger increase in bond fund ownership over time, which I later

argue is plausibly exogenous.

## 5.2 Bondholder net flows and net purchases

This sub-section shows that for firms with higher bond fund ownership ex ante, their bondholders indeed experience less inflows and make less purchases of the firms' bonds, during monetary tightening. Due to data limitation, I focus on mutual funds and insurance companies, and assume net flows to other bondholders and their net purchases to be zero.

Following Zhu (2021), bondholder net flows are defined as:

$$BHFlow_{j,t,t+h} = \frac{\sum_i AmountHeld_{i,j,t} Flow_{i,t,t+h}}{AmountOutstanding_{j,t}}$$

where  $AmountHeld_{i,j,t}$  denotes amount of firm  $j$ 's bonds held by investor  $i$  at quarter-end  $t$ ,  $AmountOutstanding_{j,t}$  denotes amount of firm  $j$ 's total bonds outstanding, and  $Flow_{i,t,t+h}$  denotes net flows to investor  $i$  from quarter  $t$  to quarter  $t+h$  (scaled by its size at quarter-end  $t$ ). Intuitively, this measure indicates what would be the net buying or selling of the firm's bonds (scaled by its bonds outstanding) if its bondholders proportionally scale up or down their existing portfolios in response to their flows.

Bondholder net purchases are defined as:

$$BHPurchase_{j,t,t+h} = \frac{\sum_i (AmountHeld_{i,j,t+h} - AmountHeld_{i,j,t})}{AmountOutstanding_{j,t}}$$

Holdings can decrease because of firm actions (e.g., early redemption), so I scale change in holdings by change in amount outstanding at the bond level. For example, if 50% of a bond is called and an investor's holding of the bond decreases 75%, I assume that the investor sold an additional 25% of its original holdings.

I run the following regression on the panel data of firm-quarter described in Section 3:

$$Y_{j,t,t+h} = \beta_h \Delta Rate_{t,t+4} \times BFOwnership_{j,t} + \gamma_h Controls + FE + \epsilon_{j,t,t+h} \quad (7)$$

where  $Y_{j,t,t+h}$  denotes either firm  $j$ 's bondholder net flows or bondholder net purchases from quarter  $t$  to quarter  $t+h$  (scaled by its bond amount outstanding at quarter-end  $t$ ),  $\Delta Rate_{t,t+4}$  changes in two-year Treasury rates from quarter  $t$  to quarter  $t+4$ , and  $BFOwnership_{j,t}$

standardized bond fund ownership of firm  $j$ 's outstanding bonds at quarter-end  $t$ .<sup>20</sup> Controls include the interaction of macro news and bond fund ownership and the interaction of rate changes with firm attributes including log total assets, cash ratio, Tobin's Q, leverage, profitability, bond share, bond rating and bond duration.<sup>21</sup>  $FE$  includes firm fixed effects and Fama-French 10 industry by quarter fixed effects.  $\beta_h$  identifies whether firms with higher bond fund ownership experience differential bondholder net flows and bondholder net purchases in response to monetary policy, at horizon  $h$ .

Figure 6 shows the results. In response to 1 p.p. increase in monetary policy rate, for firms with one-standard-deviation higher bond fund ownership, their bondholders experience lower net flows equal to 3.0% of the firms' bonds outstanding and make less purchases of the firms' bonds equal to 2.2% of the firms' bonds outstanding.

### 5.3 Bond pricing

This sub-section shows that for firms with higher bond fund ownership ex ante, as their bondholders experience less flows and buy less of their bonds, their bonds experience lower returns than other bonds with near-identical characteristics, during monetary tightening.

I run the following regression on the corporate bond-quarter panel data described in Section 3:

$$Y_{b,t,t+h} = \beta_h \Delta Rate_{t,t+4} \times BFOwnership_{j,t} + \gamma_h Controls + FE + \epsilon_{b,t,t+h} \quad (8)$$

where  $Y_{b,t,t+h}$  denotes return on bond  $b$  from quarter  $t$  to quarter  $t+h$ ,  $\Delta Rate_{t,t+4}$  changes in two-year Treasury rates from quarter  $t$  to quarter  $t+4$ , and  $BFOwnership_{j,t}$  standardized bond fund ownership of all the outstanding bonds by bond  $b$ 's issuer  $j$ .<sup>22</sup>

I include a large set of control variables. I control for the interaction of bond fund ownership and macro news such as GDP growth and inflation rate to control for bond fund flows driven by changes in macroeconomic conditions. I control for the interaction of rate changes with bond characteristics such as callability, bid-ask spread and log amount outstanding.<sup>23</sup> I

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<sup>20</sup>The regression includes both the interaction term as well as its components, i.e.  $\Delta Rate_{t,t+4}$  and  $BFOwnership_{j,t}$ .

<sup>21</sup>see Appendix B for details on variable definitions.

<sup>22</sup>The regression includes both the interaction term as well as its components, i.e.  $\Delta Rate_{t,t+4}$  and  $BFOwnership_{j,t}$ .

<sup>23</sup>Duffee (1998) for example shows that fixed callable bonds have returns that are less sensitive to interest rate changes.

control for the interaction of rate changes with issuer characteristics such as log total assets, cash ratio, Tobin's Q, leverage, and profitability.<sup>24</sup> See Appendix B for details on variable definitions.

I include rating letter by rounded duration by quarter fixed effects. Effectively, I compare corporate bonds with the same rating and the same duration at the same time. This restriction allows me to focus on near-identical corporate bonds and focus on variations not explained by rating and duration in a non-parametric way.

Panel A of Table 3 shows the baseline results. Corporate bonds with higher bond fund ownership have higher return sensitivity to monetary policy. In response to 1 p.p. increase in monetary policy rate, for corporate bonds with one-standard-deviation higher bond fund ownership, they experience 30 bps lower returns than other bonds with the same rating and the same duration.

Comparing Column 2 with Column 1, we see that controlling for additional bond-level characteristics slightly increases the identified effect. The reason is that callable bonds and liquid bonds, which tend to have lower response to monetary policy, tend to correlate with higher bond fund ownership and therefore dampen the identified effects.<sup>25</sup> Controlling for additional issuer-level characteristics in Column 3 does not significantly change the results, suggesting that there is limited selection bias beyond bond characteristics.

Is the 30 bps abnormal return economically meaningful? As shown in Table A4 of Appendix A, the average investment-grade 5-year (10-year) corporate bond has a return sensitivity – with respect to two-year Treasury rate – of 1.69 (2.23) p.p. Therefore, the 30 bps effect is economically meaningful when compared with the average monetary sensitivity.

Figure 7 shows the full dynamics of abnormal returns. The abnormal return emerges over the same window as rates increase and reaches its peak at the end of the 4-quarter window. The abnormal return is temporary and fully reverted by the end of year three, confirming that it is driven by price pressure resulting from temporary supply-demand imbalances, rather than changes in bond fundamentals. In other words, the abnormal return is due to discount rate news rather than cash flow news.

Table A2 in Appendix A shows that the amplification effect of bond fund flows is asymmetric,

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<sup>24</sup>Ottonello and Winberry (2020) for example shows that firms with larger distance to default are much more responsive to monetary policy.

<sup>25</sup>Duffee (1998) shows that callable bonds are less sensitive to risk-free rate changes.

being bigger in monetary tightening than in monetary easing. This is due to two forces. First, Section 4 shows that bond fund flows are more sensitive to monetary tightening than monetary easing, consistent with the concave flow-performance relationship documented in Goldstein et al. (2017). Secondly, Section 5.1 shows that the correspondence between bond fund flows and bond fund trading is stronger with bond fund outflows, which are more likely under monetary tightening.

### 5.3.1 Comparison with existing literature

The price effects I identify may seem puzzling, since bond funds engage in liquidity management to avoid price impacts (Choi et al., 2020; Jiang et al., 2021) and other corporate bond investors should be sensitive to mispricing (Becker and Ivashina, 2015). In particular, one might wonder why it takes such a long time for prices to revert – if prices become abnormally low, arbitrageurs should buy the bonds (financed by shorting other bonds) and prices should revert quickly. There are three main reasons. First, monetary-policy-induced flows are common across all bond funds, and common flows lead to price pressure that is large in aggregate and difficult to be absorbed by other investors, consistent with the findings in Ben-David et al. (2021b) and Coppola (2022).

Secondly, monetary-policy-induced bond fund flows are very persistent, which pose higher limits for arbitrage. As Figure 6 shows, bonds keep experiencing abnormal bondholder flows up to three years since the onset of rate change. Therefore, while arbitrage capital eventually make bond prices revert, it can be balanced out by price pressure from additional bond fund flows in the short-term. The delay of reversal and its uncertainty discourages arbitraging activities in the first place. The long-horizon dynamics here are similar to the findings in Lou (2012).

Lastly, while other investors do respond to arbitrage opportunities, their elasticities can be far smaller than we expect with rational agents in benchmark models (Kojien and Yogo, 2019; Bretscher et al., 2021; Gabaix and Kojien, 2021). Similar to bond funds, other investors can have persistent portfolio tilts. For example, insurers face high capital charges on high-yield bonds, and therefore cannot freely arbitrage on high-yield bond mispricings. As another example, even if some issuers' bonds are underpriced, if there is a high cost of acquiring information on this issuer, then bond investors may not purchase the bonds. Insurers and pension funds are buy-and-hold investors that make most of their bond purchases on the primary market and pay relatively little attention to secondary market mispricings.

Chaudhary et al. (2022) and Fang (2023) estimate that the price elasticities of corporate bond investors are far lower than the frictionless benchmarks.

## 5.4 Firm financing

In this sub-section, I show that the secondary market price effects above spill over to primary market activities. During monetary tightening, for firms with higher bond fund ownership, as their bond prices decrease more, they issue less bonds. The reduction in bond capital is largely substituted with other debt and equities for the average firm, but translate to significant contraction of real investment for the constrained firms.

I run the following regression on the firm-quarter panel data described in Section 3:

$$Y_{j,t,t+h} = \beta_h \Delta Rate_{t,t+4} \times BFOwnership_{j,t} + \gamma_h Controls + FE + \epsilon_{j,t,t+h} \quad (9)$$

where  $Y_{j,t,t+h}$  denotes firm  $j$ 's gross bond issuance, net bond issuance, net debt issuance, net equity payout, or real investment from quarter  $t$  to quarter  $t + h$  (scaled by bond amount outstanding at quarter-end  $t$ ),  $\Delta Rate_{t,t+4}$  changes in two-year Treasury rates from quarter  $t$  to quarter  $t + 4$ , and  $BFOwnership_{j,t}$  standardized bond fund ownership of firm  $j$ 's bonds outstanding at quarter-end  $t$ .<sup>26</sup> Controls include the interaction of macro news and bond fund ownership and the interaction of rate changes with firm attributes such as log total assets, cash ratio, Tobin's Q, leverage, profitability, bond share, bond rating and bond duration.<sup>27</sup>  $FE$  includes firm fixed effects and Fama-French 10 industry by quarter fixed effects. The coefficient  $\beta$  identifies whether firms with different bond fund ownership have different sensitivity to monetary policy. I focus on  $h = 12$  to capture cumulative effects and defer results on other horizons to Appendix A.

Panel A of Table 4 shows the results. Column 1 shows that, given 1 p.p. increase in monetary policy rate, firms with one-standard-deviation higher bond fund ownership decrease their gross bond issuance by 3.01% of bond amount outstanding more than the average firm. The effect is not only statistically significant but also economically large, as it represents 51% (3.01 / 5.96) of the average monetary sensitivity of gross bond issuance.

A large part of the reduction in gross bond issuance is associated with reduced refinancing

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<sup>26</sup>The regression includes both the interaction term as well as its components, i.e.  $\Delta Rate_{t,t+4}$  and  $BFOwnership_{j,t}$ .

<sup>27</sup>See Appendix B for details on variable definitions.

activities. Column 2 shows that, in response to 1 p.p. rate increase, firms with one-standard-deviation higher bond fund ownership decrease net bond issuance by 1.31% of bond amount outstanding, which is only 45% ( $1.31 / 3.01$ ) of the effect on gross bond issuance. Firms issue a lot of new bonds to replace old bonds in normal times and reduce these refinancing activities when capital from bond funds contracts. These refinancing activities, however, do not affect bond amount outstanding, and therefore does not show up in net bond issuance.

Column 3 shows that, in response to 1 p.p. rate increase, firms with one-standard-deviation higher bond fund ownership decrease net debt issuance by 0.98% of bond amount outstanding more than the average firm, which is only 75% ( $0.98 / 1.31$ ) of the effect on net bond issuance. In other words, 25% of the reduction in net bond issuance is substituted with other forms of credit, e.g. bank loans.

Despite the reduction in refinancing and the substitution from other debt, the reduction in net debt issuance at 0.98% of bond amount outstanding is still economically meaningful, as it represents 37% ( $0.98 / 2.63$ ) of the average monetary sensitivity of net debt issuance. What do firms do with the reduction in net debt issuance? Column 4 shows that firms decrease net equity payout. Given 1 p.p. monetary tightening, firms with one-standard-deviation higher bond fund ownership decrease net equity payout more than the average firm by 0.91% of bond amount outstanding, an amount that closely mirrors the effect on net debt issuance (0.98%). My results are consistent with the findings in Ma (2019), who finds that many equity payouts are financed by bond issuance driven by bond mispricing, and I provide a concrete source of bond mispricing: monetary-policy-induced bond fund flows.

Column 5 shows that there is no significant effect on real investment in CAPX and R&D, confirming that, on average, the reduction in bond issuance that I identify is not driven by lower firm demand due to reduced productive investment opportunities.

## 5.5 Real effects

Are there real effects? My baseline results show significant effects on firms' capital structure due to bond refinancing, debt substitution and equity payout. One way to assess the economic magnitude is to compare with well-known determinants of leverage, such as tax. Heider and Ljungqvist (2015) show that one-standard-deviation increase in local tax rate leads to an 40 bps increase in leverage (measured as total debt as a ratio of total assets). Therefore, the effect that I have identified here is roughly 10% of the effect of one of the

leading determinants of leverage (bond amount outstanding is roughly a third of total assets for the average firm in my sample).

Even though I find limited direct effects on real investment, there can be significant indirect effects. For example, as bond-issuing firms respond to bond capital contraction through issuing more bank loans and issuing more equities, banks and equity holders have to reduce their capital supply to other smaller firms with real investment needs. This spillover is not captured by my focus on bond-issuing firms but can be plausibly large. For example, Darmouni and Siani (2022) show that bond issuance proceeds are usually used to repay bank credit lines and term loans that are previously issued to finance real investment.

I show below that there are large direct effects on the real activities of constrained firms, consistent with theories such as Stein (1996) and Ottonello and Winberry (2020). On one hand, unconstrained firms should face less frictions in adjusting their investment policies.<sup>28</sup> On the other hand, unconstrained firms are likely already at the optimum of their level of investment, and any additional supply of capital would then simply be used to pay out dividends. To investigate this potential heterogeneity, I run the following regression:

$$Y_{j,t,t+h} = \beta_h \Delta Rate_{t,t+4} \times BFOwnership_{j,t} \times Constrained_{j,t} + \gamma_h Controls + FE + \epsilon_{j,t,t+h} \quad (10)$$

where  $Constrained_{j,t}$  is an indicator for whether firm  $j$  is constrained at quarter-end  $t$ , defined as having low payout ratio (relative to earnings), high investment ratio (relative to earnings), low cash holdings (relative to total assets), small size (in terms of total assets), or young age (defined as time since first appearance in Compustat database). The regression includes both the triple interaction term as well as its components, i.e.  $\Delta Rate_{t,t+4}$ ,  $BFOwnership_{j,t}$ ,  $Constrained_{j,t}$  and their pair-wise interactions.

Table 5 shows the results. In response to the same monetary tightening and given the same exposure to bond fund flows, constrained firms contract much more on real capital expenditure and R&D, reflecting their relative inability to substitute the reduction in bond fund capital supply with other debt or equity. The effects are economically large relative to the average monetary sensitivity and robust across different definitions of financial constraint. Interestingly, constrained firms experience smaller reduction in gross bond issuance, which can be attributed to the fact that they have limited refinancing activities to start up. The results suggest that, for these constrained firms, bond fund flows serve as an amplification channel through which monetary policy can affect the real economy.

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<sup>28</sup>For example, bank-dependent firms cannot adjust their leverage freely because of covenant restrictions that are prevalent in loan contracts.

## 5.6 Endogeneity concerns

Bond ownership by bond funds is not exogenously assigned to firms. Therefore, its effect on firm sensitivity to monetary policy could potentially be spurious. I argue for causality in two steps. First, I describe a host of plausible alternative explanations and provide additional evidence against them. Then, I employ an identification strategy relying on firm-specific variation in bond fund ownership over time. I construct a shift-share instrument that further isolates the exogenous component of the variation.

### 5.6.1 Additional evidence against alternative explanations

Some bond characteristics are mechanically linked to higher monetary sensitivity (e.g. bonds with longer maturity) and they might be happen to be preferred more by bond funds. However, my baseline analyses control for a large set of bond characteristics and firm attributes – either their interactions with rate changes or their time-interacted fixed effects – so the results are not driven by these observable factors. To further rule out alternative explanations based on observables, I analyze a sub-sample of firms that are matched on their propensity scores for bond fund exposure, and Table 4 shows that my main results remain robust.

Some firms may have lower demand for bond financing in response to monetary tightening and they are preferred more by bond funds. However, that I find bond yields and bond issuances move in the opposite direction suggests that the results are driven by creditor supply instead of firm demand. Moreover, unless the firm is financial constrained, the reduction in bond issuance is substituted with other debt and equity, leaving real investment unchanged.

One reverse-causality story is that bond funds can identify and prefer bonds with higher effective duration. This preference for implicit duration should come from bond funds that cannot simply buy bonds with higher explicit duration – for example, bond funds that already have high explicit duration relative to what their investment mandates allow. To rule out this constrained demand for implicit duration, I exclude bond funds that are in the top quintile of fund duration for each style and re-do the same bond-level regression (8). Table A2 shows the results, which show that my results are robust to excluding the bond funds that may have high demand for implicit duration.

Following papers such as Choi et al. (2020) and Ma et al. (2022), I exploit heterogeneity across bonds issued by the same firm. This exercise purges out any inherent differences in monetary

sensitivity at the issuer level. First, I redefine bond fund ownership at the bond level, instead of the issuer level. I then rerun the bond-level regression (8) with issuer-quarter fixed effects. Table A2 shows the results. Column 1 show that, across near-identical bonds issued by the same firm, higher bond fund ownership is associated with higher effective duration by 11 bps, but the effect is not statistically significant. However, if I restrict the sample to monetary tightening (i.e., when  $\Delta Rate > 0$ ), I do find larger effects that are statistically significant. This is because monetary tightening induces outflows from bond funds, and, as I have shown in Section 5.1, portfolio scaling at the bond level is much higher for outflows than for inflows. The effect of 19 bps is still significantly smaller than the baseline results in Table 3, which is unsurprising because these bonds are such close substitutes to each other that we should expect arbitrage to be easier and price impacts to be much smaller.

### 5.6.2 Shift-share instrument for bond fund ownership

Some firms might be inherently more sensitive to monetary policy in ways not captured by any of the observables that I control for, and this higher monetary sensitivity can be spuriously correlated with or reverse-cause bond fund ownership. For example, bond funds like firms with higher monetary sensitivity, they have the ability to identify these firms beyond the observables that I control for, and they select more of these firms into their portfolios. I present an identification strategy that relies on firm-specific variation in bond fund ownership over time that is plausibly exogenous.

First, I control for firm dummies interacted with rate changes in the bond-level regression (8) and the firm-level regression (9). Results are given in Table A2 and Table A3. For the same firm, higher bond fund ownership is associated with higher monetary sensitivity, where the effect is largely the same as my baseline specification. This exercise rules out any firm-specific time-invariant monetary sensitivity that could be driving my baseline results.

However, one alternative interpretation is that bond funds increase their holdings of a firm precisely when its monetary sensitivity increases, i.e. a reverse causality problem. To address this, I construct a shift-share instrument that excludes discretionary bond fund trading and zooms in on the change in bond fund ownership due to cumulative bond fund flows over long horizons:

$$z_{j,t} = \frac{\sum_i AmountHeld_{i,j,t_0} FundFlow_{i,t_0,t}}{AmountOutstanding_{j,t}} \quad (11)$$

where  $AmountHeld_{i,j,t_0}$  is bond fund  $i$ 's ownership of firm  $j$ 's bonds at the beginning of my

sample period  $t_0$ ,  $FundFlow_{i,t_0,t}$  is cumulative flows to bond fund  $i$  since the beginning of my sample period  $t_0$  to current quarter  $t$  (scaled by fund size at  $t_0$ ), and  $AmountOutstanding_{j,t}$  is firm  $j$ 's total bond amount outstanding at current quarter  $t$ .

The idea is that, if a firm has stronger initial relationships with bond funds that subsequently experience large cumulative inflows, that firm is more like to experience increase in bond fund ownership over time. As an illustrative example, Firm A has strong initial relationships with bond funds that have received particularly large cumulative inflows and pension funds that have experienced particularly large cumulative outflows, so its bond fund ownership increases from 5% at the beginning to 50% at the end of my sample period. In comparison, Firm B borrows mainly from insurers, and its bond fund ownership is constant at 0% throughout the sample period.

Is this instrument a strong instrument? Table 3 and Table 4 show that the first-stage t-statistic is over 100, well above the conventional threshold to detect weak instruments. The key to the instrument's relevance lies in how fund-firm relationship in the distant past survives to present. To illustrate this, I repeat the same analysis in Section 5.1 but extend the horizon from one year to ten years. Table 2 shows that, if a bond fund experiences 100% cumulative inflow (outflow) over ten years, it scales up (down) its existing holdings of firms by 59% (63%). The counterfactual analysis shows that the scaling coefficient would have been drastically lower and much closer to zero if bond funds simply buy the entire market in response to inflows. The results here are quite striking and further highlight the presence of relationship lending in the corporate bond market.

Panel B of Table 3 and Panel B of Table 4 show results using this shift-share instrument. The key estimates of interests remain significant and are in similar magnitudes as the baseline specifications. As a result, this identification strategy brings further credence to the causal effect of bond fund ownership on firm sensitivity to monetary policy.

My identifying assumption is that the cumulative flows to a firm's bondholders are exogenous to the firm's sensitivity to monetary policy. One can question the validity of this assumption. Although unlikely, retail investors might prefer firms with high monetary sensitivity, they are able to identify the firms that have increased monetary sensitivity as well as the bond funds that have sticky relationships with those firms, and this would mean that firm monetary sensitivity reverse-causes cumulative bond fund flows. To address this, I construct a refined shift-share instrument that focuses on cumulative bond fund flows that can be explained by

factors that are fairly certainly exogenous to firm sensitivity to monetary policy:

$$\hat{z}_{j,t} = \frac{\sum_i \text{AmountHeld}_{i,j,t_0} \text{FundFlow}_{i,t_0,t}}{\text{AmountOutstanding}_{j,t}} \quad (12)$$

where  $\text{FundFlow}$  is cumulative bond fund flows that can be explained by the secular shift from defined-benefit to defined-contribution pension plans, fund performance, and fund expense ratios through the following regression:

$$\text{FundFlow}_{i,t_0,t} = \beta_1 \text{DB/DC}_{t_0,t} + \beta_2 \text{FundReturn}_{i,t_0,t} + \beta_3 \text{ExpenseRatio}_{i,t_0,t} + \epsilon_{i,t_0,t}$$

The results with this instrument are presented in Table A2 and Table A3. My main results remain robust.

## 6 Aggregate Sensitivity to Monetary Policy

The reduced-form analyses above focus on comparing corporate bonds or firms that are near-identical to each other. This approach facilitates identification, but makes it difficult to extrapolate aggregate effects. Specifically, there are reasons to believe that the cross-sectional results may underestimate the aggregate effects. In terms of bond yields, it should be easier for investors to arbitrage across similar bonds (e.g. two bonds with the same rating and the same duration) than to arbitrage across asset classes (e.g. bonds vs stocks).<sup>29</sup> As a result, we should expect bond fund flows to have bigger impact on aggregate bond yields than what is identified in the cross section of bonds.

In terms of real investment, small firms without bond market access should be more sensitive to credit supply changes than large bond-issuing firms, which are the focus of my cross-sectional analysis. During monetary tightening when bond fund credit supply contracts, even if bond-issuing firms can easily shift borrowing from bond funds to other sources (e.g., equities), smaller firms are less likely to do so. As a result, we should expect bond fund flows to have bigger impact on aggregate real investment than what is identified in the cross section of large bond-issuing firms.

To identify the aggregate effects of bond fund flows, I use the granular instrumental variable (GIV) approach developed by Gabaix and Koijen (2020). The idea is that idiosyncratic

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<sup>29</sup>See Gabaix and Koijen (2021), Li and Lin (2022), Chaudhary et al. (2022) for related evidence.

flows from large bond funds constitute large aggregate shocks that are at the same time plausibly exogenous. I use these shocks to identify the elasticities of aggregate quantities with respect to bond fund flows, which I then use to derive counterfactual aggregate bond yields and counterfactual aggregate real investment without bond fund flows. This counterfactual exercise allows me to quantify the contribution of bond fund flows to the monetary sensitivity to aggregate bond yields and aggregate real investments.

The granular instrument variable is constructed as size-weighted minus equal-weighted average bond fund flows:

$$Flow_{t,t+4}^{GIV} = S_t^{BF} \left( \sum_{i=1}^N S_{i,t} Flow_{i,t,t+4} - \frac{1}{N} \sum_{i=1}^N Flow_{i,t,t+4} \right) \quad (13)$$

where:

$$S_t^{BF} = \frac{\sum_i BondAmountHeld_{i,t}}{BondAmountOutstanding_t}$$

and:

$$S_{i,t} = \frac{BondAmountHeld_{i,t}}{\sum_{i'} BondAmountHeld_{i',t}}$$

As elaborated in Gabaix and Koijen (2020), the two averages both capture common factors in bond fund flows, so the difference of the two isolates the idiosyncratic flows from large bond funds that are both correlated with the size-weighted average (the relevance condition) and also plausibly exogenous (the exclusion restriction). Scaling by  $S_t^{BF}$  ensures that the instrument can be interpreted as percentage change in market demand.

I run the following quarterly time series regression:

$$Y_{t,t+4} = \beta Flow_{t,t+4}^{GIV} + \gamma Controls + \epsilon_{t,t+4} \quad (14)$$

By assumption,  $Flow^{GIV}$  should be orthogonal to any aggregate factors. Following Gabaix and Koijen (2020) and Gabaix and Koijen (2021), I also control for observable common factors such as GDP growth and latent common factors extracted through principal components of bond fund flows.

Table 6 shows how aggregate quantities respond to bond fund flow shocks as obtained through GIV. Bond fund flow shocks have large impacts on aggregate bond yields and aggregate real investment. The regression coefficients imply that 1 p.p. increase in bond fund flow leads to 0.08 p.p. decrease in aggregate investment-grade five-year bond yield and an increase in aggregate real investment equal to 0.39% of bond amount outstanding. Note that these ag-

gregate estimates are considerably larger than those implied by the cross-sectional analyses, which are respectively 0.02 p.p. and 0.17%.<sup>30</sup>

Having estimated the response of aggregate quantities to bond fund flow shocks, I conduct a simple counterfactual analysis to quantify the effect of bond fund flows on monetary sensitivity. First, I calculate the implied effects of bond fund flows on aggregate quantities, making the critical assumption that aggregate quantities respond equally to bond fund flow shocks as to monetary-policy-induced bond fund flows.<sup>31</sup> Then, I estimate the sensitivity of the implied effects to monetary policy rate changes through regression (2), which I call the bond fund flow contribution to monetary sensitivity. Lastly, I compare the bond fund flow contribution to the actual monetary sensitivity of the aggregate variable.

Panel A (B) of Figure 8 shows the results for aggregate bond yields (aggregate real investment). The black bars show the actual sensitivities. In response to 1 p.p. increase in monetary policy rate, the aggregate investment-grade 5-year bond yield increases by 28 bps and the aggregate real investment increases by 3.07% of bond amount outstanding. The red arrows show the effects of bond fund flows. Without bond fund flows, increase in aggregate bond yield sensitivity would have been 15 bps less and decrease in aggregate real investment sensitivity would have been smaller by 0.75% of bond amount outstanding. In other words, bond fund flows account for 54% ( $15 / 28$ ) and 24% ( $0.75 / 3.07$ ) of the monetary sensitivity of aggregate bond yields and aggregate real investment.

The bond fund flow contribution seems to be very high relative to the total monetary sensitivity of aggregate bond yields. It is important to recognize that there are other channels that decrease total sensitivity. As I have shown in Section 5.4, firms' bond issuances are very responsive to monetary policy and act as a key counterparty to bond fund flows. I calculate the firm supply contribution to monetary sensitivity using the same methodology, assuming that bond fund flows and firm issuances are both demand shocks that affect aggregate bond yields in a similar way. Without firm issuance, the monetary sensitivity of aggregate bond yield would have been 29 bps higher. Therefore, bond fund flows account for 26% of the monetary sensitivity of aggregate bond yields if firm issuances are held constant.

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<sup>30</sup>Estimates in Section 5 show that 3 p.p. decrease in bond fund flow (which corresponds to how one-standard-deviation increase in bond fund ownership responds to 1 p.p. increase in monetary policy rate) is associated with 0.05 p.p. increase in bond yield (which corresponds to 0.35 p.p. decrease in bond return for an average corporate bond duration of 7) and a statistically insignificant decrease in real investment that is 0.51% of bond amount outstanding.

<sup>31</sup>It is possible that common bond fund flows have larger impacts because they are harder to be arbitrated away, as shown in Ben-David et al. (2021b) and Coppola (2022).

I can repeat the same exercise but restricting to different subperiods. The right side of Panel A (B) shows that the bond fund flow contribution to monetary sensitivity has increase substantially over time, reflecting the rise of bond funds and the magnitude of their flows. Because there half as many observations, the estimates have much bigger standard errors.

## 7 Conclusion

This paper sheds new light on the question of how monetary policy transmits through credit markets to the real economy. I focus on a large and fast-growing segment of the credit market that has received little research: the bond mutual funds and ETFs. I show that, in response to policy rate changes, bond funds experience large flows that exert large price pressure on bonds. Using a reduced-form approach, I find statistically and economically large differences between firms that are differentially exposed to bond fund flows, in terms of their bond prices, bond issuance, and real activities such as leverage, payout, and investment. Using a demand system approach, I assess the aggregate effect and show that the bond fund flow channel account for a large and increasing share of the aggregate corporate bond yield sensitivity to monetary policy.

My results have direct implications for the current monetary tightening. In the face of high inflation, central banks around the world are increasing interest rates at a historic speed. As a result, year-over-year bond fund flows have decreased by almost 20% and are negative at the end of 2022. My estimates show that this decrease in flows would add 30 bps to the aggregate corporate bond yield, and even more so for firms that have larger exposure to bond fund flows. These are large quantitative effects to be considered by the policymakers as they weigh the trade-offs between inflation and increasing firm financing costs through the bond market.

My paper suggests that monetary policy is a potent tool to mitigate bond fund fragility. The recent COVID crisis shows that bond fund flows are highly vulnerable to bad macroeconomic shocks, especially the illiquid bond funds with high run risk (Goldstein et al., 2017; Falato et al., 2021a). My results suggest that monetary easing can mitigate those outflows. Indeed, a back-of-envelop calculation suggests that bond fund outflows would have been 20 p.p. (26 p.p.) more and aggregate bond yields would have been 31 bps (33 bps) higher, had the Fed not aggressively decreased the federal funds rates during the 2008 financial crisis (the 2020 COVID crisis). As bond funds keep growing and bond market fragility increases, monetary

policy also becomes an increasingly important tool to combat the fragility. At the same time, monetary policy itself can be a source of fragility that induces large bond fund outflows and bond market disruptions, as was the case during the 2013 taper tantrum (Feroli et al., 2014; Kuong and Zhang, 2020).

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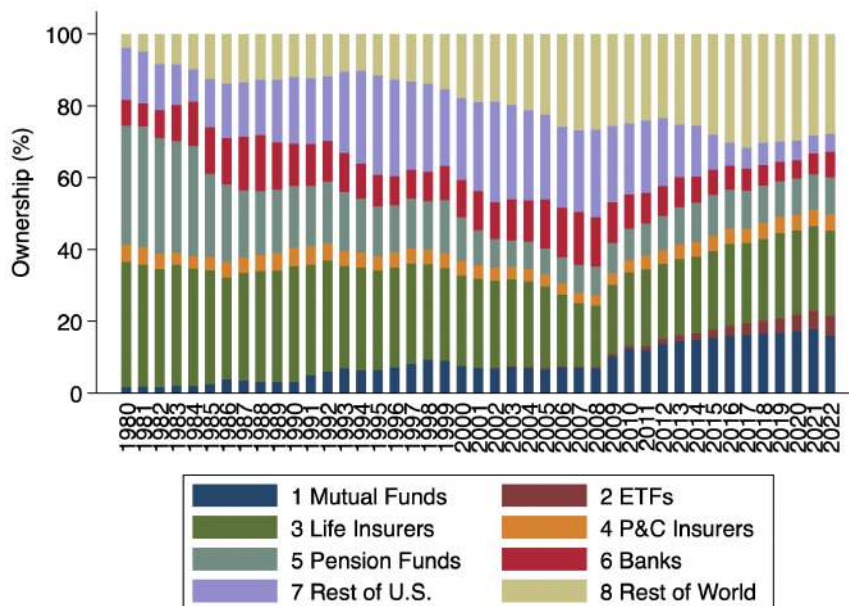
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Figure 1: **Composition of Corporate Bond Investors.** Panel A plots the ownership of corporate and foreign bonds using data from Financial Accounts of the United States (L.213). Panel B uses security-level holdings data and plots the ownership of U.S. non-financial corporate bonds.

Panel A: Corporate and Foreign Bonds



Panel B: U.S. Non-Financial Corporate Bonds

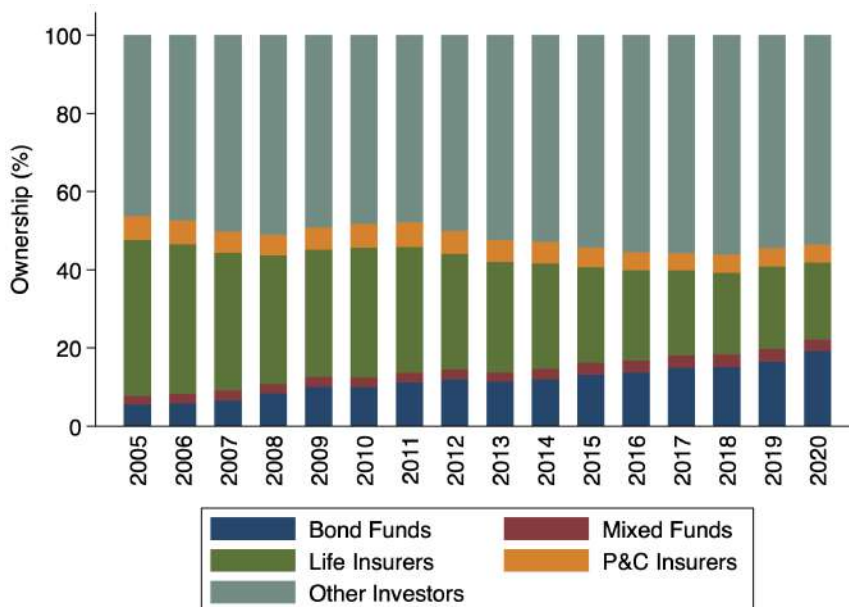
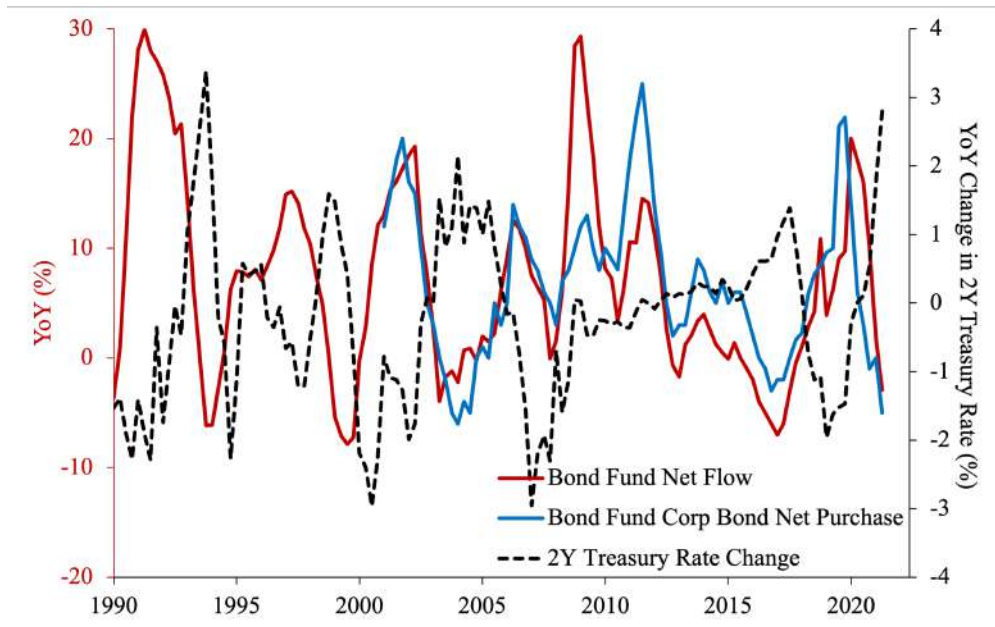


Figure 2: **Monetary Sensitivity across Corporate Bond Investors, Time Series.** Panel A plots year-over-year bond fund net flows (red) and bond fund corporate bond net purchases (blue) as well as year-over-year monetary policy rate changes (black). Panel B plots year-over-year corporate bond net purchases for bond funds (red), insurance companies (green) and the average corporate bond investor (blue).

Panel A: Bond Funds



Panel B: All Corporate Bond Investors

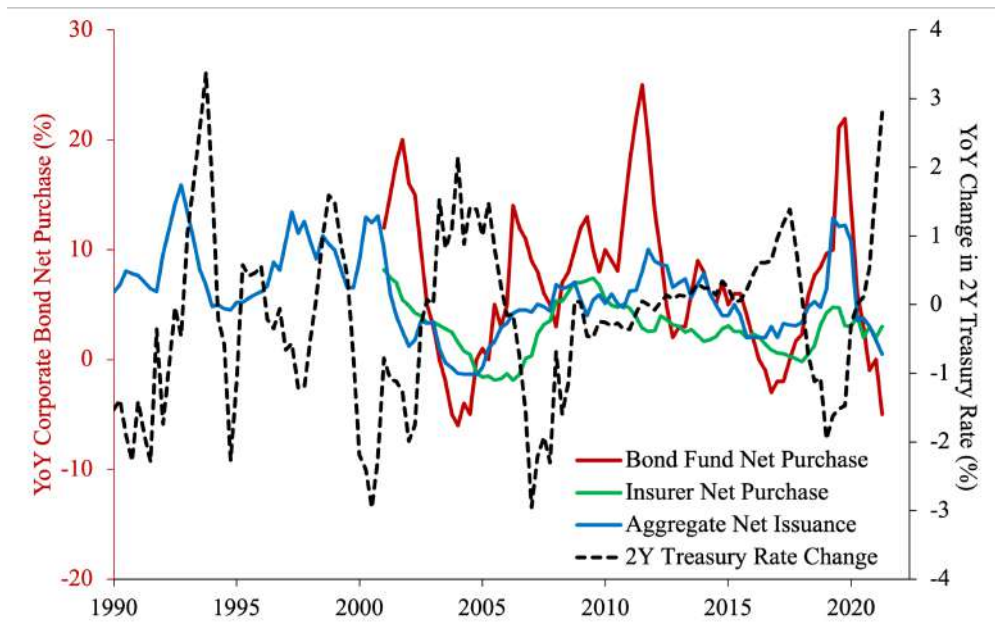
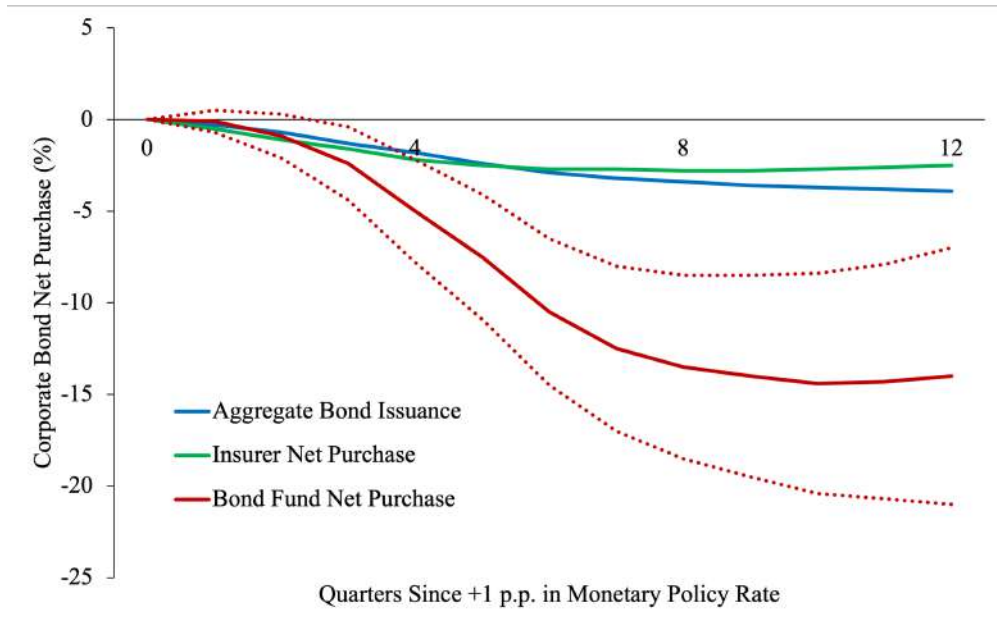


Figure 3: **Monetary Sensitivity across Corporate Bond Investors, Local Projections.** The figures plot cumulative responses of corporate bond net purchases (scaled by corporate bond holdings) for the largest institutional corporate bond investors to 1 p.p. decrease in two-year Treasury rate with 95% confidence intervals, estimated from Equation (2). Panel A shows the full dynamics of the baseline specification. Panel B shows the difference in three-year response between bond funds and insurers for a battery of alternative specifications.

Panel A: Baseline Full Dynamics



Panel B: Difference in Three-Year Response and Robustness

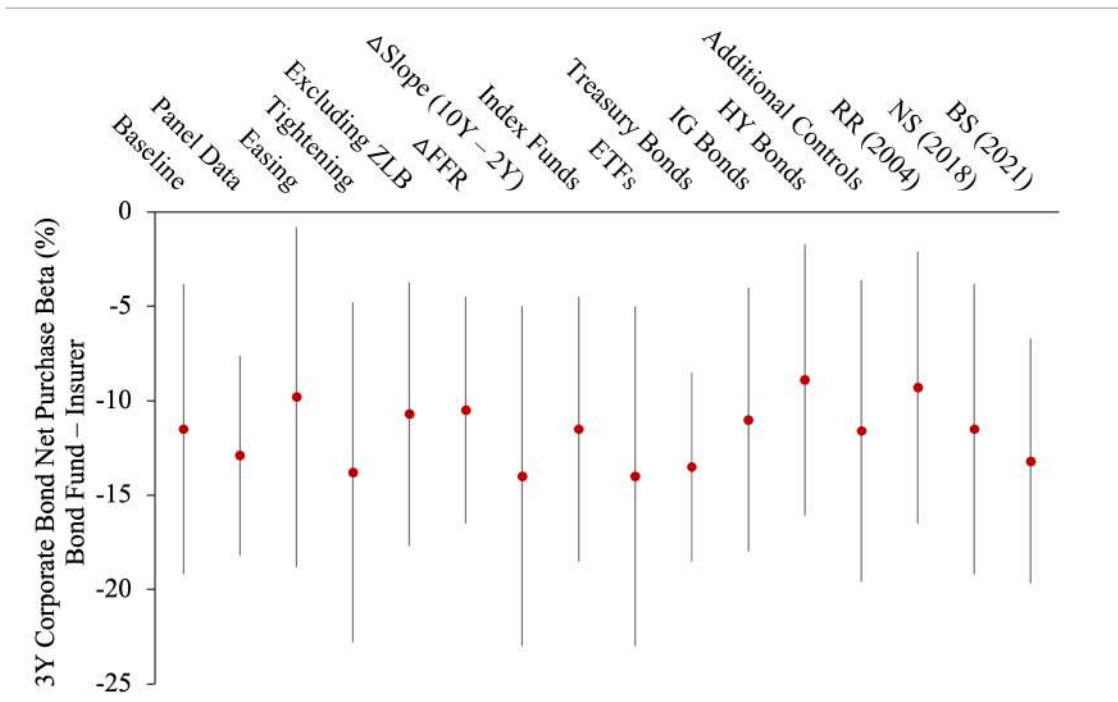
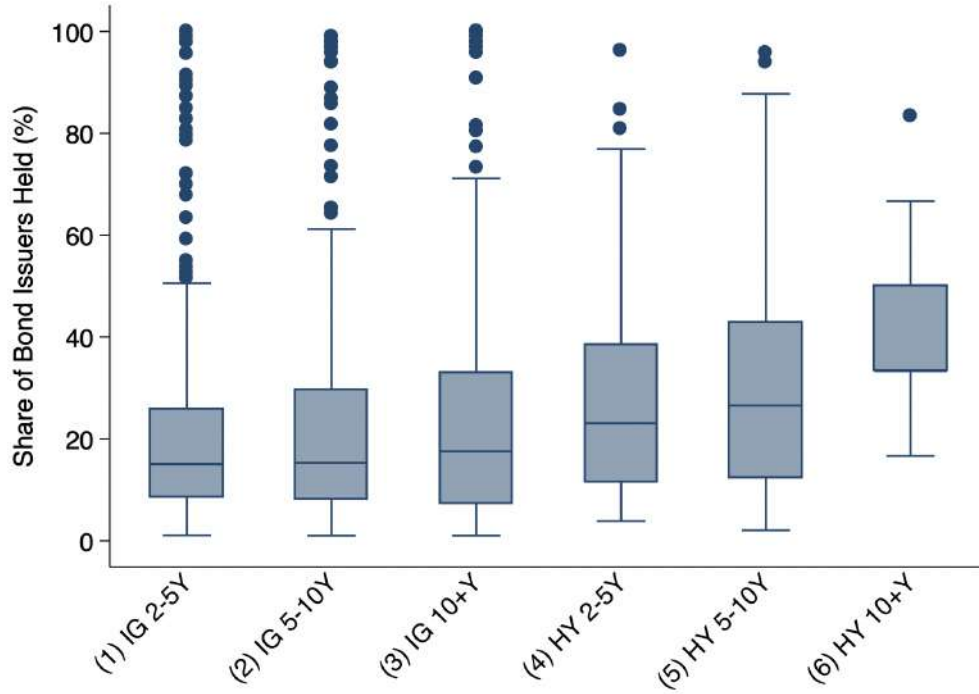


Figure 4: **Bond Fund Portfolio Concentration.** The figures plot distributions of portfolio statistics in the cross section of bond funds with at least \$10 million corporate bond holdings at year-end 2015. Panel A (B) plots the relative number of the bond issuers (corporate bonds) held of particular corporate bond style. Bond issuers (corporate bonds) are limited to those with at least \$1 million bond outstanding.

Panel A: Share of Bond Issuers Held



Panel B: Share of Corporate Bonds Held

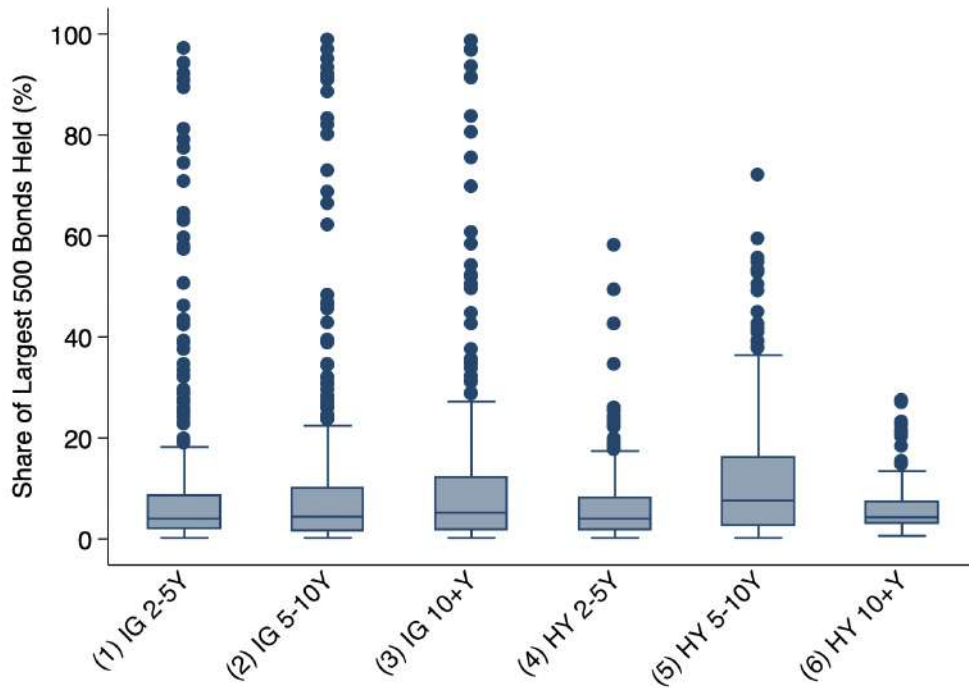
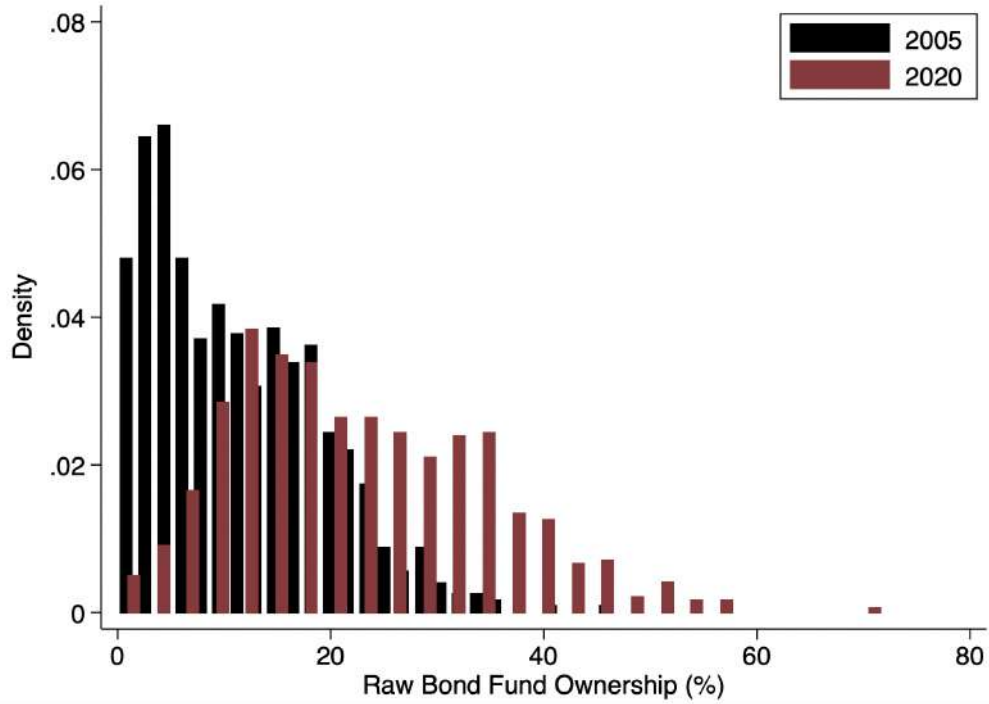


Figure 5: **Cross-Sectional Variation in Bond Fund Ownership.** The figures plot distributions of bond fund ownership across non-financial firms at year-end 2005 and 2020. Panel A shows the raw distribution. Panel B shows the residualized distribution according to Equation (6).

Panel A: Raw Distribution



Panel B: Residualized Distribution

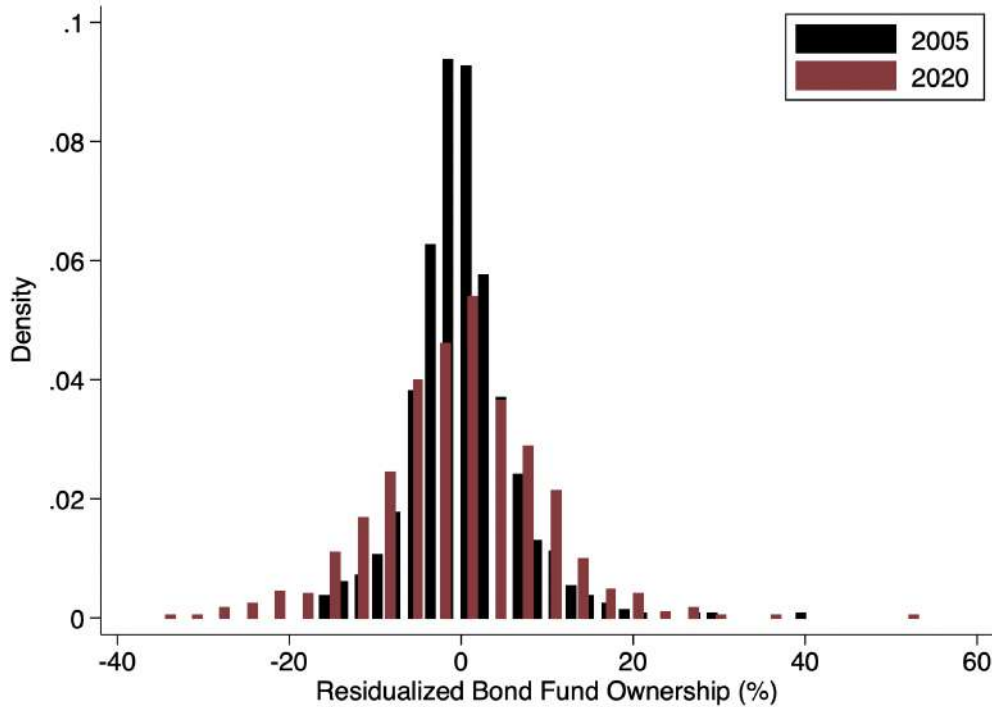


Figure 6: **Cross-Sectional Bondholder Sensitivity to Monetary Policy.** The figure shows that firms with one-standard-deviation higher bond fund ownership experience lower bondholder net flows and lower bondholder net purchases, in response to monetary tightening, estimated using Equation (7).

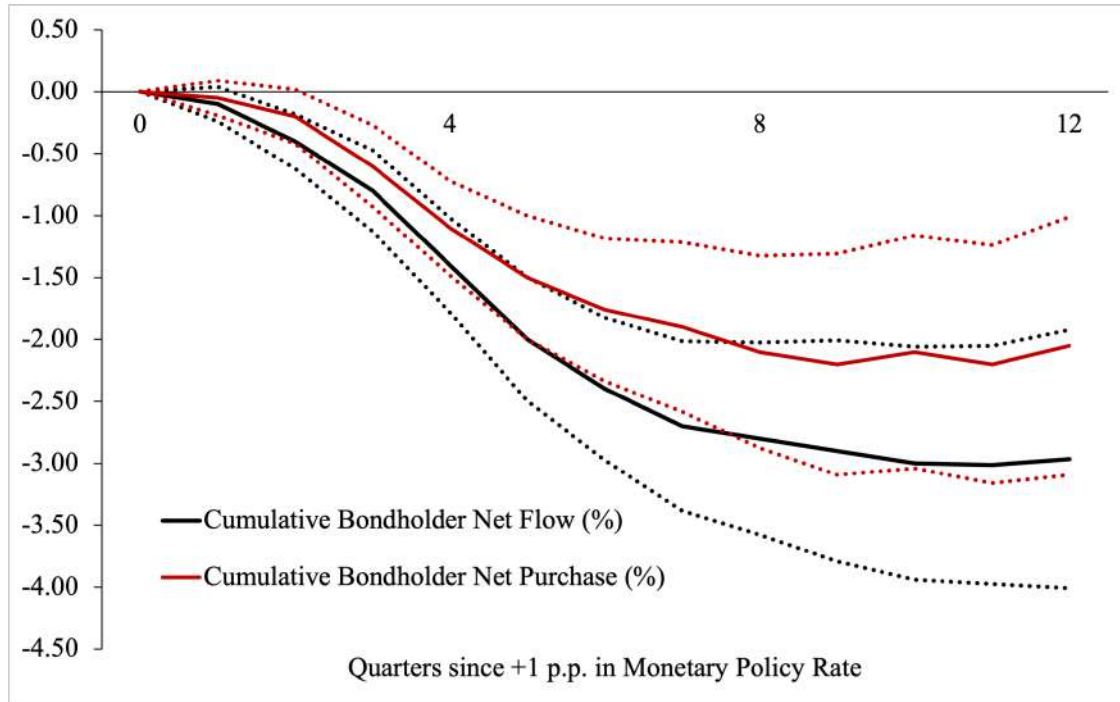


Figure 7: **Cross-Sectional Bond Sensitivity to Monetary Policy.** The figure shows that corporate bonds whose issuers have higher bond fund ownership experience lower returns in response to monetary tightening, estimated using Equation (8).

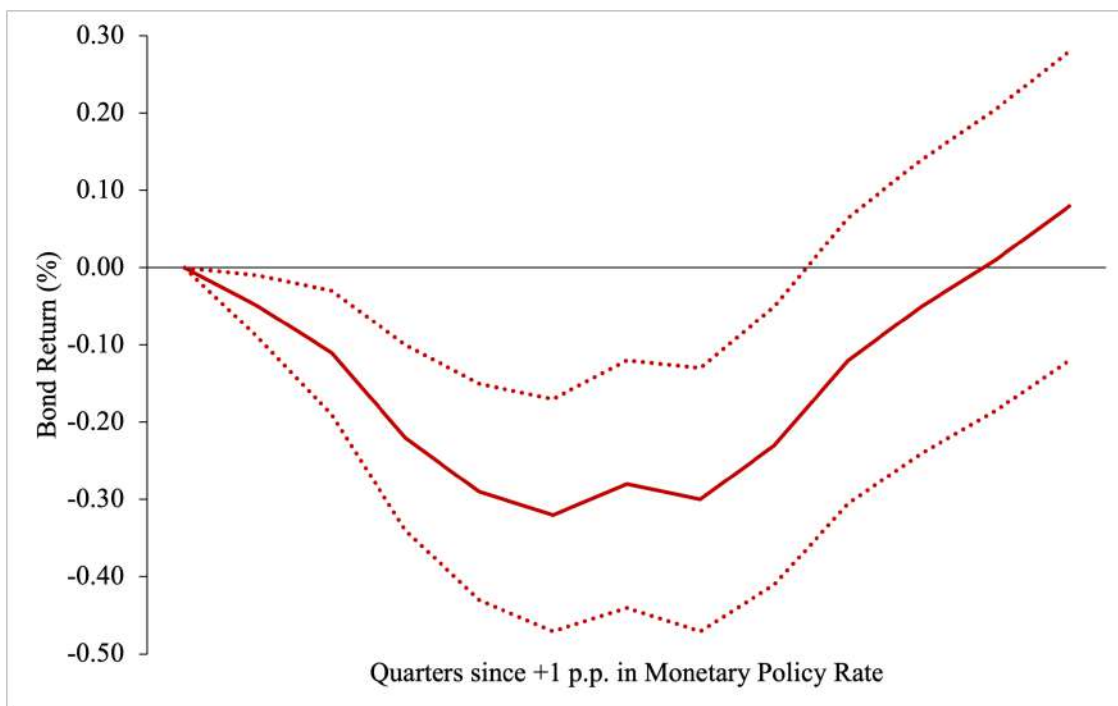
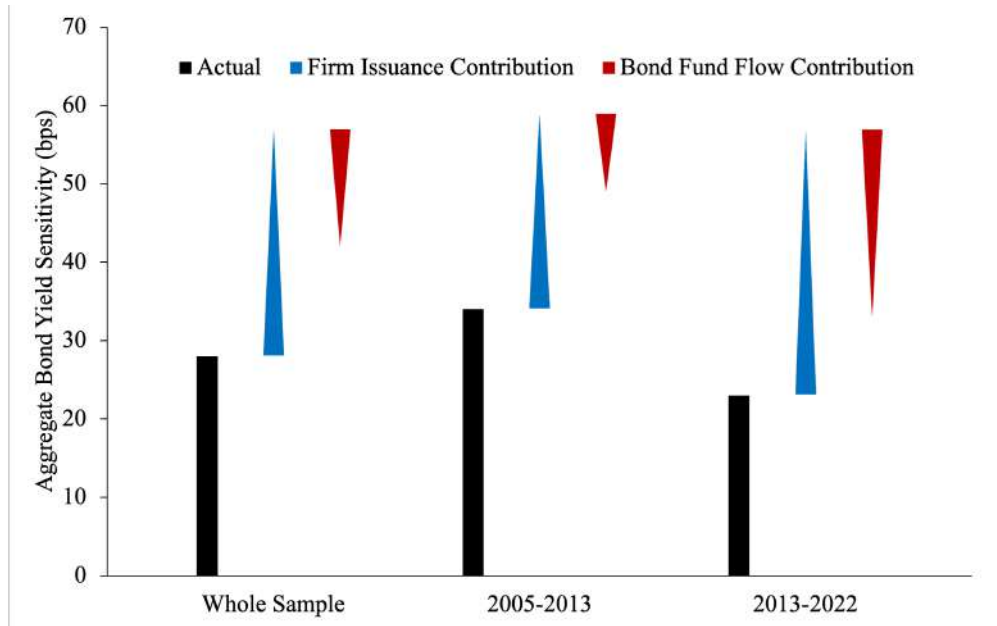


Figure 8: **Bond Fund Flow Contribution to Aggregate Monetary Sensitivity.** Panel A (B) plots the counterfactual monetary sensitivity of the aggregate investment-grade 5-year bond yields (the aggregate real investment), according to Section 6. The black bars show the actual sensitivity to changes in two-year Treasury rates, over a one-year horizon. The red arrow shows what the counterfactual sensitivity would have been if bond funds do not experience any flow.

Panel A: Aggregate Bond Yield



Panel B: Aggregate Real Investment

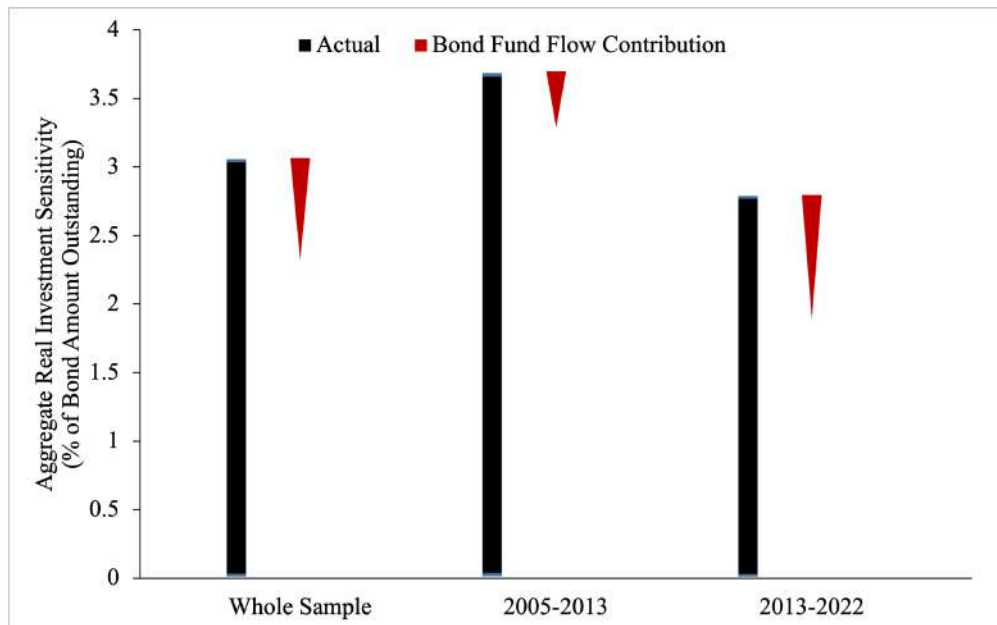


Table 1: **Summary Statistics.** Panel A provides summary statistics on aggregate quarterly variables from 1990Q1 to 2020Q4. Panel B provides summary statistics on 1,491 bond funds from 1990Q1 to 2020Q4. Panel C provides summary statistics on 11,523 corporate bonds from 2005Q1 to 2020Q4. Panel D provides summary statistics on 1,123 firms from 2005Q1 to 2020Q4. All variables are winsorized at 1%.

Panel A: Aggregate Quarterly Statistics

	N	Mean	SD	P25	P50	P75
<b>Change in 2Y Treasury Rate (%)</b>						
1Q	123	-0.06	0.53	-0.27	-0.03	0.25
1Y	120	-0.26	1.21	-1.10	-0.12	0.46
<b>Monetary Surprise (%)</b>						
1Q	107	-0.03	0.12	-0.08	-0.03	0.04
1Y	104	-0.10	0.27	-0.24	-0.07	0.06
<b>Bond Fund Flow (% of Own Size)</b>						
1Q	123	1.30	2.36	-0.01	1.24	2.69
3Y	112	17.80	16.64	5.31	16.27	26.79
<b>Life Insurer Flow (% of Own Size)</b>						
1Q	123	1.32	1.15	0.67	1.29	1.88
3Y	112	16.97	5.24	11.81	18.24	21.79
<b>Aggregate Corp Bond Net Issuance (% of Aggregate Corp Bond Outstanding)</b>						
1Q	63	1.67	1.83	0.56	1.48	2.29
3Y	52	19.31	6.20	14.25	21.53	24.29
<b>Bond Fund Corp Bond Net Purchase (% of Aggregate Corp Bond Outstanding)</b>						
1Q	63	0.32	0.60	0.01	0.30	0.52
3Y	52	4.13	2.07	2.53	4.33	5.90
<b>Life Insurer Corp Bond Net Purchase (% of Aggregate Corp Bond Outstanding)</b>						
1Q	63	0.19	0.24	0.02	0.20	0.30
3Y	52	3.00	1.49	1.77	2.44	4.16

Panel B: Bond Fund Quarterly Statistics

	N	Mean	SD	P25	P50	P75
<b>Flow (% of Own Size)</b>						
1Q	100,721	2.40	11.27	-3.81	0.00	5.74
1Y	93,051	13.52	46.23	-13.62	0.18	23.98
3Y	82,015	56.32	162.21	-31.01	0.73	66.97
<b>Flow Duration</b>	100,721	15.73	7.93	9.83	14.90	20.01
<b>Rating (AAA = 1, CCC- = 19)</b>	100,721	7.26	3.31	4.67	6.28	8.85
Duration (Years)	100,721	5.93	3.33	3.92	5.03	8.10
Yield to Maturity (%)	36,251	4.17	2.58	1.95	4.00	5.88
Cash Ratio (%)	100,721	4.95	6.53	1.25	3.34	6.54
Income Yield (%)	100,721	4.27	2.63	2.48	4.02	5.72
<b>1Y Return (%)</b>						
Alpha	100,721	0.96	2.62	-0.01	0.69	1.71
Factor-Related	100,721	2.65	5.80	-0.77	1.86	4.97
Volatility	100,721	4.15	3.01	2.10	3.45	5.01
Age (Years)	100,721	12.66	10.96	4.33	10.00	18.50
Total Net Assets (mn \$)	100,721	1,713.92	8,003.62	73.00	265.35	957.80
Expense Ratio (%)	100,721	0.71	0.39	0.45	0.68	0.93
Turnover (%)	100,721	142.81	182.87	41.00	77.00	163.00

Panel C: Corporate Bond Quarterly Statistics

	N	Mean	SD	P25	P50	P75
<b>Bondholder Flow (%)</b>						
1Q	280,509	0.28	0.90	0.00	0.22	0.64
1Y	244,994	0.98	2.42	0.00	0.74	2.04
3Y	172,507	2.72	5.12	0.31	2.28	5.06
<b>Bondholder Flow Duration (%)</b>						
issuer level	280,509	2.45	2.48	0.76	1.72	3.32
bond level	280,509	2.39	2.96	0.51	1.69	3.61
<b>Abnormal Return (%)</b>						
1Q	280,509	0.00	3.56	-1.12	-0.05	1.10
1Y	244,994	0.00	5.03	-1.88	0.11	2.01
3Y	172,507	0.00	7.36	-3.18	-0.26	3.03
<b>Rating (AAA = 1, CCC- = 19)</b>	280,509	8.72	3.06	7.00	8.00	10.00
Duration (Years)	280,509	7.95	4.16	4.59	6.55	11.14
Fixed Callable	280,509	0.24	0.21	0.00	0.00	1.00
Amount Outstanding (mn \$)	280,509	609.96	646.70	300.00	500.00	800.00

Panel D: Firm Quarterly Statistics

	N	Mean	SD	P25	P50	P75
<b>Bondholder Flow (%)</b>						
1Q	45,672	0.43	1.79	-0.36	0.33	1.09
3Y	37,101	2.30	5.64	-2.23	1.92	4.39
<b>Bondholder Flow Duration (%)</b>	45,672	2.55	2.61	0.80	1.74	3.49
<b>Gross Bond Issuance (% of TA)</b>						
1Q	45,672	1.66	5.38	0.00	0.00	0.00
3Y	37,101	22.38	31.48	2.46	12.06	27.87
<b>Net Debt Issuance (% of TA)</b>						
1Q	45,672	0.57	3.99	-0.40	0.00	0.53
3Y	37,101	9.01	20.76	-1.48	4.12	13.82
<b>Net Equity Payout (% of TA)</b>						
1Q	45,672	0.77	1.93	0.00	0.41	1.39
3Y	37,101	11.10	18.28	0.37	6.49	18.30
<b>Investment (% of TA)</b>						
1Q	45,672	1.74	1.81	0.65	1.33	2.27
3Y	37,101	22.78	24.09	8.28	16.47	27.54
<b>Total Assets (bn \$)</b>	45,672	16.90	30.89	2.49	5.99	15.22
<b>Cash Holdings (% of TA)</b>	45,672	8.85	9.83	2.06	5.04	11.99
<b>Tobin's Q</b>	45,672	3.94	6.90	0.75	1.56	4.31
<b>Leverage (Debt as % of TA)</b>	45,672	39.96	20.36	26.47	35.97	50.68
<b>Net Income (% of TA)</b>	45,672	2.79	9.82	0.96	3.42	6.81
<b>Bond Outstanding (% of Debt)</b>	45,672	67.60	31.37	45.35	69.71	90.08
<b>Bond Rating (AAA = 1, CCC- = 19)</b>	45,672	11.61	3.76	9.00	11.00	15.00
<b>Bond Maturity (Years)</b>	45,672	7.79	3.97	5.04	6.94	9.52

Table 2: **Bond Fund Portfolio Scaling.** The tables examine how bond funds scale their existing portfolios in response to fund flows over one year or ten years and at the asset class level, bond issuer level, or individual bond level, estimated from Equation (1) or Equation (4). The “Counterfactual” columns show what would be the regression coefficients if, for every corporate bond purchased, the bond fund instead bought a value-weighted portfolio of all the corporate bonds outstanding with the same style in response to inflows. t-statistics are reported in parentheses. \*, \*\*, and \*\*\* denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: 1-Year Asset Class Level

Dependent Variable	1Y Asset Class Flow (%)					
	Outflow			Inflow		
Sample	Cash	Treasuries	Corporates	Cash	Treasuries	Corporates
1Y Fund Flow (%)	1.21*** (4.21)	1.03*** (11.55)	0.90*** (15.28)	1.47*** (3.68)	1.03*** (31.59)	0.93*** (51.93)
Fixed Effects	Fund FE and Year FE					
Standard Errors	Twoway-Clustered by Fund and by Year					
Observations	23,039	16,622	16,638	25,598	14,830	15,197
R2	0.19	0.38	0.37	0.15	0.50	0.65

Panel B: 10-Year Asset Class Level

Dependent Variable	10Y Asset Class Flow (%)					
	Outflow			Inflow		
Sample	Cash	Treasuries	Corporates	Cash	Treasuries	Corporates
10Y Fund Flow (%)	1.21*** (4.21)	1.05*** (5.35)	0.95*** (29.42)	1.47*** (3.68)	1.10*** (5.93)	0.96*** (45.67)
Fixed Effects	Fund FE and Year FE					
Standard Errors	Twoway-Clustered by Fund and by Year					
Observations	2,931	2,931	2,936	3,135	3,135	3,139
R2	0.19	0.41	0.60	0.15	0.39	0.73

Panel C: 1-Year Bond Issuer Level

Dependent Variable	1Y Issuer Flow (%)		
Sample	Outflow	Inflow	Counterfactual
1Y Fund Flow (%)	0.83*** (20.26)	0.74*** (64.65)	0.08*** (62.53)
Fixed Effects	Fund FE, Issuer $\times$ Year FE		
Standard Errors	Twoway-Clustered by Fund and by Year		
Observations	97,275	216,142	216,142
R2	0.25	0.31	0.26

Panel D: 10-Year Bond Issuer Level

Dependent Variable	10Y Issuer Flow (%)		
Sample	Outflow	Inflow	Counterfactual
10Y Fund Flow (%)	0.63*** (10.89)	0.59*** (43.34)	0.05*** (39.28)
Fixed Effects	Fund FE, Issuer $\times$ Year FE		
Standard Errors	Twoway-Clustered by Fund and by Year		
Observations	28,332	53,269	53,269
R2	0.30	0.48	0.41

Panel E: Individual Bond Level

Dependent Variable	1Y Bond Flow (%)		
Sample	Outflow	Inflow	Counterfactual
1Y Fund Flow (%)	0.81*** (20.75)	0.40*** (71.06)	0.02*** (63.92)
Fixed Effects	Fund FE, Issue $\times$ Year FE		
Standard Errors	Twoway-Clustered by Fund and by Year		
Observations	407,770	1,017,406	295,134
R2	0.37	0.28	0.22

Table 3: **Cross-Sectional Bond Sensitivity to Monetary Policy.** These tables show how bond fund ownership affects bond sensitivity to monetary policy. Panel A estimate the baseline regression (8). Panel B uses the shift-share instrument in Equation 11. t-statistics are reported in parentheses. \*, \*\*, and \*\*\* denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Baseline

Dependent Variable	1Y Return (%)		
$\Delta\text{Rate} \times \text{Bond Fund Ownership}$	-0.29*** (-4.02)	-0.35** (-2.41)	-0.35** (-2.52)
Rating $\times$ Maturity $\times$ Quarter FE	Y	Y	Y
Macro News $\times$ Bond Fund Ownership	Y	Y	Y
$\Delta\text{Rate} \times \text{Bond Characteristics}$		Y	Y
$\Delta\text{Rate} \times \text{Issuer Characteristics}$			Y
Standard Errors	Two-way Clustered by Bond and by Quarter		
Observations	148127	148127	148127
R2	0.59	0.63	0.63

Panel B: Shift-Share Instrument

Dependent Variable	1Y Return (%)		
Instrumented $\Delta\text{Rate} \times \text{BFOwnership}$	-0.33** (-2.11)	-0.50* (-1.76)	-0.53* (-1.85)
Rating $\times$ Maturity $\times$ Quarter FE	Y	Y	Y
Macro News $\times$ Bond Fund Ownership	Y	Y	Y
$\Delta\text{Rate} \times \text{Bond Characteristics}$		Y	Y
$\Delta\text{Rate} \times \text{Issuer Characteristics}$			Y
$\Delta\text{Rate} \times \text{Issuer Dummies}$	Y	Y	Y
Standard Errors	Two-way Clustered by Bond and by Quarter		
Observations	148127	148127	148127
R2	0.65	0.68	0.69
First Stage F-statistic	103.47	103.47	103.47

Table 4: **Cross-Sectional Firm Sensitivity to Monetary Policy.** These tables examine how bond fund ownership affects firm sensitivity to monetary policy. Panel A estimate the baseline regression (9). Panel B uses the shift-share instrument in Equation 11. t-statistics are reported in parentheses. \*, \*\*, and \*\*\* denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Baseline

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Capital Expenditure
Average Monetary Sensitivity	-5.96	-3.90	-2.63	-2.89	-3.07
$\Delta\text{Rate} \times \text{Bond Fund Ownership}$	-3.01*** (-2.71)	-1.31*** (-2.98)	-0.98** (-2.00)	-0.91* (-1.83)	-0.51 (-0.69)
Controls	Macro News $\times$ Bond Fund Ownership, $\Delta\text{Rate} \times$ Firm Attributes				
Fixed Effects	Firm FE, Industry $\times$ Quarter FE				
Standard Errors	Two-way Clustered by Firm and by Quarter				
Observations	35372	35372	34546	34546	34546
R2	0.30	0.32	0.22	0.40	0.57

Panel B: Shift-Share Instrument

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Capital Expenditure
Average Monetary Sensitivity	-5.96	-3.90	-2.63	-2.89	-3.07
Instrumented $\Delta\text{Rate} \times \text{BFO}$	-3.61** (-2.42)	-1.07* (-1.94)	-1.50 (-1.54)	-1.08* (-1.68)	-0.78 (-0.99)
Controls	Macro News $\times$ Bond Fund Ownership, $\Delta\text{Rate} \times$ Firm Attributes, $\Delta\text{Rate} \times$ Firm FE				
Fixed Effects	Firm FE, Industry $\times$ Time FE				
Standard Errors	Two-way Clustered by Firm and by Time				
Observations	35372	35372	34546	34546	34546
R2	0.36	0.39	0.26	0.44	0.61
First Stage F-statistic	109.23	109.23	109.23	109.23	109.23

Table 5: **Cross-Sectional Firm Sensitivity to Monetary Policy, Constrained Firms.** This table examines whether the effect of bond fund ownership on firm sensitivity to monetary policy is different for firms that are financially constrained, estimated from Equation (10). t-statistics are reported in parentheses. \*, \*\*, and \*\*\* denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A:

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Capital Expenditure
$\Delta\text{Rate} \times \text{Bond Fund Ownership}$	-3.87*** (-2.98)	-1.72*** (-3.16)	-0.80** (-2.14)	-1.25* (-1.91)	-0.37 (-0.40)
$\Delta\text{Rate} \times \text{BFO} \times \text{Low Payout}$	1.09** (2.17)	0.79** (2.15)	-0.39 (-1.49)	1.33* (1.78)	-1.05** (-2.04)
Observations	35372	35372	34546	34546	34546
R2	0.30	0.32	0.23	0.40	0.57

Panel B: High Investment

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Investment
$\Delta\text{Rate} \times \text{Bond Fund Ownership}$	-4.09*** (-3.02)	-2.25*** (-2.67)	-1.39** (-2.36)	-1.54** (-1.99)	-0.46 (-0.66)
$\Delta\text{Rate} \times \text{BFO} \times \text{High Investment}$	1.95* (1.70)	0.59* (1.89)	-0.21 (-0.55)	1.20* (1.89)	-1.01** (-1.99)
Observations	35372	35372	34546	34546	34546
R2	0.30	0.32	0.23	0.41	0.57

Panel C: Low Cash

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Investment
$\Delta \text{Rate} \times \text{Bond Fund Ownership}$	-3.95*** (-3.00)	-2.15*** (-2.80)	-1.23** (-2.25)	-1.35* (-1.89)	-0.31 (-0.19)
$\Delta \text{Rate} \times \text{BFO} \times \text{Low Cash}$	0.91 (1.66)	0.55 (1.90)	-0.01 (-0.05)	1.45* (1.84)	-0.76* (-1.79)
Observations	35372	35372	34546	34546	34546
R2	0.30	0.32	0.23	0.41	0.57

Panel D: Small Size

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Investment
$\Delta \text{Rate} \times \text{Bond Fund Ownership}$	-4.21*** (-3.25)	-2.37*** (-3.21)	-1.41** (-1.99)	-1.45* (-1.80)	-0.44 (-0.79)
$\Delta \text{Rate} \times \text{BFO} \times \text{Small Size}$	2.03*** (3.03)	1.02** (2.03)	0.23 (0.59)	0.78* (1.69)	-0.98 (-1.53)
Observations	35372	35372	34546	34546	34546
R2	0.30	0.32	0.23	0.41	0.57

Panel E: Young Age

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Investment
$\Delta \text{Rate} \times \text{Bond Fund Ownership}$	-4.00*** (-3.28)	-2.51*** (-2.81)	-1.17* (-1.96)	-1.59* (-1.77)	-0.49 (-0.55)
$\Delta \text{Rate} \times \text{BFO} \times \text{Young Age}$	1.82 (1.64)	1.07* (1.89)	-0.19 (-0.79)	1.21 (1.09)	-0.87* (-1.90)
Observations	35372	35372	34546	34546	34546
R2	0.30	0.32	0.23	0.41	0.57

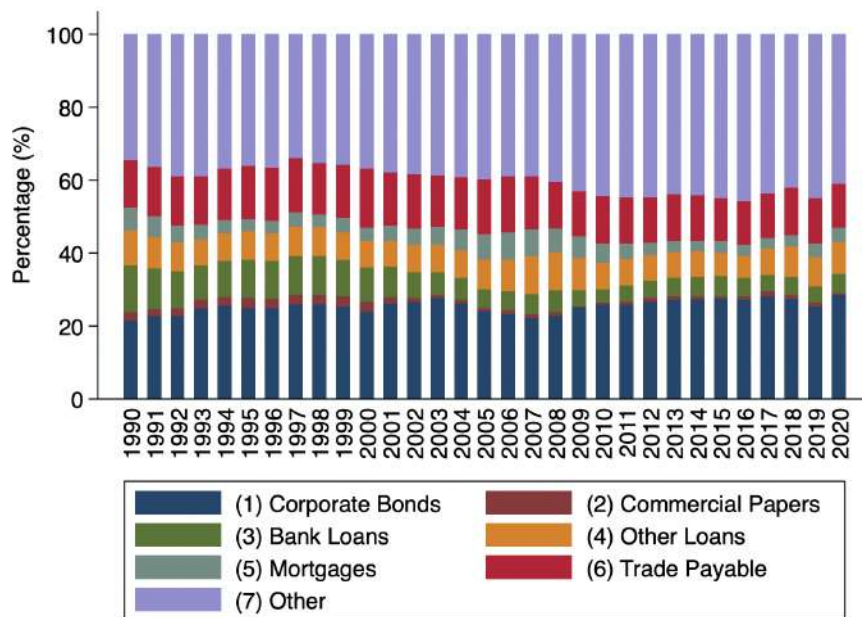
Table 6: **Aggregate Sensitivity to Bond Fund Flow Shocks.** The table shows how aggregate quantities respond to bond fund flow shocks through regression (9). Bond fund flow shocks are constructed following the granular instrument variable (GIV) approach in Gabaix and Koijen (2020) as size-weighted minus equal weighted bond fund flows. t-statistics are reported in parentheses. \*, \*\*, and \*\*\* denote p-values less than 0.10, 0.05, and 0.01, respectively.

Dependent Variable	Aggregate IG 5Y Bond Yield (%)		Aggregate Real Investment (%)	
Bond Fund Flow Shock (%)	-0.09*** (-3.13)	-0.08*** (-2.78)	0.21** (2.32)	0.39* (1.90)
GDP Growth (%)	-0.21* (-1.94)	-0.25** (-2.20)	1.04* (1.79)	0.89** (2.02)
PC1	-0.03* (-1.83)	-0.03* (-1.80)	0.00** (2.35)	0.00** (2.00)
PC2		-0.01 (-0.24)		0.39* (1.88)
Standard Errors	Newey and West (1994)			
Observations	68	68	68	68
R2	0.18	0.19	0.09	0.09

## Appendix A Additional Figures and Tables

Figure A1: **Composition of Firm Liabilities.** The figures plot the composition of liabilities for all nonfinancial corporate businesses using data from Financial Accounts of the United States (L.103) in Panel A and for non-financial public firms using data from Compustat in Panel B.

Panel A: Nonfinancial Corporate Business



Panel B: Non-Financial Public Firms

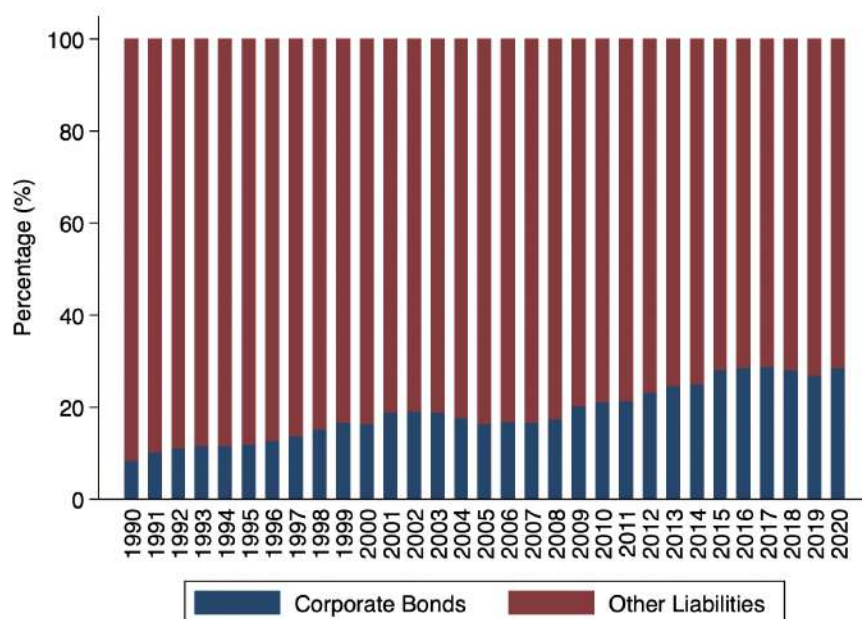
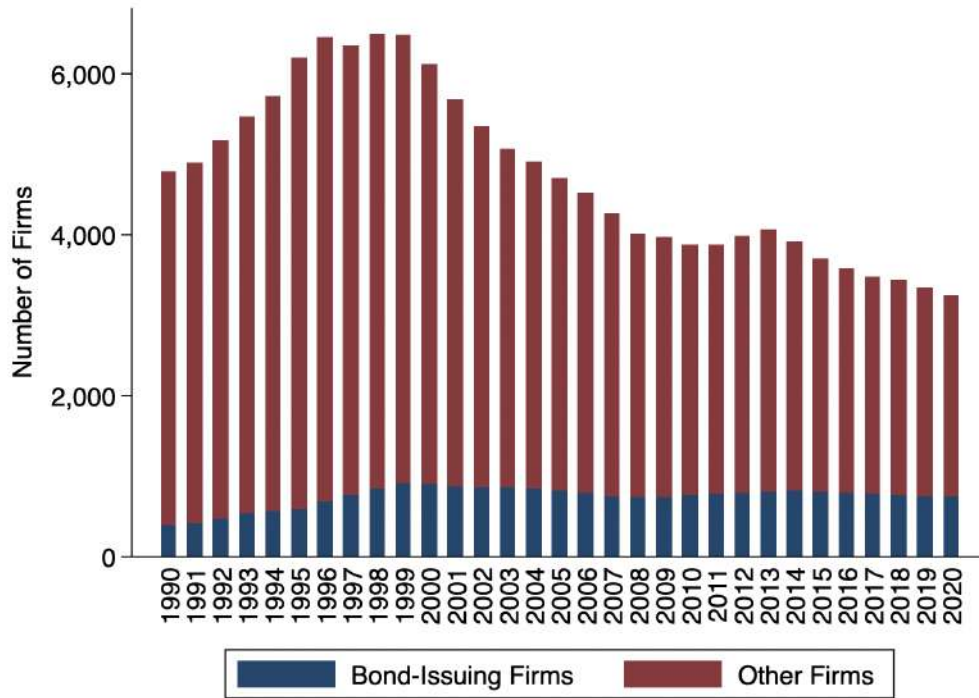


Figure A2: **Composition of Firms.**

Panel A: Number of Firms



Panel B: Total Assets

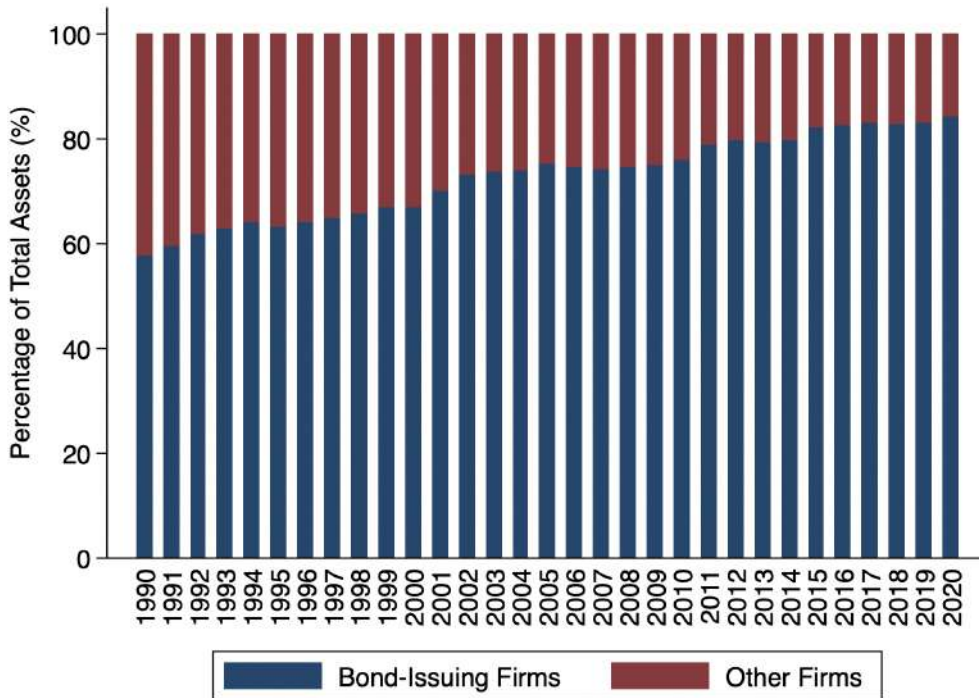
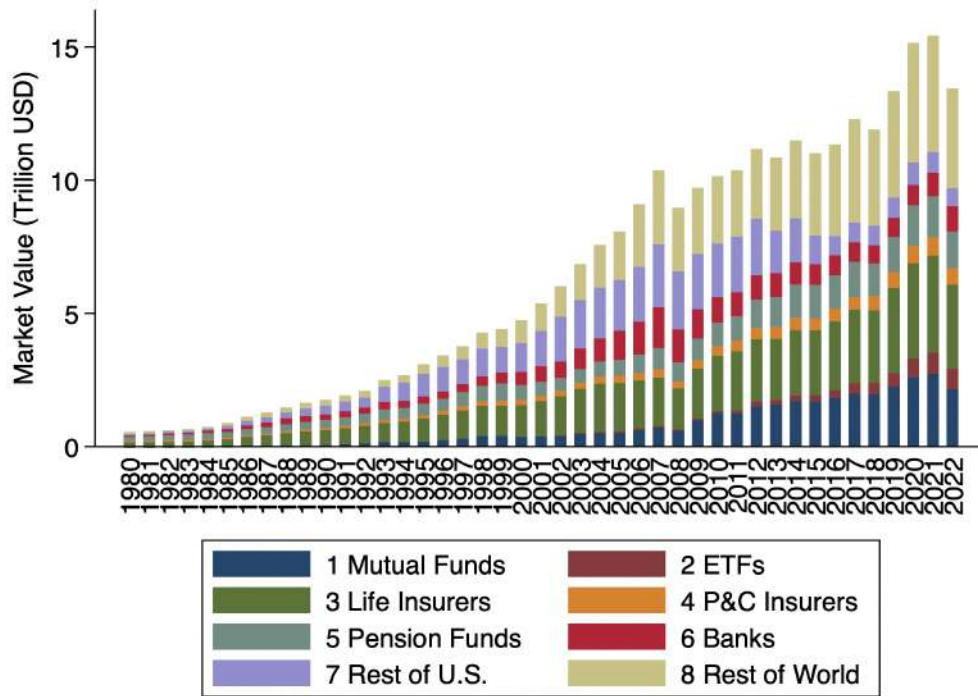
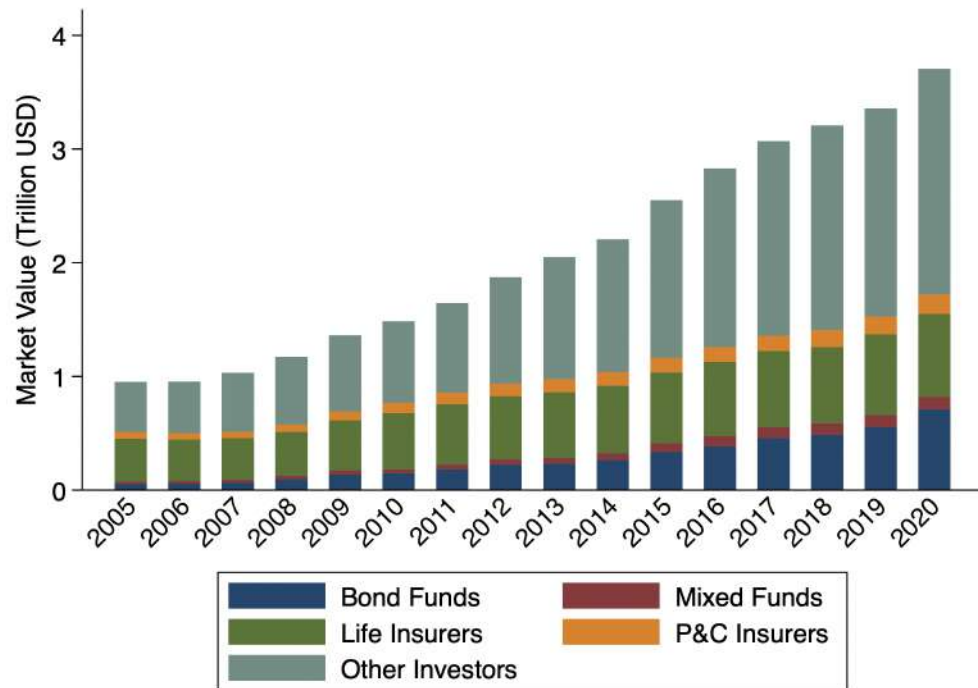


Figure A3: Additional Details on Composition of Bond Investors.

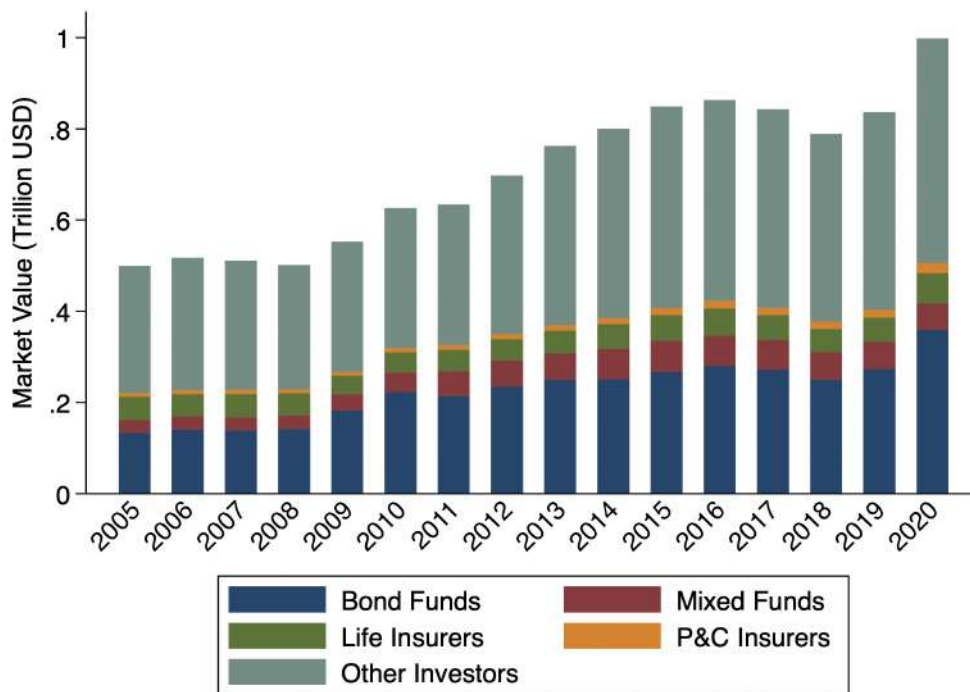
Panel A: Corporate and Foreign Bonds



Panel B: Investment-Grade Corporate Bonds



Panel C: Investment-Grade Corporate Bonds



Panel D: Treasury Securities

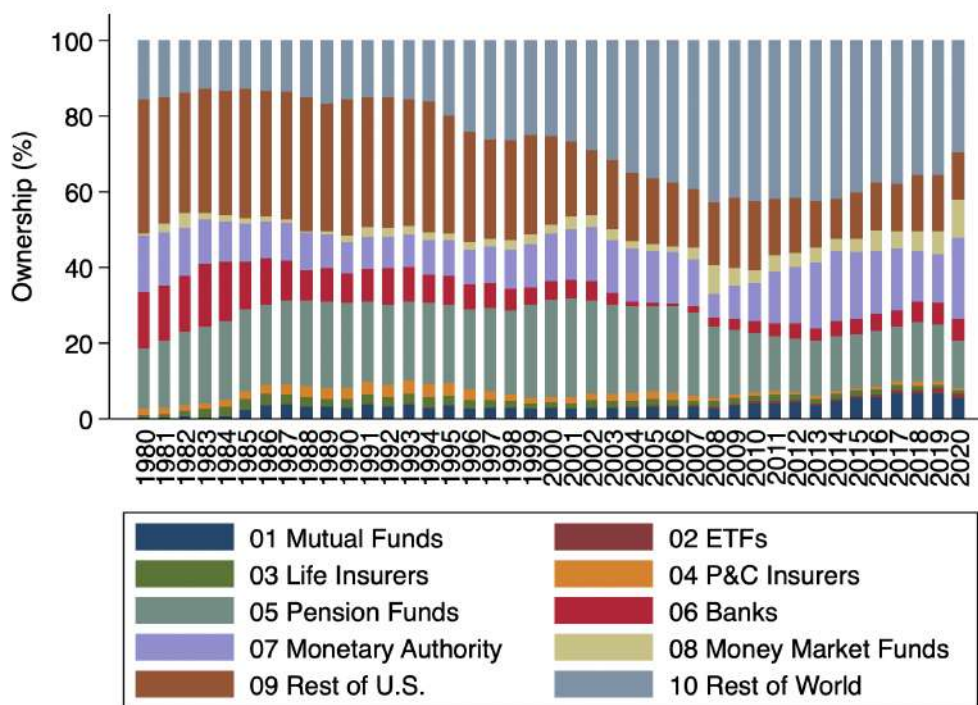
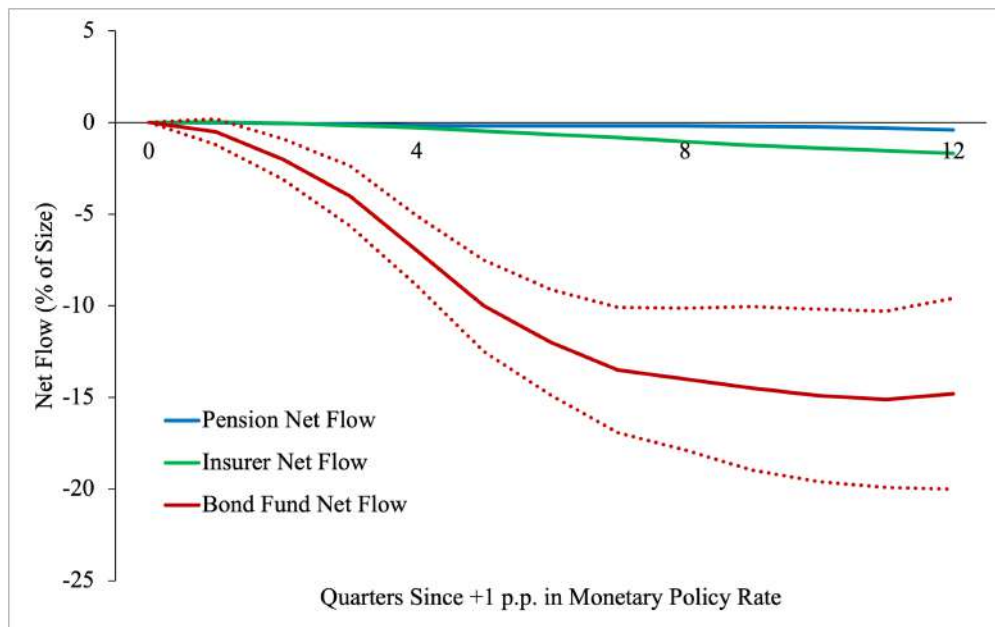


Figure A4: **Net Flow Sensitivity to Monetary Policy across Corporate Bond Investors.** The figures plot impulse responses of total flows for the largest institutional corporate bond investors to 1 p.p. decrease in two-year Treasury rate with 95% confidence intervals, estimated from Equation (2). Panel A plots the full dynamics with the baseline specification. Panel B shows the difference in three-year response between bond funds and insurers for a battery of alternative specifications.

Panel A: Baseline Full Dynamics



Panel B: Difference in Three-Year Response and Robustness

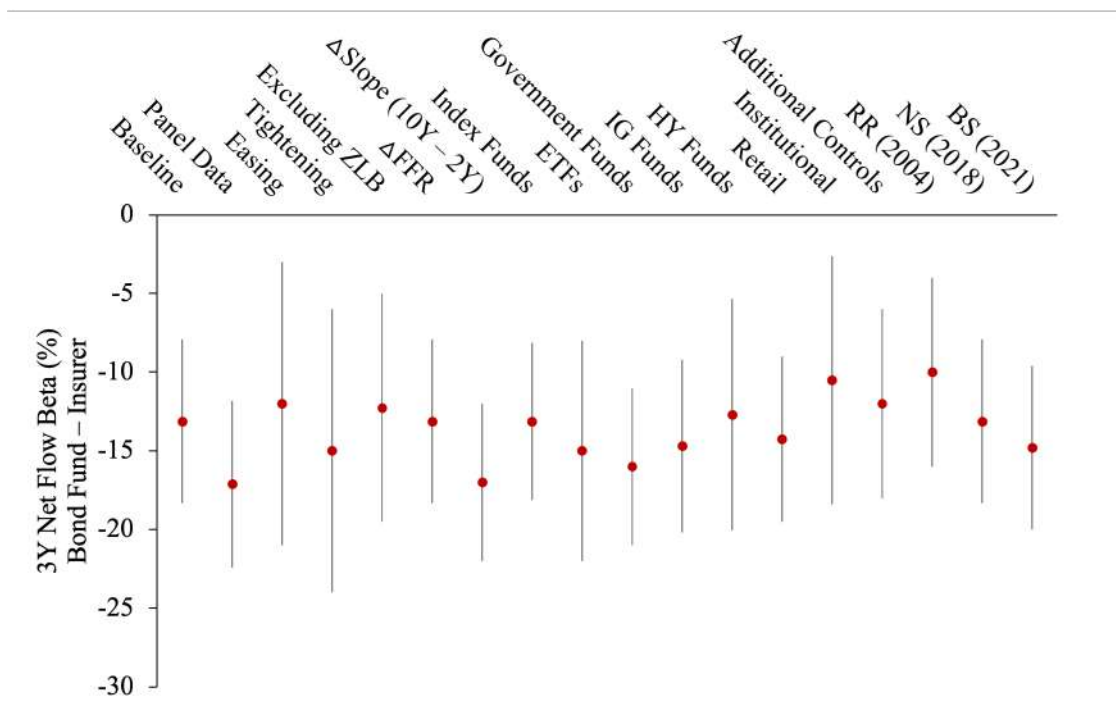
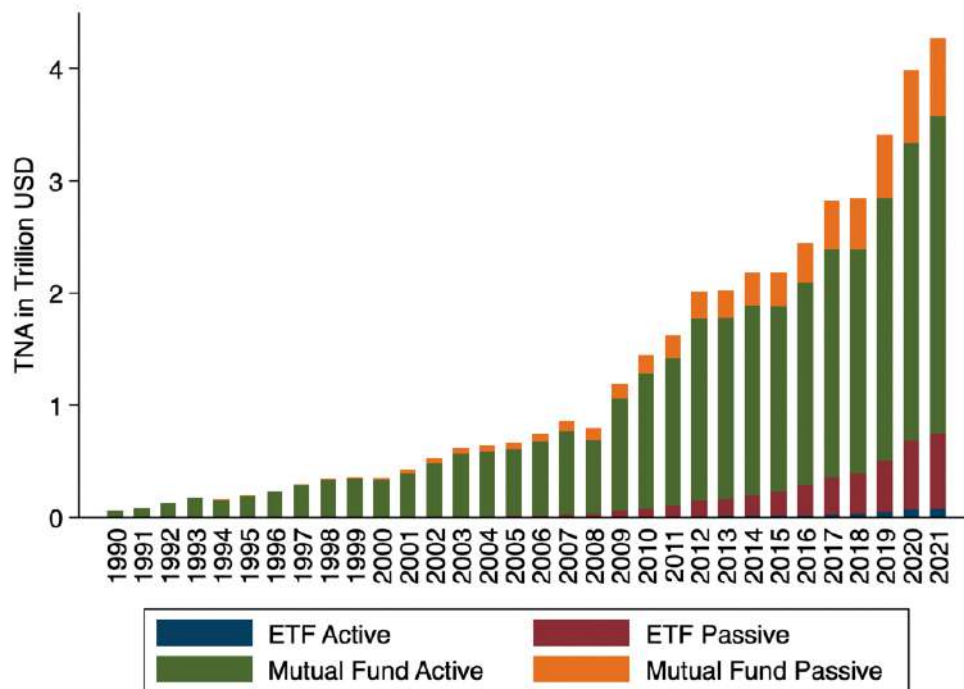
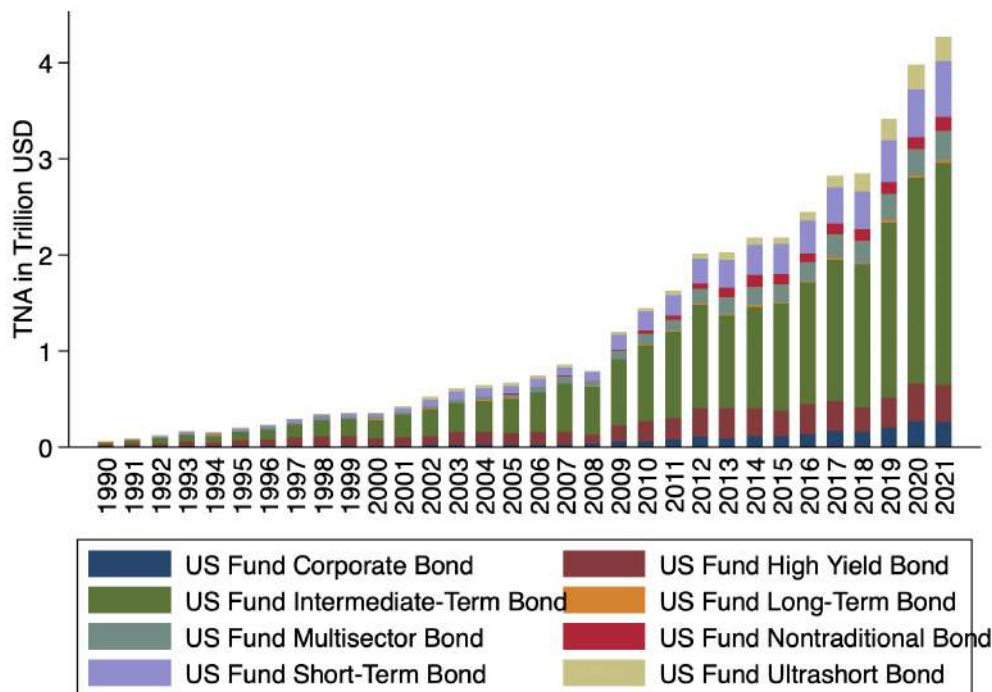


Figure A5: **Composition of Bond Funds.**

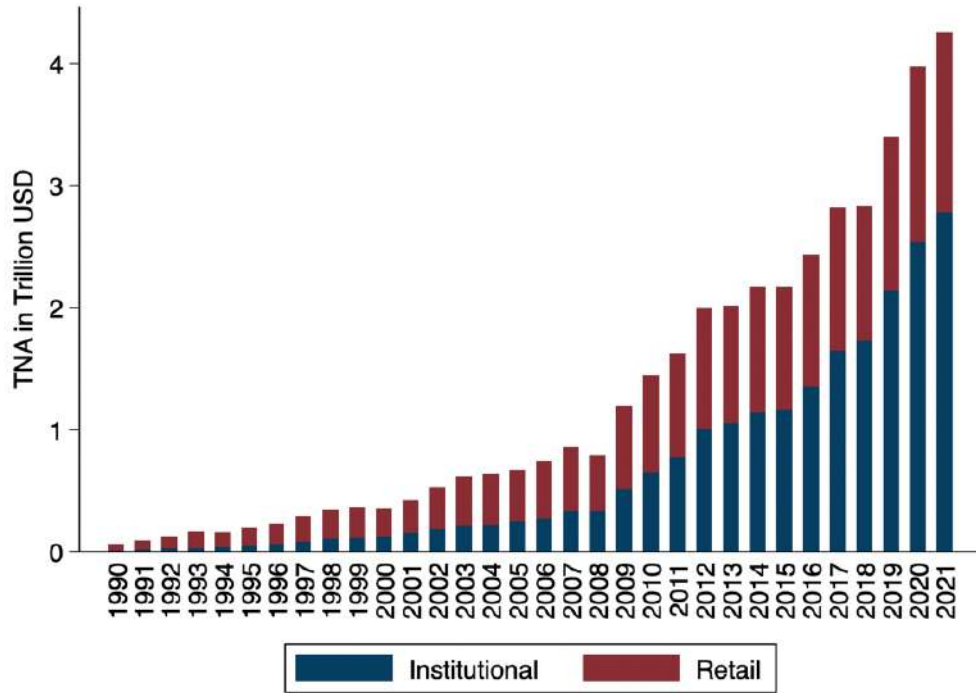
Panel A: By Type



Panel B: By Style



Panel C: By Share Class



Panel D: By Owners

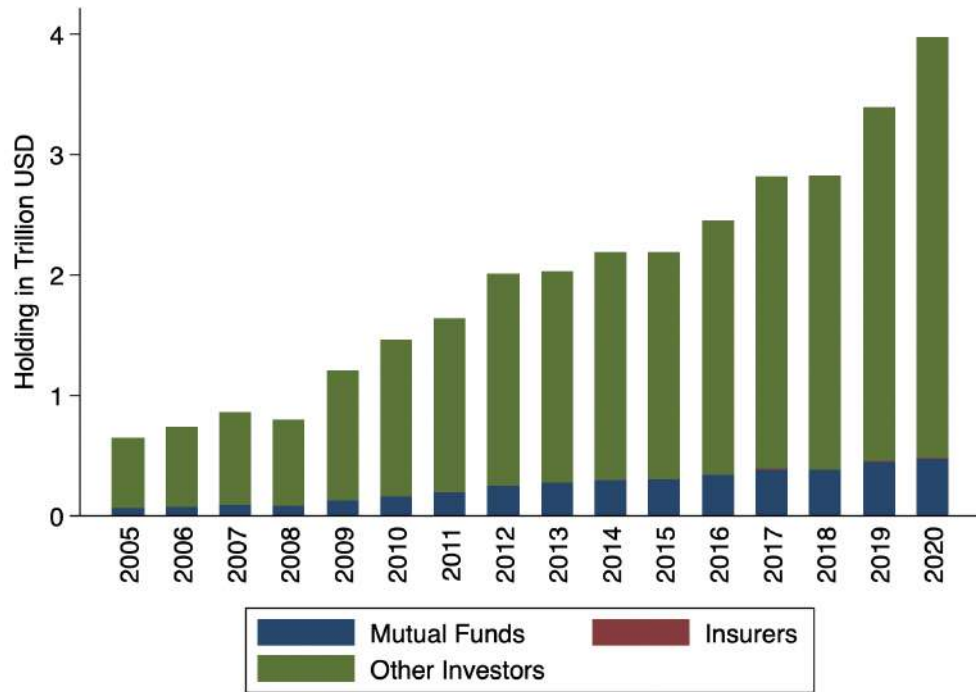
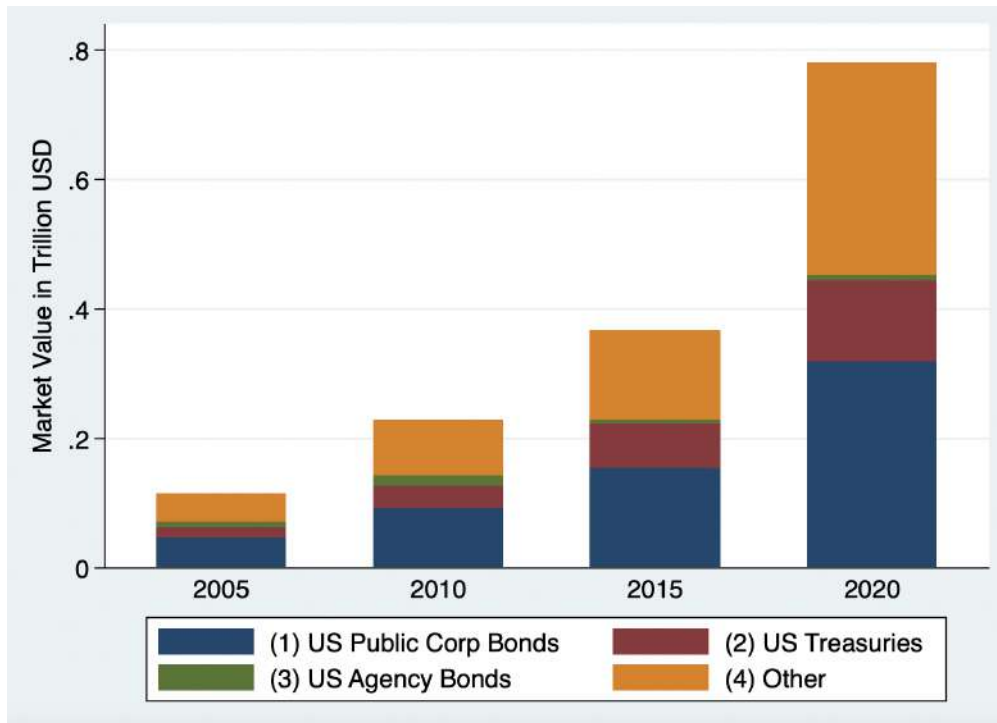
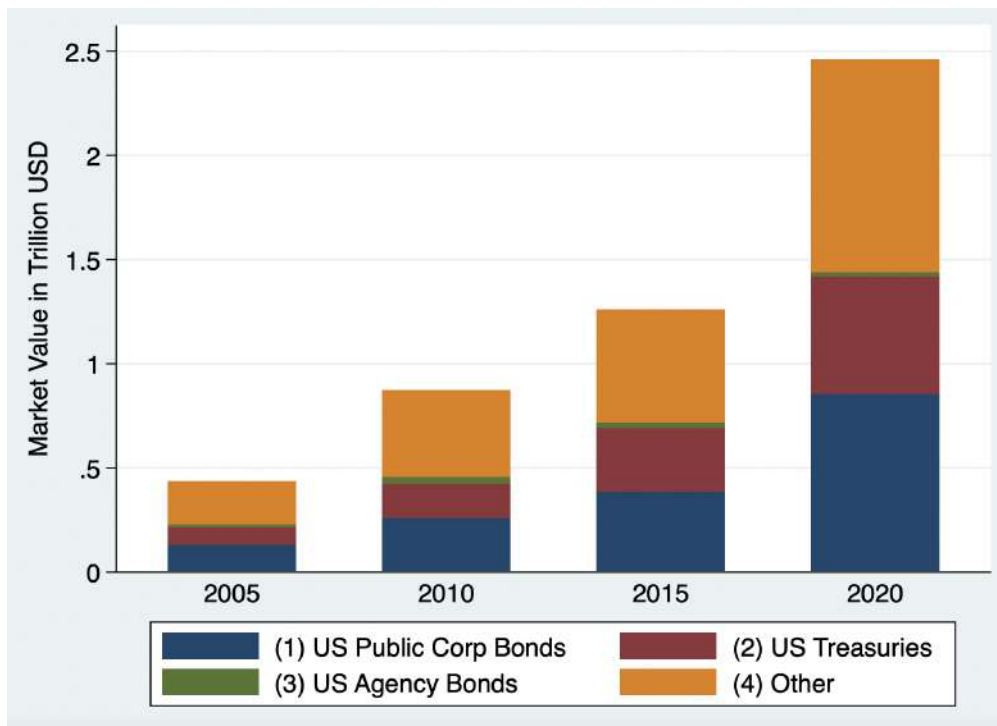


Figure A6: Holdings by Bond Funds and Insurance Companies.

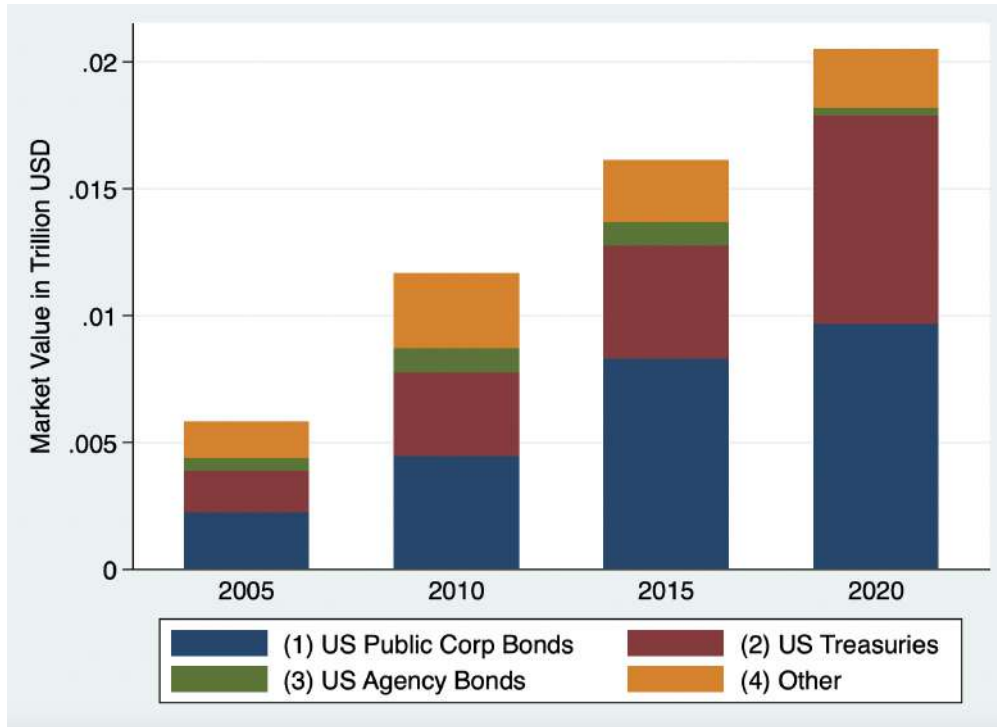
Panel A: General Short-Term Bond Funds



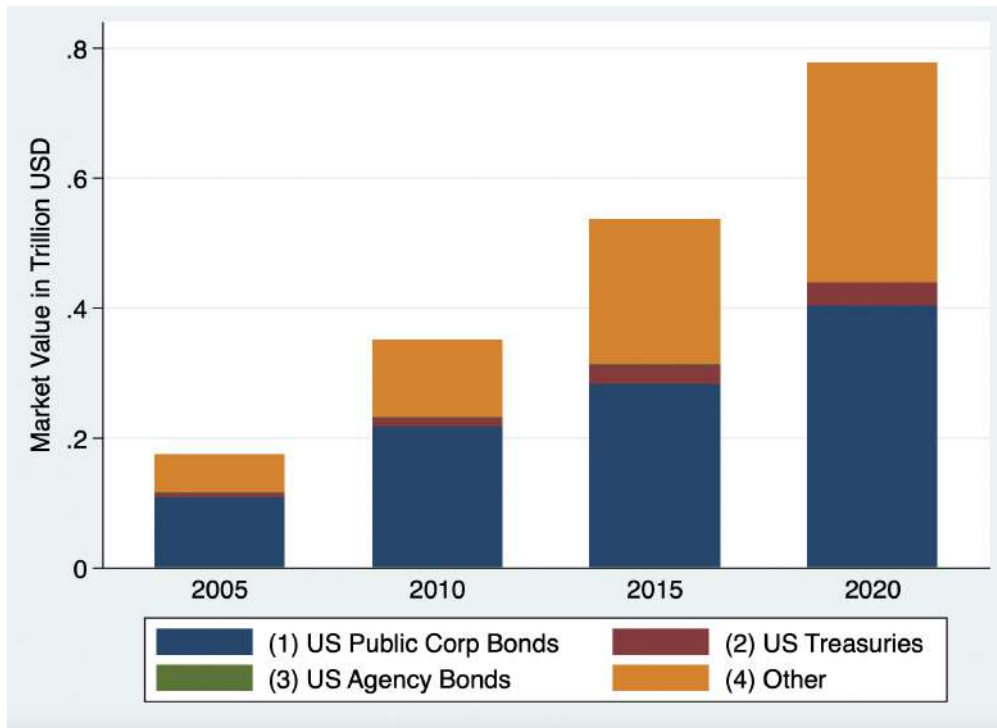
Panel B: General Medium-Term Bond Funds



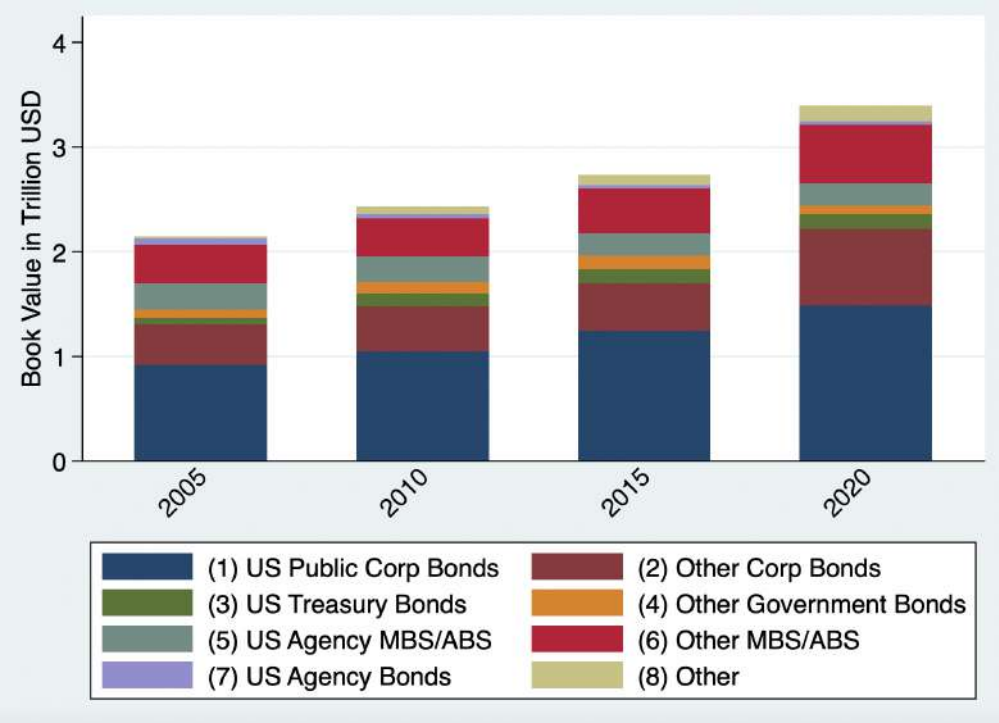
Panel C: General Long-Term Bond Funds



Panel D: High-Yield Bond Funds



Panel E: Life Insurers



Panel F: P&C Insurers

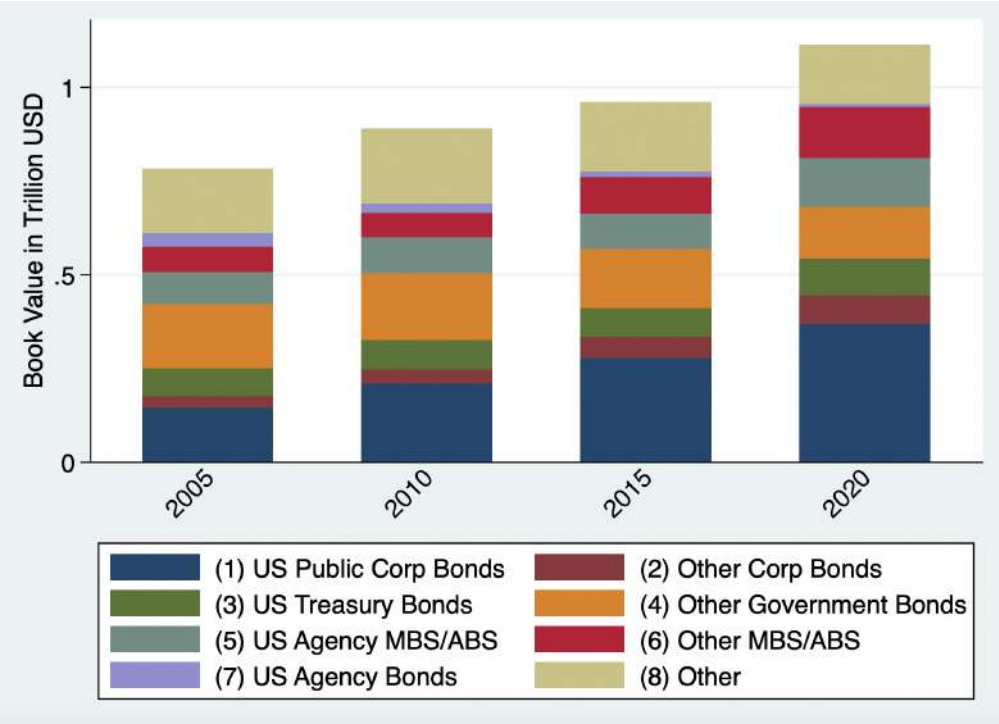
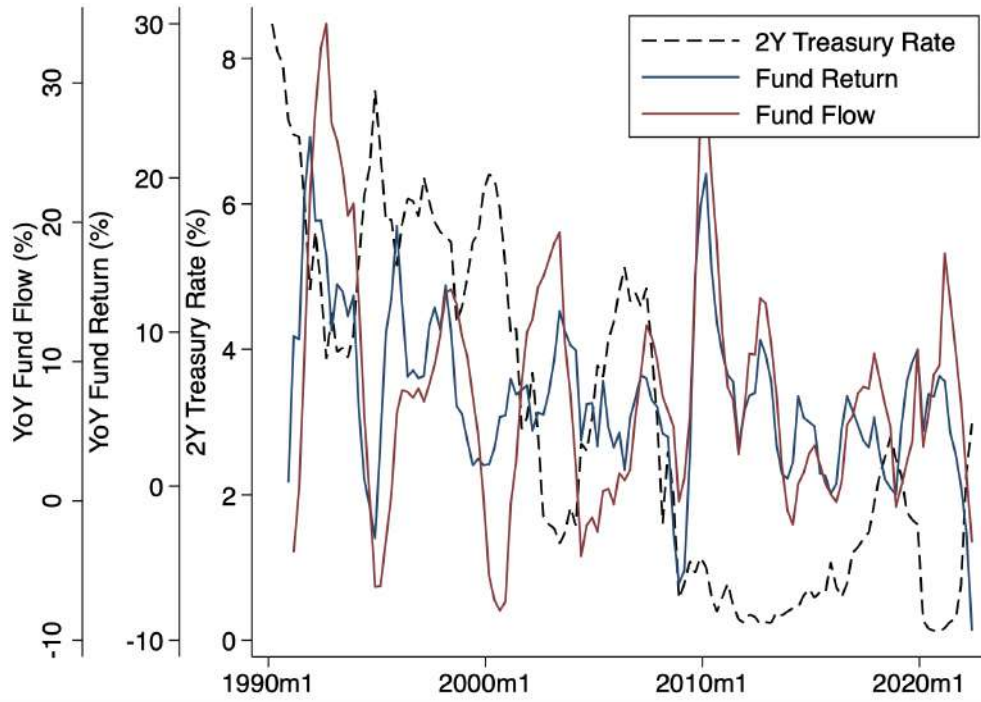
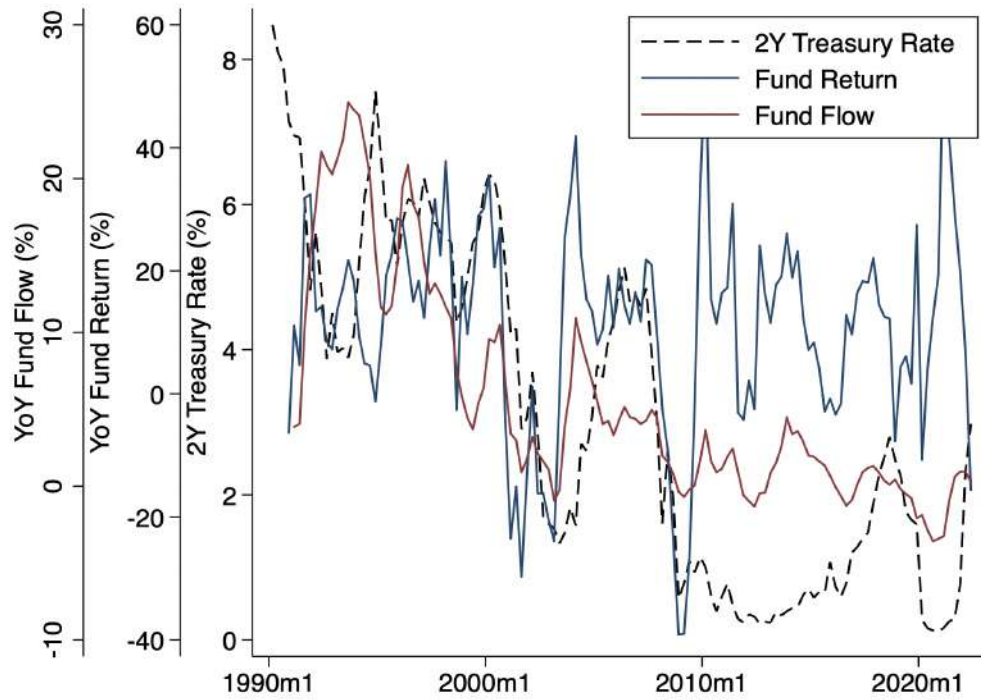


Figure A7: Monetary Sensitivity across Mutual Fund Classes, Time Series.

Bond Funds



Equity Funds



### Money Market Funds

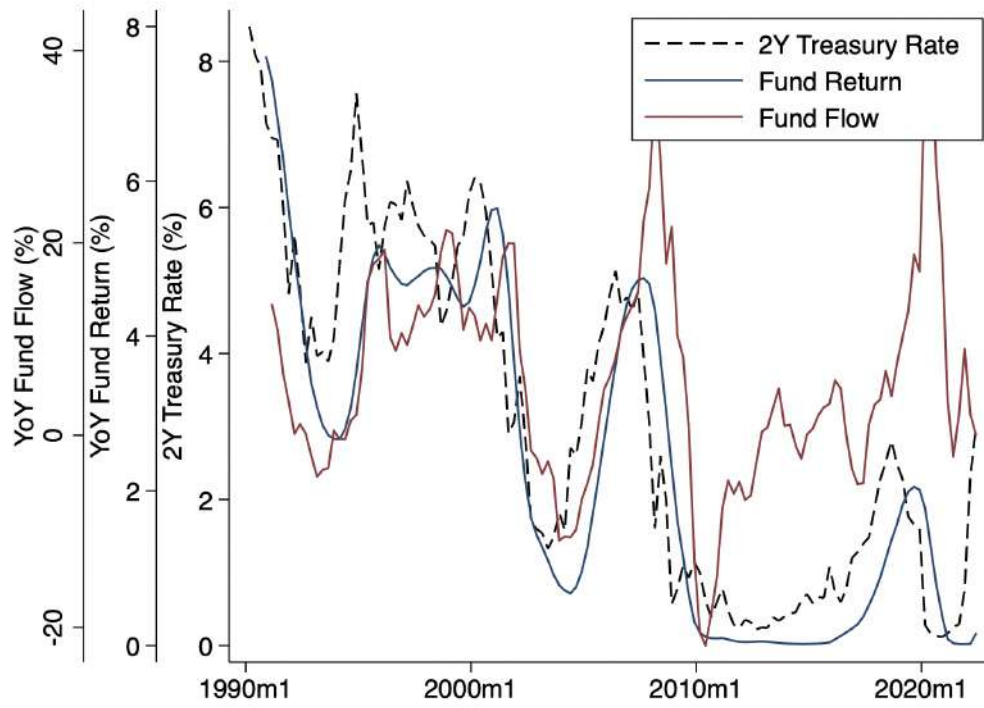


Figure A8: **Monetary Sensitivity across Mutual Fund Classes, Local Projections.** The figure plots the three-year responses of aggregate flows to various classes of mutual funds to 1 p.p. decrease in two-year Treasury rate with 95% confidence intervals, estimated from Equation (2).

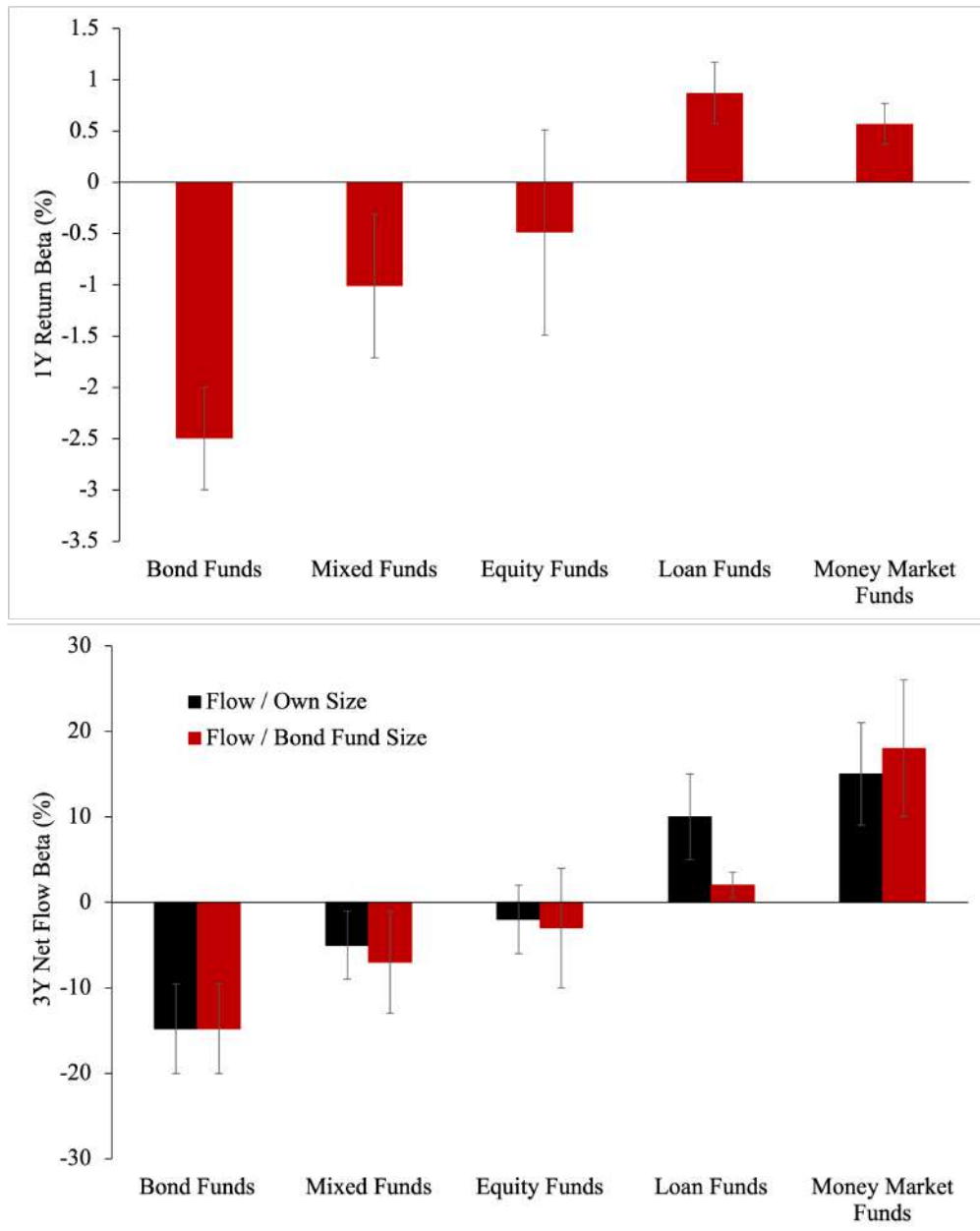


Figure A9: Investor Base Concentration.

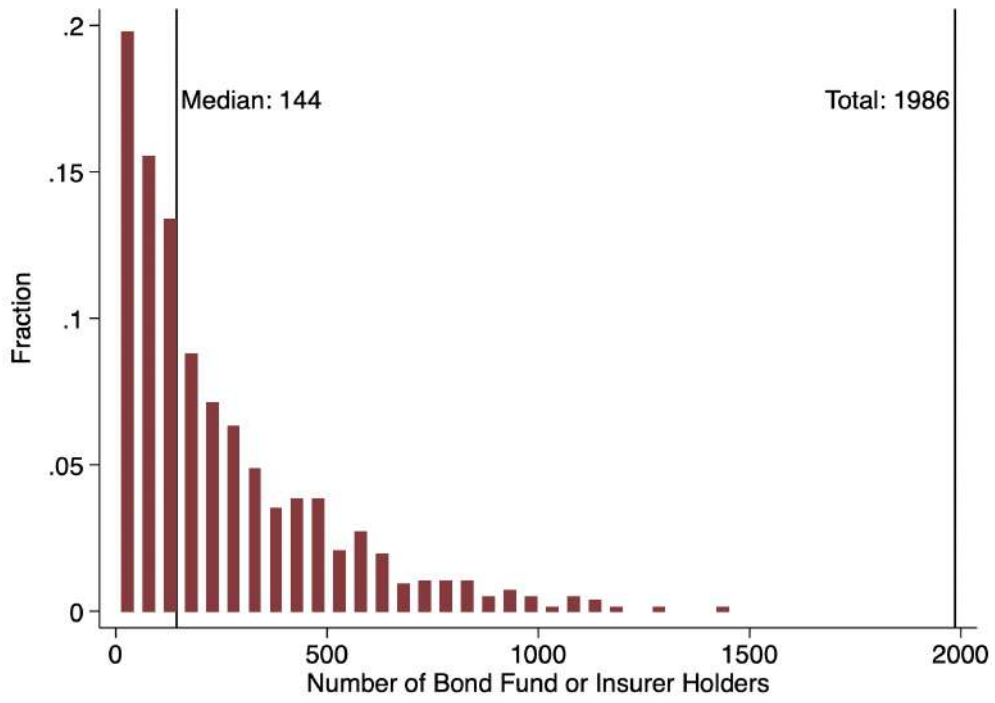
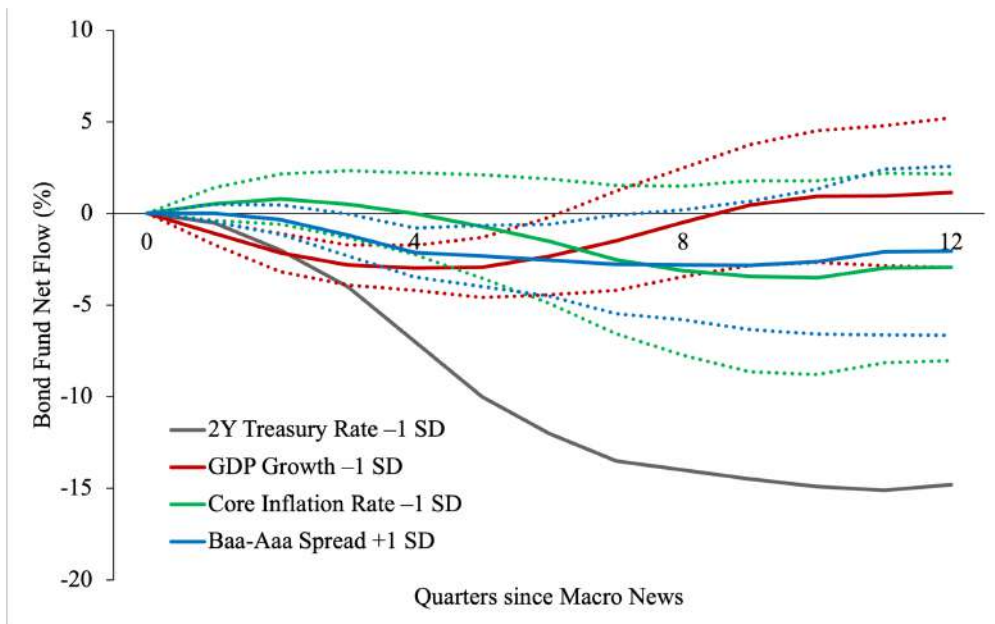
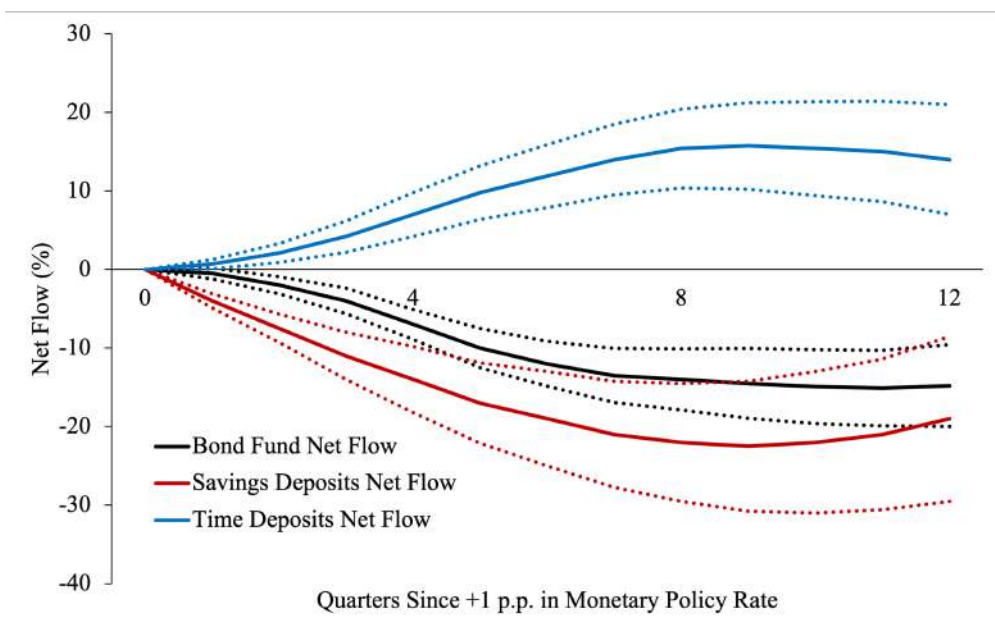


Figure A10: **Additional Local Projections.**

Panel A: Macro News and Bond Fund Flows



Panel B: Bank Deposit Flow



Panel C: Bank C&I Lending

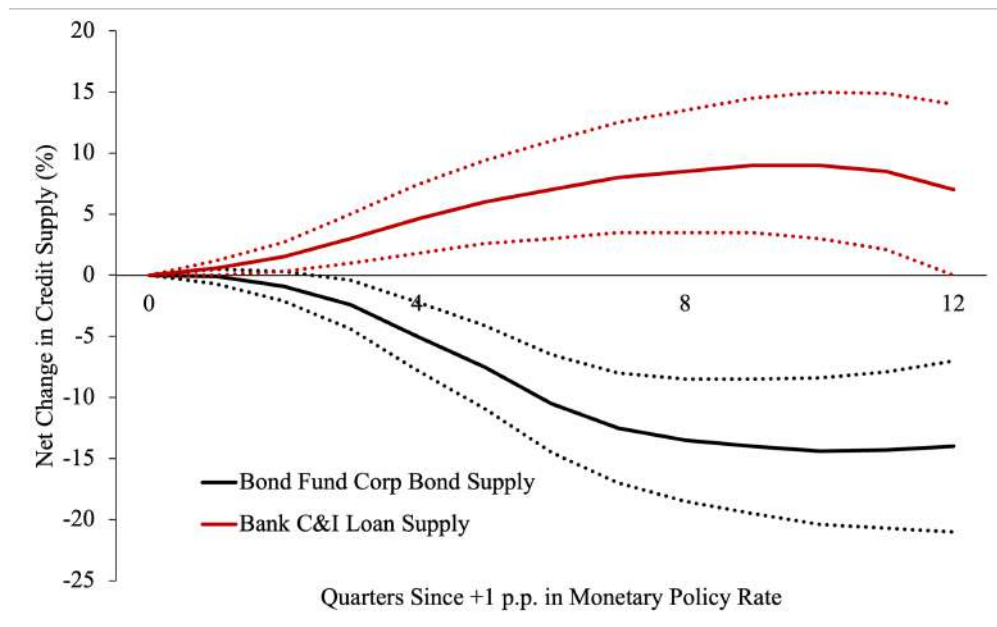


Table A1: **Monetary Sensitivity across Bond Funds.** These tables show what determines flow beta in the cross section of bond funds from Equation (3). t-statistics are reported in parentheses. \*, \*\*, and \*\*\* denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Baseline

Dependent Variable	Fund Flow (%)	
$\Delta\text{Rate} \times \text{Rating}$	-0.50 (-0.91)	-0.63 (-1.22)
$\Delta\text{Rate} \times \text{Macaulay Duration}$	-3.34*** (-3.91)	-3.09** (-2.01)
$\Delta\text{Rate} \times \text{Income Yield}$	-1.03 (-1.20)	-1.25* (-1.71)
$\Delta\text{Rate} \times \text{Yield to Maturity}$		0.15 (0.34)
Controls	$\Delta\text{Rate} \times (\text{Log TNA, Expense Ratio, Turnover, Return Alpha, Return Vol, Cash Ratio})$	
Fixed Effects	Fund FE and Style $\times$ Quarter FE	
Standard Errors	Twoway-Clustered by Fund and Quarter	
Observations	93216	29253
R2	0.15	0.12

Panel B: Horse Race

Dependent Variable	1Q Flow	3Y Flow
Mcaulay Duration vs Rating	-0.36*** (-4.97)	-3.34*** (-3.59)
Mcaulay Duration vs Income Yield	-0.30*** (-2.81)	-2.81* (1.93)
Mcaulay Duration vs Yield to Maturity	-0.48** (-1.99)	-3.14** (-2.57)

Panel C: Retail vs Institutional Share Class Flow

Dependent Variable	Total Flow	Retail Flow	Institutional Flow
$\Delta$ Rate $\times$ Rating	-0.05 (-0.97)	-0.03 (-0.25)	-0.05 (-1.49)
$\Delta$ Rate $\times$ Macaulay Duration	-0.41*** (-5.73)	-0.37*** (-4.02)	-0.45*** (-6.29)
$\Delta$ Rate $\times$ Income Yield	-0.11* (-1.69)	-0.19** (-2.02)	-0.03 (-0.25)
Controls	$\Delta$ R $\times$ (Log TNA, Expense Ratio, Turnover, Return Alpha, Return Vol, Cash Ratio)		
Fixed Effects	Fund FE and Style $\times$ Quarter FE		
Standard Errors	Twoway-Clustered by Fund and Quarter		
Observations	99163	93501	95239
R2	0.22	0.24	0.20

Table A2: Cross-Sectional Bond Sensitivity to Monetary Policy, Robustness.

## Easing vs Tightening

Dependent Variable	1Y Return (%)		
$\Delta$ Rate Hike $\times$ Bond Fund Ownership	-0.36*** (-2.96)	-0.41*** (-2.70)	-0.39** (-2.41)
$\Delta$ Rate Drop $\times$ Bond Fund Ownership	-0.25** (-2.51)	-0.32** (-2.23)	-0.30** (-2.00)
Rating $\times$ Maturity $\times$ Quarter FE	Y	Y	Y
Macro News $\times$ Bond Fund Ownership	Y	Y	Y
$\Delta$ Rate $\times$ Bond Characteristics		Y	Y
$\Delta$ Rate $\times$ Issuer Characteristics			Y
Standard Errors	Two-way Clustered by Bond and by Quarter		
Observations	148127	148127	148127
R2	0.59	0.63	0.63

## Same Issuer, Different Bonds

Dependent Variable	1Y Return (%)	
	Full	Tightening Only
$\Delta$ Rate $\times$ Bond Fund Ownership	-0.10 (-1.45)	-0.16* (-1.81)
Rating $\times$ Duration $\times$ Quarter FE	Y	Y
Macro News $\times$ Bond Fund Ownership	Y	Y
$\Delta$ Rate $\times$ Bond Characteristics	Y	Y
Issuer $\times$ Quarter FE	Y	Y
Standard Errors	Two-way Clustered by Bond and by Quarter	
Observations	91260	36235
R2	0.67	0.62

Same Issuer, Different Bond Fund Ownership over Time

Dependent Variable	1Y Return (%)		
$\Delta\text{Rate} \times \text{Bond Fund Ownership}$	-0.35*** (-2.79)	-0.41* (-1.92)	-0.40* (-1.90)
Rating $\times$ Maturity $\times$ Quarter FE	Y	Y	Y
Macro News $\times$ Bond Fund Ownership	Y	Y	Y
$\Delta\text{Rate} \times \text{Bond Characteristics}$		Y	Y
$\Delta\text{Rate} \times \text{Issuer Characteristics}$			Y
$\Delta\text{Rate} \times \text{Issuer Dummies}$	Y	Y	Y
Standard Errors	Two-way Clustered by Bond and by Quarter		
Observations	148127	148127	148127
R2	0.59	0.63	0.63

Same Firm, Different Exposure due to Predicted Bond Fund Flows

Dependent Variable	1Y Return (%)		
Instrumented $\Delta\text{Rate} \times \text{BFOwnership}$	-0.27* (-1.93)	-0.45* (-1.60)	-0.41 (-1.56)
Rating $\times$ Maturity $\times$ Quarter FE	Y	Y	Y
Macro News $\times$ Bond Fund Ownership	Y	Y	Y
$\Delta\text{Rate} \times \text{Bond Characteristics}$		Y	Y
$\Delta\text{Rate} \times \text{Issuer Characteristics}$			Y
$\Delta\text{Rate} \times \text{Issuer Dummies}$	Y	Y	Y
Standard Errors	Two-way Clustered by Bond and by Quarter		
Observations	148127	148127	148127
R2	0.65	0.68	0.69
First Stage F-statistic	39.66	39.66	39.66

Issuance Yield

Dependent Variable	Issuance Yield (bps)		
$\Delta$ Rate $\times$ Bond Fund Ownership	4.36*** (2.87)	4.97** (2.07)	4.83* (1.94)
Rating $\times$ Maturity $\times$ Quarter FE	Y	Y	Y
Macro News $\times$ Bond Fund Ownership	Y	Y	Y
$\Delta$ Rate $\times$ Bond Characteristics		Y	Y
$\Delta$ Rate $\times$ Issuer Characteristics			Y
Standard Errors	Two-way Clustered by Bond and by Quarter		
Observations	6181	6181	6181
R2	0.73	0.79	0.80

Table A3: Cross-Sectional Firm Sensitivity to Monetary Policy, Robustness.

Easing vs Tightening

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Capital Expenditure
Average Monetary Sensitivity	-5.96	-3.90	-2.63	-2.89	-3.07
$\Delta$ Rate Hike $\times$ BF Ownership	-3.15* (-1.95)	-1.41** (-2.12)	-0.95 (-1.47)	-1.21* (-1.70)	-0.43 (-0.60)
$\Delta$ Rate Drop $\times$ BF Ownership	-3.02* (-1.87)	-1.17* (-1.85)	-1.00 (-1.54)	-0.79 (-1.35)	-0.95 (-0.88)
Controls	Macro News $\times$ Bond Fund Ownership, $\Delta$ Rate $\times$ Firm Attributes				
Fixed Effects	Firm FE, Industry $\times$ Time FE				
Standard Errors	Two-way Clustered by Firm and by Time				
Observations	35372	35372	34546	34546	34546
R2	0.30	0.32	0.22	0.40	0.57

Same Firm, Different Exposure due to Predicted Bond Fund Flows

Dependent Variable (% of Bond Outstanding)	Gross Bond Issuance	Net Bond Issuance	Net Debt Issuance	Net Equity Payout	Capital Expenditure
Average Monetary Sensitivity	-5.96	-3.90	-2.63	-2.89	-3.07
Instrumented $\Delta$ Rate $\times$ BFO	-3.25* (-1.95)	-1.20 (-1.56)	-1.01* (-1.71)	-0.62 (-1.03)	-0.20 (-0.29)
Controls	Macro News $\times$ Bond Fund Ownership, $\Delta$ Rate $\times$ Firm Attributes, $\Delta$ Rate $\times$ Firm FE				
Fixed Effects	Firm FE, Industry $\times$ Time FE				
Standard Errors	Two-way Clustered by Firm and by Time				
Observations	35372	35372	34546	34546	34546
R2	0.36	0.39	0.26	0.44	0.61
First Stage F-statistic	46.11	46.11	46.11	46.11	46.11

Change in Cash Holdings

Dependent Variable	3Y Change in Cash Holdings (%)		
Average Monetary Sensitivity	0.53		
$\Delta$ Rate $\times$ Bond Fund Ownership	0.12 (0.50)	0.03 (0.20)	0.09 (0.34)
Firm FE	Y	Y	Y
Quarter FE	Y		
Rating $\times$ Quarter FE		Y	
Industry $\times$ Quarter FE			Y
Controls	Macro News $\times$ Bond Fund Ownership, $\Delta$ Rate $\times$ Firm Attributes		
Standard Errors	Two-way Clustered by Firm and by Quarter		
Observations	35372	35372	35372
R2	0.47	0.52	0.55

Table A4: Bond Sensitivity to Monetary Policy by Rating and Duration.

Dependent Variable	1Y Yield / 1Y Return Sensitivity to Monetary Policy					
Rating \ Duration	3-5	5-7	7-9	9-11	11-13	13-15
AAA	0.50 -2.13	0.50 -2.95	0.31 -3.35	0.29 -3.68	0.29 -4.61	
AA	0.44 -1.72	0.38 -2.17	0.32 -2.30	0.22 -2.09	0.37 -2.69	
A	0.37 -1.41	0.30 -1.64	0.29 -1.84	0.25 -2.00	0.11 -2.66	0.12 -2.14
BBB	0.24 -1.07	0.12 -1.17	0.11 -1.16	0.15 -1.30	0.11 -1.65	0.08 -1.51
BB	-0.21 1.06	-0.23 1.04	-0.08 0.72	0.00 -0.03		
B	-1.36 2.28	-0.74 1.83	-0.67 1.61	-0.15 1.59		
CCC	-3.19 5.51	-2.15 5.87	-1.98 4.48			

## Appendix B Additional Details on Data and Variables

### B.1 Mutual fund data

#### B.1.1 Correct errors

There are errors on total net assets, returns and expense ratios in the CRSP Survivor-Bias-Free US Mutual Fund Database. I closely follow the cleaning procedures in Ľuboř Pástor et al. (2015). In particular, I merge CRSP with Morningstar at the share class level using CUSIP and then ticker, manually check all cases where there are inconsistencies between the two databases, and set CRSP values to those in Morningstar if I can confirm that CRSP values are errors, or missing if I cannot. Common errors in CRSP include: TNA is reported in dollar instead of in million, TNA is copied from a previous month, and return is reported on a wrong decimal basis.

#### B.1.2 Consolidate share classes to funds

A fund can have multiple share classes, representing different target investors (e.g., retail vs institutional). The convention is to conduct analysis at the fund level, since all share classes of the same fund have identical gross returns and very correlated flows. In CRSP, share classes are identified by “fundno” and funds are identified by “portno”. CRSP provides a mapping between the two, which I use to consolidate returns, flows, and other statistics at the fund level.<sup>32</sup> Note that for most money market funds, holdings are not available and therefore “portno” is not assigned.

#### B.1.3 Return-implied fund rating and fund duration

For my analysis on the cross section of bond funds, I need rating and duration for a given fund at a given time, which are not directly available in CRSP. One option is to calculate these quantities using portfolio holdings. However, for a lot of the bonds held by bond funds, such as agency securities, foreign bonds and private placements, there is no readily available data. For a typical bond fund in my sample, only 46% of its holdings have ratings, and only 32% of its holdings have information on coupon, maturity and price so that duration can be calculated. In addition, fund holdings are available only starting in 2005.

Therefore, in this paper, I formulate a strategy to estimate fund rating and fund duration using fund returns, which are available on a consistent basis and in high quality. The idea is that funds with worse rating (longer duration) should have higher return betas to changes in

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<sup>32</sup>Because of changes in data provider, there was a change of “portno” for most of the funds in 2010. To account for that, I use the most recent “portno” as the identifier for a fund.

the level of credit spreads (changes in the level of interest rates). Specifically, first, I calculate returns on zero-coupon U.S. Treasury bonds of different maturities (1 year to 30 years) and I take the first principal component to represent changes in the level of interest rates. Then, I calculate return spreads of portfolios of corporate bonds over duration-matched U.S. Treasury bonds and I take the first principal component to represent changes in the level of credit spread. Given an asset for which I want to estimate duration and rating, I regress its returns on the interest rate factor and the credit spread factor and define the factor loadings as duration and rating. I normalize factor loadings so that a 10-year Treasury bond would have an estimated duration of 10 and a 10-year BBB bond would have an estimated numeric rating of 10.

Table ?? reports portfolio-implied and return-implied fund rating and fund duration across different fund styles. To ensure that the portfolio-implied quantities are reliable, I restrict to portfolios where at least 75% of holdings have the relevant information (e.g. coupon, maturity and price). Return-implied rating and duration are highly correlated with the portfolio-implied ones.

## B.2 Insurance company data

Data on insurance companies are from NAIC statutory filings. Schedule D filings provide bond purchases (Part 3) and bond disposals (Part 4) at the quarterly frequency and holdings (Part 1) at the annual frequency. I infer quarterly holdings from the previous year's holdings and the transactions in between. I hand correct all cases where the inferred holdings are negative.

## B.3 Corporate bond data

I follow Bali et al. (2021) in calculating long-term bond returns. Return on bond  $i$  from end of quarter  $t$  to end of quarter  $t + h$  is:

$$Return_{i,t,t+h} = \frac{Price_{i,t+h} + AccruedInterest_{i,t+h} + Coupon_{i,t,t+h}}{Price_{i,t} + AccruedInterest_{i,t}}$$

I first calculate the daily clean price as the trading volume-weighted average of intraday prices to minimize the effect of bid-ask spreads. I then convert the bond prices from daily to quarterly frequency. Corporate bonds occasionally default prior to reaching maturity. I use the composite default returns from Bali et al. (2021) for these defaulted bonds. Specifically, the composite default returns are -40.17% for defaulting investment-grade issues and -17.67% for defaulting high-yield issues.

There are errors in Mergent FISD. I manually check and correct the following occurrences, which I deem to be abnormal:

- FOREIGN\_CURRENCY is N but OFFERING\_AMT or AMOUNT\_OUTSTANDING is greater than \$100 billion.
- ACTION\_TYPE is I but AMOUNT\_OUTSTANDING is significantly different from OFFERING\_AMT.

## B.4 Firm data

Firm variables are defined as follows, with Compustat data items in *italic*:

- Bond amount outstanding: sum of par amounts of all bonds outstanding from Mergent FISD
- Net debt issuance: long-term debt issuance (*dltis*) minus long-term debt reduction (*dltr*)
- Net equity payout: repurchase of common and preferred stock (*prstk*) minus sale of common and preferred stock (*sstk*) plus dividends (*dvq*)
- Real investment: capital expenditure (*capx*) plus R&D (*xrd*)
- Log total assets: log of total assets (*at*)
- Cash ratio: cash holdings (*che*) divided by total assets (*at*)
- Tobin's Q: debt (*dlc* + *dltt*) plus market value of equity ( $prcc \times csho$ ) minus current assets (*act*) divided by plant, property and equipment (*ppegt*), following Erickson and Whited (2012)
- Total debt: debt in current liabilities (*dlc*) and long-term debt (*dltt*)
- Leverage: total debt to total assets
- Profitability: net income (*ni*) divided by total assets (*at*)
- Bond share: ratio of bond amount outstanding to total debt
- Bond rating: average of bond ratings weighted by amount outstanding
- Bond maturity: average of bond maturity weighted by amount outstanding

# Appendix C Alternative measures of exposure to bond fund flows

## C.1 Bondholder flow beta

As I have shown in Section 4, some bond funds (e.g., those with higher return beta) have significantly higher flow beta than others. Therefore, a corporate bond would have higher exposure to bond fund flows if it is owned more by bond funds (extensive margin) and in particular bond funds with higher flow beta (intensive margin). I construct an alternative measure of bond fund exposure to capture the intensive margin. First, for a given bond fund  $i$ , its flow beta is defined as the expected cumulative three-year flows (relative to its current size) given 1 p.p. decrease in two-year Treasury rate over the next year:

$$FlowBeta_{i,t} = E_t[Flow_{i,t,t+12} \mid \Delta Rate_{t,t+4} = -1\%] = f(X_{i,t}) \quad (15)$$

where the last equality comes from the regression results in Equation (3), which shows that a bond fund's flow beta is non-trivially affected by its characteristics such as return duration. For a firm  $j$ , I define Bondholder Flow Beta as the expected flows to its bond fund bondholders (relative to its bond amount outstanding) given 1 p.p. decrease in two-year Treasury rate:

$$BHFlowBeta_{j,t} = \sum_i \frac{AmountHeld_{i,j,t}}{AmountOutstanding_{j,t}} FlowBeta_{i,t} \quad (16)$$

This measure adapts from the Bondholder Flow measure in Zhu (2021).<sup>33</sup> Suppose that a bond issuer is owned entirely by a single bond fund, then its Bondholder Flow Beta is exactly the flow beta of that bond fund. Suppose that a bond issuer is not owned by any bond fund (e.g., it is owned entirely by insurers), then its Bondholder flow beta is zero.

## C.2 Monetary-induced price pressure

A more complicated definition takes into account the differential scaling of bond fund portfolio in response to flows due to flow direction and liquidity concerns (Lou, 2012; Choi et al., 2020; Ma et al., 2022). Specifically, monetary-induced price pressure is defined as:

$$MIPP_{j,t} = \sum_i \frac{AmountHeld_{i,j,t}}{AmountOutstanding_{j,t}} \times FlowBeta_{i,t} \times ScalingFactor_{i,j,t} \quad (17)$$

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<sup>33</sup>This measure is also similar to Chodorow-Reich (2013) in the context of measuring relationship-based bank lending supply.

where

$$\begin{aligned} \text{ScalingFactor}_{i,j,t} = & 1(\text{FlowBeta}_{i,t} < 0)(0.80 + 0.12 \times \text{LiquidityRank}_{i,j,t}) \\ & + 1(\text{FlowBeta}_{i,t} > 0)(0.58 + 0.20 \times \text{LiquidityRank}_{i,j,t}) \end{aligned}$$

The scaling factor is similarly defined in Lou (2012) and Ma et al. (2022) and captures the differential effect of inflows vs outflows and liquidity on relationship between fund flows and fund trading. As shown in 2, trading is more mechanically linked to outflows than inflows, and bond funds prioritize trading of more liquid bonds, even at the annual frequency.