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Funds of Funds' Portfolio Rebalancing during the COVID-19 Crisis*

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Abstract

During the COVID-19 crisis, large outflows from bond mutual funds disrupted debt markets. We show that "funds of funds"—mutual funds that invest in other mutual funds—accounted for a third of those outflows in March 2020. They rebalanced their portfolios mechanically in response to equity market losses, selling bond funds and purchasing equity funds. While they sold 14 percent of their total bond fund holdings, they concentrated sales in government bond funds, liquidating 34 percent of their holdings, over 100 percent of outflows from these funds. Our findings highlight how mechanical portfolio rebalancing can transmit shocks across markets and generate destabilizing effects.

Keywords: Funds of Funds, Mutual Funds, Portfolio Rebalancing, Bond Fund Outflows, COVID-19 Crisis, Target-Date Funds, Financial Fragility

JEL: G01, G11, G23, G28

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1 Introduction

Debt markets faced major disruptions in March 2020 as the COVID-19 pandemic shook financial markets. That month, bond mutual funds experienced net investor outflows equal to about six percent of their total assets, and their unusually large liquidations played a crucial role.[1] However, it remains unclear which investors were withdrawing from bond funds and why. In this paper, we examine the role of mutual funds that invest in other mutual funds, commonly referred to as "funds of funds." We find that despite experiencing limited redemptions themselves, these intermediaries were responsible for about a third (30 to 35 percent) of all outflows from bond funds in March 2020. Notably, they began withdrawing before other investors, potentially amplifying the market stress.

Why were the funds of funds withdrawing? We find that their behavior reflects a portfolio rebalancing process. These intermediaries typically maintain fixed portfolio allocations between equity funds and bond funds on a monthly basis (for example, 60 percent equity funds, 40 percent bond funds). Equity prices began falling in late February 2020, while bond prices remained relatively stable until mid-March. By then, funds of funds had already faced losses of about 30 percent on their equity fund holdings compared to only 7.5 percent on their bond fund holdings, prompting them to sell bond funds and purchase equity funds to restore their target allocations. These trades generated significant outflows from bond funds that were not directly linked to investor withdrawals, but instead transmitted equity market volatility to bond markets through mechanical rebalancing.

The funds-of-funds landscape has been transformed by target-date funds over the past decade. These funds, which gradually adjust their equity-bond allocations as they approach their target retirement date, now account for about a third of all 401(k) retirement plan assets and represent about 80 percent of all funds of funds (e.g., Mitchell and Utkus (2022) and Parker, Schoar, and Sun (2023)).[2] Driven by growth in target-date funds, total funds of funds assets increased from about $500 billion in 2010 to over $2 trillion by the end of 2023. Their share of all open-end mutual fund assets more than doubled, from about 5 percent to over 10 percent, and the average fund of funds grew to $3.5 billion.

[1] See, e.g., Haddad, Moreira, and Muir (2021), Falato, Goldstein, and Hortaçsu (2021), Ma, Xiao, and Zeng (2022).

[2] Target-date funds are projected to reach half of all 401(k) assets by 2030 (Doyle, 2025).

We document that U.S.-domiciled funds of funds (including both target-date and non-target-date funds) share two key characteristics.[3] They predominantly invest in two types of mutual funds: equity funds (65 percent on average) and bond funds (30 percent on average), which themselves invest primarily in equities and bonds respectively. This straightforward structure distinguishes U.S. funds of funds from their European counterparts, which often invest in other funds of funds, creating complex, multi-layered ownership structures (Allaire, Breckenfelder, and Hoerova, 2022). Moreover, funds of funds maintain remarkably stable portfolio allocations on a monthly basis: bond and equity fund allocations exhibit R^2 values of 0.96 and 0.98 respectively when regressed on their prior-month values.

There are four main results. Our first main result quantifies the role of funds of funds during the COVID-19 crisis. Using detailed holdings data combined with daily price information, we estimate that funds of funds sold \$70-80 billion in bond funds in March 2020, representing a third (30-35 percent) of total bond fund outflows of about \$240 billion. As we observe changes in holdings but not transaction prices, we calculate a range based on minimum and maximum daily prices during this period. These bond fund sales far exceeded the outflows that funds of funds themselves experienced: investors redeemed only \$16 billion from funds of funds, less than one percent of their net assets.

Our second main result establishes that mechanical portfolio rebalancing drove these sales. The high persistence in portfolio allocations between equity and bond funds suggests that funds of funds actively rebalance to maintain stable target allocations in response to market movements. To establish this mechanism, we first formalize it using a parsimonious model similar to Parker et al. (2023) and then test its predictions empirically. Fund-level regressions confirm that funds of funds with larger relative losses on equity funds (compared to bond funds) sold more bond funds and purchased more equity funds. Further confirming this rebalancing mechanism, funds of funds maintained their target portfolio allocations throughout the crisis: the high month-to-month persistence observed between February and March 2020 matched that of normal times.

Our third main result compares the behavior of funds of funds to that of other

[3]We do not find significant differences between target-date and non-target-date funds in portfolio composition, allocation persistence, or rebalancing behavior, so we study them together in this paper. See Appendix A for detailed comparisons.

investors, revealing differences in timing, direction, and magnitude. We examine share-class-level flows and find that bond fund share classes that were heavily held by funds of funds (over 15 percent) experienced significantly larger and faster outflows than other share classes within the same fund.[4] The timing difference is striking: outflows from funds-of-funds-heavy share classes began in late February, when equity prices declined but well before bond prices did, while other share classes continued to see inflows until mid-March when bond prices actually fell. This timing pattern holds when we separate bond fund share classes not held by funds of funds into institutional and non-institutional categories following Schmidt, Timmermann, and Wermers (2016): both categories behaved similarly. The contrast across share classes was even starker for equity funds: share classes held by funds of funds experienced net inflows while other share classes experienced net outflows, moving in opposite directions during the same period.

To address the potential selection bias that funds of funds simply choose different types of funds, we estimate regressions with fund-time fixed effects, which compare share classes within the same fund on the same day. These within-fund comparisons reveal substantial differences: bond fund share classes held by funds of funds experienced cumulative outflows six percentage points larger than other share classes in the same fund, while equity fund share classes held by funds of funds saw cumulative inflows four percentage points higher.

Collectively, these differences in timing, direction, and magnitude demonstrate that funds of funds behaved distinctly from other investors in ways consistent with portfolio rebalancing. While we do not identify what motivated other investors' decisions, funds of funds' early bond fund sales, occurring before bond price declines, and their contrarian equity fund purchases align with mechanical rebalancing in response to relative performance across asset classes.

Our fourth main result examines which bond funds were sold by funds of funds. While funds of funds sold about 14 percent of their total bond holdings, they concentrated sales in government bond funds, liquidating 34 percent of those holdings. This pattern reflects a liquidity-driven strategy: when selling large volumes quickly, funds of funds prioritized

[4]Mutual funds typically offer multiple share classes with different fee structures and minimum investments, which are held by different types of investors. For example, institutional share classes have lower fees and higher minimum investments than retail share classes.

the most liquid funds to minimize transaction costs. This behavior parallels the "reverse flight to quality" documented by Ma et al. (2022), where bond funds sold their most liquid assets first during the crisis. Moreover, funds of funds' sales of government bond funds accounted for more than 100 percent (specifically, 139 percent) of all outflows from government bond funds. Thus, a stark divergence in investor behavior emerged during the COVID-19 crisis: Funds of funds liquidated government bond funds to efficiently rebalance their portfolios, while other investors exhibited the usual flight to quality by purchasing these same funds.

Our findings have broad implications for financial stability. While prior research emphasizes how funds of funds can stabilize equity markets through contrarian rebalancing (Parker et al., 2023; Parker and Sun, 2025), we show this comes at a cost: stabilizing one market destabilizes another. During the COVID-19 crisis, funds of funds indeed purchased equity funds, potentially dampening equity declines. However, these purchases were financed by selling bond funds, creating a cross-market transmission channel. This transmission is particularly important for financial stability as bond markets are less liquid than equity markets and thus more vulnerable to selling pressure.

These dynamics create a fundamental tension between individual investor protection and financial stability. For individual investors, funds of funds' discipline in maintaining target allocations ensures promised risk exposures even during turmoil. This practice has acquired systemic importance as funds of funds have grown to over $2 trillion. Funds of funds also concentrate crisis-period sales in government bond funds, minimizing transaction costs for individual investors. But at scale, their concentrated trading channels pressure to Treasury markets that are critical to financial system stability. Our findings suggest that market stabilization efforts must account for mechanical rebalancing alongside redemption pressures, and that financial stability monitoring should track these cross-market linkages as funds of funds continue to grow.

1.1 Related literature

This paper contributes to three key strands of literature: target-date funds and portfolio rebalancing, the role of bond mutual funds in debt market stress at the onset of the COVID-19 pandemic, and fragility of mutual funds and nonbank financial intermediaries.

First, our paper is closely related to a literature on target-date funds and portfolio

rebalancing. Parker et al. (2023) show that rapidly growing target-date funds can have market-wide impacts, emphasizing the role of target-date funds in generating contrarian trading and potentially dampening stock market volatility.[5] Parker and Sun (2025) analyze the effects of target-date funds on stabilizing equity markets during the COVID-19 crisis. While this literature acknowledges the potential for cross-market transmissions from portfolio rebalancing, the economic magnitude and implications of these effects have not been established. We demonstrate that this channel is quantitatively important and has destabilizing effects: funds of funds' mechanical rebalancing accounts for a third of withdrawals from bond funds during the crisis.

Harvey, Mazzoleni, and Melone (2025) develop proxies for portfolio rebalancing and show that they have significant impacts on both equity and bond returns. Drawing on estimates that over $20 trillion is invested in equity and debt across public and private defined benefit and defined contribution pension plans, they show that predictable rebalancing is subject to front running and imposes significant costs on investors (see references therein for other examples of portfolio rebalancing and related studies).[6] We focus specifically on portfolio rebalancing by funds of funds, where we can directly observe rebalancing and quantify the cross-market transmission effects during the COVID-19 crisis. Given the widespread nature of portfolio rebalancing documented by Harvey et al. (2025), our findings likely have broader implications beyond funds of funds.

Second, our paper contributes to a growing literature on the role of bond mutual funds in debt market stress at the onset of the COVID-19 pandemic. Haddad et al. (2021) document extreme disruptions in debt markets during the COVID-19 crisis. They show bond mutual funds played a crucial role in selling off fixed income securities and study the contribution of Federal Reserve programs to stabilizing markets. Falato et al. (2021) show that mutual funds that held illiquid bonds suffered particularly severe stress during the COVID-19 crisis.[7] Ma et al. (2022) also study the effects of sell offs by bond mutual

[5]Earlier literature on target-date funds includes Campbell and Viceira (2002), who provide the theoretical foundation for lifecycle asset allocation, as well as Tang, Mitchell, and Utkus (2012) on 401(k) participant trading during the 2008-09 crisis, and Mitchell and Utkus (2022) on target-date fund growth following the Pension Protection Act 2006. On performance, see Elton, Gruber, de Souza, and Blake (2015), Balduzzi and Reuter (2018), and Brown and Davies (2024).

[6]See also Tuzun (2014), who studies portfolio rebalancing by leveraged and inverse exchange traded funds and shows that their positive-feedback trading behavior amplifies volatility.

[7]Kargar, Lester, Lindsay, Liu, Weill, and Zúñiga (2021) provide a microstructure explanation for the evaporation of corporate bond secondary market liquidity in March 2020, documenting how dealers became reluctant to hold inventory, increasing transaction costs and worsening price declines. Lester (2021) further highlights the role of strained market-making capacity in worsening price distortions.

funds during the COVID-19 crisis. They show that bond funds experiencing a wave of investor redemptions sold their asset holdings in a hierarchy of liquidity starting with their most liquid assets, such as U.S. Treasury securities. Allaire et al. (2022) highlight the contribution of heterogeneity in ownership to mutual funds' fragility. They show that in Europe, institutional investors—particularly funds of funds—drove significant withdrawals from bond funds during the COVID-19 crisis. Further, European funds of funds appear to differ significantly from those in the United States. In Europe, they often invest in other funds of funds creating complex ownership structures. In contrast, U.S. funds of funds invest almost exclusively in non-funds of funds. Our paper studies the role that funds of funds played in U.S. financial markets and provides evidence consistent with a portfolio rebalancing mechanism.

Third, our findings connect to the literature on fragility of mutual funds and nonbank financial intermediaries more generally. The fragility of mutual funds has been well-documented, particularly in cases where coordination failures among investors contribute to large-scale redemptions (Chen, Goldstein, and Jiang, 2010; Schmidt et al., 2016; Goldstein, Jiang, and Ng, 2017; Da, Larrain, Sialm, and Tessada, 2018). Pritsker (2001) and Kodres and Pritsker (2002) provide a broad framework to study financial contagion through multiple mechanisms, including learning from prices about shared risk factors.[8] Our study builds on these insights by examining how funds of funds, as an increasingly important class of nonbank financial intermediaries, contribute to cross-market spillovers through their portfolio rebalancing.

The rest of the paper proceeds as follows. Section 2 provides an overview of the data and describes funds of funds. Sections 3 and 4 present the main empirical results. Section 5 discusses policy implications. Section 6 concludes.

Jiang, Li, Sun, and Wang (2022) show that corporate bonds held by mutual funds with more illiquid assets ex ante suffered more negative returns and larger reversals around March 2020.

[8]The network-based perspective of financial contagion is further explored by Gai and Kapadia (2010), who emphasize how counterparty exposures in financial networks create the potential for systemic spillovers. Antón and Polk (2014) complement these views by showing that common asset holdings among institutional investors generate excess return comovement, reinforcing contagion. More recently, Brunetti, Carl, Gerszten, Scotti, and Shin (2024) illustrate that while financial interconnectedness can stabilize markets under normal conditions, it amplifies systemic stress during crises.

2 Data Overview and Funds of Funds Description

2.1 Data Overview

We use data from Morningstar to analyze the role of funds of funds in financial markets. The methodology for constructing the dataset is detailed in Appendix B, with a complete list of data citations in Appendix B.1. We show our data provide a reliable measure of U.S. mutual fund assets by comparing them with the Z.1 Financial Accounts prepared by the Federal Reserve, see Appendix B.2.

2.2 Description of funds of funds

2.2.1 Definition

To identify funds of funds, we begin with open-end mutual funds that self report as "funds of funds" in Morningstar. The vast majority of these funds hold more than 95 percent of their portfolios in open-end mutual funds. Following Allaire et al. (2022), we focus on funds of funds that hold at least 65 percent of their portfolios in mutual funds. This subset persistently represents more than 85 percent of the assets held by funds that hold other mutual funds, see Appendix B.

Funds of funds have grown substantially in the past decade. Their total net asset market value has risen from about $0.5 trillion at the end of 2010 to more than $2 trillion at the end of 2023, while their share of total open-end mutual fund assets has more than doubled from around 5 percent at the end of 2010 to over 10 percent at the end of 2023 (Figure 1). Over the same period, the number of funds of funds rose from 500 to about 750, implying the average size of each fund of funds grew from $1 billion at the end of 2010 to $3.5 billion at the end of 2023.

A large subset of funds of funds is target-date funds, which grew rapidly in the years since the financial crisis 2007-09 and now account for about 80 percent of all funds of funds, see Figure 2. Most of the growth can be attributed to the increasing popularity of target-date funds, which the Pension Protection Act 2006 sanctioned as default investments in automatic enrollment plans (Mitchell and Utkus, 2022).

In this paper, we do not distinguish between target-date and non-target-date funds and study them together. We do not find significant differences between these types

Figure 1: US-domiciled funds of funds. The denominator for the blue dashed line is all US-domiciled mutual funds. Source: Authors' calculations based on data from Morningstar.

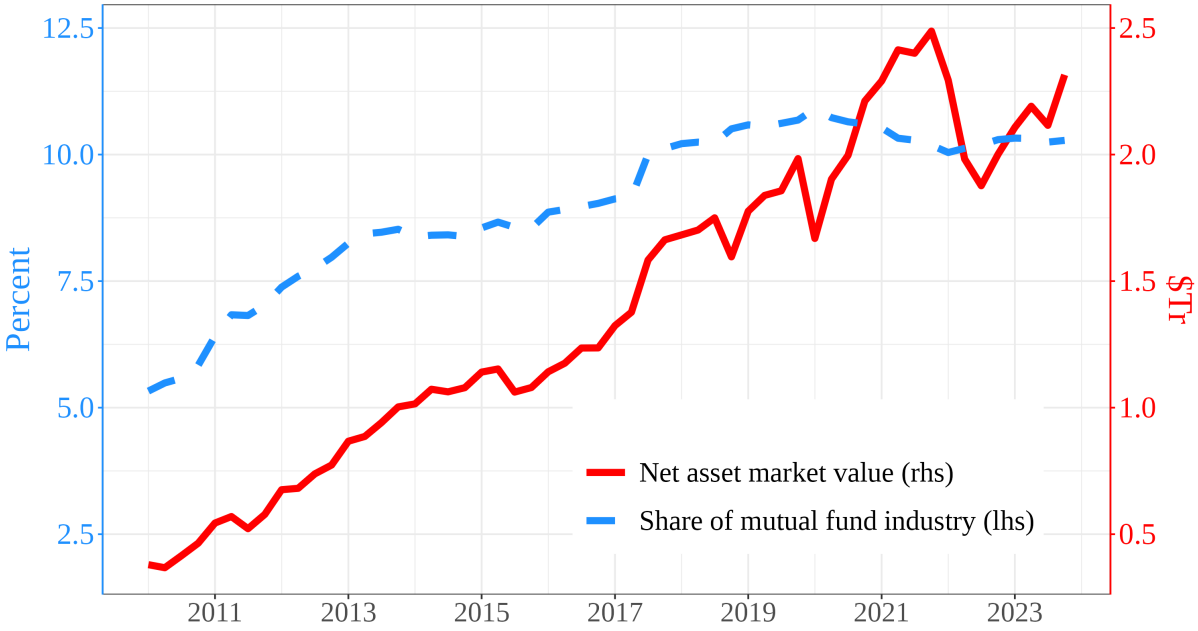
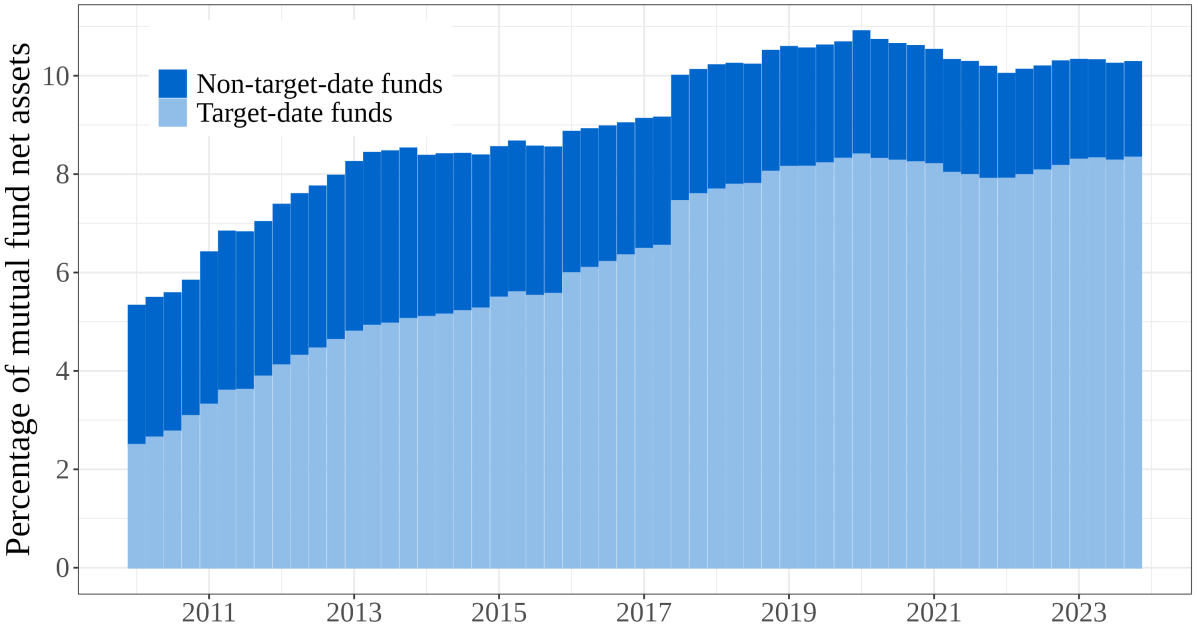


Figure 2: US-domiciled funds of funds as a share of all US-domiciled mutual funds. Source: Authors' calculations based on data from Morningstar.



of funds along the properties that are important for our analysis, i.e., the portfolio allocations to equity and bond funds and the persistence in portfolio allocations. Further, we do not find significant differences in expense ratios. See Appendix A for details.

2.2.2 Funds of Funds' Portfolios

Funds of funds hold on average 13 open-end mutual funds (3 bond funds and 8 equity funds, defined below), with any single holding's maximum weight in the portfolio at about 23 percent.[9] Typically, they invest in mutual funds from their own fund family, which in total account for more than 90 percent of their total assets.[10] The vast majority of mutual funds held by funds of funds are either mainly holding bonds or mainly holding equity, but not both.[11] We define a *bond (equity) mutual fund* as one that has allocated more than 75 percent of its portfolio to bonds (equity) and less than 10 percent of its portfolio to equity (bonds). Bond mutual funds and equity mutual funds account for approximately 95 percent of the market value of most funds of funds' portfolios in the sample. Figure 3 shows the overall share of bond funds and equity funds held by all funds of funds reported at the end of each year. These allocations have remained stable with around 65 percent of funds of funds' portfolios allocated to equity funds and about 30 percent to bond funds.[12]

The funds of funds' holdings we study in this paper appear to differ significantly from funds of funds in Europe as studied by Allaire et al. (2022). They show that European funds of funds often invest in other funds of funds, creating complex ownership structures. In the United States, funds of funds holding other funds of funds is rare. Based on their holdings reported at the end of 2019, we observe only one fund of funds that holds a single other fund of funds.

2.3 Persistence of Bond-Equity Allocations

Funds of funds' portfolio allocations between bond funds and equity funds are persistent at a month-to-month frequency.[13] This fact is evident in scatterplots of bond and equity

[9] See Appendix C for details.

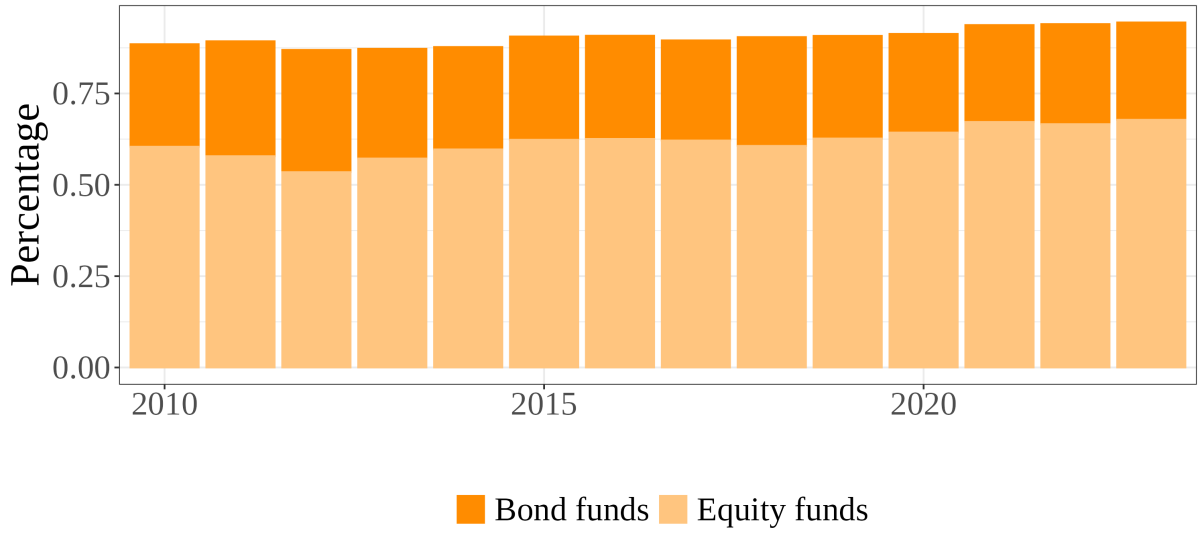
[10] See Figure 11 in Appendix A.

[11] See Figure 18 in Appendix C

[12] Across the distribution of funds of funds the median fund of funds has an equity fund-bond fund allocation ratio of 2.2, see Figure 19 in Appendix C.

[13] Over the long run, funds of funds' portfolio allocations may still evolve over time. For example, target-date funds adjust their allocations over time, following a predictable 'glide path' that gradually

Figure 3: Fund of funds' year-end portfolio allocations to bond mutual funds and equity mutual funds. Source: Authors' calculations based on data from Morningstar.



allocations, Figure 4, which show a tight correlation between current and past monthly allocations, with an R^2 of 0.96 for bond funds and 0.98 for equity funds. Panels (a) and (b) show scatterplots for portfolio allocations to bonds and equity, respectively, with the current monthly allocation on the y-axis and the lagged monthly allocation on the x-axis. Each small black dot represents the end-of-month allocation of a fund of funds' portfolio. The large orange dots are the weighted-averages for each of 20 bins, with each observation within the bin weighted by net asset value.[14] While temporary short positions in bonds or equities occur, these instances are rare and short-lived.[15]

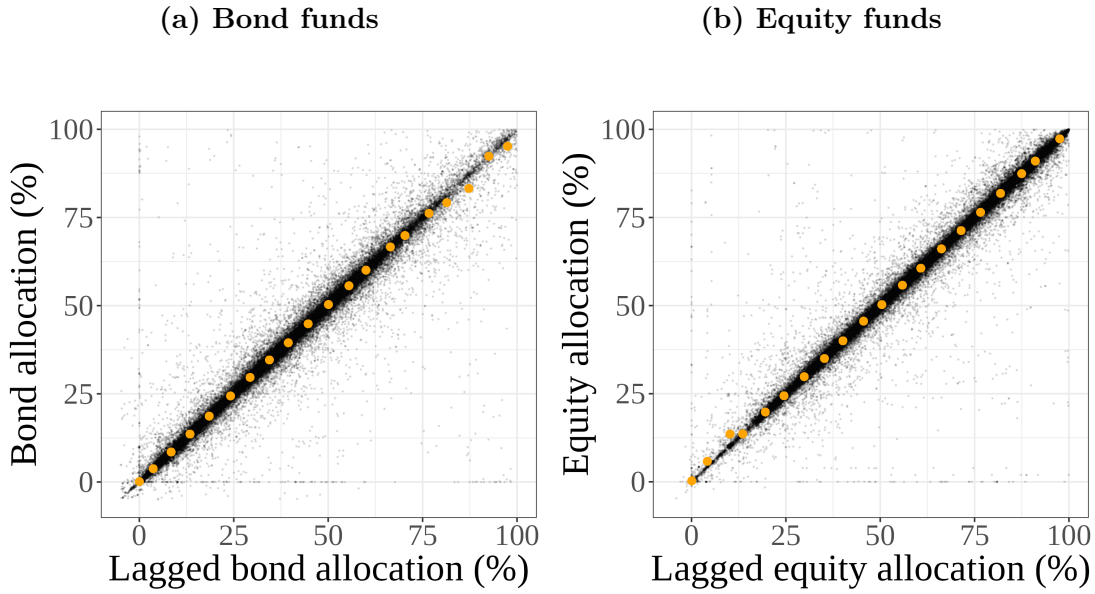
The persistence in portfolio allocations suggests that funds of funds actively engage in mechanical rebalancing in response to market movements. The monthly persistence further implies that many rebalance at least monthly, if not more frequently, although systematic data on rebalancing frequency are not available. Industry sources indicate that many funds of funds also use a threshold-based approach which triggers rebalancing only when allocations deviate from their target weights beyond a set threshold or combine

puts more weight on bond funds relative to equity funds as they approach their target date.

[14]We also prepared scatterplots including March 2020 and without weighting by net asset value and found almost identical results.

[15]Figure 21 in Appendix C.2 shows that, in aggregate, funds of funds' short positions are negligible, amounting to only about one percent of their long positions.

Figure 4: Persistence in fund of funds' portfolio allocations. The unit of observation is a fund of funds in a month. The data cover 2010-2023, excluding March 2020. The large orange dots in each plot show the weighted averages for each of 20 bins, where each observation is weighted by the net asset value of the fund of funds. For legibility, the data are censored at −5 to remove a few observations when funds of funds held short positions. Source: Authors' calculations based on data from Morningstar.



this with periodic rebalancing at fixed intervals.[16]

3 Quantifying FOFs' Sales and Purchases

Disruptions in debt markets in March 2020 as the COVID-19 pandemic shook financial markets and the contribution of sell offs by bond funds are well documented (e.g., Haddad et al. (2021), Falato et al. (2021), and Ma et al. (2022)). Table 1 reports that bond funds suffered substantial outflows in March 2020, which we estimate amounted to about $240 billion withdrawals, equivalent to about six percent of their net asset value as of the end of 2019. Our estimate is similar to that of $264 billion outflows from fixed income mutual funds reported by Ma et al. (2022).

On the other hand, neither equity funds nor funds of funds suffered substantial outflows during this period. Table 1 reports that equity funds experienced outflows of only about $26 billion, equivalent to 0.2 percent of their net asset value as of the end

[16]See e.g., Alliance Bernstein (2024), T. Rowe Price (2024), and Vanguard (2024). Contacts at one large fund family indicated that rebalancing by the end of each month was typical.

Table 1: Summary statistics for fund types. Fund types are mutually exclusive in this table. Bond (equity) funds are those with more than 75 percent of the portfolio allocated to bonds (equity) and less than 10 percent allocated to equity (bonds). Other funds are open-end mutual funds not classed as either equity or bond funds. The initialism 'FOF' means fund of funds. Source: Authors' calculations based on data from Morningstar.

	Fund type			
	Bond	Equity	Other	FOF
Number of funds	1,749	3,625	1,008	756
Net asset value (Dec 2019, $bn)	3,870	11,200	1,511	1,982
NAV held by FOF (Dec 2019, $bn)	535	1,227	83	0
Net flow (Mar 2020, $bn)	-237	-26	-63	-16
Net flow/Net asset value (%)	-6.12	-0.23	-4.14	-0.83

of 2019. Similarly, funds of funds experienced modest outflows of about $16 billion, less than one percent of their net asset value.

We estimate the size of funds of funds' sales and purchases due to portfolio rebalancing by combining their quarterly holdings data with daily price data for each fund held. While we know how many shares each fund of funds bought or sold, we do not know the price for each transaction. Instead, we calculate the transaction values for a range of prices spanning the highest daily price observed during the period to the lowest daily price observed during the period. This calculation provides upper and lower bounds on the values.

We start from the relationship between net flow, net assets, prices, and shares in share class i for a fund given by:

$$\begin{aligned} TNA_1 - (1 + r_1)TNA_0 &= \sum_i p_1 s_{1i} - (p_1/p_0) \sum_i p_0 s_{0i} \\ &= \sum_i p_1 (s_{1i} - s_{0i}) \end{aligned} \tag{1}$$

Denote by $s^m_{j,t}$ the shares of fund $j \in J$ held by fund of funds m in period t. We continue to let $J^B \subset J$ be the subset of all funds that are classed as bond funds and $J^E \subset J$ be the subset classed as equity funds. Then the total value of funds of funds' transactions

(net flow) of bond funds is:

$$\sum_{m} \sum_{j \in J^B} \hat{p}_j (s^m_{j,Mar31} - s^m_{j,Dec31}) \tag{2}$$

where a negative value indicates sales. We calculate estimates based on (i) the maximum daily price, (ii) the minimum daily price, and (iii) the mean daily price for the set of fund prices $\{\hat{p}_j\}_{J^B}$ during the period from December 31, 2019 to March 31, 2020. We calculate similar estimates for the total value of transactions in equity funds $j \in J^E$.

Table 2 reports the estimated purchases and sales for the range of prices. We find that bond fund sales by funds of funds amounted to \$70-80 billion, equivalent to 30-35 percent of the total net outflows in bond funds (reported in Table 1). Those sales financed equity fund purchases amounting to \$20-35 billion as well as \$5-10 billion of other open-end mutual funds. In addition, according to Table 2, funds of funds used the proceeds from selling their bond fund holdings to build their liquidity buffers in cash and money market funds by about \$10 billion. Lastly, funds of funds used the proceeds from selling their holdings of bond funds to meet their own investors' withdrawals amounting to about \$15 billion (see Table 1).

Table 2: Estimated sales/purchases by funds of funds. Bond (equity) funds are those with more than 75 percent of the portfolio allocated to bonds (equity) and less than 10 percent allocated to equity (bonds). Other funds are open-end mutual funds not classed as either equity or bond funds. Transaction prices are the max, min, or mean during the period from Dec 31, 2019 to Mar 31, 2020. The initialism 'MMF' means money market funds. All values are \$bn. A negative (positive) value indicates sales (purchases). Source: Authors' calculations based on data from Morningstar.

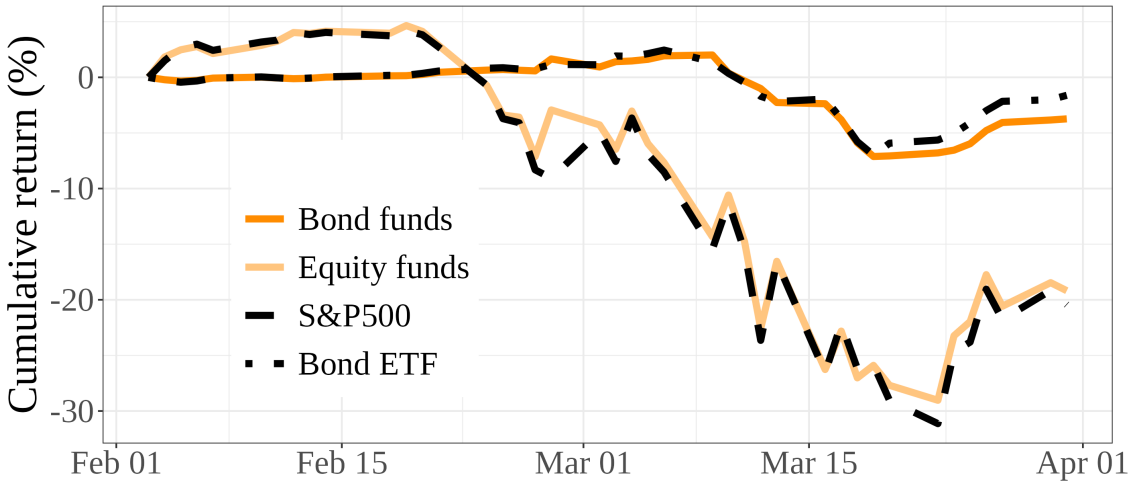
	Transaction price		
	Max	Mean	Min
Bond funds	-80.93	-77.02	-72.98
Equity funds	33.64	30.46	21.80
Other funds	8.47	7.20	4.58
Cash & MMFs	-	8.66	-
Other assets	-	4.16	-

4 Portfolio Rebalancing during the COVID-19 Crisis

4.1 Model of Portfolio Rebalancing

Although equity funds did not suffer substantial withdrawals during the crisis (Table 1) equity prices dropped significantly. Figure 5 shows the scale of the shock to returns on the holdings of funds of funds. Peak losses for equity funds held by funds of funds were around 30 percent while peak losses on bond funds held by funds of funds were only around 7.5 percent. Each line in the figure is a weighted-average cumulative return on the funds held by funds of funds at the end of 2019, where the weights are each individual fund's daily net asset value. For comparison, the figure also shows the cumulative returns on the S&P500 (black dashed line) and Fidelity's Total Bond ETF (black dot-dashed line), which is a broad-based basket of US fixed income securities that includes Treasury securities, Agency securities, and corporate bonds.

Figure 5: Bond and equity fund cumulative returns February—March 2020. The solid lines show the weighted-average daily cumulative returns of equity funds and bond funds for all funds that were held by funds of funds at the end of 2019. The weights in the calculations are each fund's daily net asset market value. The dashed line shows the cumulative return on the S&P500. The dot-dashed line shows the cumulative return on Fidelity's Total Bond ETF, which is a broad-based basket of US fixed income securities. Source: Authors' calculations based on data from Morningstar.



These large drops in equity fund prices, or more importantly, larger losses on equity fund holdings relative to bond fund holdings, may require funds of funds to rebalance

their portfolios significantly. Given that funds of funds strive to maintain their portfolio allocations in the short term, the larger losses in the market value of their equity funds compared to their bond funds imply that funds of funds may need to liquidate their bond fund holdings and purchase equity funds, even though funds of funds did not themselves suffer severe investor outflows.

To clarify the portfolio rebalancing mechanism, we present a parsimonious model similar to that of Parker et al. (2023), which predicts that a fund of funds' portfolio rebalancing is a function of (i) its initial bond:equity portfolio allocation and (ii) returns on its bond funds relative to its equity funds. If a fund of funds wants to keep its portfolio allocation constant, it must rebalance its portfolio in response to equity and bond fund relative returns.

Consider a generic fund of funds with assets under management $\$M$ that has allocated ω fraction of its asset portfolio to equity funds and $1-\omega$ fraction to bond funds. Denote the returns on the equity funds and bond funds held by the fund of funds over a given period of time by r_e and r_b, respectively. Also denote the net flows as a fraction of assets under management by f_l.

At the end of the period, the realized returns alter the market values of the assets and, thus, the portfolio composition. To restore the initial portfolio allocation, the fund of funds needs to change its equity fund holdings by

$$\$\Delta_e = \omega(1+\omega r_e + (1-\omega)r_b + f_l)M - \omega(1+r_e)M = ((r_b - r_e)(1-\omega) + f_l)\omega M. \quad (3)$$

In terms of the fraction of its initial equity holding ($M_e = \omega M$), the change in its equity fund holdings needed to restore the original portfolio allocation will be: $(r_b - r_e)(1-\omega) + f_l$. The amount increases with the return differences between bond and equity funds and the difference becomes even more significant when bonds constitute a larger share of the portfolio. The fund of funds also responds to net flows by adjusting the equity allocation proportionately. We denote the change in the fund of funds' equity holdings divided by its initial equity holdings by $\delta_e = \Delta_e / M_e$.

Similarly, to restore the original portfolio allocation, the fund of funds needs to change

its bond fund holdings by

$$\begin{aligned} \$\Delta_b &= (1-\omega)(1+\omega r_e + (1-\omega)r_b + f_l)M - (1-\omega)(1+r_b)M \\ &= (\omega(r_e - r_b) + f_l)(1-\omega)M = -\$\Delta_e. \end{aligned} \tag{4}$$

In terms of the fraction of its initial bond fund holding, $M_b = (1-\omega)M$, the change in the fund of funds' bond fund holdings needed to restore the original portfolio allocation will be: $\omega(r_e - r_b) + f_l$. We denote the change in the fund of funds' bond holdings divided by its initial bond holdings by $\delta_b = \Delta_b / M_b$.

The main prediction from this parsimonious model of portfolio rebalancing is that $\delta_b = \omega(r_e - r_b) + f_l$ and $\delta_e = (\omega - 1)(r_e - r_b) + f_l$.

4.1.1 Taking the model to the data

We construct changes in bond fund and equity fund holdings (δ_b and δ_e) based only on the bond funds and equity funds, respectively, in each fund of funds' portfolio. Let $x^m_{j,t}$ be the holding of fund of fund m in fund j in period t. For simplicity, assume we have only two periods. Let $J^B \subset J$ be the subset of all funds that are classed as bond funds and $J^E \subset J$ be the subset classed as equity funds.

Dropping the time subscript, as we have only two periods, the change in bond funds held by fund of funds m as a fraction of its total initial holdings is:

$$\delta^m_b \equiv \frac{\sum_{J^B}(x^m_{j,t} - x^m_{j,t-1})}{\sum_{J^B} x^m_{j,t-1}} \tag{5}$$

The realized return on the initial bond funds held by fund of funds m is:

$$r^m_b \equiv \frac{\sum_{J^B} x^m_{j,t-1} \times \left(\frac{p_{j,t} - p_{j,t-1}}{p_{j,t-1}}\right)}{\sum_{J^B} x^m_{j,t-1}}. \tag{6}$$

And the initial bond fund allocation of fund of funds m as

$$\omega^m_b \equiv \frac{\sum_{J^B} x^m_{j,t}}{\sum_J x^m_{j,t}}. \tag{7}$$

For the equity fund holdings of fund of funds m, δ^m_e, r^m_e, and ω^m_e are defined analogously.

With these variables calculated for each fund of funds, we can estimate two cross-

sectional regression specifications, one for bond funds and one for equity funds:

$$\delta_b^m = \alpha_b + \beta_b(\omega_e^m)(r_e^m - r_b^m) + \gamma_b f_l + \epsilon_b^m \tag{8}$$

$$\delta_e^m = \alpha_e + \beta_e(\omega_b^m)(r_e^m - r_b^m) + \gamma_e f_l + \epsilon_e^m \tag{9}$$

The main predictions from the model are $\beta_b > 0$, $\beta_e < 0$, $\gamma_b > 0$, and $\gamma_e > 0$. We can identify these coefficients through cross-sectional variation in the exposures of funds of funds to different funds as well as variation in their initial portfolio allocations to bond and equity funds.

4.2 Testing the Portfolio Rebalancing Mechanism

For each fund of funds m, we use the quarterly holdings data to calculate the total return on its bond funds (r_b^m), the total return on its equity funds (r_e^m), the change in bond funds held as a fraction of its initial holdings (δ_b^m), the change in equity funds held as a fraction of its initial holdings (δ_e^m), the initial share of its portfolio allocated to bond funds (ω_b^m), and the initial share of its portfolio allocated to equity funds (ω_e^m) as described in subsection 4.1.1. We also calculate the net flow of investments in March 2020 divided by total net assets at the end of 2019 ($Flow/Assets^m$). Table 9 in Appendix D.2 reports summary statistics for all the variables used in the regressions. The unit of observation is a fund of funds. Based on the reported statistics, there is substantial variation in δ_b^m and δ_e^m. A key prediction of the rebalancing mechanism is that the variation in actual bond fund sales (δ_b^m) and equity fund sales (δ_e^m) should be driven in part by variation in bond rebalancing ($\omega_e^m(r_e^m - r_b^m)$) and equity rebalancing ($\omega_b^m(r_e^m - r_b^m)$), respectively. We label these right-hand side variables as $BondRebalancing^m$ and $EquityRebalancing^m$, respectively, for simplicity.

Table 3 presents the results from estimating regression specifications 8 and 9. Columns 1 and 3 report the baseline results. Consistent with the theoretical rebalancing mechanism, the coefficients on the key right-hand side variables are statistically and economically significant. A one standard deviation decrease in those variables corresponds to an eleven percentage point decrease in the market value of bond funds and a three percentage point increase in the market value of equity funds held by a fund of funds. We report heteroskasticity-robust standard errors throughout the table.

Table 3: Testing the rebalancing mechanism. The unit of observation is a fund of funds. The left-hand side variable is the percent change in the market value of bond funds (δ_b^m) or equity funds (δ_e^m) held. The main right-hand side variables are the product of the allocation to equity (ω_e^m) or the allocation to bonds (ω_b^m) and the return to the funds' equity holdings net of the funds' return to its bond holdings over the period from Dec 31, 2019 and Mar 31, 2020 ($r_e^m - r_b^m$). Robust standard errors are reported in parentheses. *p<0.1; **p<0.05; ***p<0.01 Source: Authors' calculations based on data from Morningstar.

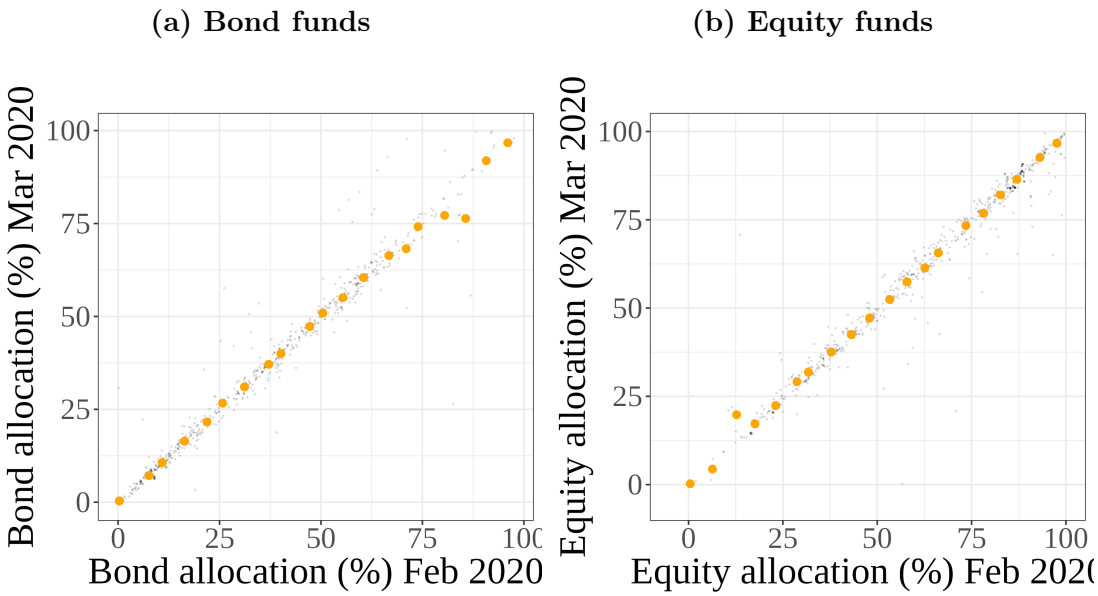
Dep. var.:	*Bond funds* (δ_b^m)		*Equity funds* (δ_e^m)	
	(1)	(2)	(3)	(4)
$BondRebalancing^m$	1.56***	2.00***		
	(0.58)	(0.63)		
$EquityRebalancing^m$			−0.58**	−1.16***
			(0.26)	(0.28)
$Flow/Assets^m$		3.21***		2.81***
		(0.70)		(0.37)
Std. error	Robust	Robust	Robust	Robust
Observations	646	643	646	643
Adjusted R^2	0.02	0.04	0.02	0.19

Columns 2 and 4 control for the amount of investor outflows on each fund using the variable $Flow/Assets^m$. While the coefficient is statistically significant, the economic effect implied by the average amount of investor withdrawals is an order of magnitude smaller than the economic effect of rebalancing implied by the average values of $\omega_e^m(r_e^m - r_b^m)$ and $\omega_b^m(r_e^m - r_b^m)$. Note, to be sure, that these regression results in isolation should not be treated as identifying a causal relationship as there may be (unobserved) fund-of-fund-specific factors that drive both their trading behavior and their realized portfolio performance over the sample period.

Next, we examine the persistence of bond and equity fund portfolio allocations over March 2020. Panels (a) and (b) of Figure 6 present scatterplots of bond and equity fund allocations, respectively, for funds of funds. The funds of funds' allocations at the end of March 2020 are plotted on the y-axis and their allocations at the end of February are plotted on the x-axis. Each small black dot represents the allocation of a fund of funds' portfolio. The large orange dots are the weighted-averages for each of 20 bins, with

each observation within the bin weighted by net asset value. Consistent with the high persistence of allocations documented in Section 2.3, bond and equity fund allocations were highly persistent in March 2020, with R^2 values of 0.96 and 0.98 for bond and equity funds, respectively. This shows that funds of funds' bond fund sales and equity fund purchases were closely tied to maintaining their target allocations

Figure 6: Portfolio rebalancing by funds of funds in March 2020. The unit of observation is a fund of funds. The y-axes show allocations at the end of March 2020, the x-axes show their allocations at the end of February 2020 (upper panels) and December 2019 (lower panels). The large orange dots in each plot show the weighted averages for each of 20 bins, where each observation is weighted by the net asset value of the fund of funds. Source: Authors' calculations based on data from Morningstar.



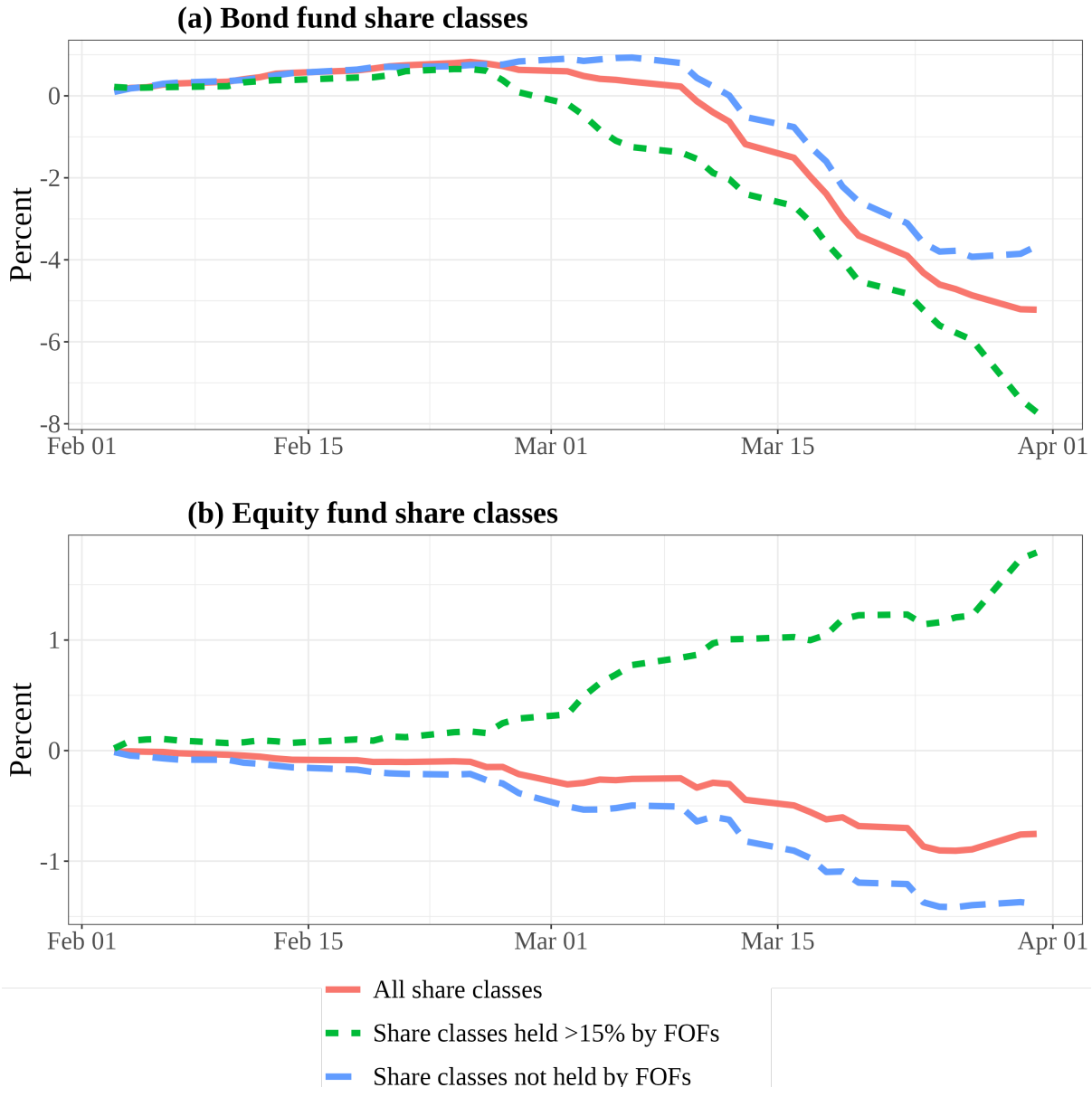
4.3 Fund of Funds' Trading Behavior Relative to Other Investors

4.3.1 Flow Comparison Across Share Classes

Time series of aggregate investor flows reveal a distinct pattern. Share classes of bond funds that were predominantly held by funds of funds experienced significantly faster net outflows compared to other share classes. In contrast, share classes of equity funds that were predominantly held by funds of funds saw net inflows, which aligns with funds of funds rebalancing their portfolios by shifting from bond funds to equity funds.

Figure 7 shows the cumulative net flows for the share classes of bond and equity funds held by funds of funds at the end of 2019. Panel (a) indicates that the share classes of

Figure 7: Bond and equity fund cumulative net flows February—March 2020. This figure shows the cumulative net flows for all share classes separately for (a) bond funds and (b) equity funds of all funds that were held by funds of funds at the end of 2019. Each panel shows cumulative net flows as a percent of total net assets as of February 3, 2020. The red solid line is the cumulative net flows of all share classes. The green dotted line is the cumulative net flows of share classes with more than 15 percent of total net assets held by funds of funds at the end of 2019. And the blue dashed line is the cumulative net flows of share classes not held by funds of funds at the end of 2019. Source: Authors' calculations based on data from Morningstar.



bond funds predominantly held by funds of funds experienced net outflows that were faster than outflows in other share classes. Panel (b) shows that equity funds predominantly held by funds of funds experienced cumulative net inflows throughout March, consistent with purchases by funds of funds. The figure suggests that, rather than passively holding assets, funds of funds played an active role in market fluctuations during this period.

4.3.2 Within-Fund Regression Analysis

A potential concern in interpreting these patterns is the possibility of selection bias. Funds of funds may have systematically invested in funds that were already more susceptible to investor withdrawals in times of crisis. If this were the case, the observed higher outflows from bond funds held by funds of funds might not be caused by funds of funds rebalancing but rather by the characteristics of the funds in which they had invested. To address this concern, we employ a time-fund fixed effects regression model that allows for a more precise comparison. By analyzing share classes within the same fund, this approach isolates the effect of funds of funds' ownership on outflows and controls from broader fund-level trends.

The regression model estimates cumulative net flows as a function of funds of funds ownership, measured at the share class level. Specifically, the dependent variable is the cumulative net flow for each share class, scaled by initial net assets, over the period from February 3, 2020, to March 31, 2020. The key independent variable is a dummy indicating whether a share class was largely held by funds of funds at the end of 2019. By including fund-day fixed effects, the model controls for differences between funds and isolates whether funds-of-funds-heavy share classes experienced greater outflows than other share classes within the same fund. This approach closely follows Allaire et al. (2022).

In precise terms, $CNF_{i,k,t}$ is defined as the cumulative net flows in share class i of fund k over the period from February 3, 2020 to t (up to T =March 31, 2020) scaled by the initial net assets in that share class on February 3, 2020. We winsorize $CNF_{i,k,t} < |150|$ to address a handful of outliers.

$$CNF_{i,k,t} = \frac{\sum_{\tau=Feb\ 3}^{t} (TNA_{i,k,\tau} - (1 + r_{i,k,\tau}) \times TNA_{i,k,\tau-1})}{TNA_{i,k,Feb\ 3}}$$

$FOF\_hold^{2019}_{i,k}$ is defined as the fraction of net assets in share class i of fund k held by funds of funds as of December 31, 2019. We then define a dummy variable for share classes that are 'largely' held by funds of funds.[17]

$$FOF\_hold\_DV^{2019}_{i,k} = \begin{cases} 0 \text{ if } FOF\_hold^{2019}_{i,k} > 0.15 \\ 1 \text{ if } FOF\_hold^{2019}_{i,k} < 0.15 \end{cases}$$

The set of dummy variables, $\{week^w_t\}$, is defined to take the value 1 if day t is within week w and 0 otherwise. These dummy variables allow us to summarize the differential cumulative net flows over the days within a given week. The regression specification is

$$CNF_{i,k,t} = \alpha_{k,t} + \sum_w \beta^w \left(FOF\_hold\_DV^{2019}_{i,k} \times week^w_t \right) + \epsilon_{i,k,t} \tag{10}$$

where $\alpha_{k,t}$ are fund-day fixed effects.[18] The set of coefficients $\{\beta^w\}$ is the average *within-fund* difference in cumulative net flows during week w between share classes that were largely held by funds of funds and those that were not largely held by funds of funds.

The solid lines in Figure 8 show the time series of β^w coefficients from estimating equation 10 for bond funds and equity funds, respectively. The shaded regions around the coefficient estimates indicate the 95 percent confidence intervals obtained from specifying standard errors clustered by fund-date.[19] The coefficient estimates indicate that cumulative net inflows to the share classes in equity funds largely held by funds of funds were significantly higher than the share classes not largely held by funds of funds *within the same fund*. A share class that was held largely by funds of funds experienced, on average, a cumulative net inflow during March 2020 that was four percentage points higher than a share class *within the same fund* that was not largely held by funds of funds.

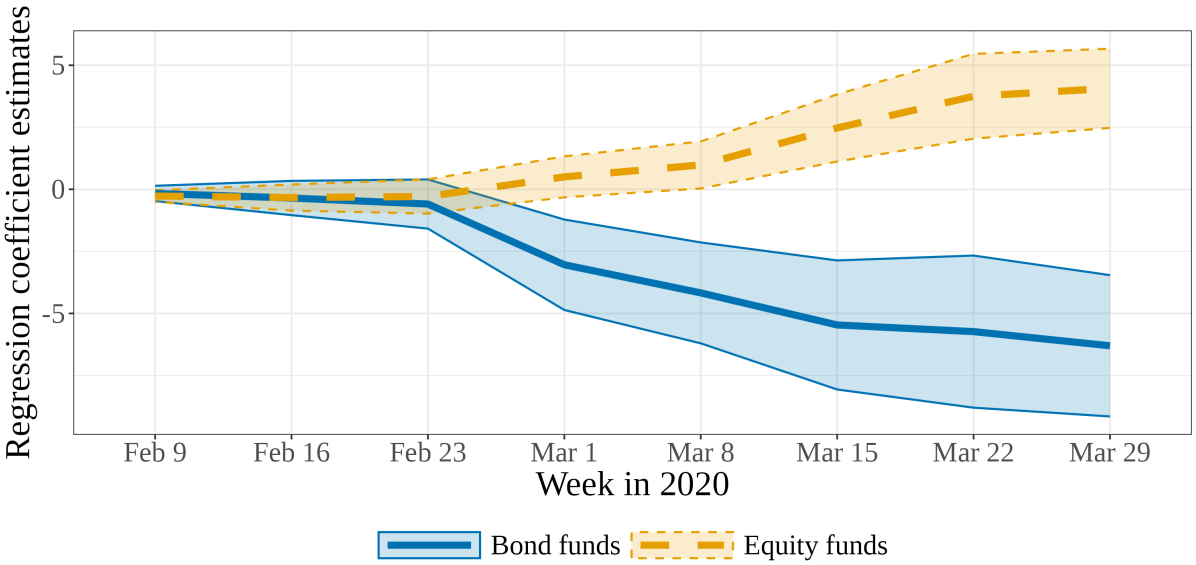
The coefficient estimates also indicate that cumulative net outflows from the share classes in bond funds largely held by funds of funds were significantly higher than the share classes not largely held by funds of funds *within the same fund*. A share class that

[17] We use an arbitrary 15 percent threshold based on examining the distribution of holdings of all share classes, reported in Appendix C.1. Allaire et al. (2022) used a similarly-arbitrary 25 percent threshold.

[18] We also estimated equation 10 including share class fixed effects i.e., $\mu_{i,k}$ and found similar results.

[19] Table 8 in Appendix D.1 reports the regression results together with alternative standard errors clustered by fund or date. Table 10 in Appendix D.2 reports summary statistics for the variables used in the regression analysis.

Figure 8: Regression coefficients from estimating equation 10. The figure shows the weekly β^w coefficients that measure the differential cumulative net flows on the share classes that were largely held by funds of funds compared to other share classes within the same fund. The shaded regions indicate 95 percent confidence intervals. Source: Authors' calculations based on data from Morningstar.



was held largely by funds of funds experienced, on average, a cumulative net outflow during March 2020 that was six percentage points higher than a share class *within the same fund* that was not largely held by funds of funds.

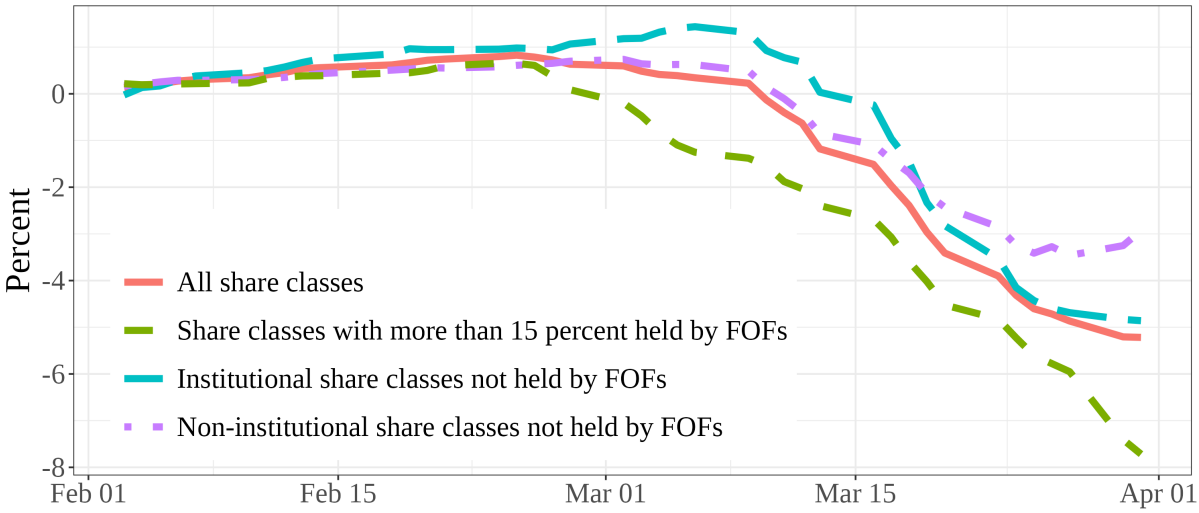
4.3.3 Alternative Hypotheses

Thus far, we have analyzed the behavior of funds of funds through the lens of portfolio rebalancing, showing that their liquidation of bond funds was driven by the larger decline in equity fund returns. We now consider two alternative hypotheses focusing on the role of institutional investors.

The first hypothesis is based on information. The sharp drop in equity returns in early March may have signaled future losses in bond markets, influencing the withdrawal decisions of information-sensitive institutional investors, including funds of funds. Accordingly, the liquidation of bond funds by funds of funds could have been motivated by public information embedded in equity prices. Because bonds are generally less liquid than equities, their prices may not have immediately reflected this information, with declines only beginning in mid-March.

To test this, we categorize share classes not held by funds of funds into institutional share classes and the rest (non-institutional share classes), following Schmidt et al. (2016). We find that while share classes with more than 15 percent held by funds of funds experienced investor outflows in early March, both institutional and non-institutional share classes not held by funds of funds experienced outflows only around mid-March, when bond fund prices began to decline, see their cumulative net flows in Figure 9.

Figure 9: Bond fund cumulative net flows February—March 2020. This figure shows the cumulative net flows as a percent of total net assets as of February 3, 2020 for the share classes of bond funds that were held by funds of funds at the end of 2019. Source: Authors' calculations based on data from Morningstar.



In Table 4, we study the cumulative net flows on share classes of bonds funds that were held by funds of funds at the end of 2019.[20] In column 1, we compare the cumulative net flow of institutional share classes with the cumulative net flow of non-institutional share classes within the sample of share classes that were *not held* by funds of funds. We find no significant difference between net flows on institutional share classes and non-institutional share classes in early March. Institutional share classes experienced significantly larger net outflows than non-institutional classes only in the latter half of March, when bond prices began to decline.

[20]The dependent variable ($CNF_{i,k,t}$) throughout the table is the day t cumulative net flow as a percent of total net assets as of February 3, 2020 for the share class i of a bond fund k. All specifications include bond-fund-by-day fixed effects. Standard errors clustered by fund-day are reported in parentheses. Table 10 in Appendix D.2 reports summary statistics for the variables used in the regression analysis.

The difference in timing in both Figure 9 and column 1 in Table 4 is inconsistent with the alternative, information-based hypothesis. The evidence suggests that the liquidation behavior of funds of funds documented in this paper is unlikely to have been driven by information about fundamentals embedded in equity prices.

Table 4: Analysis of institutional share classes of bond funds held by funds of funds. The unit of observation is a share class i of bond fund k on day t. The dependent variable throughout is the cumulative net flow ($CNF_{i,k,t}$) as a percent of total net assets as of February 3, 2020 for the share class of a bond fund that was held by funds of funds at the end of 2019. The right-hand side $\mathcal{X}$-variable in column 1 takes the value 1 if it is an institutional share class and 0 otherwise. The right-hand side $\mathcal{X}$-variable in columns 2 and 3 takes the value 1 if more than 15 percent of the share class is held by funds of funds and 0 otherwise. The sample in column 1 is all share classes *not held* by funds of funds. The binary variable $Inst\_DV_{i,k}$ takes the value 1 if the share class i of bond fund k is institutional and 0 otherwise. The sample in column 2 is all share classes in bond funds held by funds of funds. The sample in column 3 combines (i) all share classes in bond funds with $FOF\_hold\_DV_{i,k}^{2019} = 1$ and (ii) institutional share classes *not held* by funds of funds. Standard errors clustered by $fund \times day$ are reported in parentheses. *p<0.1; **p<0.05; ***p<0.01 Source: Authors' calculations based on data from Morningstar.

$\mathcal{X}$-*variable:*	$Inst\_DV_{i,k}$	$FOF\_hold\_DV_{i,k}^{2019}$	
	(1)	(2)	(3)
$\mathcal{X} \times [week2-09]$	0.28^{***}	-0.17	-0.39^{**}
	(0.09)	(0.16)	(0.15)
$\mathcal{X} \times [week2-16]$	0.35	-0.35	-0.62
	(0.34)	(0.35)	(0.42)
$\mathcal{X} \times [week2-23]$	0.11	-0.59	-0.65
	(0.44)	(0.51)	(0.58)
$\mathcal{X} \times [week3-01]$	-0.80	-3.04^{***}	-2.40^{**}
	(0.55)	(0.93)	(0.97)
$\mathcal{X} \times [week3-08]$	-1.43^{*}	-4.17^{***}	-3.04^{**}
	(0.81)	(1.04)	(1.15)
$\mathcal{X} \times [week3-15]$	-3.61^{***}	-5.46^{***}	-2.66^{*}
	(1.00)	(1.33)	(1.38)
$\mathcal{X} \times [week3-22]$	-4.60^{***}	-5.73^{***}	-2.16
	(1.06)	(1.56)	(1.66)
$\mathcal{X} \times [week3-29]$	-4.53^{***}	-6.30^{***}	-2.79^{*}
	(0.98)	(1.45)	(1.52)
FEs: fund×day, week	Y	Y	Y
Observations	61,093	68,908	21,467
Adjusted R^2	0.19	0.17	0.30

The second hypothesis centers on the key role institutional investors may play in coordination failures and fragility in investor flows, as emphasized in prior research

and discussed in Section 1.1. In the second half of March, institutional share classes experienced significantly larger net outflows than non-institutional classes within the same bond-fund-by-day, as shown in column 1 of Table 4. If concerns about bond illiquidity and the risk of fire sales drove these liquidations, then funds of funds—being a type of institutional investor—may have responded to the same concerns.

Figure 6 shows that bond and equity fund allocations were highly persistent in March 2020. These data suggest that funds of funds' bond fund liquidations were closely tied to maintaining their target allocations, rather than being driven by broader concerns.

In addition, column 2 of Table 4 reports the baseline results comparing the cumulative net flow of share classes with at least 15 percent held by funds of funds to other share classes within the same bond fund-day (these results are also reported in Table 8). column 3 compares the cumulative net flow of institutional share classes with the cumulative net flow of share classes with at least 15 percent held by funds of funds and institutional share classes that were *not held* by funds of funds. Compared to the baseline analysis reported in column 2, the sample size is about 70 percent smaller, which diminishes the power of our tests. Nevertheless, we find that net outflows on the share classes held largely by funds of funds experienced significantly larger cumulative net outflows than other institutional share classes. Comparing the coefficient estimates in columns 2 and 3 indicates that the magnitude of the difference was economically large as well as statistically significant.

Combined with the different timing of liquidations by funds of funds compared to other institution investors discussed above, both the persistence in portfolio allocations in Figure 6 and the regression results in column 3 of Table 4 are inconsistent with the hypothesis based on general liquidation behavior by institutional investors and instead further supports the portfolio rebalancing motive unique to funds of funds highlighted in this paper.

4.4 Cross-Sectional Analysis on Liquidated Bond Funds

We decompose funds of funds' liquidation of bond funds by the fund category, as reported by Morningstar, in Table 5. The funds of funds' sales of bond funds (approximately $77 billion based on the mean transaction price during the period) account for 14 percent of their total bond fund holdings (Column 3). There is substantial heterogeneity across

fund categories, suggesting that this liquidation was not uniform across different types of bond funds.

Table 5: Estimated sales of types of bond funds by funds of funds. Bond funds are those with more than 75 percent of the portfolio allocated to bonds and less than 10 percent allocated to equity. The categories of bond funds are from Morningstar. Transaction prices are the mean during the period from Dec 31, 2019 to Mar 31, 2020. Holdings are market values at the end of 2019. Outflows are monthly net outflows in March 2020. Source: Authors' calculations based on data from Morningstar.

	(1) Sales ($bn)	(2) Holdings ($bn)	(3) $\frac{\text{Sales}}{\text{Holdings}}$ (%)	(4) Outflows ($bn)	(5) $\frac{\text{Sales}}{\text{Outflows}}$ (%)
Total bond funds	77.0	562.2	13.7	239.3	32.2
Category					
Government	15.2	45.0	33.7	10.9	138.6
Inflation-protected	6.3	52.0	12.0	7.1	88.5
Intermediate core	40.3	303.5	13.3	81.6	49.4
Global	7.5	63.5	11.8	18.1	41.2
High-yield	2.0	17.1	11.7	20.3	9.9
Short-term	1.4	29.4	4.8	23.6	6.0
Corporate	0.0	1.8	2.3	3.4	1.2
Municipal	0.1	0.3	44.9	31.3	0.5

About half the total bond fund sales were from intermediate core bond funds, which invest primarily in medium-term investment-grade U.S. fixed income securities including government, corporate, and securitized debt. This large share in sales reflects funds of funds' large holdings in this category rather than targeted selling. Indeed, as a fraction of holdings, funds of funds sold about 13 percent of their intermediate core bond fund holdings, comparable to the 14 percent liquidation rate for bond funds overall.

In contrast, funds of funds sold about 34 percent of their holdings of government bond funds, more than double the overall liquidation rate. While funds of funds also sold 45 percent of their municipal bond fund holdings, their holdings in this category are so small ($0.3 billion relative to $45 billion in government bond funds) that this represents a negligible portion of total sales. This disproportionate liquidation of government bond funds reflects a liquidity-driven strategy: funds of funds needed to quickly sell large volumes for rebalancing and prioritized the most liquid government bond funds

to minimize transaction costs. This behavior parallels the "reverse flight to quality" documented by Ma et al. (2022), where bond funds sold their most liquid assets (such as Treasury securities) first during the COVID-19 crisis.

Column 5 of the table reports bond fund sales as a fraction of the net outflows these funds experienced in March 2020.[21] Notably, funds of funds' sales of government bond funds exceeded the total net outflows from these funds, reaching almost 139 percent. This implies that other investors were net purchasers of government bond funds during the same period, offsetting a portion of funds of funds' sales. Thus, it appears that there was a stark divergence in investor behavior during the COVID-19 crisis. Funds of funds liquidated government bond funds to rebalance their portfolios while minimizing transaction costs. On the other hand, other investors exhibited flight to quality by purchasing these same funds. Consequently, the net outflows from government bond funds were entirely driven by funds of funds' liquidity-driven selling rather than broad-based investor redemptions.

To gauge whether sales of different categories varied systematically *within* funds of funds, we first calculate a binary variable $sales_b^m$ that measures sales based on the shares held by fund of funds m in bond fund b on Dec 31, 2019 and on Mar 31, 2020:

$$sales_b^m = \begin{cases} 1 & \text{if } s_{j,Mar31}^m - s_{j,Dec31}^m < 0 \\ 0 & \text{if } s_{j,Mar31}^m - s_{j,Dec31}^m \geq 0 \end{cases}$$

We relate this measure of sales to the Morningstar category of bond fund b. For each category reported in Table 5, we define a dummy variable that takes the value 1 if bond fund b is in that category and 0 otherwise. The right-hand-side variables in our regressions are these selected mutually-exclusive dummy variables, with the omitted categories pooled in the regression's constant term.

Table 6 shows that the probability a bond fund was sold by funds of funds was highest for government funds.[22] The coefficients reported in column 1 indicate that funds

[21] Comparing the estimated quarterly sales to bond funds' monthly net outflows is more conservative than comparing to quarterly net outflows as most bond funds experienced net inflows in January and February 2020. Funds of funds' estimated quarterly sales were about 48 percent of the $160.7 billion net outflows experienced by all bond funds in 2020Q1.

[22] Summary statistics for all the variables used in these regresions are reported in table 11 in Appendix D.2.

of funds reduced their holdings of about 90 percent of government bond funds.[23] By contrast, they reduced their holdings of only about 80 percent of intermediate core bond funds. The regression estimates reported in column 2 include fund of funds fixed effects (with clustered standard errors) to show that even within a fund of funds, the probability a bond fund was sold was significantly higher for government bond funds. Columns 2 and 3 of the table replace the dependent variable ($sales_b^m$) with the percentage of shares sold ($SharesSold_b^m$). Funds of funds sold on average about 34 percent of their shares in each government bond fund while they sold only about 5 percent of their shares in each intermediate core bond fund.

5 Discussion: Implications for Financial Stability

Our findings reveal a double-edged nature of mechanical portfolio rebalancing. Prior research emphasizes the stabilizing role of funds of funds in equity markets: their disciplined rebalancing generates contrarian demand, buying equities when others sell (Parker et al., 2023; Parker and Sun, 2025). During the COVID-19 crisis, funds of funds indeed purchased $20–35 billion in equity funds, potentially dampening equity market declines.

However, this stabilization required selling $70–80 billion in bond funds despite funds of funds themselves experiencing only $16 billion in redemptions (less than one percent of their assets). Mechanical rebalancing thus creates a cross-market contagion channel that operates even when the transmitting institutions face minimal liquidity pressures. This transmission is especially important for financial stability. Bond markets are less liquid than equity markets and thus more vulnerable to selling pressure. Volatility originating in liquid markets can be mechanically transmitted to less liquid ones through institutional rebalancing, with potentially destabilizing effects concentrated in the more fragile market.

This cross-market transmission reveals a fundamental tension between individual investor protection and financial stability. For individual investors, funds of funds' disciplined maintenance of target allocations is valuable: it ensures their portfolios deliver the promised risk exposures even during market turmoil. This practice has acquired systemic importance as funds of funds have grown to over $2 trillion. The

[23] We did not find evidence of systematic selling *within* the category of government bond funds either by Morningstar ratings based on risk-adjusted returns or by fund family. See Appendix D.3.

Table 6: What categories of bond funds did funds of funds sell? The unit of observation in these regressions is a bond fund b held by a fund of fund m. The dependent variable $sales_b^m$ takes the value 1 if the bond fund was sold by the fund of funds during the period from Dec 31, 2019 to Mar 31, 2020 and 0 otherwise. In columns 3 and 4 the dependent variable is the percent change in shares held from Dec 31, 2019 to Mar 31, 2020. The independent dummy variables are based on Morningstar's fund categories. *p<0.1; **p<0.05; ***p<0.01 Source: Authors' calculations based on data from Morningstar.

Dependent variable:	$Sold_b^m \in \{0,1\}$		$SharesSold_b^m$	
	(1)	(2)	(3)	(4)
$Government_b$	0.35***	0.40***	25.53***	32.66***
	(0.03)	(0.03)	(2.19)	(2.14)
$InflationProtected_b$	0.25***	0.26***	3.97**	7.43***
	(0.03)	(0.03)	(1.86)	(1.55)
$IntermediateCore_b$	0.24***	0.24***	5.64***	4.54***
	(0.02)	(0.03)	(1.43)	(1.37)
$Global_b$	0.16***	0.14***	0.97	1.76
	(0.04)	(0.04)	(2.45)	(2.27)
$HighYield_b$	−0.09**	−0.14***	−5.39***	−8.08***
	(0.04)	(0.04)	(1.94)	(2.33)
$ShortTerm_b$	0.11***	0.14***	0.35	3.07**
	(0.04)	(0.03)	(1.83)	(1.42)
$Constant$	0.55***		−0.31	
	(0.02)		(0.88)	
Std. error	Robust	Cluster	Robust	Cluster
Fixed effects	-	FOF	-	FOF
Observations	2,495	2,495	2,495	2,495
R^2	0.09	0.52	0.07	0.49
Adjusted R^2	0.09	0.37	0.07	0.34

same mechanical rebalancing that protects individual investors can amplify market stress by transmitting volatility from equity markets to more fragile bond markets.

An additional tension emerges in how funds of funds execute their rebalancing. They liquidated 34 percent of their government bond holdings compared to 14 percent of total bond holdings, concentrating sales in the most liquid assets. This liquidity-driven strategy minimizes transaction costs for individual funds executing large trades quickly. Yet when applied at scale, it channels selling pressure to Treasury markets that anchor the financial system. During March 2020, Treasury markets experienced severe disruptions requiring unprecedented Federal Reserve intervention (Vissing-Jorgensen, 2021).

These findings suggest several policy implications. Market stabilization efforts during crises should account for mechanical rebalancing flows alongside traditional redemption pressures, recognizing that stress in one asset class can trigger selling in another through this channel. Financial stability monitoring should track these cross-market linkages: as funds of funds have grown substantially over the past decade, their mechanical rebalancing has become systemically significant. This channel likely played a smaller role during the 2008 global financial crisis when funds of funds were considerably smaller, but their current large size and anticipated growth make it a key consideration for future stress events. Finally, policymakers should recognize that the concentration of crisis-period selling in government bond funds may contribute to stress in Treasury markets that are critical to financial stability.

6 Concluding Remarks

This paper examines portfolio rebalancing by funds of funds. Funds of funds have grown significantly over the past decade, primarily invest in bond and equity mutual funds, and their portfolio allocations between bond and equity funds remain highly stable from month to month. We demonstrate that funds of funds engage in mechanical portfolio rebalancing to maintain their target allocations. When equity prices fall while bond prices remain relatively stable, funds of funds sell bond funds and purchase equity funds to restore their target allocations. This rebalancing behavior transmits shocks between bond and equity markets and can have destabilizing effects, as bond markets are less liquid than equity markets and thus more vulnerable to selling pressure.

The COVID-19 crisis provides striking evidence of this mechanism. Our analysis reveals that funds of funds accounted for one-third of total bond fund outflows during the crisis. They sold a large fraction of their government bond fund holdings, accounting for more than 100 percent of net outflows from these funds. These findings highlight a cross-market transmission mechanism through which equity market volatility can destabilize bond markets, with important implications for financial stability and the need for monitoring the cross-market linkage as funds of funds continue to grow.

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Appendix for online publication only

A Comparing Target-Date and Non-Target-Date Funds

In this appendix, we show that target-date and non-target-date funds are the same along the key characteristics that matter for our analysis. In particular, we focus on comparing their allocations to bond funds and equity funds, the persistence of their portfolio allocations over time, their portfolio allocations to funds within the same fund family, and their expense ratios for both liabilities and assets.

Figure 10 shows boxplots of funds of funds' portfolio allocations to bond funds (panel (a)) and equity funds (panel (b)) for target-date funds and non-target-date funds from 2010 to 2023. The unit of observation is a fund of funds at the end of year. The panels show that both types of funds invest similar shares of their portfolios in equity funds and bond funds. Note that these boxplots do not weight observations (funds of funds) by their total asset value.

Figure 11 compares target-date and non-target-date funds' portfolio allocations to funds within the same fund family from 2010 to 2023. Panel (a) shows that, in each year during this period, both target-date and non-target-date funds consistently allocated between 85 and 98 percent of their portfolios to funds within the same fund family, indicating that both types of funds strongly favor within-family investments. Panel (b) shows the distribution of portfolio allocations to same-family funds across both target-date and non-target-date funds. The similarity between these boxplots suggests that the aggregate results are driven by large allocations to same-family funds across both fund types.

Figure 12 compares expense ratios for target-date and non-target-date funds. The boxplots in panel (a) show the distribution of liability expenses minus asset expenses divided by total assets. The distributions of these net liability-asset ratios for target-date and non-target-date funds track closely. Panels (b) and (c) show target-date and non-target-date funds' liabilities and assets expense ratios, respectively. For both liabilities and assets, the expense ratios are about the same for target-date and non-target-date funds.

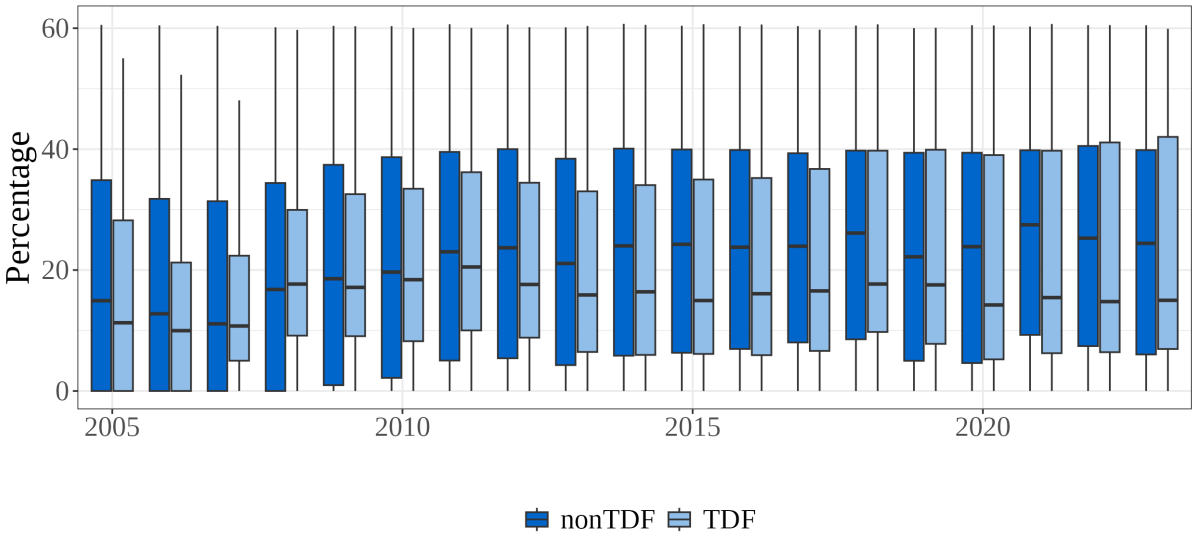
Figure 13 shows the monthly persistence of target-date and non-target-date funds' portfolio allocations to bond funds (panel (a)) and equity funds (panel (b)) from 2010

to 2023. The larger dots represent the mean values of the underlying scatterplots within each bin (with bin size of 20), highlighting the alignment of both scatterplots with the 45-degree line. Both panels show that the allocations are highly persistent over time for both types of funds' bond and equity allocations. For equity funds, the R^2 statistics are 0.96 and 0.94 for target-date and non-target-date funds, respectively. For bond funds, the R^2 statistics are 0.97 and 0.98 for target-date and non-target-date funds, respectively. Funds of funds maintain similar allocations in the current month compared to the previous month, demonstrating a high degree of consistency in their allocation decisions over time.

In summary, the comparison of target-date and non-target-date funds reveals that they exhibit highly similar characteristics and behaviors. They have very similar portfolio allocations to bond funds and quity funds, they demonstrate high persistence in their portfolio allocations over time, they show a strong preference for within-family investments, and they maintain closely-aligned expense ratios. This suggests that, in practice, target-date and non-target-date funds operate under similar investment strategies and cost structures, making them largely indistinguishable in key aspects of fund management.

Figure 10: Allocations of funds of funds' portfolios to bond funds and equity funds. The boxplots in panels (a) and (b) show the distribution across funds of funds of allocation to bond funds and equity funds, respectively. Source: Authors' calculations based on data from Morningstar.

(a) Bond funds



(b) Equity funds

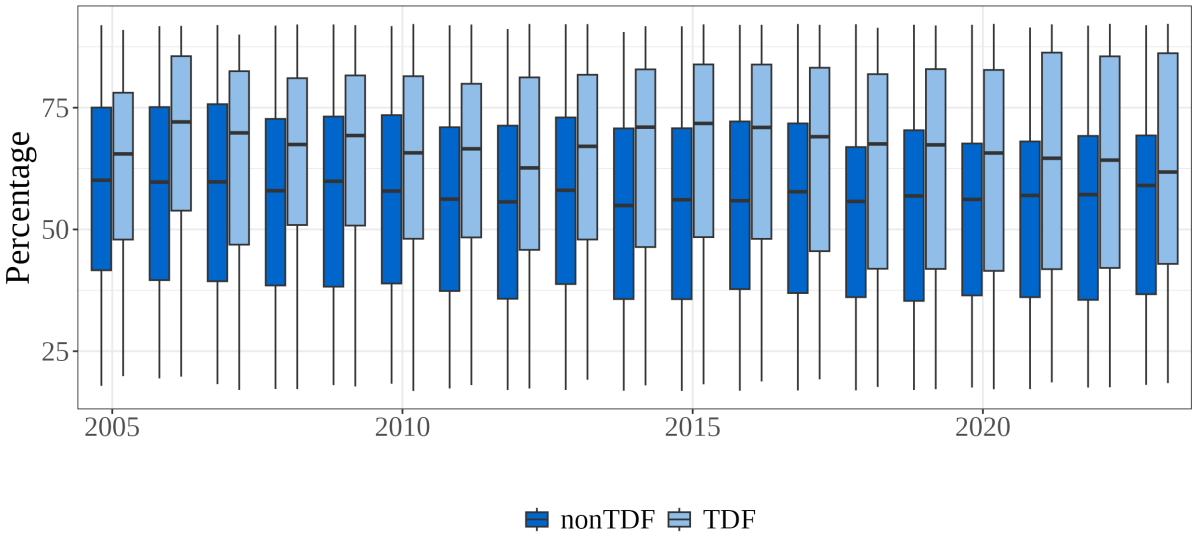
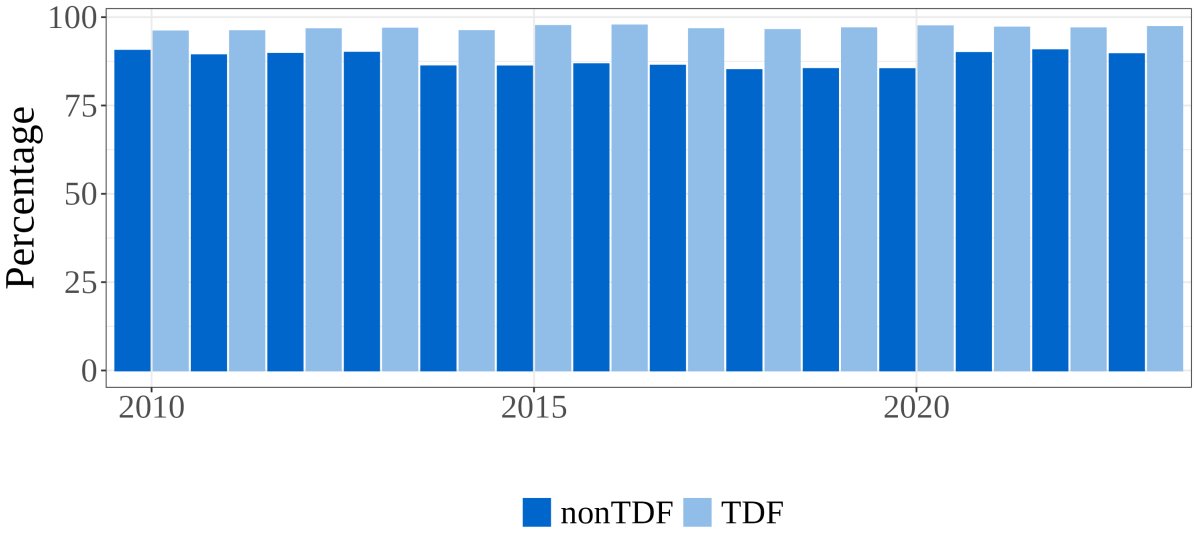


Figure 11: Allocations of funds of funds' portfolios to funds within the same fund family. Panel (a) shows the aggregate allocations to non-target-date funds (nonTDFs) and target-date funds (TDFs). The boxplots in panel (b) show the distributions across funds of funds for nonTDFs and TDFs. Source: Authors' calculations based on data from Morningstar.

(a) Aggregate



(b) Distribution across funds of funds

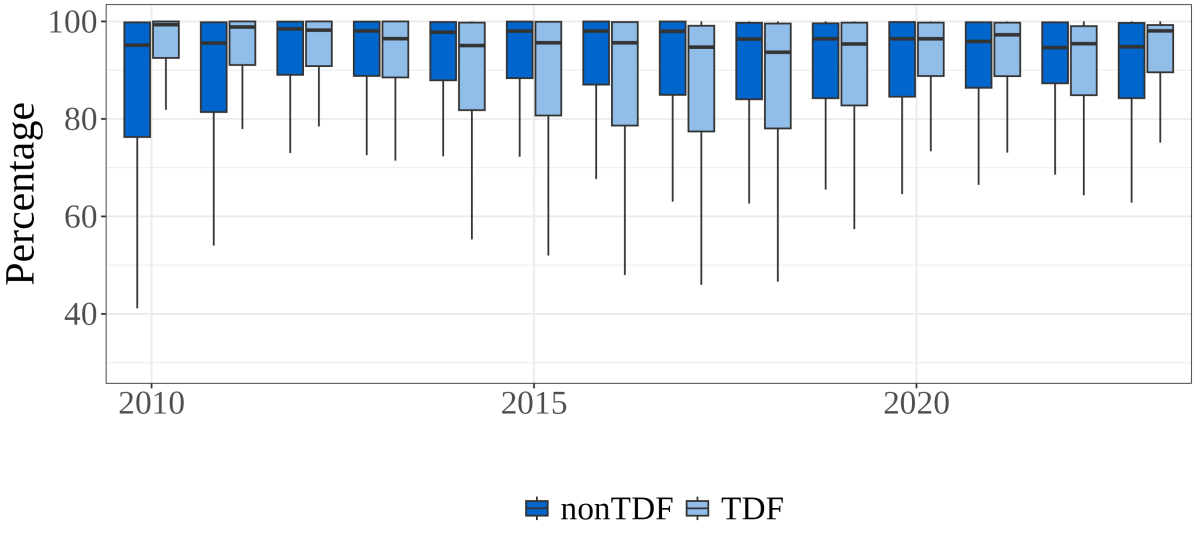
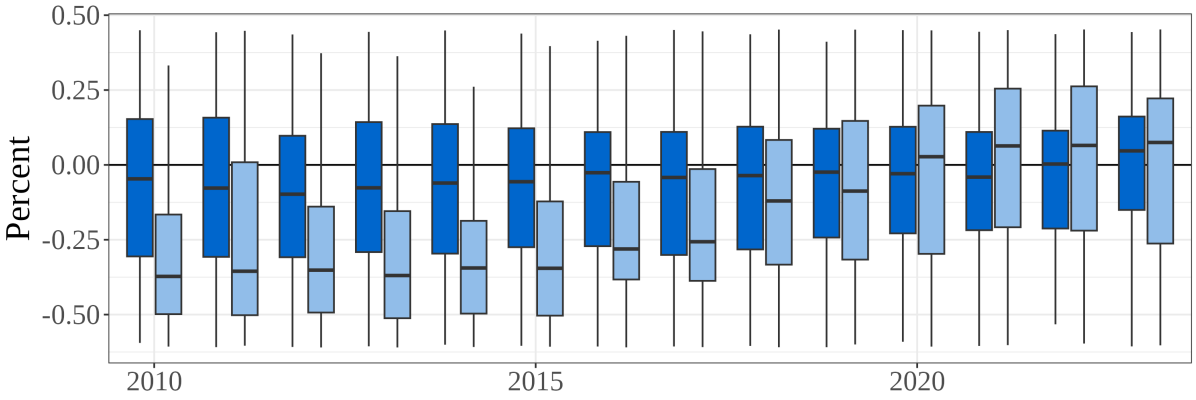
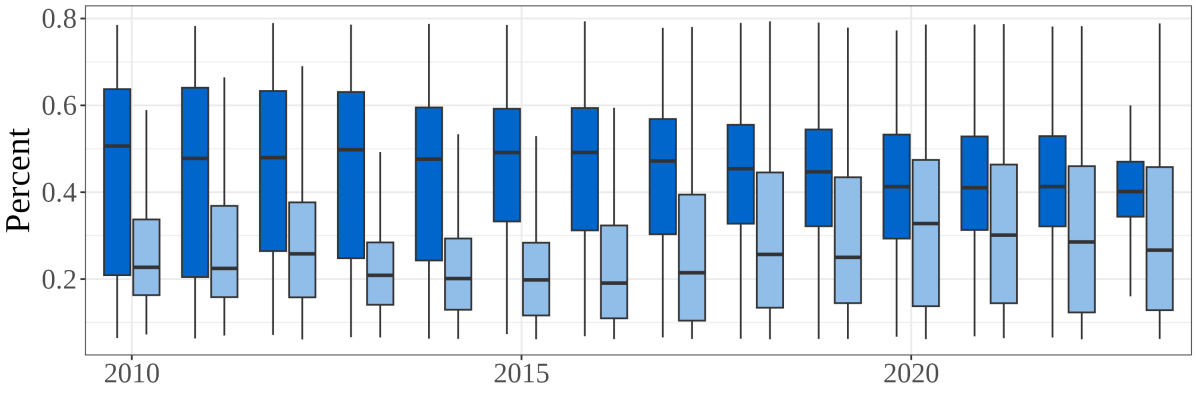


Figure 12: Expense ratios for funds of funds. The boxplots show the distribution across funds of funds of expenses divided by total assets. Source: Authors' calculations based on data from Morningstar.

(a) Liabilities-assets expense ratios



(b) Liabilities expense ratios



(c) Assets expense ratios

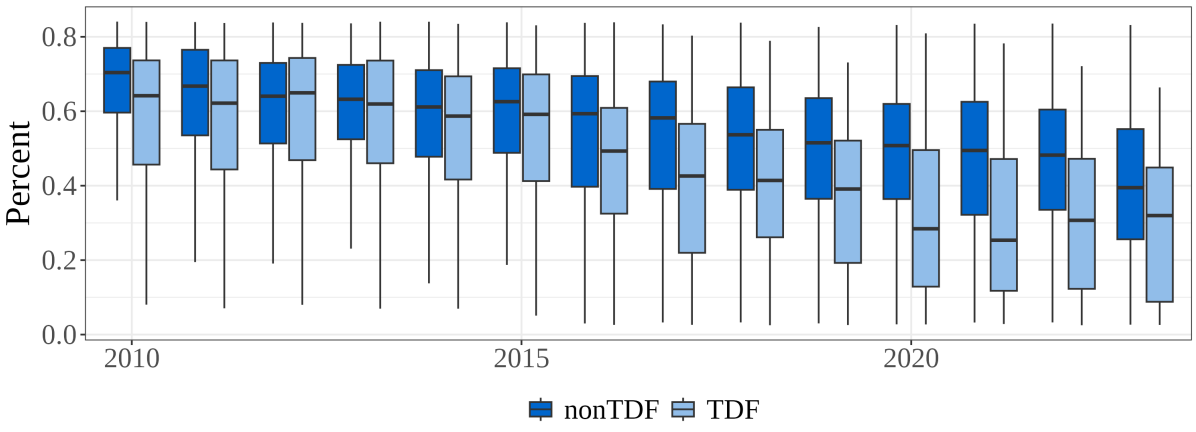
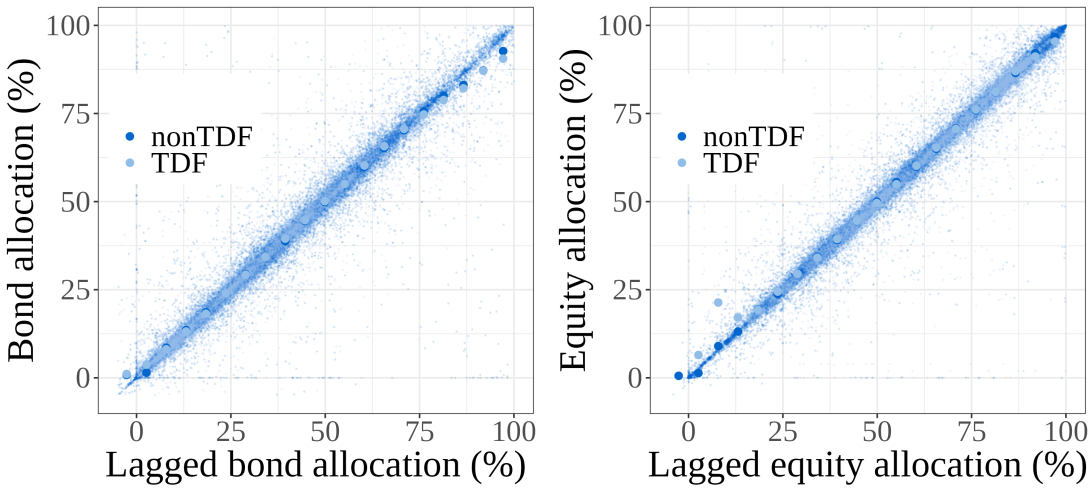


Figure 13: Persistence in fund of funds' portfolio allocations. For legibility, the data were censored at -5 to remove a few observations when funds of funds held short positions. Data are monthly for all funds of funds from 2010-2023. Source: Authors' calculations based on data from Morningstar.

(a) Bond funds **(b) Equity funds**



B Data construction

Our dataset begins with the universe of open-end mutual funds compiled by Morningstar and accessed through the Morningstar Direct Python package MORNINGSTAR_DATA 1.10.4. Throughout our analysis, we restrict the sample to funds that are domiciled in the U.S. (LS017 == 'USA'). For these funds, we collect cross-sectional data on the type of fund (OF128 and OF028) and their share classes (LS012). We also collect time-series data on the market value of their net assets (HS111), their portfolio allocations to bonds (HS11F) and equity (HF11C), and their fund-level net flows from aggregating estimated net flows over share classes (CS006). Share-class level net flows are reported by Morningstar and estimated following the prior literature (e.g., Chevalier and Ellison (1997)), which is to define the net flow of share class i in period t as the flow of new assets i.e., $NetFlow_{i,t} = \frac{TNA_{i,t}-(1+r_{i,t})\times TNA_{i,t-1}}{TNA_{i,t-1}}$, where $TNA_{i,t}$ is total net assets and $r_{i,t}$ is the return on existing assets. We exclude short-term funds identified as those types of funds (OF128) that contain the text 'SHORT-TERM' or 'ULTRASHORT'.

For funds of funds, we begin by subsetting the universe of open-end mutual funds using Morningstar's own identifier (OF00A == 1). We then collect detailed holdings data compiled by Morningstar at an annual frequency. Information about the types of holdings is summarized in Figure 14, which plots annual net asset values as a function of the share of the portfolio that each funds of funds holds in open-end mutual funds. The figure reveals that about 80 percent of funds of funds hold the vast majority of their portfolios (>95 percent) in open-end mutual funds. We follow Allaire, Breckenfelder and Hoerova (2022) and identify funds of funds as those funds that hold at least 65 percent of their portfolios in open-end mutual funds. This subset accounts for more than 85 percent of the assets held by funds that hold other open-end mutual funds.

We identify target-date funds as those whose Morningstar category (OF028) contains the text 'TARGET-DATE'. For the individual open-end mutual funds held by funds of funds, we collect time-series data on the market value of their net assets (HS111), their portfolio allocations to bonds (HS11F) and to equity (HF11C). Funds of funds that hold less than 65 percent of their portfolios in open-end mutual funds tend to be smaller and have many small holdings of bonds and/or equities. Panels A and B of Figure 15 show the holdings of funds of funds that have at least 65 percent and less than 65 percent, respectively, of their portfolios in open-end mutual funds.

We also collect higher frequency time-series for funds of funds around the time of the pandemic outbreak on the market value of their net assets at the share-class level (monthly NH001 and daily HS0DQ), the estimated net flow at the share-class level (monthly CS001 and daily CS007). For the open-end mutual funds that are held by funds of funds, we collect daily time-series on their fund price (HS538), as well as information about all the share classes, identified using Morningstar's proprietary identifier (SecID), issued by those funds, including the market value of their net assets (HS0DQ) and their estimated net flow (CS007).

Figure 14: Net asset value of funds of funds separated by the share of their portfolios held in open-end mutual funds. Each fund of funds is bucketed based on its individual holdings and the net asset values are summed across funds within each bucket. Source: Authors' calculations based on data from Morningstar.

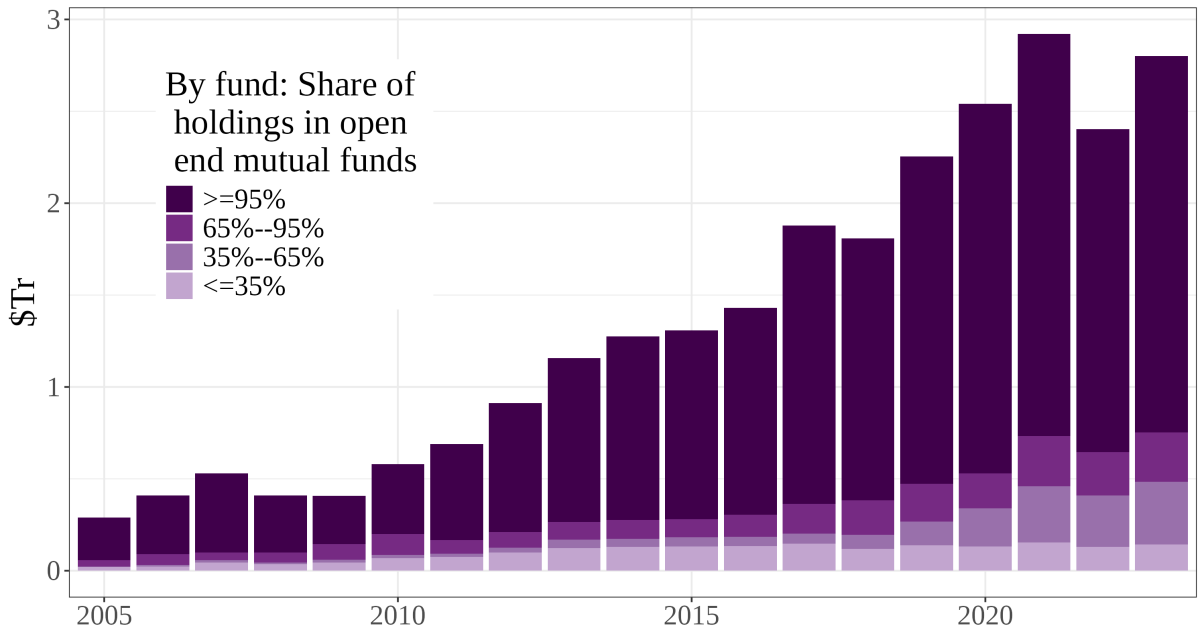
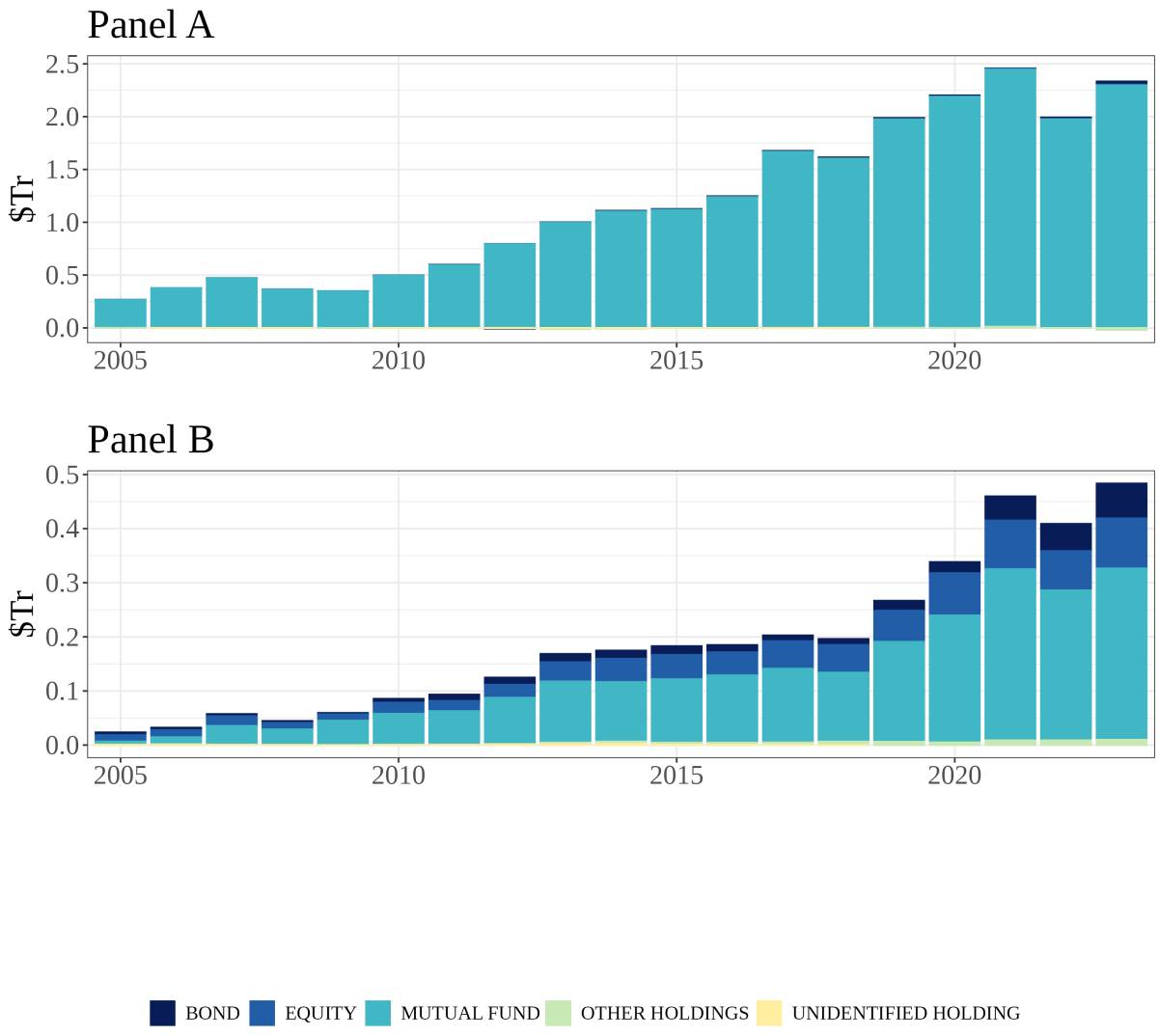


Figure 15: Total holdings of funds of funds by share in open-end mutual funds. Panel A shows the holdings of funds of funds that have at least 65 percent of their total portfolio in open-end mutual funds. Panel B shows the holdings of funds of funds that have less than 65 percent of their total portfolio in open-end mutual funds. Data are as of year end. Source: Authors' calculations based on data from Morningstar.



B.1 Data citations

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  - BOGZ1LM564090005Q — Board of Governors of the Federal Reserve System (US), Exchange-Traded Funds; Total Financial Assets, Market Value Levels, retrieved from FRED, Federal Reserve Bank of St. Louis; https://fred.stlouisfed.org/series/BOGZ1LM564090005Q

B.2 Comparison with Z.1 Financial Accounts

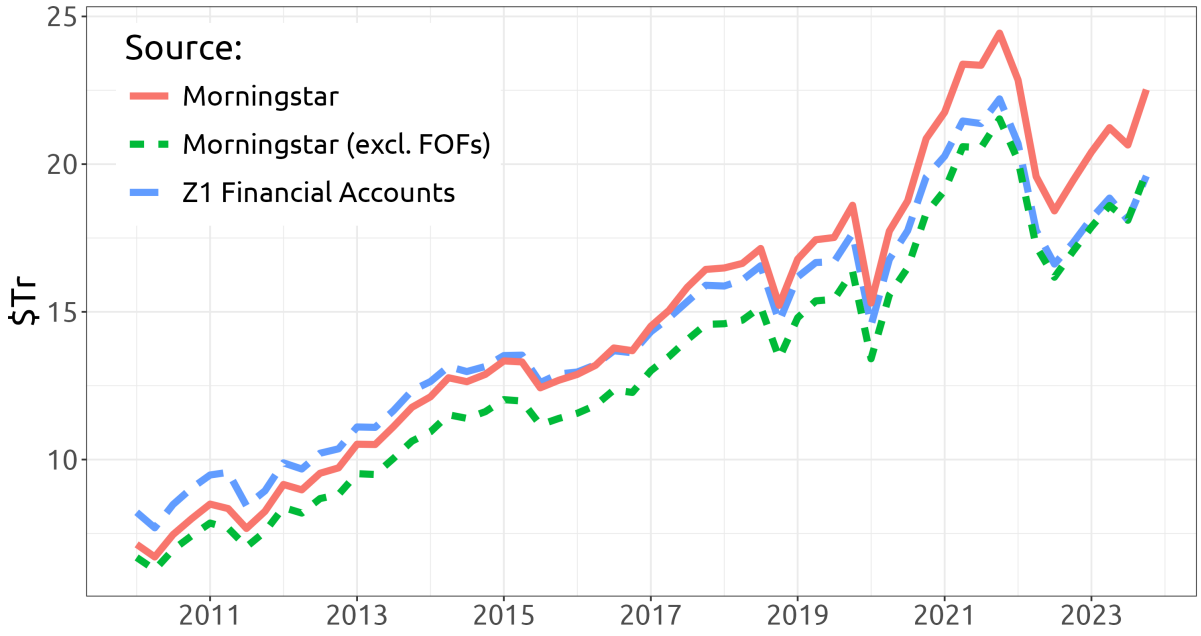
In this appendix, we compare our estimate of the mutual fund universe based on data from Morningstar to the Federal Reserve's Z.1 Financial Accounts of the United States. The Z.1 Financial Accounts data for mutual funds are sourced from subscription-based Investment Company Institute (ICI) data and ICI Statistics Report Builder, which constructs aggregate mutual fund levels by summing unadjusted net new cash flow and reinvested dividends. Comparable data are also available in Tables 1 and 1.1 of ICI's monthly Trends in Mutual Fund Investing report. The Z.1 series excludes funds of funds to avoid double counting assets within the sector.

Figure 16 compares the quarterly series. The red solid line shows the estimate of the mutual fund universe using Morningstar data, while the green short-dashed line shows the same series excluding the total net asset value of fund of funds. The blue long-dashed line shows the estimate of the mutual fund universe from the Z.1 Financial Accounts, which by construction excludes funds of funds. The blue and green series track closely, exhibiting a pairwise correlation of 0.99. Both series start at about $5 trillion in 2009:Q1 and peak at over $20 trillion in 2021:Q1.

The minor discrepancies and near-perfect correlation between the series suggests that Morningstar captures the same underlying movements in mutual fund valuations as the

Z.1 Accounts and can provide a reliable measure of U.S. mutual fund assets.

Figure 16: Comparing Morningstar and Z.1 Financial Accounts. The lines show estimates of the total net asset market value of US-domiciled mutual funds. Data are as of quarterly. Source: Morningstar and FRED.



C Holdings of funds of funds

In this appendix, we provide additional details on funds of funds' holdings to contextualize the main analysis. We begin with an overview of how funds of funds structure their portfolios, followed by a closer look at their investment across share classes and the composition of their long and short positions in sections C.1 and C.2, respectively.

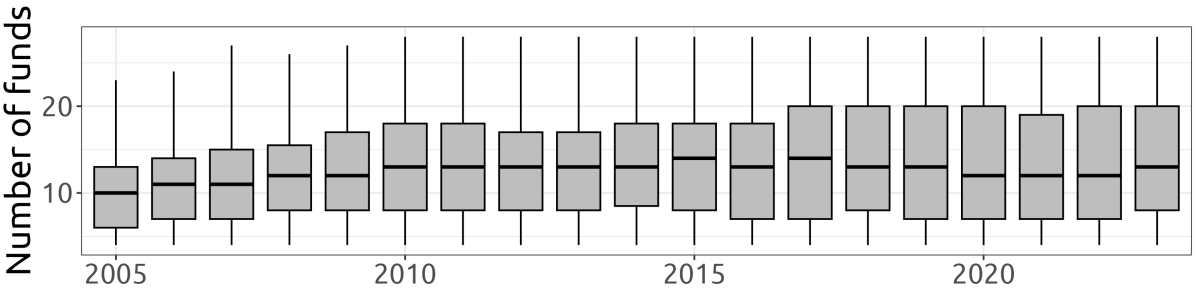
Figure 17 shows the distribution of open-end mutual funds held by funds of funds, summarizing the number of funds held (panel (a)), the share allocated to the largest holding (panel (b)), the average share allocated to each fund (panel (c)), and the overall size of each fund of funds (panel (d)). Panel (a) shows that the typical fund of funds holds 13 open-end mutual funds. Panel (b) shows that a fund of funds' largest holding accounts for about 23 percent of the total market value of its holdings. Panel (c) shows that the average weight of each fund of funds' holding is about 15 percent of the total market value of its holdings. Panel (d) shows that the median size of funds of funds is less than $500 million, while the mean size shown by the red dots in the panel is $1-2 billion, indicating some skew in the size distribution.

Figure 17 shows that the vast majority of mutual funds held by funds of funds hold either equity, shown in Panel (b), or bonds, shown in Panel (c), but not both. We define a *bond (equity) fund* as one that has allocated more than 75 percent of its portfolio to bonds (equity) and less than 10 percent of its portfolio to equity (bonds). As of year end 2019, funds of funds held $535 billion of bond funds and $1,227 billion of equity funds, equivalent to 14 percent of all bond funds' net asset value and 11 percent of all equity funds' net asset value, see Table 1.

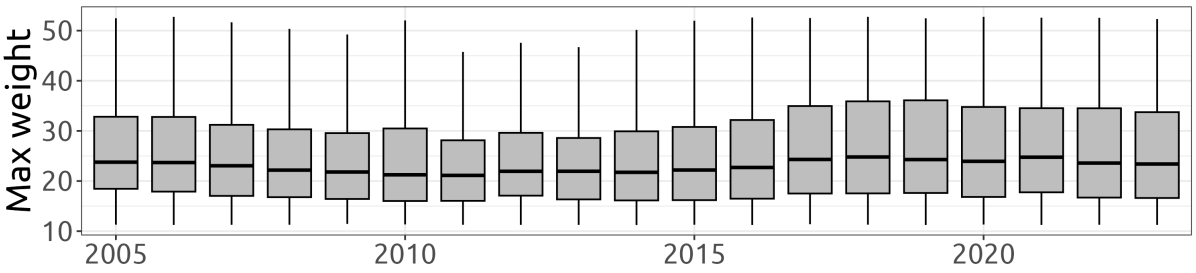
Complementing the aggregate allocations to bond funds and equity funds shown in Figure 3 of the main text, Figure 19 shows the distribution of the ratio of equity funds to bonds allocation across individual funds of funds. The distribution shown in the figure is censored at five to visualize the bulk of the distribution and its median value. The median value is 2.2, as indicated by the red dashed vertical line.

Figure 17: Distributions of funds of funds' holdings. Each panel shows year-end distributions across funds of funds. Panel (a) shows the number of mutual funds held. Panel (b) shows the maximum weight of a holding as a percent of the total market value of the fund of funds' holdings. Panel (c) shows the average weight of individual holdings as a percent of the total market value of the fund of funds' holdings. And Panel (d) shows the overall net asset value of funds of funds. The red dots in Panel (d) are the means of the distributions. Source: Authors' calculations based on data from Morningstar.

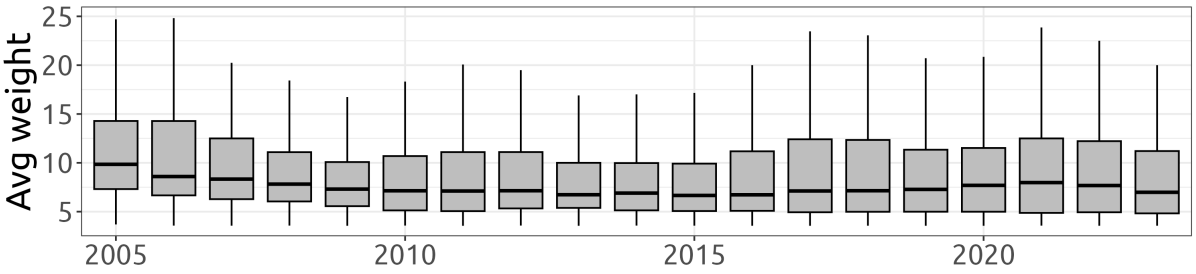
(a) Number of open-end mutual funds held



(b) Maximum weight in portfolio



(c) Average weight in portfolio



(d) Size of funds of funds by net asset value

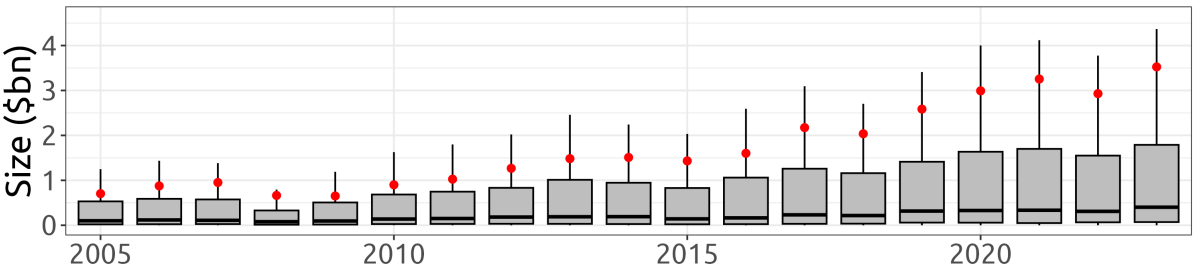
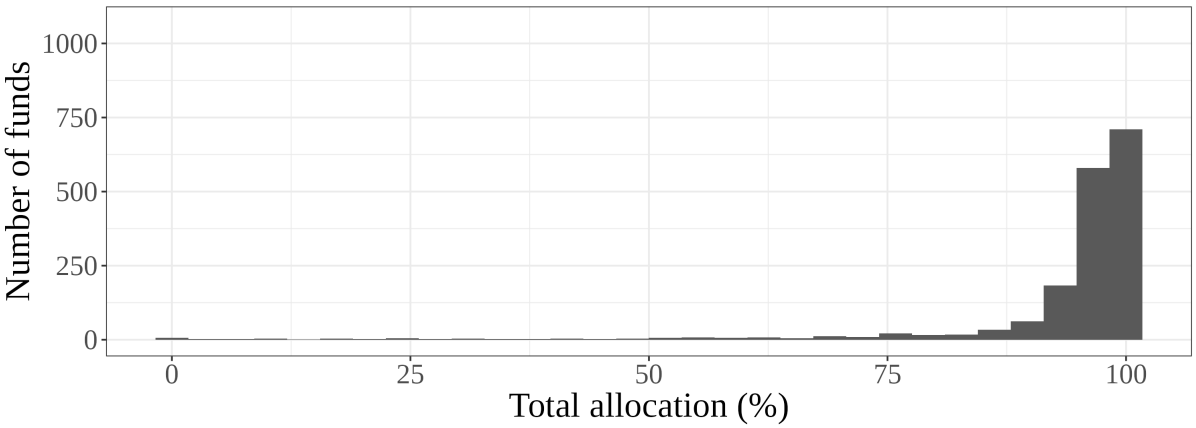
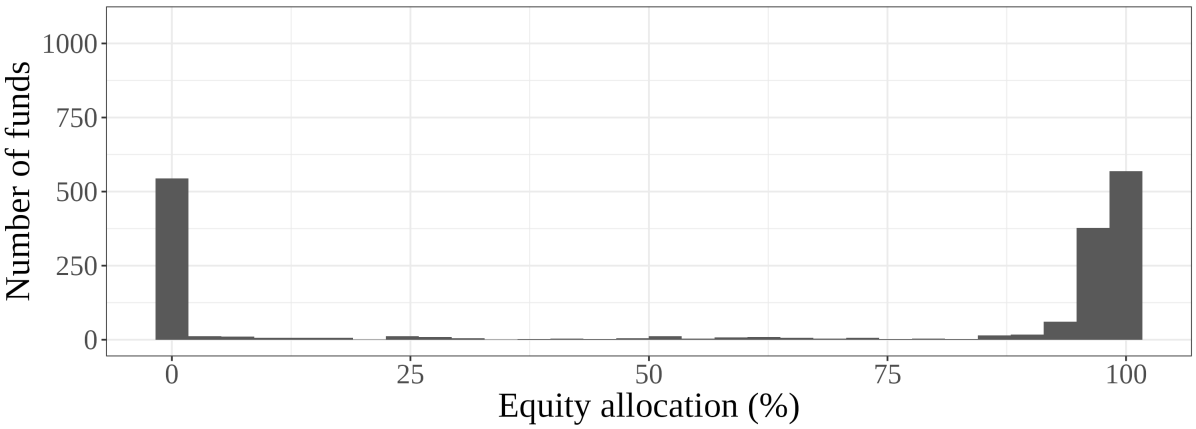


Figure 18: Portfolio allocations of funds held by funds of funds. Each figure is a histogram of the number of funds held by funds of funds as a function of those funds' allocations to bonds and/or equity. Panel (a) shows the funds' allocations to bonds and equity combined. Panel (b) shows the funds' allocation to equity only. Panel (c) shows the funds' allocation to bonds only. Allocations are as of December 31, 2019 based on all the open-end mutual funds held by funds of funds on December 31, 2019. Source: Authors' calculations based on data from Morningstar.

(a) Allocation to bonds and equity



(b) Allocation to equity



(c) Allocation to bonds

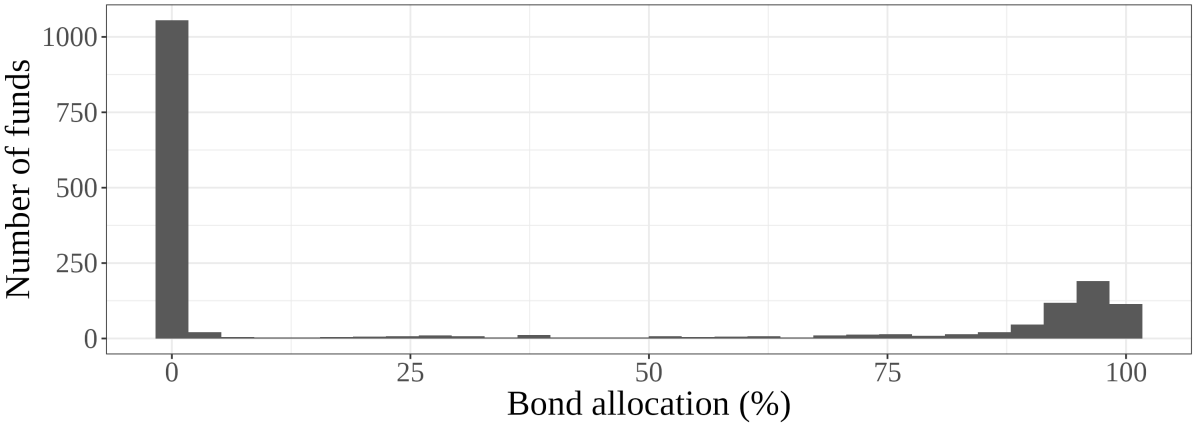
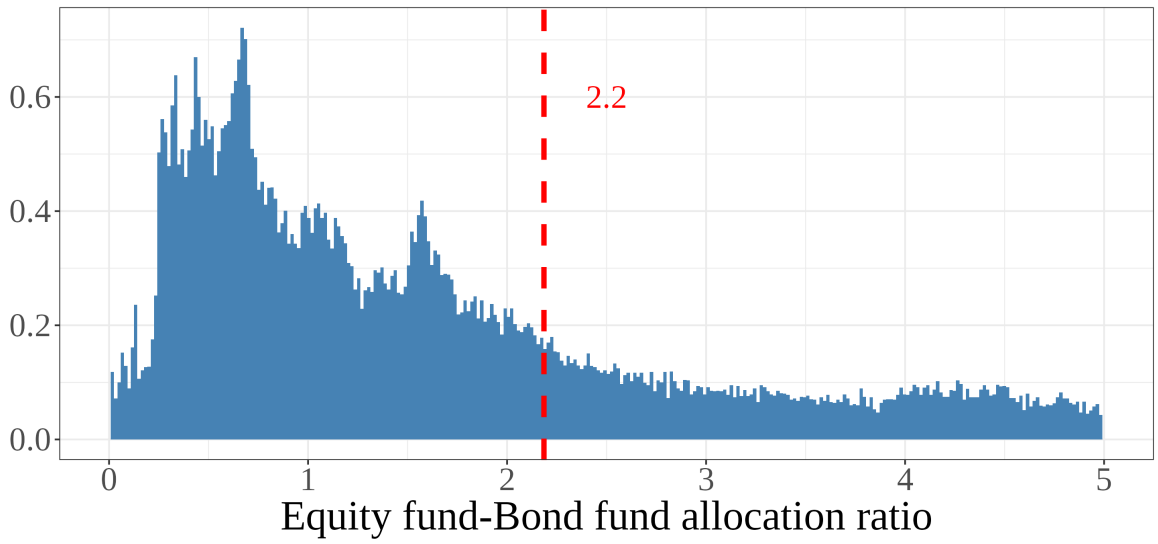


Figure 19: Fund of funds' portfolio allocations to bond funds and equity funds. The figure shows the distribution of the ratio of equity funds to bond funds allocation across funds of funds, with the median value indicated by the red dashed vertical line. The distribution is censored at five to focus on the bulk of the distribution and its median value. Source: Authors' calculations based on data from Morningstar.

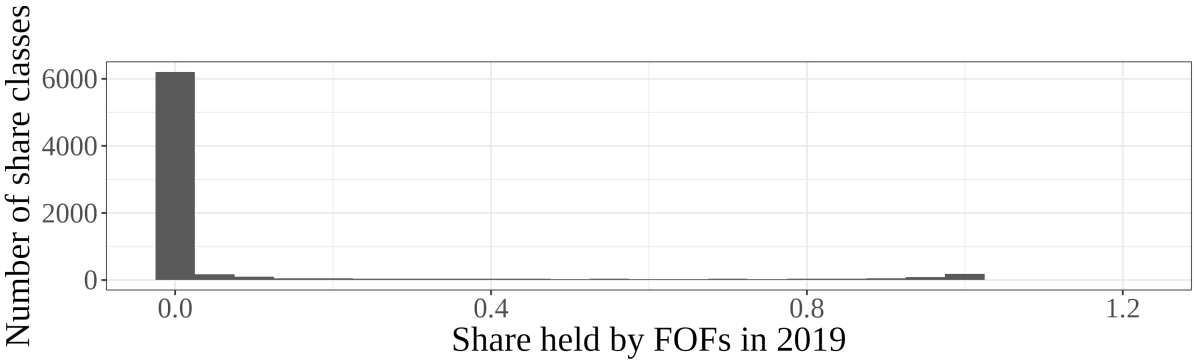


C.1 Distribution of fractions of share classes held

Figure 20 shows the distribution of fractions of share classes of all the funds held by funds of funds at the end of 2019. Panel (a) shows the distribution of all share classes, with a large mass concentrated at zero holdings. Panel (b) shows the distribution of only share classes with non-zero holdings by funds of funds. Table 7 shows the values (fractions) for specific percentiles of the distributions shown in Figure 20, together with the number of observations above and below the percentiles. We use this variation to analyze the behavior of share classes within funds as a function of their holdings by funds of funds.

Figure 20: Fraction of share classes held by funds of funds at the end of 2019. These histograms show the distribution across share classes of funds held by funds of funds, conditional on at least one share class being held. Source: Authors' calculations based on data from Morningstar.

(a) All share classes of funds held by funds of funds



(b) Share classes with non-zero holdings by funds of funds

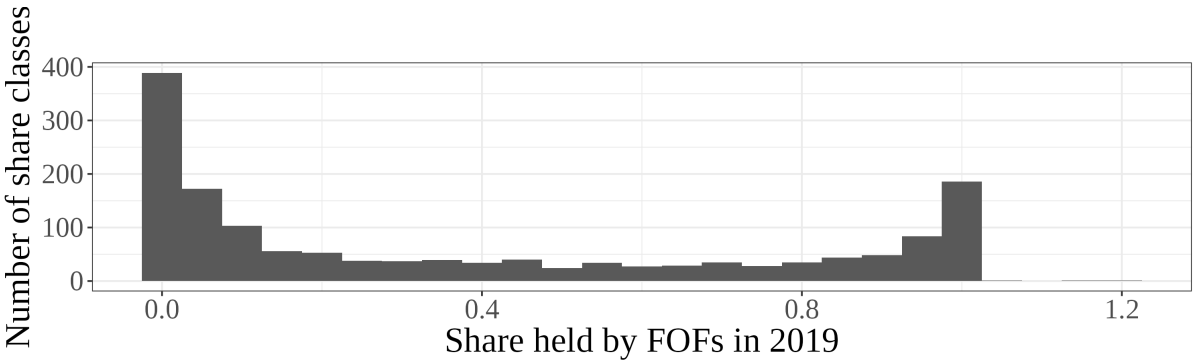


Table 7: Percentiles of the distribution of all share classes of funds held by funds of funds. Panels (a) and (b) show selected percentiles of the distributions shown in Figures 20a and 20b, respectively. For each percentile, we report the fraction of the share class held by funds of funds, the number of observations (share classes) above that percentile, and the number of observations (share classes) below that percentile. Source: Authors' calculations based on data from Morningstar.

Panel (a)

Percentile	0.85	0.86	0.87	0.88	0.89	0.90
Fraction of share class held	0.03	0.05	0.08	0.12	0.18	0.26
Observations above percentile	1,104	1,031	957	883	810	736
Observations below percentile	6,255	6,328	6,402	6,476	6,549	6,623

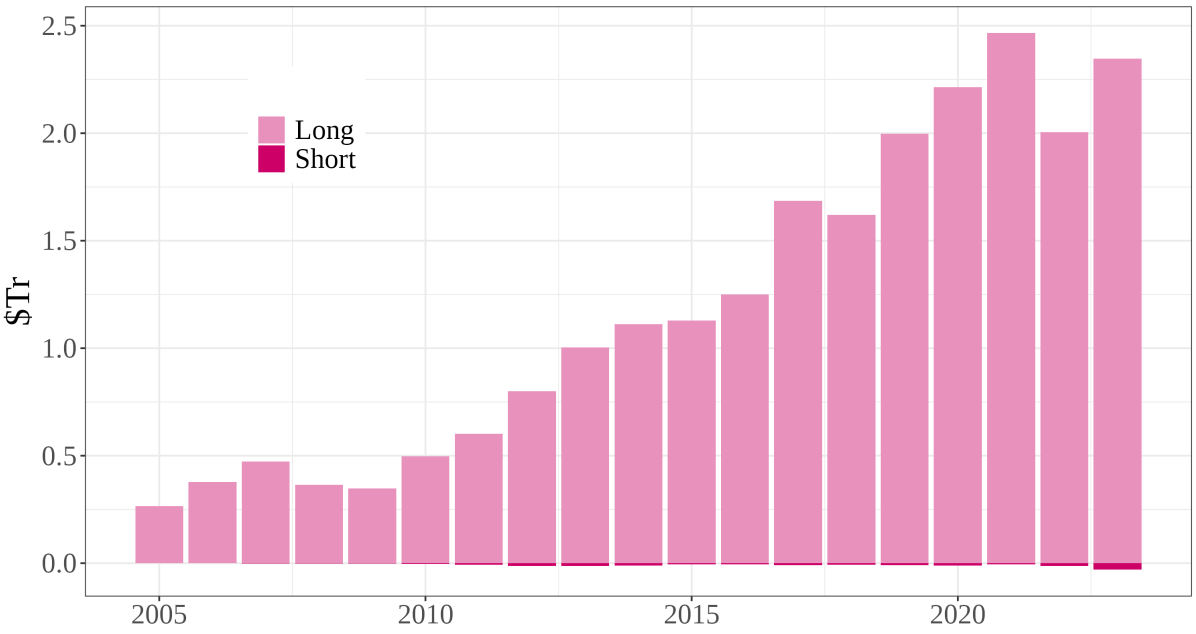
Panel (b)

Percentile	0.35	0.4	0.45	0.5	0.55	0.6
Fraction of share class held	0.07	0.11	0.15	0.21	0.32	0.43
Observations above percentile	1,000	923	846	769	692	615
Observations below percentile	538	615	692	769	846	923

C.2 Long and short holdings of funds of funds

Figure 21 shows the total long and short asset positions for funds of funds at the end of each year. In aggregate, funds of funds' short positions are about one percent of their long positions. Some individual funds of funds can take larger short positions temporarily (not shown in the figure).

Figure 21: Funds of funds long and short holdings. Data are annual as of year end. Source: Authors' calculations based on data from Morningstar.



D Supplementary Results

D.1 Regression Results Underpinning Figure 8

Table 8: Cumulative net flows in share classes of bond funds and equity funds held by funds of funds. The unit of observation is a share class i of a fund k on day t. The sample of funds is all bond funds and equity funds held by fund of funds on December 31, 2019. The variable $CNF_{i,k,t}$ is the cumulative net flow from February 3, 2020 until March 31, 2020. The variable $FOF\_hold\_DV_{i,k}^{2019}$ takes the value 1 if the fraction of net assets held by funds of funds on December 31, 2019 is above 15 percent and takes the value 0 otherwise. In addition to the fixed effects, the estimated coefficient on $FOF\_hold\_DV_{i,k}^{2019}$ is not reported in the table. *p<0.1; **p<0.05; ***p<0.01 Source: Authors' calculations based on data from Morningstar.

Dep. var.: $CNF_{i,k,t}$	Bond funds			Equity funds		
	(1)	(2)	(3)	(4)	(5)	(6)
$FOF\_hold\_DV_{i,k}^{2019} \times [week2-9]$	−0.17	−0.17	−0.17	−0.27**	−0.27*	−0.27***
	(0.16)	(0.23)	(0.13)	(0.12)	(0.15)	(0.07)
$FOF\_hold\_DV_{i,k}^{2019} \times [week2-16]$	−0.35	−0.35	−0.35***	−0.33	−0.33	−0.33***
	(0.35)	(0.47)	(0.11)	(0.27)	(0.31)	(0.08)
$FOF\_hold\_DV_{i,k}^{2019} \times [week2-23]$	−0.59	−0.59	−0.59***	−0.29	−0.29	−0.29**
	(0.51)	(0.59)	(0.22)	(0.35)	(0.38)	(0.12)
$FOF\_hold\_DV_{i,k}^{2019} \times [week3-1]$	−3.04***	−3.04***	−3.04***	0.50	0.50	0.50***
	(0.93)	(1.01)	(0.18)	(0.42)	(0.45)	(0.10)
$FOF\_hold\_DV_{i,k}^{2019} \times [week3-08]$	−4.17***	−4.17***	−4.17***	0.98**	0.98*	0.98***
	(1.04)	(1.08)	(0.28)	(0.48)	(0.52)	(0.14)
$FOF\_hold\_DV_{i,k}^{2019} \times [week3-15]$	−5.46***	−5.46***	−5.46***	2.47***	2.47***	2.47***
	(1.33)	(1.20)	(0.24)	(0.69)	(0.71)	(0.25)
$FOF\_hold\_DV_{i,k}^{2019} \times [week3-22]$	−5.73***	−5.73***	−5.73***	3.75***	3.75***	3.75***
	(1.56)	(1.45)	(0.14)	(0.87)	(0.88)	(0.13)
$FOF\_hold\_DV_{i,k}^{2019} \times [week3-29]$	−6.30***	−6.30***	−6.30***	4.07***	4.07***	4.07***
	(1.45)	(1.52)	(0.14)	(0.81)	(0.95)	(0.07)
FEs: fund×date, week	Y	Y	Y	Y	Y	Y
Standard Errors	fund×date	fund	date	fund×date	fund	date
Observations	68,908	68,908	68,908	136,813	136,813	136,813
Adjusted R^2	0.17	0.17	0.17	0.19	0.19	0.19

D.2 Regression Analysis Summary Statistics

In this appendix, we provide tables of summary statistics for the data used in regression analyses throughout the paper. Table 9 presents summary statistics for the analysis in subsection 4.2 testing the rebalancing mechanism at the level of individual funds of funds. Table 10 presents summary statistics for the analysis in subsections 4.3.2 and 4.3.3 of cumulative net flows in the share classes of funds held by funds of funds. Table 11 presents summary statistics for the analysis in subsection 4.4 of the categories of bond funds sold by funds of funds.

Table 9: Summary statistics for testing the rebalancing mechanism. The unit of observation is a fund of funds. The variables ω_b^m and ω_e^m are the initial allocation to bonds and to equity, respectively. The variables r_b^m and r_e^m are the return on the fund of funds' equity fund holdings net of their return to bond fund holdings over the period from Dec 31, 2019 to Mar 31, 2020. The variables δ_b^m and δ_e^m are the percent change in the market value of bond and equity funds held, respectively. $Flow/Assets$ is the ratio of net flows in March 2020 to net assets on Dec 31, 2019. Source: Authors' calculations based on data from Morningstar.

Variable	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
ω_b^m	660	0.32	0.22	0.01	0.10	0.50	0.92
ω_e^m	660	0.59	0.26	0.01	0.38	0.84	0.99
r_b^m	660	-0.01	0.04	-0.25	-0.03	0.01	0.11
r_e^m	660	-0.20	0.06	-0.49	-0.23	-0.21	0.00
δ_b^m	646	-0.00	0.74	-1.00	-0.16	-0.04	8.58
δ_e^m	646	-0.19	0.22	-1.00	-0.24	-0.14	2.78
$\omega_b^m(r_e^m - r_b^m)$	660	-0.06	0.05	-0.25	-0.10	-0.02	0.03
$\omega_e^m(r_e^m - r_b^m)$	660	-0.12	0.07	-0.27	-0.16	-0.06	0.05
$Flows/Assets^m$	657	-0.00	0.03	-0.08	-0.02	0.01	0.12

Table 10: Summary statistics for analyzing cumulative net flows. The unit of observation is a share class i of a fund k on day t. The sample of funds is all bond funds and equity funds held by fund of funds on December 31, 2019. The variable $CNF_{i,k,t}$ is the cumulative net flow from February 3, 2020 until March 31, 2020. The variable $FOF\_hold\_DV_{i,k}^{2019}$ takes the value 1 if the fraction of net assets held by funds of funds on December 31, 2019 is above 15 percent and takes the value 0 otherwise. Source: Authors' calculations based on data from Morningstar.

Variable	Fund type	N	Mean	SD	Min	Pctl(25)	Pctl(75)	Max
$CNF_{i,k,t}$	Bond	68,908	-0.48	14.30	-95.64	-2.16	0.85	150
$CNF_{i,k,t}$	Equity	136,813	-0.57	11.43	-150	-2.06	0.24	150
$FOF\_hold\_DV_{i,k}^{2019}$	Bond	91,389	0.11	0.31	0	0	0	1
$FOF\_hold\_DV_{i,k}^{2019}$	Equity	171,667	0.12	0.32	0	0	0	1
$Inst\_DV_{i,k}$	Bond	91,389	0.25	0.43	0	0	1	1
$Inst\_DV_{i,k}$	Equity	171,667	0.24	0.43	0	0	0	1

Table 11: Summary statistics for analyzing the types of bond funds sold by funds of funds. The unit of observation is a bond fund b held by a fund of funds m. The variable $sales_b^m$ takes the value 1 if the bond fund b was sold by the fund of funds m during the period from Dec 31, 2019 to Mar 31, 2020 and 0 otherwise. The variable $SharesSold_b^m$ is the percent change in shares held from Dec 31, 2019 to Mar 31, 2020. The variable $Rating\_2019_b$ is the rating of the bond fund b on Dec 31, 2019. Source: Authors' calculations based on data from Morningstar.

Variable	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
$sales_b^m$	2,495	0.68	0.47	0	0	1	1
$SharesSold_b^m$	2,495	3.28	27.66	-100	-1.5	14.7	98.9
$Government_b$	2,652	0.08	0.28	0	0	0	1
$InflationProtected_b$	2,652	0.11	0.31	0	0	0	1
$IntermediateCore_b$	2,652	0.26	0.44	0	0	1	1
$Global_b$	2,652	0.05	0.22	0	0	0	1
$HighYield_b$	2,652	0.11	0.31	0	0	0	1
$ShortTerm_b$	2,652	0.10	0.30	0	0	0	1

D.3 Additional Analysis of Types of Bond Funds Sold

Table 12 extends the analysis reported in Table 6 to test whether the bond funds sold by a given fund of funds were systematically related to their Morningstar ratings as of Dec 31, 2019 ($Rating\_2019_b$). Morningstar fund ratings measure a fund's risk-adjusted return relative to similar funds on a scale from one to five.[24] The best performers receive five stars and the worst performers receive one star.[25] While there is some evidence that funds of funds sold their lower-rated funds, there is no strong evidence of disproportionate selling of government bond funds across rating categories.

Table 13 extends the analysis reported in Table 6 to test whether the bond funds sold by a given fund of funds were disproportionately within the same fund family.[26] The variable $OwnFamily_b$ takes the value 1 if the bond fund is within the same fund family as the fund of funds and 0 otherwise. While there is some evidence that funds of funds lowered the intensive margin of selling for within-family funds (columns 3 and 4), there is no strong evidence of disproportionate selling of government bond funds within the fund family.

[24] According to Morningstar, risk-adjusted return is calculated by subtracting a risk penalty from each fund total return, after accounting for all loads, sales charges, and redemption fees. The risk penalty is determined by the amount of variation in the fund's monthly return, with emphasis on downward variation. The greater the variation, the larger the penalty. `https://awgmain.morningstar.com/webhelp/glossary_definitions/mutual_fund/mfglossary_MorningstarRating.html`

[25] For an overview of the evidence that star ratings provide information about future performance, see Huang, Li, and Weng (2020).

[26] Figure 11 shows that both target-date funds and non-target-date funds hold more than 90 percent of total net assets in funds within the same family as the fund of funds.

Table 12: Did funds of funds disproportionately trade funds with certain ratings? The unit of observation in these regressions is a bond fund b held by a fund of fund m. The dependent variable $sales_b^m$ takes the value 1 if the bond fund was sold by the fund of funds during the period from Dec 31, 2019 to Mar 31, 2020 and 0 otherwise. In columns 3 and 4 the dependent variable is the percent change in shares held from Dec 31, 2019 to Mar 31, 2020. The independent dummy variables are based on Morningstar's fund categories and fund ratings as of Dec 31, 2019. *p<0.1; **p<0.05; ***p<0.01 Source: Authors' calculations based on data from Morningstar.

Dependent variable:	$Sold_b^m \in \{0,1\}$		$SharesSold_b^m$	
	(1)	(2)	(3)	(4)
$Rating2019_b$	-0.08^{***}	-0.06^{***}	-4.90^{***}	-1.92^{***}
	(0.01)	(0.01)	(0.68)	(0.57)
$Government_b$	0.36^{**}	0.23	27.70^{*}	17.53
	(0.16)	(0.15)	(16.75)	(17.67)
$InflationProtected_b$	0.11	0.17^{**}	-1.72	8.16
	(0.11)	(0.08)	(6.44)	(5.90)
$IntermediateCore_b$	0.04	0.01	-10.23	-11.04^{**}
	(0.10)	(0.10)	(6.93)	(5.13)
$Global_b$	0.74^{***}	0.35^{**}	25.05^{**}	21.60^{**}
	(0.14)	(0.14)	(10.36)	(10.60)
$HighYield_b$	-0.42^{**}	-0.11	-18.04^{*}	1.14
	(0.20)	(0.21)	(9.70)	(8.07)
$ShortTerm_b$	0.22	0.22	8.86	14.81^{**}
	(0.19)	(0.17)	(7.52)	(7.01)
$Rating2019_b \times Government_b$	-0.01	0.04	-1.09	4.53
	(0.05)	(0.05)	(5.27)	(5.91)
$Rating2019_b \times InflationProtected_b$	0.04	0.02	1.25	-0.53
	(0.03)	(0.03)	(2.25)	(2.10)
$Rating2019_b \times IntermediateCore_b$	0.06^{**}	0.06^{**}	4.56^{***}	4.11^{***}
	(0.03)	(0.02)	(1.76)	(1.31)
$Rating2019_b \times Global_b$	-0.14^{***}	-0.05	-5.91^{*}	-4.98^{*}
	(0.04)	(0.04)	(3.11)	(2.98)
$Rating2019_b \times HighYield_b$	0.09^{*}	-0.002	3.68	-2.25
	(0.05)	(0.06)	(2.70)	(2.46)
$Rating2019_b \times ShortTerm_b$	-0.03	-0.02	-2.06	-3.06^{*}
	(0.05)	(0.05)	(2.14)	(1.81)
Constant	0.84^{***}		16.92^{***}	
	(0.05)		(2.17)	
Std. error	Robust	Cluster	Robust	Cluster
Fixed effects	-	FOF	-	FOF
Observations	2,495	2,495	2,495	2,495
R^2	0.11	0.53	0.09	0.50
Adjusted R^2	0.11	0.38	0.09	0.34

Table 13: Did funds of funds disproportionately trade within-family funds? The unit of observation in these regressions is a bond fund b held by a fund of fund m. The dependent variable $sales_b^m$ takes the value 1 if the bond fund was sold by the fund of funds during the period from Dec 31, 2019 to Mar 31, 2020 and 0 otherwise. In columns 3 and 4 the dependent variable is the percent change in shares held from Dec 31, 2019 to Mar 31, 2020. The independent dummy variables are based on Morningstar's fund categories and the reported fund family. *p<0.1; **p<0.05; ***p<0.01 Source: Authors' calculations based on data from Morningstar.

Dependent variable:	$Sold_b^m \in \{0,1\}$		$SharesSold_b^m$	
	(1)	(2)	(3)	(4)
$OwnFamily_b$	−0.07	−0.14	−7.80***	−8.64**
	(0.05)	(0.09)	(2.18)	(3.98)
$Government_b$	0.19	0.67***	41.85**	84.61***
	(0.19)	(0.18)	(17.15)	(17.05)
$InflationProtected_b$	0.34***	0.23***	2.75	5.37**
	(0.07)	(0.07)	(2.35)	(2.60)
$IntermediateCore_b$	0.005	0.14**	1.90	10.56*
	(0.07)	(0.07)	(3.50)	(5.49)
$Global_b$	−0.26**	−0.02	−13.74**	0.85
	(0.12)	(0.09)	(6.19)	(4.34)
$HighYield_b$	−0.61***	−0.89***	−33.33***	−50.32***
	(0.05)	(0.08)	(7.08)	(9.07)
$ShortTerm_b$	−0.04	0.10	−6.94	2.89
	(0.14)	(0.09)	(6.30)	(5.54)
$OwnFamily_b \times Government_b$	0.17	−0.26	−15.68	−52.45***
	(0.19)	(0.18)	(17.30)	(17.16)
$OwnFamily_b \times InflationProtected_b$	−0.09	0.05	2.00	3.15
	(0.07)	(0.08)	(3.10)	(3.31)
$OwnFamily_b \times IntermediateCore_b$	0.28***	0.13*	4.52	−4.92
	(0.07)	(0.07)	(3.84)	(5.77)
$OwnFamily_b \times Global_b$	0.50***	0.20**	17.48***	2.93
	(0.13)	(0.10)	(6.73)	(5.05)
$OwnFamily_b \times HighYield_b$	0.58***	0.83***	31.69***	46.83***
	(0.06)	(0.08)	(7.34)	(9.32)
$OwnFamily_b \times ShortTerm_b$	0.16	0.07	8.53	1.36
	(0.15)	(0.09)	(6.58)	(5.75)
Constant	0.61***		6.28***	
	(0.05)		(1.95)	
Std. error	Robust	Cluster	Robust	Cluster
Fixed effects	-	FOF	-	FOF
Observations	2,495	2,495	2,495	2,495
R^2	0.11	0.54	0.09	0.52
Adjusted R^2	0.11	0.39	0.08	0.37

Online appendix references

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Chevalier, Judith and Glenn Ellison, "Risk Taking by Mutual Funds as a Response to Incentives," *Journal of Political Economy*, 1997, *105* (6), 1167–1200.