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

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Abstract

During the COVID-19 crisis, bond mutual funds experienced significant outflows that disrupted debt markets. We show that "funds of funds"—mutual funds that invest in other mutual funds—played a surprisingly large role in this episode. Despite experiencing minimal redemptions themselves, funds of funds rebalanced their portfolios mechanically in response to equity market losses, selling approximately $70–80 billion of bond funds and purchasing equity funds. This behavior accounted for 25–30 percent of all bond fund outflows in March 2020. Our findings highlight how portfolio rebalancing by institutional investors can transmit shocks across markets and amplify financial fragility.

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

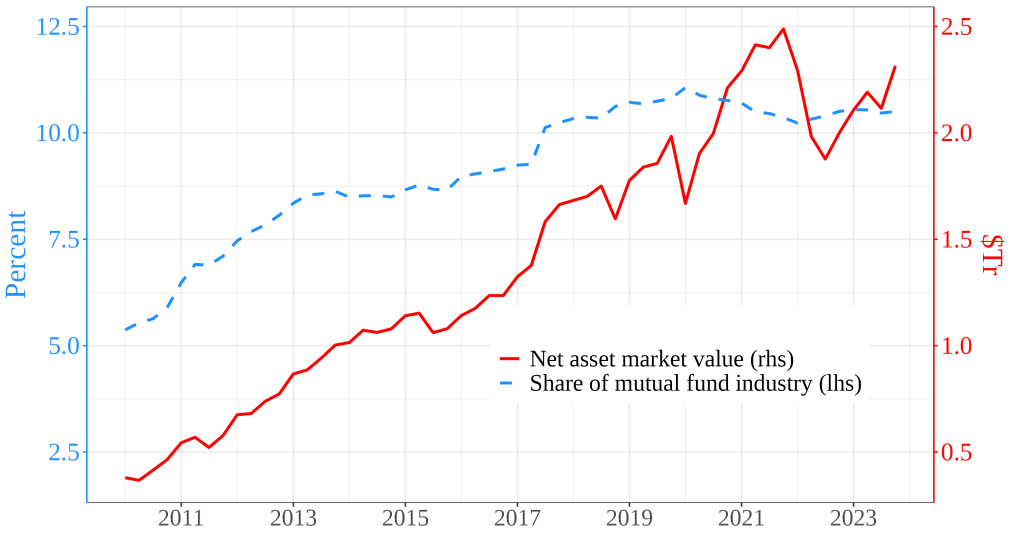
Who were the investors withdrawing from bond funds in March 2020, and why? Debt markets faced major disruptions in March 2020 as the Covid-19 pandemic shook financial markets, with unusually large liquidations by bond mutual funds playing a significant role (e.g., Haddad, Moreira, and Muir (2021), Falato, Goldstein, and Hortaçsu (2021), Ma, Xiao, and Zeng (2022)). That month, bond funds experienced net investor outflows equal to about 6 percent of their total assets. This paper presents new evidence that a substantial share of withdrawals came not from direct investors, but from an overlooked group of intermediaries: mutual funds that invest in other mutual funds—commonly referred to as "funds of funds." Despite experiencing limited redemptions themselves, they accounted for 25 to 30 percent of the outflows from bond funds during the crisis.

The behavior of funds of funds reflects a mechanical portfolio rebalancing process. These intermediaries, including target-date funds, typically maintain fixed portfolio weights between equity and bond funds over short horizons. As equity prices fell sharply in March 2020 while bond prices remained relatively stable, funds of funds sold bond fund shares and purchased equity fund shares to restore their target allocations. These trades generated significant outflows from bond funds that were not directly linked to investor withdrawals, but were instead induced by relative price movements across asset classes.

Funds of funds have grown significantly over the past decade. Their total assets increased from about $500 billion in 2010 to over $2 trillion by the end of 2023, see Figure 1. During the same period, their share of all open-end mutual fund assets more than doubled—from about 5 percent to over 10 percent—and the average size of each fund of funds has grown to $3.5 billion. Most of the growth in funds of funds can be attributed

to the increasing popularity of target-date funds (e.g., Mitchell and Utkus (2022) and Parker, Schoar, and Sun (2023)), which now account for about 80 percent of all funds of funds.[1]

Figure 1: US-domiciled funds of funds. Source: Authors' calculations based on data from Morningstar.



Funds of funds predominantly invest in bond mutual funds and equity mutual funds, which themselves hold mostly bonds and equities, respectively and together make up 95 percent of their total assets. On average, 65 percent is allocated to equity funds and 30 percent to bond funds. This finding about funds of funds domiciled in the United States stands in contrast with European counterparts, which, as Allaire, Breckenfelder, and Hoerova (2022) show, often invest in other funds of funds, leading to complex ownership structures.

Further, funds of funds' portfolio allocations to bond and equity funds are highly persistent from month to month, with an R^2 of 0.96 for bond

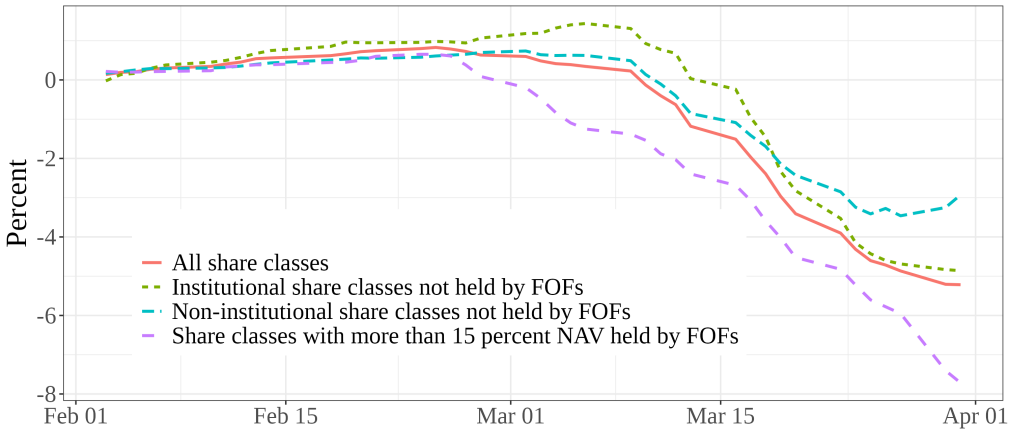
[1]We do not find significant differences between target-date and non-target-date funds in the key features relevant to our analysis, so we study them together in this paper.

funds and 0.98 for equity funds. While these allocations may shift gradually over time, the short-term persistence in portfolio allocations suggests that funds of funds regularly rebalance their portfolios in response to market movements. To explain the portfolio rebalancing mechanism, we present a parsimonious model akin to that of Parker et al. (2023). Funds of funds rebalance when returns on their holdings of bond and equity funds differ—selling the funds with higher returns and buying the funds with lower returns.

We use the Covid-19 crisis to study funds of funds rebalancing portfolios in response to market shocks. In March 2020, bond funds experienced substantial outflows of about $240 billion, or 6 percent of their end-2019 assets, while equity funds and funds of funds saw much smaller outflows—around 0.2 percent and 1 percent of their net assets, respectively. Even though equity funds did not experience major withdrawals, equity prices fell sharply. Funds of funds faced peak losses of about 30 percent on their equity fund holdings and about 7.5 percent on their bond fund holdings. The model predicts that these return differences would require funds of funds to sell their holdings of bond funds and buy equity funds.

We have four sets of main results. First, we focus on aggregate trends. Among funds held by funds of funds at the end of 2019, bond fund share classes with more than 15 percent of their value held by funds of funds experienced significantly larger and faster outflows than other share classes, see Figure 2. In contrast, equity fund share classes held by funds of funds saw significant inflows, while other share classes experienced net outflows. To address potential selection bias—such as funds of funds investing in more vulnerable funds—we run a regression with fund-time fixed effects and find consistent results for share classes within the same fund at the same point in time. We also compare funds of funds' overall allocations at the end of March 2020 to those at the end of 2019. Despite a sharp drop

Figure 2: 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 equity fund values, funds of funds successfully rebalanced to maintain their target allocations, with the median equity allocation declining only slightly from 63 percent to 62 percent and the median bond allocation from 31 percent to 30 percent.

Second, we examine portfolio rebalancing by individual funds of funds in a regression framework using data on their portfolio allocations and performance. Consistent with the model, we find that a fund of funds whose equity fund holdings performed worse than their bond fund holdings sold more bond funds and bought more equity funds to rebalance their portfolios. We also study the persistence of bond and equity fund portfolio allocations in March 2020 and find that funds of funds' bond fund sales and equity fund purchases were closely tied to maintaining their target allocations. Aggregating these individual rebalancing activities, we estimate that funds of funds sold $70 to 80 billion in bond funds, accounting for 25 to 30 percent of total bond fund during the Covid-19 crisis.

Third, we explore cross-sectional characteristics of the bond funds sold by funds of funds. First, we analyze bond fund categories. Relative to their end-2019 holdings, funds of funds sold over 33 percent of their government bond funds—the largest reduction across all bond categories. This behavior resembles bond funds selling their most liquid assets first, or a "reverse flight to quality," as documented by Ma et al. (2022). Second, we analyze bond fund performance. Funds of funds were more likely to sell poorly-performing bond funds, with funds of funds reducing their holdings in more than 90 percent of the worst-performing bond funds.

Lastly, we consider two alternative hypotheses. The first hypothesis is based on information. The sharp drop in equity fund returns in early March might have signaled future bond fund losses, potentially influencing information-sensitive investors—such as funds of funds—to withdraw. To investigate this alternative mechanism, we separate bond fund share classes not held by funds of funds into institutional, which tend to be held by information-sensitive investors, and non-institutional categories (as in Schmidt, Timmermann, and Wermers (2016)). We find that both categories experienced outflows that only began around mid-March, when bond prices actually started to fall, and this timing does not support the information-based story.

The second alternative hypothesis is based on more general liquidation motives of institutional investors. In the second half of March, institutional share classes experienced significantly larger net outflows than non-institutional ones. Funds of funds may have responded to the same concerns that drove other institutional investors. However, as we discussed above, funds of funds' bond fund sales were closely tied to maintaining their target allocations. The persistence of funds of funds' portfolio allocations over March 2020—and the contrast between funds of funds' behavior and other institutional investors—support the portfolio rebalancing motive rather

than the alternative hypothesis.

Our findings have broader implications for how we understand fragility in asset management. Because equity markets are typically more volatile and liquid than bond markets, large swings in equity prices and the resulting divergence in prices can trigger mechanical reallocations that amplify stress in less-liquid bond markets, even in the absence of investor withdrawals. The COVID-19 crisis highlights the scale of this mechanism and the growing role of funds of funds, underscoring the need to better understand their implications for market fragility and financial stability.

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) articulate 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. Parker and Sun (2025) analyze the effects of target-date funds on stabilizing equity markets during the COVID-19 crisis. Harvey, Mazzoleni, and Melone (2025) study economic implications of portfolio rebalancing more broadly and show that predictable rebalancing is subject to front running and can impose significant costs on investors (see references therein for other examples of portfolio rebalancing and related studies). Our paper focuses on portfolio rebalancing by funds of funds and shows that their mechanical rebalancing accounts for 25-30 percent of withdrawals from bond funds during the Covid-19 crisis.

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) highlight the growing importance of mutual funds in debt markets. Focusing on corporate bond funds, they show that funds that held illiquid bonds suffered particularly severe stress during the Covid-19 crisis.[2] Ma et al. (2022) also study the effects of sell offs by bond mutual 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.[3] 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

[2]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. See also Vissing-Jorgensen (2021).

[3]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.

(Chen, Goldstein, and Jiang, 2010; Schmidt et al., 2016; Goldstein, Jiang, and Ng, 2017). Pritsker (2001) and Kodres and Pritsker (2002) provide a broad framework to study financial contagion through multiple mechanisms, including portfolio rebalancing through learning from prices about shared risk factors.[4] 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 defines funds of funds and provides an overview of the data. Section 3 presents preliminary results on funds of funds' portfolios and introduces a simple portfolio rebalancing model. Section 4 presents the main empirical results. Section 5 discusses further analyses. Section 6 concludes.

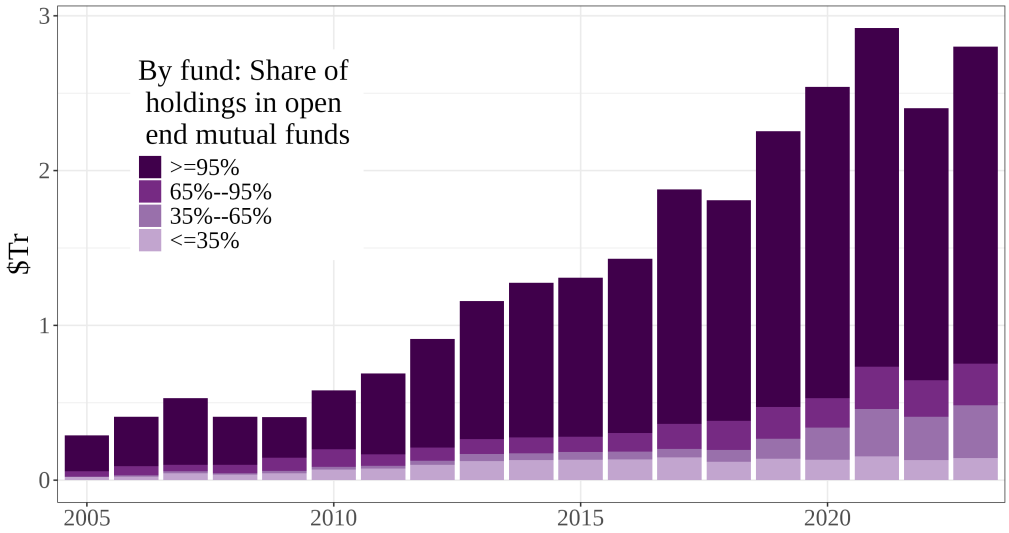
2 Funds of Funds Definition and Data Overview

2.1 Definition

We study open-end mutual funds that hold other open-end mutual funds, which we call *funds of funds*. To identify funds of funds, we begin with the universe of open-end mutual funds in Morningstar and select those that self report as "funds of funds." We find that most of these funds hold more than 95 percent of their portfolios in open-end mutual funds, see Figure 3. Following Allaire et al. (2022), we focus on funds of funds that hold at least 65 percent of their portfolios in open-end mutual funds. These funds

[4]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.

Figure 3: 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.



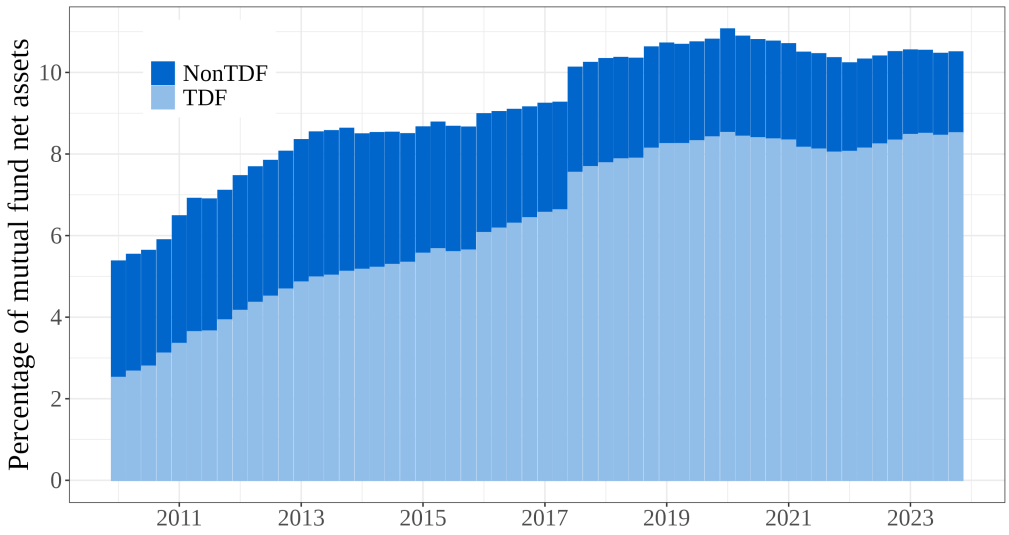
of funds account for about 65 percent of all funds that hold other open-end mutual funds and more than 85 percent of assets they hold.

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 4. Most of the growth in the

funds of funds 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).

Figure 4: US-domiciled funds of funds as a share of all US-domiciled open-end mutual funds.



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

2.2 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 A, with a complete list of data citations in Appendix A.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 A.2.

3 Funds of Funds' Portfolios

3.1 Bond Funds and Equity Funds

Funds of funds hold about 10 open-end mutual funds on average, with any single holding's maximum weight in the portfolio at around 20 percent.[5] Typically, they invest in mutual funds from their own fund family, which in total account for more than 90 percent of their total assets.[6]

The vast majority of mutual funds held by funds of funds are either mainly holding bonds or mainly holding equity, but not both, see Figure 5. 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).

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. The upper panel in Figure 6 shows the overall share of bond funds and equity funds held by all funds of funds reported at the end of each year. The lower panels in Figure 6 show the distributions of portfolio allocations to equity funds and bonds funds, respectively, across individual funds of funds. The majority of funds of funds allocate a significant portion of their assets to both equity funds and bond funds, with equity funds typically comprising around 65 percent of the median fund of funds' portfolio and bond funds around 30 percent. As of year end 2019, funds of funds held

[5]See Appendix B for details.

[6]See Figure 18 in Appendix C. When analyzing fund of funds' bond fund liquidations during the COVID-19 crisis, we tested whether they favored selling or keeping investments within their own fund family. Overall, we found no strong evidence of a clear pattern.

$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.

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. However, funds of funds holding other funds of funds is rare in the United States. 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.

3.2 Persistence of Bond-Equity Allocations

Funds of funds' portfolio allocations between bond funds and equity funds are persistent at a month-to-month frequency. This is evident in scatterplots of bond and equity allocations, Figure 7, 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 black dot represents the end-of-month allocation of a fund of funds' portfolio. The orange dots are the weighted-averages for each of 20 bins, with each observation within the bin weighted by net asset value.[7] While temporary short positions in bonds or equities occur, these instances are rare and short-lived.[8]

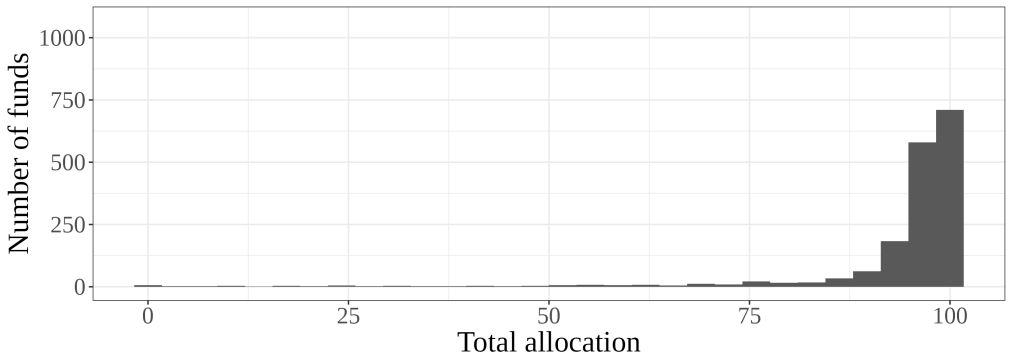
The persistence in portfolio allocations suggests that funds of funds ac-

[7]We also prepared scatterplots including March 2020 and without weighting by net asset value and found almost identical results. The respective R^2 in those plots were 0.95 for bond funds and 0.98 for equity funds.

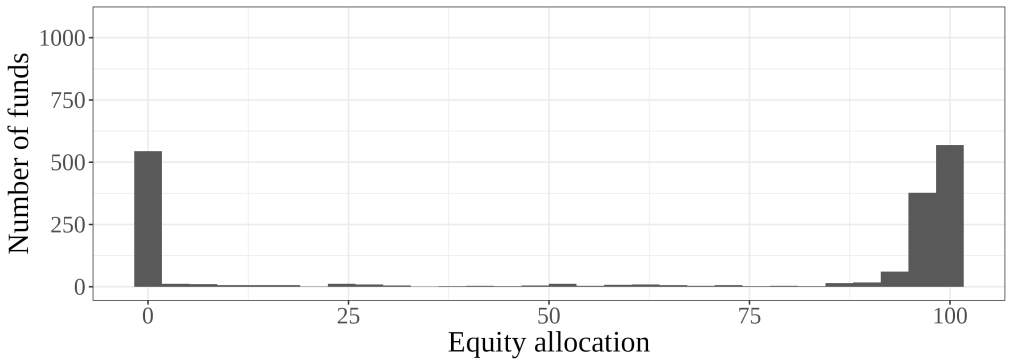
[8]Figure 16 in Online Appendix B.2 shows that, in aggregate, funds of funds' short positions are negligible, amounting to only about one percent of their long positions.

Figure 5: 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

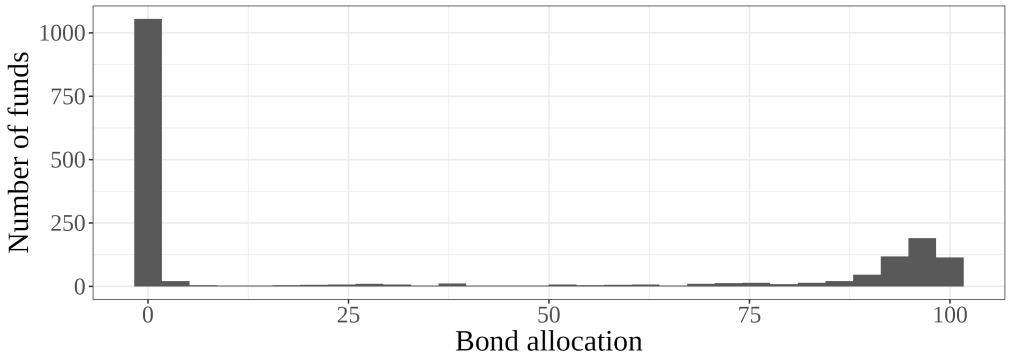
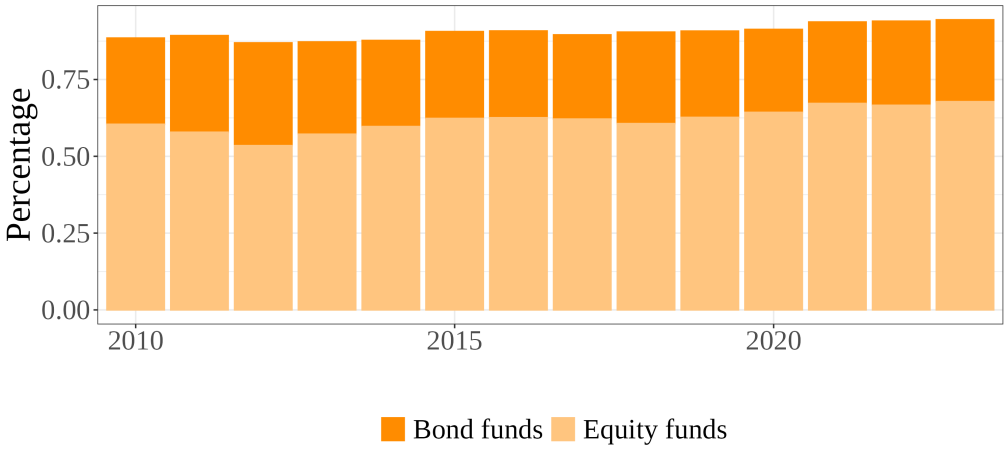


Figure 6: Fund of funds' portfolio allocations to bond funds and equity funds. The upper panel shows the aggregate allocation to bond funds and equity funds by all funds of funds reported at the end of each year. The lower left and right panels show the distributions across funds of funds of the allocations to bond funds and equity funds, respectively. The lower panels are based on monthly data for all funds of funds from 2010-2023. Source: Authors' calculations based on data from Morningstar.



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

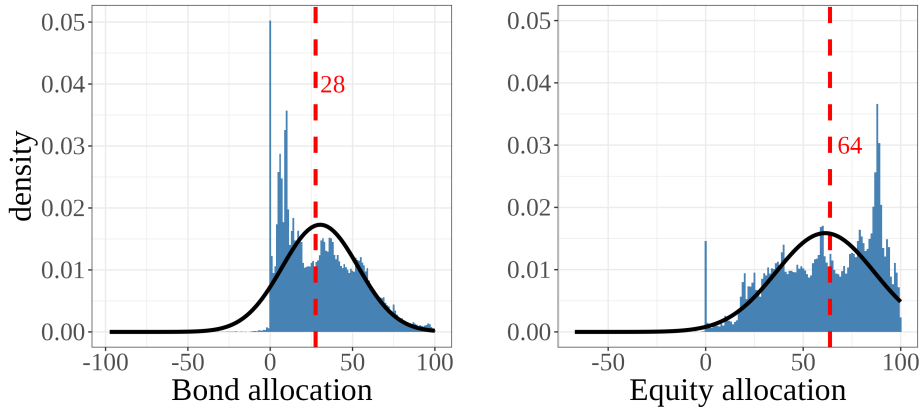
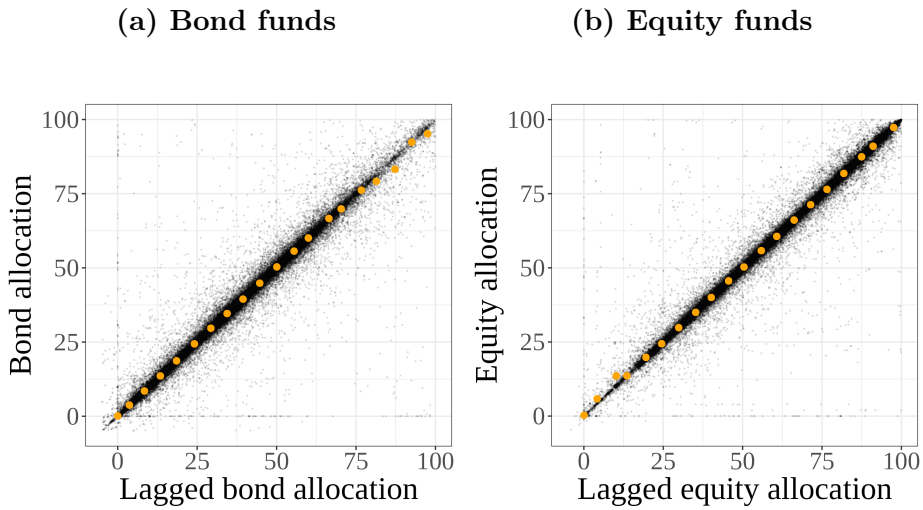


Figure 7: Persistence in fund of funds' portfolio allocations. The unit of observation is a fund of funds in a month. Data are for all funds of funds from 2010-2023, excluding March 2020. The large orange dots in each plot show the weighted averages for each of 20 bins, where each observation is weighted 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.



tively 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 also use a threshold-based approach which triggers rebalancing only when allocations deviate from target weight beyond a set threshold or combine this with periodic rebalancing at fixed intervals.[9]

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

[9]See e.g., Alliance Bernstein (2024), T. Rowe Price (2024), and Vanguard (2024).

3.3 Model of Portfolio Rebalancing

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 w fraction of its asset portfolio to equity funds and $1 - w$ 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

$$\$\Delta_e = w(1+wr_e+(1-w)r_b+f_l)M - w(1+r_e)M = ((r_b-r_e)(1-w)+f_l)wM.$$

In terms of the fraction of its initial equity holding ($M_e = wM$), the change in its equity fund holdings needed to restore the original portfolio allocation will be: $(r_b - r_e)(1 - w) + f_l$. 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

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

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

3.3.1 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:

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

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

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

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

$$\omega_b^m \equiv \frac{\sum_{J^B} x_{j,t}^m}{\sum_J x_{j,t}^m}.$$

For the equity fund holdings of fund of funds m, δ_e^m, r_e^m, and ω_e^m 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:

$$\delta_b^m = \alpha_b + \beta_b(\omega_e^m)(r_e^m - r_b^m) + \gamma_b f_l + \epsilon_b^m \tag{1}$$

$$\delta_e^m = \alpha_e + \beta_e(\omega_b^m)(r_e^m - r_b^m) + \gamma_e f_l + \epsilon_e^m \tag{2}$$

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 Covid-19 Crisis and Portfolio Rebalancing

4.1 Covid-19 Crisis and Stress in Bond Funds

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 6 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).

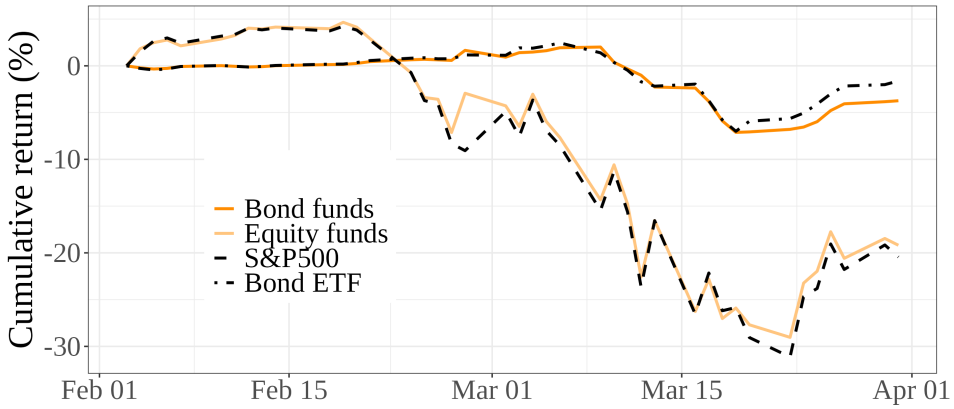
Table 1: Summary statistics for fund types. Fund types are mutually exclusive in this table. Bond (equity) funds are those with more than 75 percent of the portfolio allocated to bonds (equity) and less than 10 percent allocated to equity (bonds). Other funds are open-end mutual funds not classed as 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

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 of 2019. Similarly, funds of funds experienced modest outflows of about $16 billion, less than 1 percent of their net asset value.

Although equity funds did not suffer substantial withdrawals, equity prices dropped significantly. Figure 8 shows the scale of the shock to returns on the holdings of funds of funds in March 2020. 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

Figure 8: 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.



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.

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 bond-equity 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.

4.2 Portfolio Rebalancing during the Covid-19 Crisis

4.2.1 Aggregate Trends

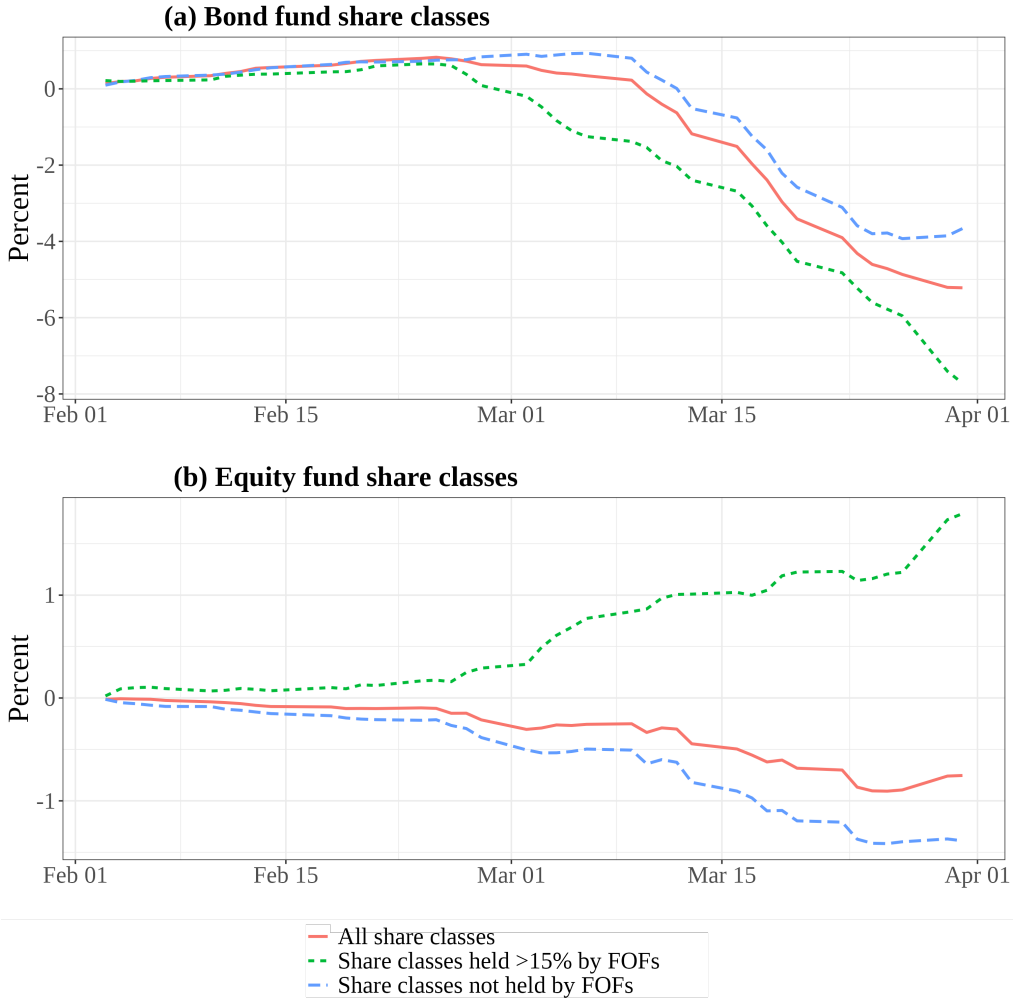
Time series of aggregate investor flows reveal a distinct pattern. Share classes of bond funds that were predominantly held by funds of funds experienced significantly faster net outflows compared to other share classes. In contrast, share classes of equity funds that were predominantly held by funds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

Figure 9 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 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.

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 behavior itself 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

Figure 9: 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.



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.

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

$FOF_hold_{i,k}^{2019}$ 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.[10]

$$FOF_hold_DV_{i,k}^{2019} = \begin{cases} 0 \text{ if } FOF_hold_{i,k}^{2019} > 0.15 \\ 1 \text{ if } FOF_hold_{i,k}^{2019} < 0.15 \end{cases}$$

The set of dummy variables, $\{week_t^w\}$, 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

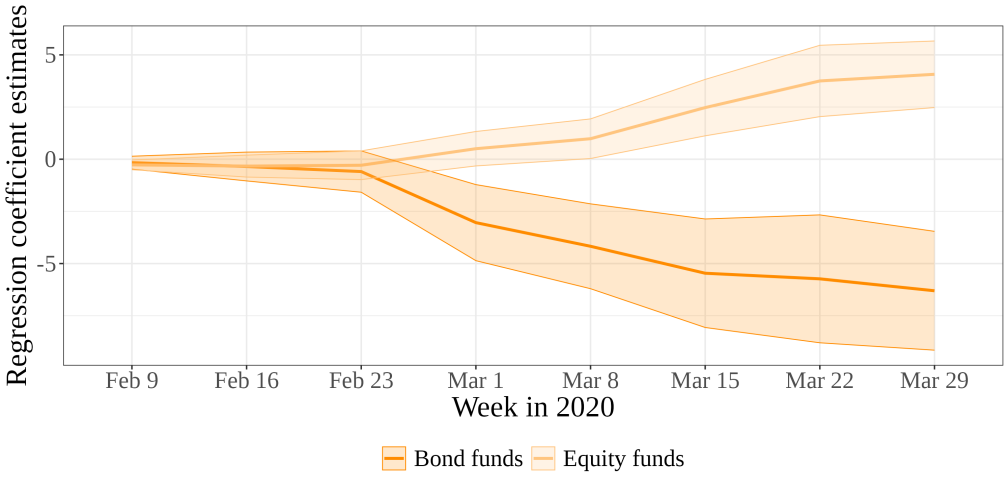
[10]We use an arbitrary threshold of 15 percent based on examining the distribution of holdings of all share classes, reported in Online Appendix B.1. Allaire et al. (2022) used a similarly-arbitrary 25 percent threshold.

given week. The regression specification is

$$CNF_{i,k,t} = \alpha_{k,t} + \sum_{w} \beta^{w} \left(FOF_hold_DV_{i,k}^{2019} \times week_{t}^{w} \right) + \epsilon_{i,k,t} \qquad (3)$$

where $\alpha_{k,t}$ are fund-day fixed effects. 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.

Figure 10: Regression coefficients from estimating equation 3. 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.



The solid lines in Figure 10 show the time series of β^w coefficients from estimating equation 3 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.[11] The coefficient estimates indicate that cumulative net inflows

[11]Table 9 in Online Appendix D.1 reports the regression results together with alternative standard errors clustered by fund or date. Table 10 in Online Appendix D.2

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 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.

Table 2: Fund of funds' holdings as of Dec 31, 2019 and Mar 31, 2020. In this table, the estimated market values of bond fund and equity fund holdings are calculated by summing the product of bond fund and equity fund allocations with total market values. Source: Authors' calculations based on data from Morningstar.

	Holdings as of	
	2019-12-31	2020-03-31
Number of funds of funds	767	765
Total market value ($bn)	1,988	1,642
Median allocation to bonds (%)	31.19	29.90
Median allocation to equity (%)	63.44	61.73

Table 2 shows that funds of funds managed to restore their target allocations to bond and equity funds despite the enormous relative decline in the value of their equity fund holdings. The estimated market value of funds of funds' equity holdings fell by about 20 percent to about $1 trillion

reports summary statistics for the variables used in the regression analysis.

and the corresponding value of bond holdings fell by almost 15 percent to about $500 billion. As a result, the median fund of funds' allocation to equity dipped only slightly from 63 percent to 62 percent from the end of 2019 to the end of March 2020. Over the same period, the median fund of funds' allocation to bonds also dipped slightly from 31 percent to 30 percent, consistent with our later finding that funds of funds increased their allocations to liquid assets such as cash and money market funds.

4.2.2 Individual Funds of Funds' Rebalancing

For each fund of funds m, we use the quarterly holdings data to calculate the set of variables: $\{r_b^m,\ r_e^m,\ \delta_b^m,\ \delta_e^m,\ \omega_b^m,$ and $\omega_e^m\}$. 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 11 in Online 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 model is that the variation in these variables should be driven in part by variation in $\omega_e^m(r_e^m - r_b^m)$ and $\omega_b^m(r_e^m - r_b^m)$, respectively.

Table 3 presents the results from estimating regression specifications 1 and 2.[12] 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.

Columns 2 and 4 control for the amount of investor outflows on each

[12]Table 11 in Online Appendix D.2 reports summary statistics for the variables used in the regression analysis.

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 (δ_b^m) or equity (δ_e^m) funds held. The right-hand side is 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.

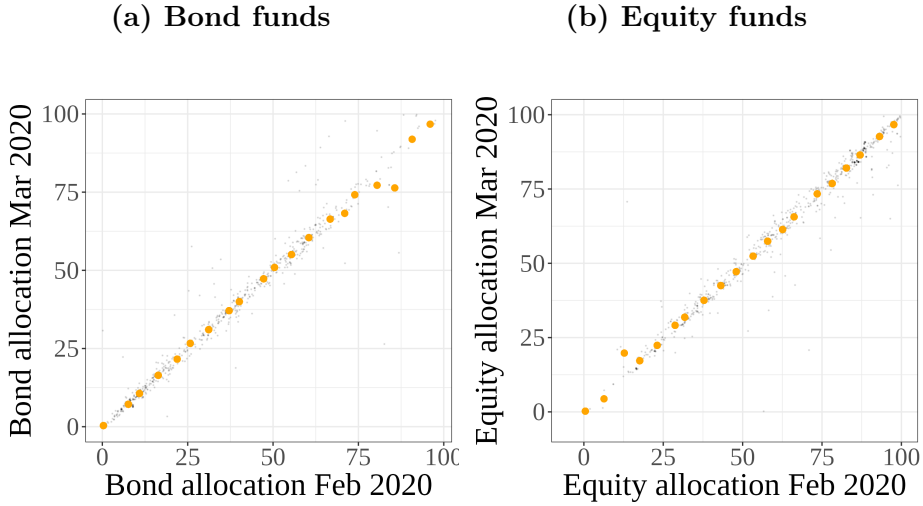
Dep. var.:	δ_b^m		δ_e^m	
	(1)	(2)	(3)	(4)
$\omega_e^m(r_e^m - r_b^m)$	1.56***	2.00***		
	(0.58)	(0.63)		
$\omega_b^m(r_e^m - r_b^m)$			−0.58**	−1.16***
			(0.26)	(0.28)
$Flow/Assets^m$		3.21***		2.81***
		(0.70)		(0.37)
Std. error	Robust	Robust	Robust	Robust
Observations	646	643	646	643
Adjusted R^2	0.02	0.04	0.02	0.19

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. Nevertheless, the results strongly support the rebalancing mechanism.

Next, we examine the persistence of bond and equity fund portfolio allocations over March 2020. Panels (a) and (b) of Figure 11 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. Consistent with the high persistence of allocations documented in Section 3.2, 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 11: Portfolio rebalancing by fund of funds in March 2020. The unit of observation is a fund of fund. 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.



4.2.3 Sizing Up the Rebalancing

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 value of purchases/sales.

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

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

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:

$$\sum_m \sum_{j \in J^B} \hat{p}_j (s^m_{j,Mar31} - s^m_{j,Dec31}) \tag{4}$$

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 4 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 25-30 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 4, 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 4: 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	-

5 Further Analyses

This section further analyzes funds of funds' bond fund liquidations in March 2020. Section 5.1 reports the types of bond funds liquidated by funds of funds, based first on bond fund categories and second on bond fund performance. Section 5.2 explores two alternative hypotheses.

5.1 Cross-Sectional Analysis on Liquidated Bond Funds

5.1.1 Bond Fund Categories

We decompose funds of funds' liquidation of bond funds by the fund category, as reported by Morningstar, in Table 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. Funds of funds also sold large amounts of government bond funds, amounting to about 20 percent of total bond fund sales.

Table 5: Estimated transactions 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. 2019 holdings are the market values at the end of 2019. A negative (positive) value indicates sales (purchases). Source: Authors' calculations based on data from Morningstar.

	Transactions ($bn)	2019 holdings ($bn)	Sales/Holdings (%)
Total bond funds	-77.02	562.15	-13.70
Category			
Government	-15.16	45.20	-33.54
Intermediate core	-40.32	303.54	-13.28
Inflation-protected	-2.75	21.03	-13.08
High yield	-1.63	16.72	-9.73
Large blend	0.05	1.12	4.72
Corporate	-0.04	1.75	-2.26

Relative to the market value of their holdings at the end of 2019, funds of funds sold over 33 percent of their government bond funds and about 13 percent of their intermediate core bond funds. Funds of funds selling a

large fraction of their holdings of government bond funds is akin to bond funds selling their most liquid assets (such as Treasury securities) first during the Covid-19 crisis, as documented by Ma et al. (2022).

5.1.2 Bond Fund Performance

We find evidence that funds of funds sold their poorest-performing bond funds with the lowest Morningstar ratings, which measure a fund's risk-adjusted return.[13] To gauge the relationship between sales and performance, 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 rating of bond fund b 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.[14] The best performers receive five stars and the worst performers receive one star.

Table 6 shows that the probability a bond fund was sold by funds of funds was higher for funds with lower Morningstar ratings. The constant term indicates that funds of funds reduced their holdings of more than 90 percent of bond funds with the lowest Morningstar rating of 1. By

[13] We also tested whether funds of funds disproportionately sold or retained their holdings of share classes within their own fund family. Overall, we did not find strong evidence either way. See Online Appendix D.3.

[14] 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`

Table 6: What ratings were the bond funds that funds of funds sold? 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 column 7 the dependent variable is the percent change in shares held from Dec 31, 2019 to Mar 31, 2020. The independent variables are based on Morningstar five-point fund ratings, which measure a fund's risk-adjusted return. $Rating_2019_b$ is the bond fund's rating on Dec 31, 2019. *p<0.1; **p<0.05; ***p<0.01 Source: Authors' calculations based on data from Morningstar.

Dependent variable:	$sales_b^m \in \{0,1\}$				$\Delta shares_b^m$	
	(1)	(2)	(3)	(4)	(5)	(6)
$Rating_2019_b$	-0.07^{***}	-0.06^{***}				
	(0.01)	(0.01)				
$Rating_2019_b == 1$					-0.17^{***}	-0.09^{***}
					(0.02)	(0.01)
$Rating_2019_b == 2$			-0.20^{***}	-0.25^{***}	-0.07^{***}	-0.02^{**}
			(0.05)	(0.04)	(0.01)	(0.01)
$Rating_2019_b == 3$			-0.18^{***}	-0.21^{***}	-0.07^{***}	-0.03^{***}
			(0.04)	(0.03)	(0.01)	(0.01)
$Rating_2019_b == 4$			-0.31^{***}	-0.37^{***}	-0.003	0.04^{***}
			(0.04)	(0.03)	(0.01)	(0.01)
$Rating_2019_b == 5$			-0.30^{***}	-0.29^{***}	0.01	0.01
			(0.04)	(0.03)	(0.01)	(0.01)
Constant	0.92^{***}		0.92^{***}			
	(0.03)		(0.03)			
Std. error	Robust	Cluster	Robust	Cluster	Robust	Cluster
Fixed effects	-	FOF	-	FOF	-	"FOF"
Observations	2,495	2,495	2,495	2,495	2,495	2,495
Adjusted R^2	0.02	0.27	0.02	0.29	0.02	0.41

contrast, they reduced their holdings of only about 60 percent of the highest-rated bond funds. We report the results using each fund's average Morningstar rating in December 31, 2019 and March 31, 2020, as well as its original rating in December 31, 2019. We also report results from estimating the regressions with fund of funds fixed effects (with appropriately clustered standard errors) to show that even within funds of funds, the probability a bond fund was sold by each fund of funds was higher for bond funds with lower Morningstar ratings. The final two columns of the table report the average percentage of shares sold by funds of funds in the bond funds for each Morningstar rating.[15] Funds of funds sold on average about 20 percent of their shares in the lowest-rated bond funds while the change in their shares in the highest-rated bond funds was statistically zero.

5.2 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

[15]The specifications exclude a constant term to simplify the interpretation of the coefficients. The last column approximates a specification with fund of funds fixed effects by including the mean sales of each fund of funds as a dependent variable, with standard errors clustered by funds of funds, as there is insufficient variation within each fund of funds to estimate the model with fixed effects.

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 2.

In Table 7, we study the cumulative net flows on share classes of bonds funds that were held by funds of funds at the end of 2019.[16] 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.

The difference in timing in both Figure 2 and column 1 in Table Table 7 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.

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

[16]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 Online Appendix D.2 reports summary statistics for the variables used in the regression analysis.

Table 7: 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 columns 1 and 2 takes the value 1 if more than 15 percent of the share class is held by funds of funds and 0 otherwise. The right-hand side $\mathcal{X}$-variable in column 3 takes the value 1 if it is an institutional share class and 0 otherwise. The sample in column 1 is all share classes in bonds funds held by funds of funds. The sample in column 2 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. The sample in column 3 is all 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×date, week	Y	Y	Y
Observations	61,093	68,908	21,467
Adjusted R^2	0.19	0.17	0.30

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 7. 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 11 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 7 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 shown in Figure 10 and reported in Column 3, 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. Column 3 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. 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 11 and the regression results in column 2 of Table 7 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.

6 Concluding Remarks

We have studied portfolio rebalancing by funds of funds. Funds of funds have grown significantly over the past decade, primarily invest in bond mutual and equity mutual funds, and their portfolio shares of bond and equity funds remain highly stable from month to month. We have presented a parsimonious model of portfolio rebalancing and found support for the main mechanism in a regression framework using the Covid-19 crisis as an empirical laboratory. Overall, funds of funds accounted for 25 to 30 percent of all bond fund outflows in March 2020. We have also shown that funds of funds sold a large fraction of their government bond fund holdings and were more likely to sell worse performing bond funds.

This paper has shown how funds of funds can transmit shocks between bond and equity markets through portfolio rebalancing. Equity markets typically are more volatile and liquid than bond markets. Whenever bond and equity prices do not move in tandem, funds of funds may need to buy those funds with lower returns and sell those with higher returns. Through this process, the high volatility in equity markets can be transferred to bond markets, whose lower liquidity makes them more vulnerable to disruptions. The Covid-19 crisis clearly highlighted the growing significance of funds of funds and thus the importance of further research into their implications for financial markets and overall stability.

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Appendix for online publication only

A 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 3, 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 most 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

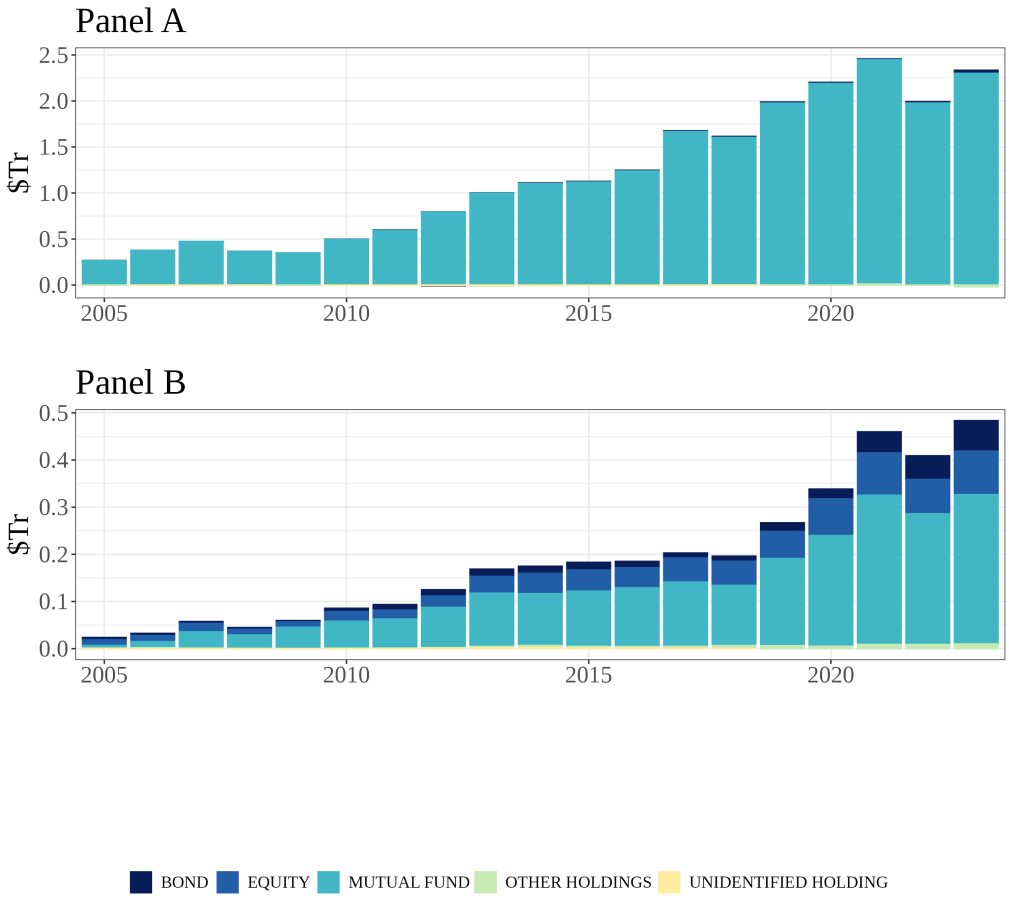
of funds as those funds that hold at least 65 percent of their portfolios in open-end mutual funds. We identify target-date funds as those whose Morningstar category (OF028) contains the text 'TARGET-DATE'. For the individual open-end mutual funds held by funds of funds, we collect time-series data on 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 12 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).

A.1 Data citations

- Morningstar, Inc. Morningstar Direct, `http://corporate.morningstar.com/US/asp/subject.aspx?xmlfile=40.xml`.
- FRED
  - BOGZ1LM654090000Q — Board of Governors of the Federal Reserve System (US), Mutual Funds; Total Financial Assets, Market Value Levels, retrieved from FRED, Federal Reserve

Figure 12: 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: Morningstar.



Bank of St. Louis; https://fred.stlouisfed.org/series/BOGZ1LM654090000Q

– 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

A.2 Comparison with Z.1 Financial Accounts

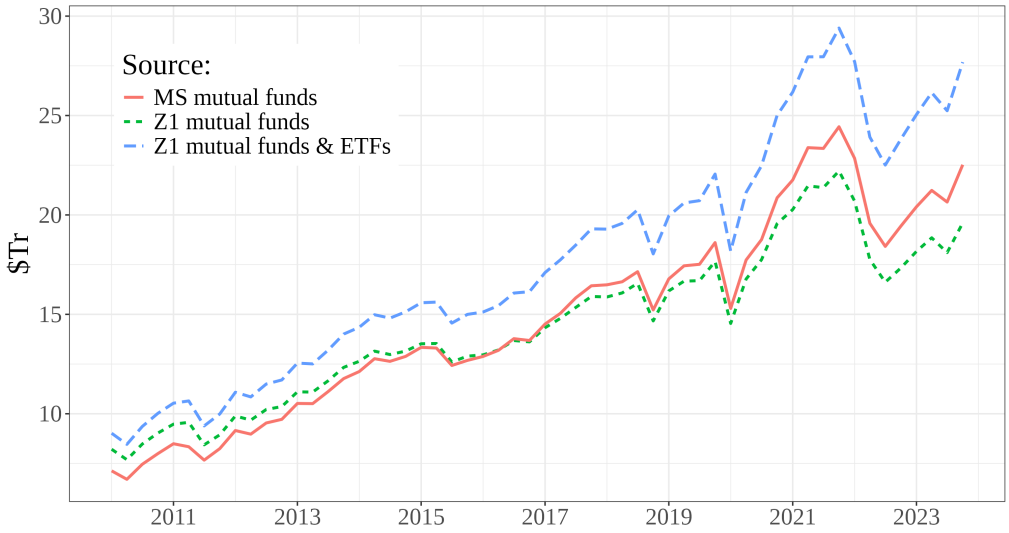
In this appendix, we compare our estimate of the mutual fund universe based on data from Morningstar to the Federal Reserve's Z.1 Financial Accounts of the United States. The Z.1 Financial Accounts data for mutual funds are sourced from subscription-based Investment Company Institute (ICI) data and ICI 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 includes variable annuity long-term mutual funds and variable annuity mutual funds of the College Retirement Equities Fund from 1980:Q1 through 1990:Q4.

Figure 13 compares the two quarterly data series. The two series track closely, exhibiting a pairwise correlation of 0.999. Both series trough at under $6 trillion in 2009:Q1 and peak at over $20 trillion in 2021:Q1. The largest discrepancy between the two series occurs in 2023:Q4, when Morningstar's estimate exceeds the Z.1 measure by about $3 trillion. However, this difference remains modest relative to the total market size, which stood at about $22.5 trillion in 2023 according to Morningstar.

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



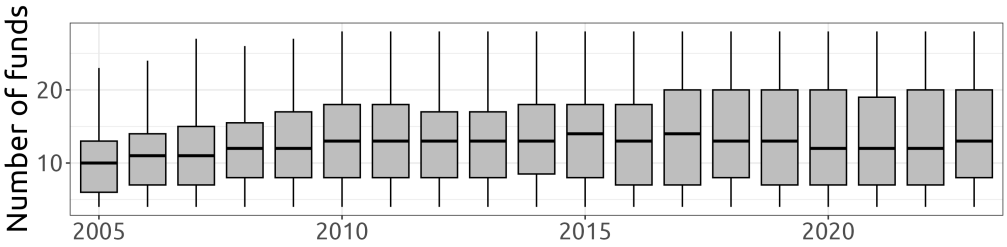
B Holdings of funds of funds

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 B.1 and B.2, respectively.

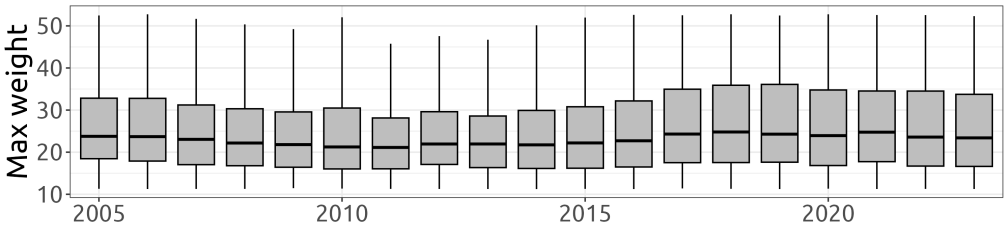
Figure 14 shows the distribution of open end mutual funds held by funds of funds, summarizing the number of funds held (panel (a)), the share allocated to the largest holding (panel (b)), the average share allocated to each fund (panel (c)), and the overall size of each fund of funds (panel (d)). Panel (a) shows that the typical fund of funds holds about 10 open-end mutual funds. Panel (b) shows that a fund of funds' largest holding accounts for about 20 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 14: 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.

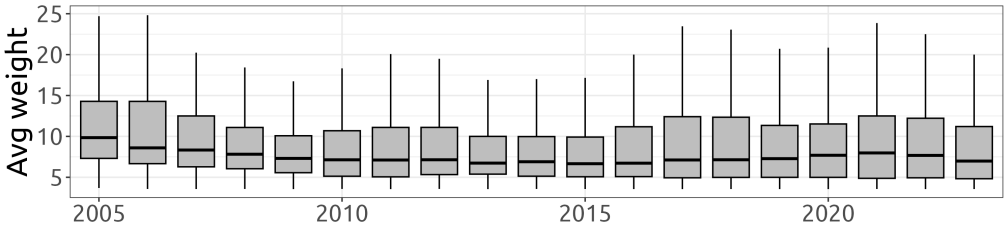
(a) Number of open end mutual funds held



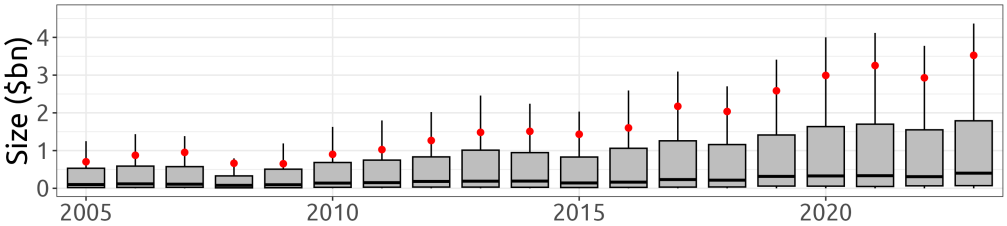
(b) Maximum weight in portfolio



(c) Average weight in portfolio



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

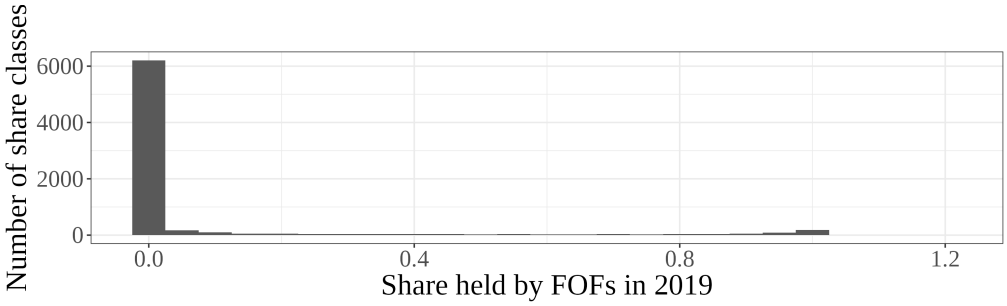


B.1 Distribution of fractions of share classes held

Figure 15 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 8 shows the values (fractions) for specific percentiles of the distributions shown in Figure 15, 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 15: 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

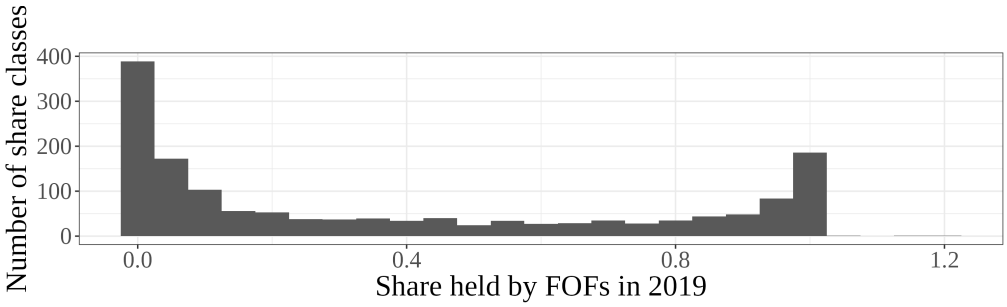


Table 8: Percentiles of the distribution of all share classes of funds held by funds of funds. Panels (a) and (b) show selected percentiles of the distributions shown in Figures 15a and 15b, respectively. For each percentile, we report the fraction of the share class held by funds of funds, the number 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

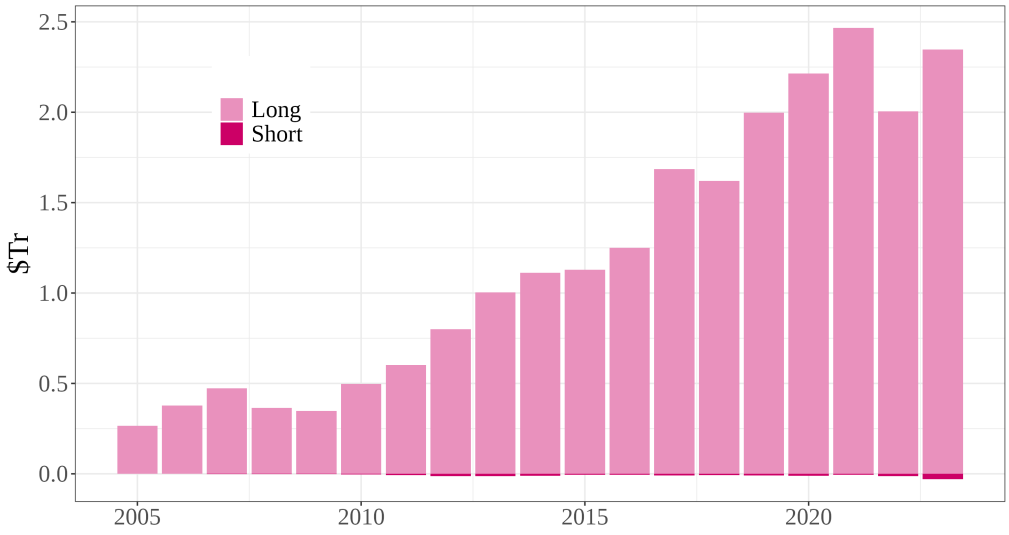
Panel (b)

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

B.2 Long and short holdings of funds of funds

Figure 16 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 16: Funds of funds long and short holdings. Data are annual as of year end. Source: Morningstar.



C 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 17 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 20 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.

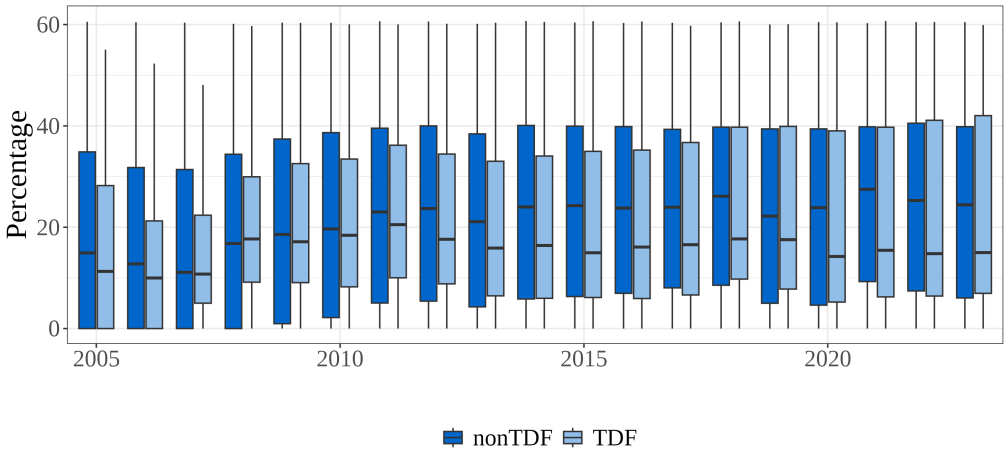
Figure 18 compares target date and non-target date funds' portfolio allocations to funds within the same fund family from 2010 to 2023. Panel (a) shows that, in each year during this period, both target date and non-target date funds consistently allocated between 85 and 98 percent of their portfolios 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 19 compares expense ratios for target date and non-target date funds. The boxplots in the upper figure 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. The lower panels (a) and (b) 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.

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 the 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 17: 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

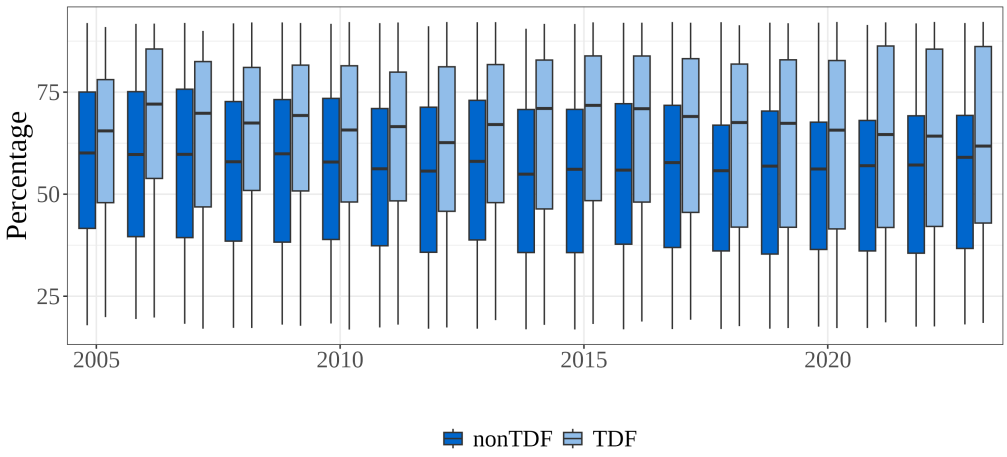
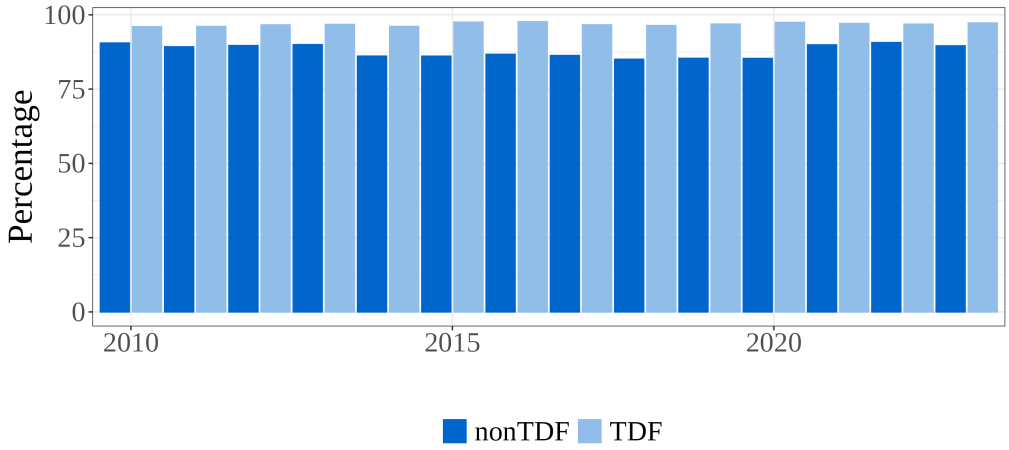


Figure 18: Allocations of funds of funds' portfolios to funds within the same fund family. Source: Authors' calculations based on data from Morningstar.

(a) Aggregate



(b) Distribution across funds of funds

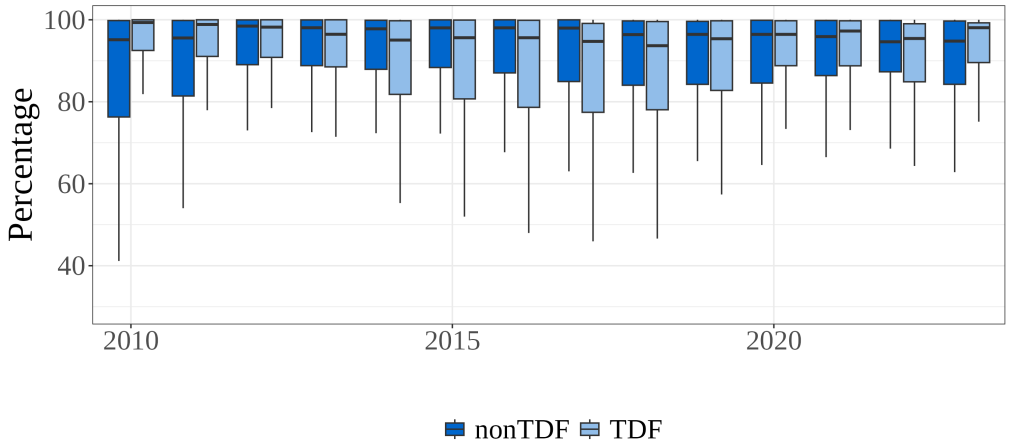
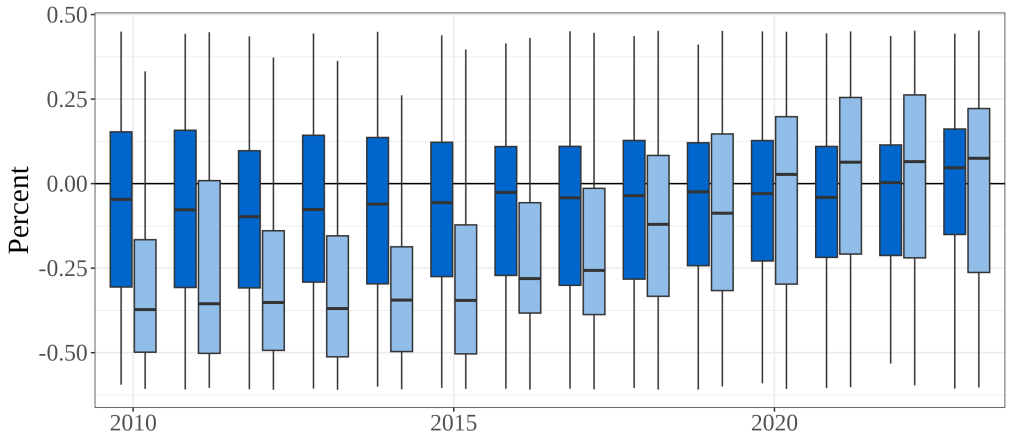
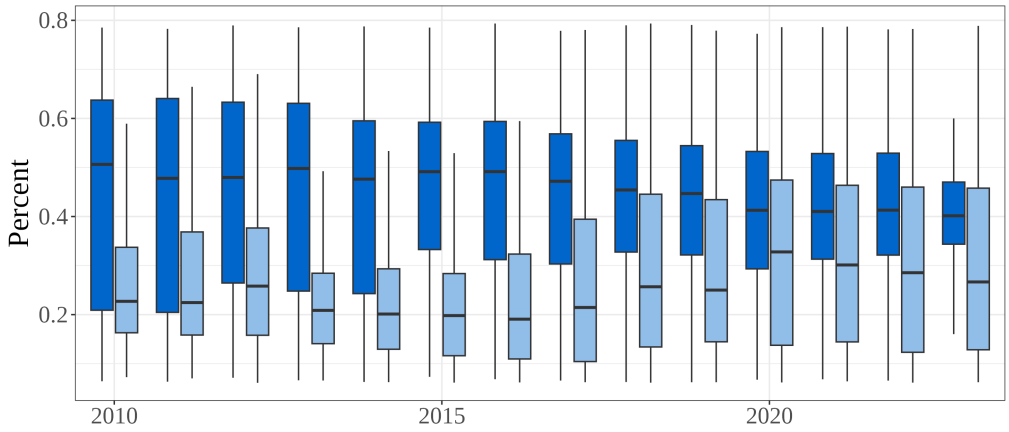


Figure 19: Net liability-asset expense ratios for funds of funds. The boxplots show the distribution across funds of funds of liability expenses minus asset expenses divided by total assets. Source: Authors' calculations based on data from Morningstar.



(a) Liabilities expense ratios



(b) Assets expense ratios

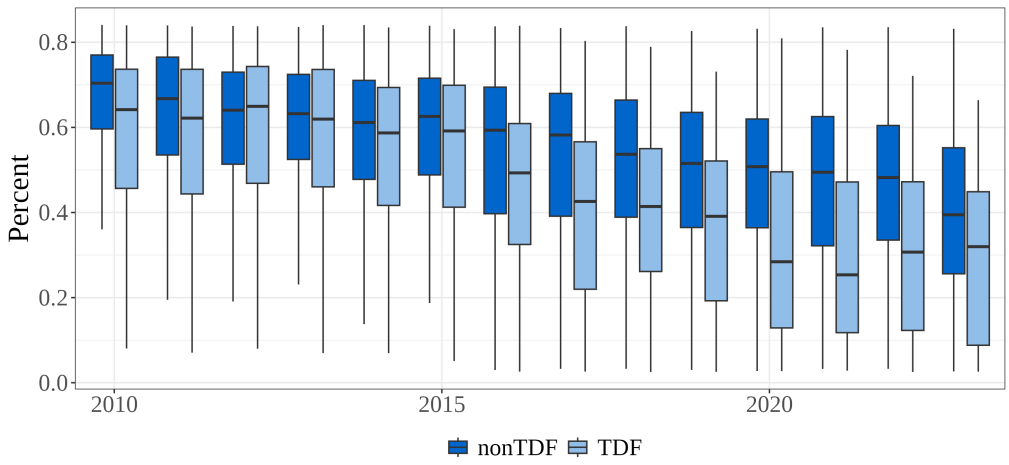
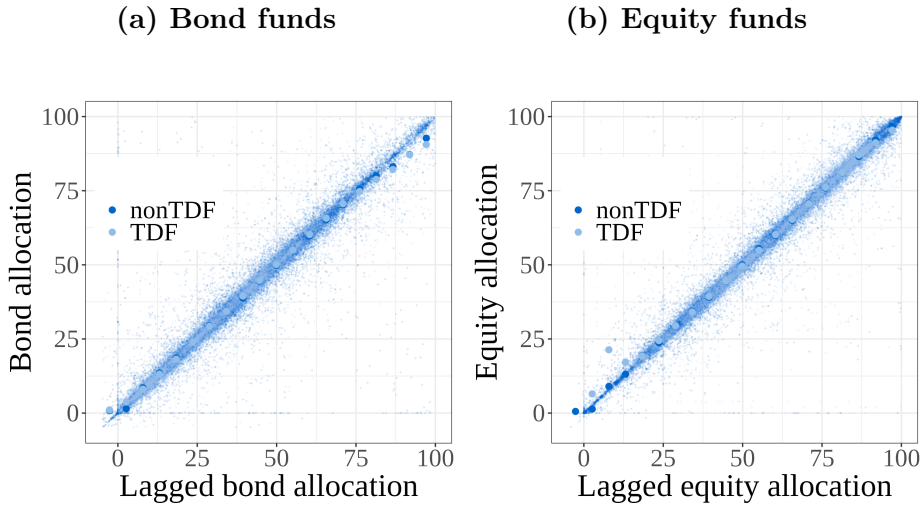


Figure 20: Persistence in fund of funds' portfolio allocations. For legibility, the data were censored at -5 to remove a few observations when funds of funds held short positions. Data are monthly for all funds of funds from 2010-2023. Source: Authors' calculations based on data from Morningstar.



D Supplementary Results

D.1 Regression Results Underpinning Figure 10

Table 9: 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 10 presents summary statistics for the analysis in subsections 4.2.1 and 5.2 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 4.2.2 testing the rebalancing mechanism at the level of individual funds of funds. Table 12 presents summary statistics for the analysis in subsection 5.1.2 of the performance ratings of bond funds sold by funds of funds.

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	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
$CNF_{i,k,t}$	Bond fund	68,908	-0.48	14.30	-95.64	-2.16	0.85	150
$CNF_{i,k,t}$	Equity fund	136,813	-0.57	11.43	-150	-2.06	0.24	150
$FOF_hold_DV_{i,k}^{2019}$	Bond fund	91,389	0.11	0.31	0	0	0	1
$FOF_hold_DV_{i,k}^{2019}$	Equity fund	171,667	0.12	0.32	0	0	0	1
$Inst_DV_{i,k}$	Bond fund	91,389	0.25	0.43	0	0	1	1
$Inst_DV_{i,k}$	Equity fund	171,667	0.24	0.43	0	0	0	1

Table 11: 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 12: Summary statistics for analyzing the ratings 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 $\Delta shares_b^m$ 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
$\Delta shares_b^m$	2,495	-0.03	0.28	-0.99	-0.15	0.02	1
$Rating_2019_b$	2,510	3.64	0.92	1	3	4	5

D.3 Fund Family Analysis

Funds of funds predominantly—but not exclusively—source their holdings of bond funds and equity funds from within their own fund families. Figure 18 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 13 extends the analysis of Table 6 to test whether the bond funds sold by a given fund of funds were disproportionately within the same fund family. The variable Own_Family_b takes the value 1 if the bond fund is within the same fund family as the fund of funds and 0 otherwise. Overall, we do not find strong evidence either way.

Table 13: Did funds of funds disproportionately sell their own family's 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 column 7 the dependent variable is the percent change in shares held from Dec 31, 2019 to Mar 31, 2020. The independent variables are based on Morningstar five-point fund ratings, which measure a fund's risk-adjusted return. $AvgRating_b$ is the bond fund's average rating on Dec 31, 2019 and Mar 31, 2020. $Rating_2019_b$ is the bond fund's rating on Dec 31, 2019. Own_Family_b takes the value 1 if the bond fund is within the same fund family as the fund of funds and 0 otherwise. *p<0.1; **p<0.05; ***p<0.01 Source: Authors' calculations based on data from Morningstar.

	$sales_b^m \in \{0,1\}$				$\Delta sales_b^m$	
	(1)	(2)	(3)	(4)	(5)	(6)
$Rating_2019_b$	−0.06**	−0.05***				
	(0.02)	(0.02)				
$Rating_2019_b == 1$					−0.14***	−0.16***
					(0.04)	(0.03)
$Rating_2019_b == 2$			−0.18	−0.49***	−0.03	0.01
			(0.12)	(0.09)	(0.03)	(0.01)
$Rating_2019_b == 3$			−0.46***	−0.79***	0.01	0.01
			(0.10)	(0.09)	(0.02)	(0.02)
$Rating_2019_b == 4$			−0.42***	−0.62***	−0.01	−0.01
			(0.08)	(0.07)	(0.03)	(0.03)
$Rating_2019_b == 5$			−0.37***	−0.51***	−0.07***	−0.05*
			(0.09)	(0.07)	(0.03)	(0.02)
Own_Family_b	0.14	−0.01	−0.01	−0.51***	−0.04	0.09***
	(0.10)	(0.10)	(0.08)	(0.09)	(0.05)	(0.03)
$Rating_2019_b \times Own_Family_b$	−0.003	−0.02				
	(0.03)	(0.02)				
$Rating_2019_b \times Own_Family_b == 2$			−0.02	0.28***	−0.004	−0.12***
			(0.13)	(0.09)	(0.06)	(0.03)
$Rating_2019_b \times Own_Family_b == 3$			0.31***	0.66***	−0.05	−0.14***
			(0.10)	(0.10)	(0.05)	(0.04)
$Rating_2019_b \times Own_Family_b == 4$			0.14	0.32***	0.05	−0.03
			(0.09)	(0.07)	(0.06)	(0.05)
$Rating_2019_b \times Own_Family_b == 5$			0.09	0.29***	0.14**	−0.02
			(0.10)	(0.07)	(0.06)	(0.03)
$Constant$	0.79***		0.93***			
	(0.09)		(0.06)			
Std. error	Robust	Cluster	Robust	Cluster	Robust	Cluster
Fixed effects	-	FOF	-	FOF	-	"FOF"
Observations	2,495	2,495	2,495	2,495	2,495	2,495
Adjusted R^2	0.02	0.27	0.03	0.30	0.03	0.42

Online appendix references

Allaire, Nolwenn, Johannes Breckenfelder, and Marie Hoerova, "Fund Fragility: The Role of Investor Base," *SSRN working paper*, 2022.

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