Target Allocation Funds, Strategic Complementarities, and Market Fragility*

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Abstract

Target allocation funds (TAFs) make predictable rebalancing trades to maintain portfolio weights across asset classes. During the COVID-19 crisis when equities declined much more than bonds, TAFs sold $59 billion of bond fund shares and simultaneously purchased a similar amount of equity fund shares. We show that predictable TAF rebalancing triggered strategic complementarity: bond mutual funds facing larger rebalancing-induced sales by TAFs experienced greater outflows from *other* non-TAF investors. This effect was particularly pronounced for illiquid bond funds and amplified aggregate bond fund outflows during COVID-19 by an additional $27 billion. Rebalancing by TAFs, together with the strategic amplification by other investors, transmits equity shocks to bond returns, accounting for 17% of the rise in stock-bond correlation over the past decade.

Keywords: target allocation funds, strategic complementarity, stock-bond correlation

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1 Introduction

The bond market experienced tremendous turmoil during the COVID-19 crisis. Safe bonds such as Treasury bonds and investment-grade corporate bonds traded at surprisingly large discounts that were hard to reconcile with economic fundamentals (Haddad et al., 2021). A major contributor was large outflows from bond mutual funds (Vissing-Jorgensen, 2021; Falato et al., 2021). Panel A of Figure 1 shows that investors withdrew a record $178 billion from bond mutual funds in the single quarter of 2020Q1. In order to meet redemptions, bond mutual funds sold holdings of underlying bonds, particularly liquid safe bonds to minimize liquidation costs (Ma et al., 2022). A key question remains: why were there large outflows from bond mutual funds? According to conventional wisdom, safe investment vehicles such as bond funds should have attracted flight-to-safety inflows during crisis periods (e.g., Baele et al., 2019).

Target allocation funds (TAFs) were a major contributor to the outflows from bond mutual funds during the COVID-19 crisis. The red bars in Panel A of Figure 1 show that TAFs sold $59 billion worth of bond fund shares, accounting for 33% of the total outflows from bond mutual funds. The magnitude is large, considering that TAFs only held 12% of bond fund shares outstanding at year-end 2019. Panel B of Figure 1 shows that, in percentage terms, TAFs sold 12% of their bond fund shares during COVID-19, 4 times that of other bond mutual fund investors. The reason behind TAFs' sales is evident from Panel A of Figure 2, which shows that TAFs simultaneously sold bond fund shares and bought equity fund shares during the COVID-19 crisis. During COVID-19, equity values dropped sharply by -21%, declines in bond values were much smaller, and therefore bonds' relative portfolio weights rose. To maintain target allocations, TAFs sold bond funds and bought equity funds. Contemporaneous work by Foley-Fisher and Lee (2025) also demonstrates this rebalancing behavior.

Beginning with a detailed analysis of TAFs' rebalancing activities, we uncover how they trigger strategic runs from other bond fund investors and transmit shocks across markets. We have three findings. First, TAFs trade in a highly predictable manner conditional on realized returns to stay on their target allocations. Their rebalancing is influenced by liquidation costs, depending on whether they are internalized at the fund family level. Second, when equities experience large declines – such as those during the COVID-19 crisis – predictable rebalancing-induced sales by TAFs trigger strategic redemptions from *other* non-TAF bond mutual fund investors. This strategic complementarity is particularly salient for bond mutual funds with illiquid holdings, and we rule out alternative explanations by analyzing holdings by *individual* bond fund investors. Lastly, bonds with more exposure to TAFs co-move more with equity market returns. We estimate that TAFs' rebalancing activities and the coordinated trading they trigger account for a large portion of the increase in stock-bond correlation over the past decade.

We begin by showing that TAFs rebalance in a highly predictable manner, focusing on their holdings of bond mutual funds. A TAF's portfolio weight on a bond fund is typically held constant over a quarterly horizon. Building on this allocation rigidity, we characterize the theoretical rebalancing trades a TAF would conduct in response to return shocks on its portfolio funds. These theoretical rebalancing-induced trades, or RIT, represent the adjustments required to keep the TAF exactly at its target allocations. We show that there is a near one-for-one relationship between RIT and TAFs' actual trades. During COVID-19, most of the bond fund sales and equity fund purchases can be explained by RIT.

We show that the relationship between theoretical versus actual rebalancing depends on the illiquidity of the bond mutual funds. For affiliated funds, TAFs trade less than one-for-one with RIT for illiquid funds, especially during illiquid periods such as the COVID-19 crisis. However, such liquidity pecking order is not observed for unaffiliated funds. When redeeming from bond mutual funds affiliated with the same fund families, TAFs internalize the costs

of liquidating the underlying bonds. For unaffiliated funds, the liquidation costs are fully external. Using this liquidity adjustment, we refine the calculation of RIT and reaffirm its predictive power in the cross section of bond mutual funds.

Because TAFs' rebalancing activities are highly predictable based on lagged holdings and realized returns that are publicly available to market participants in real time, other fund investors may react strategically. As shown by Chen et al. (2010) and Goldstein et al. (2017), for liquidity transformation vehicles such as bond mutual funds, when some investors request redemptions, the costs associated with liquidating the underlying bonds are borne by the *remaining* investors. Therefore, when TAFs are expected to redeem their bond fund shares, it is optimal for other investors to also sell their bond fund shares, in order to avoid bearing the liquidation costs.

We show strong evidence of strategic complementarity in the cross section of bond funds during the COVID-19 crisis. For each bond mutual fund in each period, we aggregate predicted rebalancing trades by all TAFs, accounting for liquidity adjustment based on fund affiliation. We find that bond mutual funds facing higher rebalancing-induced sales by TAFs experienced larger outflows from *other* non-TAF bond fund investors. Specifically, when a bond mutual fund is expected to experience 1% higher rebalancing-induced redemption from its TAF investors, it simultaneously experiences 0.684% higher outflows from other investors. Consistent with the prediction of theories, this coordination between TAFs and other investors is much more pronounced for bond mutual funds holding illiquid bonds, where liquidation costs are high. We show robustness of our results with respect to various measures of illiquidity.

To further rule out alternative explanations, such as endogenous selection of unobserved rebalancers, we analyze holdings by *individual* investors of bond mutual funds, including non-TAF mutual funds and insurance companies. By including investor fixed effects, we purge out any heterogeneity across investors and zoom in on the same investor's trading

across bond mutual funds. We find similar co-movement with TAF rebalancing-induced trading: a non-TAF mutual fund or insurance company is more likely to decrease holdings of the bond funds that face larger rebalancing-induced sales by TAFs. This investor-level analysis provides compelling confirmation of the presence of strategic complementarity.

Strategic reactions by other investors amplify rebalancing-induced sales by TAFs. Using the estimates from our cross-sectional regression, we quantify the aggregate amount of strategic sales by other investors during COVID-19 to be $27 billion. Total sales by TAFs and other investors due to strategic complementarity explain $86 billion, or 48%, of the total outflows from bond mutual funds during the COVID-19 crisis. This amplification gives rise to a concave relationship between flows to TAF-exposed bond funds and equity market returns. When equity markets experience large negative returns, TAF rebalancing triggers strategic runs by other investors, and this coordination is absent for positive equity returns.

Turning to asset pricing implications, we show that TAFs transmit equity market shocks to the bond market. For identification, we focus on the cross section of Treasury and corporate bonds that are differentially exposed to TAFs' rebalancing activities. We take a bottom-up approach and aggregate two layers of intermediation: buying and selling of bond funds by a given TAF, and buying and selling of bonds by a given bond fund. For each layer, we carefully adjust for liquidity pecking order, using the same approach as Ma et al. (2022). Our rebalancing exposure is a significant predictor of how bond returns co-move with the aggregate equity market. During the COVID-19 stock market crash, bonds with higher exposure to TAF rebalancing experienced more negative returns.

Lastly, we show evidence that TAF rebalancing contributes significantly to the rise in aggregate stock-bond correlation over the past decade. To do this, we calculate aggregate TAF rebalancing-induced trades on equities and bonds, taking into account the amplifying trades by other investors due to strategic complementarity. We then multiply these aggregate trades by existing estimates of aggregate multipliers (Gabaix and Koijen, 2021; Ma et al.,

2022) to arrive at rebalancing-induced returns. By subtracting these rebalancing-induced returns from actual returns, we can derive counterfactual aggregate stock-bond correlation without TAF rebalancing. The results show that, without TAF rebalancing-induced trades, aggregate stock-bond correlation would have decreased from 0.11 to -0.01 at year-end 2023, eliminating 17% of its rise over the past decade.

1.1 Literature

Our paper contributes to the understanding of bond market turmoil during the COVID-19 crisis (Haddad et al., 2021; Vissing-Jorgensen, 2021; Falato et al., 2021; Ma et al., 2022; Allaire et al., 2023). Existing literature including Falato et al. (2021) and Ma et al. (2022) shows that bond mutual fund outflows were a major contributor, although the sources of these outflows are not fully understood. Together with concurrent work by Foley-Fisher and Lee (2025), we uncover rebalancing activities by TAFs as a major driver. We derive a theoretical measure of rebalancing-induced trading (RIT), which matches nearly one-for-one with observed TAF trading. More importantly, we show that TAF rebalancing-induced sales were significantly amplified by strategic runs from other bond fund investors, transmitting equity market declines to the bond market. This phenomenon will likely become more important in future crises, as target date funds and other target allocation funds continue to grow relative to the bond market.

We contribute to the understanding of target allocation – an investment strategy that has experienced tremendous growth – and its unintended consequences (Balduzzi and Reuter, 2018; Massa et al., 2022; Andonov et al., 2024; Harvey et al., 2025). We uncover another unintended consequence: rebalancing transmits shocks from one market to another. This increases the correlation across asset classes, and our quantification suggests that TAF rebalancing can explain 17% of rise in stock-bond correlation over the past decade. The closest

papers to ours are Parker et al. (2023) and Parker and Sun (2023), who show that TAFs make the stock market more resilient, since negative equity returns induce them to purchase more equities, partially reversing the shocks. We show the other side of the coin: the bond market is now more vulnerable to equity market shocks due to TAF rebalancing, amplified by strategic complementarity.

Most importantly, we present novel evidence on the presence of strategic complementarity in liquidity transformation vehicles. Existing studies focus on the link between liquidity transformation and the probability of a run in response to worsening fundamentals, based on the prediction of Goldstein and Pauzner (2005). Chen et al. (2024) show evidence for banks, while Chen et al. (2010) and Goldstein et al. (2017) show evidence for equity and bond mutual funds. This paper complements existing studies with a much more direct test on the presence of strategic complementarity. TAFs make plausibly exogenous rebalancing-induced trades due to their investment mandates, and other bond mutual fund investors strategically run to avoid bearing the liquidation costs. Our results imply that predictable rebalancing activities are a new source of fragility for the bond market.

2 Background and Data

Many mutual funds follow a target allocation strategy, meaning that they try to maintain specific portfolio allocations across asset classes. For example, BlackRock 60/40 Target Allocation Fund states on its prospectus: "The Fund, which is a fund of funds, normally intends to obtain exposure to equity securities (and certain other instruments described below) in an amount equal to 60% of its assets and exposure to fixed-income securities in an amount equal to 40% of its assets." When equities and bonds realize different returns, the fund would need to rebalance: buy equities and sell bonds, or vice versa, such that the equity ratio of its portfolio is maintained at 60%, the bond ratio 40%. Panel A of Figure A3

shows that the total AUM of target allocation funds has more than doubled from less than $1 trillion in 2012 to almost $2.5 trillion in 2023. TAF assets are managed by a broad set of managers, the biggest of which include Vanguard, Fidelity and American Funds.

One important group of TAFs that we focus on are target date funds (TDFs). These funds have target allocations that adjust slowly over time. For example, the prospectus of Fidelity Freedom 2055 Fund describes its strategy as: "Investing primarily in a combination of Fidelity U.S. equity funds, international equity funds, bond funds, and short-term funds... Allocating assets according to a neutral asset allocation strategy shown in the glide path below..." According to the glide path, copied in Figure A1, the fund initially targets 55% allocation to equities and 45% to bonds. Parker et al. (2023) shows that, at quarterly frequency, TDFs are effectively TAFs that arguably rebalance even more aggressively to stay on their allocation targets. Panel B of Figure A3 shows that TDFs have experienced tremendous growth and have overtaken conventional target allocation funds in size since 2014. One important driver is the 2006 Pension Protection Act, which designated TDFs as a qualified default investment alternative in 401(k) plans Mitchell and Utkus (2021).

Most of target allocation funds are funds of funds, meaning that they invest in other funds and not directly in equities or bonds. This way, the asset class-level allocation decision is separated from the individual asset-level portfolio decision: the TAF focuses on broad asset allocation by rebalancing between specialized funds, and the specialized funds focus on picking the individual stocks or bonds. For most of our analyses, we focus on funds of funds and exclude TAFs that invest more than 50% of their assets directly in individual stocks or bonds. Panel C of Figure A3 shows that TAFs mostly invest in affiliated funds, which – as we will show later – facilitates the internationalization of liquidation costs.

Most target allocation funds, especially target date funds, target allocations to a broad set of asset classes, not just equities versus bonds. Panel D of Figure A3 show that, TAFs invest more than 20% of their portfolios in foreign equity funds and foreign bond funds, i.e.

funds that invest in stocks and bonds of foreign entities. Foreign equities (bonds) can have meaningfully different returns than domestic equities (bonds), which is an important consideration for our bottom-up rebalancing measure in Equation 1, which captures heterogeneity in returns within equity funds and within bond funds.

2.1 TAF rebalancing during the COVID-19 crisis

The COVID-19 crisis illustrates TAFs' rebalancing activities. In the first quarter of 2020, the S&P 500 declined by 21% from 3258 to 2585. Over the same period, the Bloomberg Aggregate Bond Index (AGG) rose 5%. A fund with 60-40 allocation between equities and bonds would see the portfolio move to 52-48, without rebalancing. To maintain the 60-40 target allocation, the fund needs to sell bonds – which have appreciated in values – and buy equities – which have declined in values. In other words, a TAF trades in a contrarian manner (Parker et al., 2023).

This contrarian trading is indeed what happened during the COVID-19 crisis. Panel A of Figure 2 shows that, during the COVID-19 crisis, TAFs sold large quantities of bond funds and simultaneously bought large quantities of equity funds in nearly equal amounts. The quantities are large at $59 billion, which account for 33% of the total outflows from bond funds during COVID-19, as shown in Panel A of Figure 1.

Panel B of Figure 2 shows that this contrarian behavior is remarkably consistent throughout the past decade, not limited to COVID-19. The black line shows return differences between equity funds and bond funds that are held by TAFs. Equity returns are much more volatile than bond returns and drive most of the variation. The bars show TAF net purchases of equity funds (blue) and bond funds (red). Whenever equity returns turn negative, TAFs purchase more equity funds and sell more bond funds. The graph also shows that the absolute amounts of these rebalancing trades have grown substantially over time, mirroring

the rapid growth of target date funds and other target allocation funds.

2.2 Sample and data sources

Our data on target allocation funds and bond mutual funds come from CRSP and Morningstar. The data contain quarterly snapshots of fund holdings at the CUSIP level.[1] This means that we can link the CUSIPs to the bond mutual funds that they belong to and obtain a database of TAFs' holdings of bond mutual funds. We manually correct any anomalies we observe in the holdings data.[2][3] The data contain total net assets (TNA), returns, expense ratios, and turnover ratios for each fund at monthly frequency. We identify fund family affiliation using management company names, following (Dannhauser and Spilker, 2023).[4] For both TAFs and the bond mutual funds they hold, we aggregate share class information to the fund level.

As mentioned above, we consider both conventional target allocation funds and target date funds, which effectively have allocation targets in the short run. We identify these funds as those whose Morningstar Category contains the keyword "Allocation" or "Target-Date". We focus on TAFs domiciled in the United States. We exclude tactical allocation funds and target volatility funds, which do not have allocation targets and tend to have the opposite trading behavior to TAFs. Most of TAFs are funds of funds, and we restrict to TAFs whose fund holdings are consistently above 50% of their total holdings.

[1] Although some mutual funds report monthly holdings, most funds report quarterly. For funds that do not report at quarter-end, we use the reporting dates closest to quarter-end. Specifically, if a fund reports holdings on January, April, July and October, we will assign those holdings to Q4 of previous year, Q1, Q2 and Q3, respectively.

[2] For example, almost all of the share classes held by T. Rowe Price TAFs after March 2020 are missing from CRSP, e.g. T. Rowe Price Equity Index 500 Z TRHZX 779552504. We manually download these share classes from Morningstar and link them to the corresponding CRSP funds.

[3] For example, American Funds TAFs report duplicated positions in 2021Q4 and 2022Q1 (e.g. on Intermediate Bond Fund of America R-6 RBOGX 45880981), which we identify from the sum of portfolio weights and delete from our final data.

[4] We take into account mergers between fund families. For example, Nuveen funds are assigned under TIAA after 2014.

We focus on TAFs' trading of bond mutual funds, identified by Lipper Objective Code.[5] For each bond fund in each quarter, we measure the illiquidity of its holdings by average credit rating, where AAA is 1, AA+ is 2, ..., and CCC- is 19. For each bond, we take the median rating across S&P, Moody's and Fitch. Our sample period starts in 2012Q4, when rating agencies are first required to publicly disclose all of their ratings according to SEC Rule 17g-7. For robustness, we also consider measuring portfolio illiquidity by average bid-ask spread, share of corporate bonds, or share of high-yield bonds.[6]

In defining illiquid periods, we use the average corporate bond bid-ask spread. Specifically, we calculate each corporate bond's bid-ask spread on each date as the difference between dealer-to-customer (buy) prices and customer-to-dealer (sell) prices, normalized by deal-to-dealer prices, following Kargar et al. (2021). We then take the average of bid-ask spreads across corporate bonds for each date. To ensure comparability, we focus on BBB-rated corporate bonds with a rounded duration of 5 years. To address the secular decline in bid-ask spreads, we residualize the data with respect to a linear time trend. We define a period to be illiquid if its average corporate bond bid-ask spread in that period is in the upper quartile of the time series distribution.

S&P 500 aggregate returns are from CRSP. Bloomberg Aggregate Bond Index returns are from Bloomberg. Data on Treasury bonds are from CRSP Treasury Database. Data on U.S. corporate bonds are from Mergent FISD and TRACE.

[5] We include government bond funds (GUS, GUT, IUG, IUT, SIU, SUS, SUT), investment-grade bond funds (A, ARB, BBB, CPB, GB, IID, SID, SII, USO), high-yield bond funds (FLX, HY, LP, MSI, SFI, SHY), and international bond funds (EMD, EML, GHY, GLI, INI, SWM).

[6] Cash and cash equivalents (e.g. shares of money market funds) are assigned AAA rating and zero bid-ask spread.

2.3 Measuring flow variables

We are interested in *flow* variables such as trading by TAFs and flows to bond mutual funds. However, our datasets contain *stock* variables such as total net assets and holdings. To make the conversion, we need to exclude returns. Net flows to mutual fund i during quarter t is measured as:

$$NetFlow_{i,t} = TNA_{i,t} - TNA_{t-1}(1 + Return_{i,t}) - M\&A_{i,t}$$

where $M\&A$ captures acquisitions of other funds, which do not represent inflows of new capital.

Net purchases – or trading – by TAF i of bond mutual fund j during quarter t is similarly measured as:

$$Trading_{i,j,t} = Holding_{i,j,t} - Holding_{i,j,t-1}(1 + Return_{j,t})$$

where *Return* includes both NAV changes and distributions.

3 Predictability of TAF Rebalancing

This section shows that target allocation funds (TAFs) make rebalancing trades in a highly predictable manner. To begin, we verify that TAFs indeed have target allocations that are sticky in the short run and maintained at the fund level. Given target allocations, we construct a novel measure, called rebalancing-induced trading (RIT), that predicts how TAFs trade using lagged holdings and realized fund returns, which are publicly available to all market participants in real time. We confirm that there is a near one-for-one relationship between RIT and TAFs' actual trading of individual bond funds. At the same time, this

relationship is influenced by illiquidity for affiliated bond funds. Liquidity-adjusted *RIT* almost exactly predicts actual TAF trading across bond funds.

3.1 Allocation stickiness

As elaborated in Section 2, TAFs have explicit mandates on allocations at the asset class level, which are either fixed or, in the case of TDFs, slowly adjusted according some predetermined glide path. Panel A of Figure 3 confirms that the asset-class-level allocation is indeed very sticky at the quarterly frequency, for both conventional TAFs or TDFs. Specifically, allocation to bond funds this quarter is often identical to allocation to bond funds last quarter, even though there can be large positive or negative returns to equity funds that shrink or expand bond fund allocation absent rebalancing. Such asset-class-level allocation stickiness has also been shown by Parker et al. (2023) and Foley-Fisher and Lee (2025).

Perhaps surprisingly, TAFs seem to also target allocations at the individual fund level. Panel B of Figure 3 shows that, within the bond fund portfolio, allocation to an *individual* bond fund is also highly persistent, often invariant from previous quarter to the current quarter. This stickiness exists for both conventional TAFs and TDFs. There are two explanations for this fund-level target allocation. First, a typical TAF holds a small number of funds, each representing a sub-asset class. For example, Figure A2 shows that Vanguard Target Retirement 2025 Fund – the largest TAF in our sample – holds only 5 funds. Within bond funds, it holds a fund investing in domestic bonds and a fund investing in international bonds, and this sub-asset class allocation is also specified in the fund's investment mandate.

More generally, maintaining portfolio weights with respect to external shocks is a prevalent portfolio management practice that goes beyond TAFs. In particular, there is pervasive evidence that mutual funds proportionally scale up or down their portfolios in response to inflows or outflows (Edmans et al., 2012; Lou, 2012). When equity funds experience large

returns and a TAF need to rebalance by scaling up or down its bond funds, this is akin to inflow or outflow to the TAF's bond fund portfolio. Rather than trading the bond funds in an arbitrary manner, the TAF would likely trade proportional to the existing portfolio weights, so that there is minimal distortion to its original investment strategy.

3.2 Rebalancing-induced trading

Suppose that TAF i targets portfolio weight $w^*_{i,j}$ in fund j. We can derive the exact amount of trading required in order to maintain target allocation $w^*_{i,j}$ from $t-1$ to t:

$$\begin{aligned} & A_{i,t}w^*_{i,j} - A_{i,t-1}w^*_{i,j}R_{j,t} \\ & = (A_{i,t-1}(\sum_k w_{i,k,t-1}R_{k,t}) + F_{i,t})w^*_{i,j} - A_{i,t-1}w^*_{i,j}R_{j,t} \\ & = \underbrace{A_{i,t-1}w^*_{i,j}(\sum_k w_{i,k,t-1}R_{k,t} - R_{j,t})}_{\textbf{RIT}} + \underbrace{F_{i,t}w^*_{i,j}}_{\textbf{FIT}} \end{aligned} \tag{1}$$

On the first line, the first term is the target dollar allocation to fund j, and the second term is the realized dollar allocation to fund j before portfolio adjustment. The second line applies the law of motion for AUM, where changes in AUM can come from both returns and flows. The third line re-arranges terms and shows the two components of trading to maintain target allocation: rebalancing-induced trading (RIT) and flow-induced trading (FIT).

FIT arises because of inflows or outflows of capital (Edmans et al., 2012; Lou, 2012). When a TAF experiences inflows, it needs to buy fund j proportional to its target allocation, so that its overall allocation in the portfolio remains the same. The opposite applies for outflows.

RIT arises because of return differences across funds held. If all funds have the same return, then no rebalancing is required. If fund j experiences more negative return than other funds, its portfolio weight would shrink more, and the TAF needs to sell other funds to buy shares

of fund j to restore its target allocation. The opposite applies for positive return. Effectively, TAFs engage in contrarian trading. Note how RIT depends on the returns of *all* funds in the portfolio. For example, even if a fund experiences zero return, its RIT would be negative if other funds have negative returns.

Compared to Parker et al. (2023), who calculate equity-vs-bond rebalancing, our calculation of RIT captures the heterogeneity across funds, which can be significant. Indeed, Section 2 shows that almost half of TAFs' equity funds specialize in foreign equities. The returns to these funds can be meaningfully different from domestic equity returns. By incorporating this heterogeneity, our approach aims to produce more accurate predictions of the rebalancing trades. At the same time, returns on individual funds are publicly available to all market participants in real time, just like aggregate market returns, so our measure is not subject to any look-ahead bias.

Similar to Parker et al. (2023), we measure w^* by the rolling-window average of revealed portfolio weights over the last 6 months. The previous subsection shows that TAFs adhere to their target allocations and these allocations are sticky in the short run.

$$w^*_{i,j,t} = \frac{1}{6}\sum_{\tau=1}^{6} w_{i,j,t-\tau} \tag{2}$$

We calculate RIT on each bond fund and equity fund by each TAF in each period. To emphasize, these rebalancing trades are predicted by lagged portfolio holdings and realized fund returns, all of which publicly available to all market participants in real time, and we do not use any information on TAFs' actual trading. Figure 4 shows TAFs' aggregate trading and RIT on bond funds (Panel A) and equity funds (Panel B). Almost all of TAFs' bond fund sales and equity fund purchases during the COVID-19 crisis in 2020Q1 can be predicted through by our RIT measure.

To formally assess the accuracy of our RIT measure in predicting TAF trading, we estimate the following regression:

$$Trading_{i,j,t} = \beta RIT_{i,j,t} + FE + \epsilon_{i,j,t} \tag{3}$$

where $Trading_{i,j,t}$ denotes actual trading by TAF i of bond fund j during quarter t, RIT our measure of rebalancing-induced trading according to Equation 1, and FE TAF-by-quarter fixed effects and bond-fund-by-quarter fixed effects, which purge out common buying or selling of all bond funds by a TAF and common buying or selling of a bond fund across TAFs. Both actual and predicted trading are normalized by lagged holdings. To avoid the influence of small positions, we estimate the regression using weighted least squares, with holding amounts as weights. Standard errors are three-way clustered by TAF i, by bond fund j and by quarter t.

Column 1 of Table 2 shows the results. There is a near one-for-one relationship between actual bond fund trades by TAFs and our RIT measure, which predicts rebalancing-induced trades based on lagged holdings and realized returns. For each dollar of RIT, the actual trading is 1.080 dollar. Column 2 separates the negative and the positive component of RIT and shows that the near one-for-one relationship applies to both rebalancing-induced sales and purchases. The coefficient on negative RIT is noticeably smaller, meaning that actual selling appears to be smaller than negative RIT, and we will show below that this is driven by liquidity concerns on affiliated bond funds.

3.3 Liquidity adjustment

Trading costs should play a role in TAFs' rebalancing.[7] TAFs may deviate more from theoretical rebalancing for illiquid assets, where the cost per unit of trading is higher. Following

[7]For example, (Research, 2024) explicitly mentions trading costs in its rebalancing strategies.

Ma et al. (2022), we define the illiquidity rank of bond fund j in TAF i's portfolio as:

$$IlliquidityRank_{i,j,t} = \sum_{k} w_{i,k,t} \mathbb{1}[Illiquidity_{k,t} < Illiquidity_{j,t}] + \frac{1}{2} w_{i,j,t} \tag{4}$$

where the illiquidity of a bond fund is measured by the average credit rating (AAA = 1, CCC- = 19) of its bond holdings. The higher the value its illiquidity rank, the more illiquid the bond fund is relative to other bond funds in the TAF's portfolio. We augment Regression 3 with an interaction term between RIT and illiquidity rank:

$$Trading_{i,j,t} = \beta RIT_{i,j,t} \times IlliquidityRank_{i,j,t-1} + FE + \epsilon_{i,j,t} \tag{5}$$

Column 3 of Table 2 shows that illiquidity significantly affects the relationship between RIT and actual TAF rebalancing. For the most liquid bond funds ($IlliquidityRank = 0$), TAFs sell almost exactly one dollar for each dollar of negative RIT. However, this one-for-one relationship is significantly dampened for illiquid bond funds. For the most illiquid bond funds ($IlliquidityRank = 1$), the relationship is reduced by 0.194, and additional 0.184 during illiquid periods, when liquidation costs are higher. This liquidity effect is absent for positive RIT.

Columns 4 shows that the dampening effect of illiquidity mostly comes from affiliated bond funds. In contrast, Column 5 shows that the coefficients on the interaction terms are insignificant for unaffiliated bond funds. In fact, the coefficients are positive, meaning that unaffiliated illiquid bond funds appear to be sold *more* than one-for-one with RIT, especially during illiquid periods. In other words, whereas TAFs follow a liquidity pecking order for affiliated bond funds, they follow a *reverse* pecking order on liquidity for unaffiliated bond funds.

What explains the liquidity adjustment and its asymmetric effect on affiliated versus unaf-

filiated bond funds? Ma et al. (2022) show that bond mutual funds avoid selling illiquid bonds that may incur high liquidation costs. In contrast, TAFs do not invest in illiquid bonds directly. They invest in bond mutual funds that in turn invest in illiquid bonds. Bond mutual funds provide liquidity transformation and insulate the liquidation costs from their TAF investors. However, in the case of affiliated bond funds, the liquidation costs are ultimately borne by the same fund families. As a result, TAFs internalize the liquidation costs for affiliated funds and avoid incurring these costs in the first place. This concern is absent for unaffiliated bond funds, whose liquidation costs are entirely external to the TAFs and their fund families.

Panel B and C of Table 2 show that the predictability of rebalancing is similar for conventional TAFs and TDFs. For both types of TAFs, there is a near one-for-one relationship between RIT and actual trading, and illiquidity dampens the relationship for affiliated bond funds, where liquidation costs are internalized by the same fund families.

Based on the evidence above on liquidity adjustment, we refine the prediction of rebalancing-induced trading as:

$$\widehat{RIT}_{i,j,t} = \begin{cases} RIT_{i,j,t} \times (1 - (\hat{\beta}_1 + \hat{\beta}_2 \mathbb{1}[IlliqPeriod_t]) \times IlliqRank_{i,j,t-1}) & , \ RIT_{i,j,t} < 0 \ \& \ j \in Aff \\ RIT_{i,j,t} & , \ \text{otherwise} \end{cases} \tag{6}$$

where unadjusted RIT comes from Equation 1, illiquidity rank is based on Equation 4, and illiquid periods are those with upper-quartile corporate bond bid-ask spreads. $\hat{\beta}_1$ and $\hat{\beta}_2$ are estimated through Regression 5. To avoid look-ahead bias, we estimate $\hat{\beta}_1$ and $\hat{\beta}_2$ using only the data prior to t. For example, to estimate $\hat{\beta}_1$ and $\hat{\beta}_2$ and used for RIT during 2020Q1, we train Regression 5 using the data prior to 2020. For the remainder of the paper, we will refer to this adjusted version of RIT simply as RIT.

4 Strategic Complementarity

The previous section shows that TAFs make rebalancing trades that are highly predictable based on lagged holdings and realized returns, which are available to all market participants in real time. This section shows that predictable rebalancing trades by TAFs trigger strategic redemptions by *other* non-TAF bond mutual fund investors.

Chen et al. (2010) show that, for mutual funds that invest in illiquid assets such as corporate bonds, one investor's decision to withdraw from the fund affects those by other investors. Specifically, to meet the redemption request of an investor, the mutual fund needs to liquidate underlying assets, which can be costly because of illiquidity. However, in U.S. and most jurisdictions without swing pricing, the liquidation costs are not borne by the redeeming investor, but rather by the remaining investors of the mutual fund. This is because mutual funds allow redeeming investor to redeem at the current NAV, which does not include the liquidation costs that come subsequently. As a result, if some investors are expected to redeem from the fund, other investors are incentivized to redeem as well, in order to avoid the liquidation costs.

Such strategic complementarity can be triggered by TAF rebalancing. When there are large negative equity returns, TAFs are expected to rebalance from bond funds to equity funds, which would lead to outflows from bond mutual funds, especially those held more by TAFs. Investors of bond mutual funds are incentivized to "front run" the TAFs so that they do not bear the liquidation costs.

To test this hypothesis, we utilize the cross section of bond funds. Some bond funds are expected to experience larger TAF rebalancing-induced selling compared to other bond funds: these bond funds may be held more by TAFs, the TAF holders' equity funds may experience worse returns than the average equity funds, or they may be unaffiliated or have lower illiquidity rank in their TAF holders' portfolios. We hypothesize that these bond mutual funds

experience higher redemptions by other non-TAF investors, due to strategic complementarity.

We first reaffirm the predictability of TAF trading in the cross section of bond mutual funds:

$$\frac{\sum_i Trading_{i,j,t}}{TNA_{j,t-1}} = \beta \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} + FE + \epsilon_{j,t} \tag{7}$$

The dependent variable is total trading of bond fund j by all TAFs. The main independent variable is liquidity-adjusted rebalancing induced trading according to Equation 6. Table 3 shows that our RIT measure moves near one-for-one with actual TAF trading in both the single period of 2020Q1 during COVID-19 and throughout all sample periods. RIT alone accounts for 0.818 (0.549) of the R-squared of the cross section of actual TAF trading during 2020Q1 (all sample periods), which is close to the maximum R-squared achievable by adding a host of other observable variables.

Having validated the predictability of TAF trading, we examine the strategic interaction between TAFs and other investors using the cross section of bond mutual funds:

$$\frac{Flow_{j,t} - Flow^{TAF}_{j,t}}{TNA_{j,t-1} - TNA^{TAF}_{j,t-1}} = \beta \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} + \gamma Controls + FE + \epsilon_{j,t} \tag{8}$$

The dependent variable measures net flows from *other* investors – excluding net flows from TAFs – normalized by lagged TNA held by these other investors. The regressor of interest is the sum of rebalancing-induced trading across TAFs, according to Equation 6, normalized by the bond mutual fund's TNA. For simplicity, we refer to this variable as RIT. Following Goldstein et al. (2017), we control for fund alpha, lagged flow, log TNA, log age, expense ratio, and rear load. We include Lipper Object Code by quarter fixed effects to zoom in on the comparison between similar bonds at the same time. Standard errors are clustered by Lipper Object Code in each quarter. To avoid the influence of small funds, we estimate the regression using weighted least squares, with non-TAF TNA as weights.

We first focus on the single quarter of 2020Q1, i.e. the COVID-19 crisis. Panel A of Table 4 shows the baseline results. In Column 1, the coefficient on RIT is positive, statistically significantly, and economically large. 1% rebalancing-induced sales by TAFs are associated with 0.684% sales by *other* non-TAF investors. The coefficients on control variables exhibit expected signs. For example, the negative coefficient on the illiquid indicator shows that there were more outflows from illiquid bond funds, consistent with the findings in Falato et al. (2021).

The magnitude of liquidation costs should play a role: compared to Treasury bond mutual funds, mutual funds investing in illiquid corporate bonds or foreign bonds should have higher liquidation costs and therefore exhibit more strategic complementarity. In Panel B of Table 4, we estimate the same regression separately for different styles of bond mutual funds, sorted by illiquidity. Whereas β is insignificant for Treasury bond funds, it is larger and statistically significant for investment-grade bond funds that invest in not only Treasury bonds but also agency MBS and corporate bonds, which have significant illiquidity. β is even larger for more illiquid mutual funds that invest in high-yield bonds and international bonds. The estimate is not statistically significant because most of these funds have small exposure to TAFs and therefore there is small cross-sectional variation in RIT.

To investigate the effect of illiquidity more formally, we augment the baseline regression with an interaction term with fund illiquidity:

$$\frac{Flow_{j,t} - Flow_{j,t}^{TAF}}{TNA_{j,t-1} - TNA_{j,t-1}^{TAF}} = \beta \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} \times IlliquidFund_{j,t} + \gamma Controls + FE + \epsilon_{j,t} \qquad (9)$$

We measure fund illiquidity by the average credit rating (AAA = 1, CCC- = 19) across its holdings, weighted by par amount held. To ease interpretation, we focus on an indicator variable of whether the bond mutual fund's portfolio illiquidity is above median for each cross section. Both the interaction term and its components are included in the regression.

Column 2 of Panel A of Table 4 shows the result. The coefficient on the interaction term is also significantly positive, meaning that the co-movement between RIT and trading by other investors is stronger for illiquid bond funds. In fact, the co-movement is *twice* as large for the illiquid bond funds (0.402 + 0.418) compared to the average bond funds (0.402). This result further strengthens the interpretation of strategic complementarity, because illiquid bond funds are where liquidation costs are most relevant and strategic behaviors mostly valuable. For liquid bond funds, it is relatively cost-free to liquidate the underlying assets (e.g. Treasury bills), so redemptions by TAFs would not trigger run incentives for the other investors. For most bond mutual funds, liquidating underlying bonds was still costly during COVID-19, even for Treasury bonds and investment-grade bonds (Harvey et al., 2025).

Panel C of Table 4 shows robustness with alternative measures of fund illiquidity, including average bid-ask spread of portfolio bonds, portfolio share of corporate bonds, and portfolio share of high-yield (BB+ or worse) bonds. The identified illiquid funds are largely the same, and the regression results are remarkably similar to the baseline ones.

Having analyzed the COVID-19 crisis, we turn to the full panel data from 2017Q4 to 2023Q4. Our sample starts in 2017Q4 because we estimate $\widehat{RIT}$ using five-year rolling window, and the underlying data (e.g. credit rating) start in 2012Q4. Table 5 shows the results. Following Goldstein et al. (2017), we separately analyze cases with rebalancing-induced purchases ($RIT \geq 0$) versus with rebalancing-induced sales ($RIT \leq 0$). Column 1 and 2 show that the coefficient on RIT when RIT is positive is not significantly different from zero. When a bond fund experiences inflows from TAFs, it is not forced to buy bonds at a cost, so other investors are not incentivized to react strategically.

Column 3 focuses on the observations where RIT is negative – that is, when TAF investors are predicted to rebalance out of the bond fund. Similar to the COVID-19 crisis analysis, the coefficient on RIT is positive. The interaction with the illiquid period indicator is positive and statistically significant, meaning that: when TAFs are expected to sell more, other non-

TAF investors also sell more, particularly during illiquid periods, where liquidation costs are elevated.

Column 4 adds further interaction with an indicator for illiquid bond mutual funds, defined as those whose bond holdings have above-median illiquidity in each quarter. The coefficient on the triple interaction term is significant, meaning that the strategic coordination is mainly driven by illiquid bond funds, where liquidation costs are particularly high.

Our results provide direct evidence on the presence of strategic complementarity. In the ideal experiment, we want to have some investors randomly decide to redeem their mutual fund shares, which create liquidation costs for the other investors, and we want to see if other investors indeed choose to exit at the same time to avoid bearing the liquidation costs. Previous literature such as Chen et al. (2010); Goldstein et al. (2017) focuses on return-induced redemption, which simultaneously affect all investors. In contrast, TAF rebalancing-induced trades are plausibly exogenous to other investors' redemption decisions except through the liquidation cost spillover channel.

4.1 Investor-level evidence

The analyses so far pool all non-TAF investors together. In this subsection, we examine bond mutual fund trading at the individual investor level. This helps ruling out an important alternative explanation: some non-TAF investors are also rebalancers, they are attracted to the same bond mutual funds that are held more by TAFs, so the co-movement with TAF rebalancing is not strategic complementarity but rather simultaneous rebalancing from unobserved rebalancers. To rule out this endogeneity concern, we analyze a subset of investors for which we directly observe holdings. Effectively, we examine whether *a given investor* tilts away from bond funds that face higher TAF rebalancing-induced sales, which is free from the selection bias aforementioned.

The investors for which we have investor-level portfolio holdings data include 32 non-TAF mutual funds and 79 insurance companies.[8] We require the investors to have at least \$100K holdings in at least 3 unaffiliated bond funds as of year-end 2019. Analogous to Regression 8, we examine the co-movement between trading by these non-TAF investors $\{k\}$ and RIT by TAFs:

$$\frac{Trading_{k,j,t}}{Holding_{k,j,t-1}} = \beta \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} \times IlliquidFund_{j,t} + FE + \epsilon_{k,j,t} \tag{10}$$

The dependent variable is trading of bond mutual fund j by non-TAF investor k, normalized by lagged holding. The independent variables are the same as Regression 8. Crucially, FE includes investor-by-time fixed effects, which effectively zoom in on the variation of trading across bond funds by *the same investor at the same time*. Standard errors are clustered by each investor k in each quarter t. To avoid the influence of small positions, we estimate the regression using weighted least squares, with holdings. Due to data limitation, we focus on the single period of 2020Q1 during the COVID-19 crisis.

Table 6 shows the results. Column 1 analyzes non-TAF funds only. Similar to Regression 8, the coefficients on RIT and the interaction with illiquid indicator are both positive, with the latter being statistically significantly. Importantly, with investor fixed effects, the interpretation can be sharpened to: a typical non-TAF fund sells more (or buys less) of bond funds with more expected sales due to TAF rebalancing, particularly for bond funds with illiquid holdings. Column 2 shows similar patterns for insurance companies, with the exception that insurers seem to tilt towards illiquid bond funds during the COVID-19 crisis. Column 3 pools these non-TAF funds and insurers together, and the overall patterns are again similar.

[8] We obtain insurers' general account holdings from their Schedule D reports filed with National Association of Insurance Commissioners (NAIC).

4.2 Amplifying effects

The analyses above show that TAFs' rebalancing-induced trading is amplified by trading by other investors due to strategic complementarity. While we have shown the *direct* contribution of TAF trades to aggregate COVID-19 outflows in Figure 1, how much of the outflows was attributable to the *amplification* of TAF trades due to strategic complementarity? To answer that question, we make use of our cross-sectional estimate from Regression 8. Specifically, for each bond fund j that experiences *negative* TAF rebalancing-induced sales in each *illiquid* quarter t, the amplifying flows in dollar are calculated as:

$$(0.313 + 0.259 \times IlliquidFund_{j,t}) \times \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} \times (TNA_{j,t-1} - TNA^{TAF}_{j,t-1}) \qquad (11)$$

where 0.313 and 0.259 are directly from Panel B of Table 4.

Figure 5 shows that the amplifying outflows from other investors in response to expected rebalancing-induced sales by TAFs total $27 billion during the COVID-19 crisis in 2020Q1. As a result, the sum of direct sales by TAFs and the indirect sales by other investors reacting to TAF rebalancing is $86 billion – or 48% – of the total outflows from bond mutual funds during 2020Q1.

Existing research has studied the link between bond fund returns and bond mutual fund outflows (Goldstein et al., 2017). Due to TAF rebalancing, a new form of flow-performance relationship arises, where equity market returns affect bond fund outflows. Moreover, according to our analyses above, negative equity market returns induce TAF sales that further trigger additional strategic outflows from other investors. Positive equity market returns, on the other hand, do not trigger symmetric inflows, as liquidation costs do not apply. Figure 6 shows this concave bond-fund-flow-to-equity-market-return relationship. Each dot plots the average bond fund flows (normalized by TNA) against the S&P 500 stock return in a quarter. To ensure apple-to-apple comparisons, we residualize bond fund flows against the

known determinants, including return, size, expense ratio and turnover. Bond funds with high exposure to TAFs (defined as 10% or more TAF ownership) exhibit a salient concave flow to equity market return relationship: good equity returns are associated with inflows to these bond funds, but their outflows associated with bad equity returns are much larger. In contrast, for other bond funds, there is no visible relationship between their flows with equity market returns.

5 Cross-Market Shock Transmission

The previous analyses establish that TAFs sell bond funds to buy equity funds when the equity market under-performs, and these actions are amplified by coordinated trading from other investors due to strategic complementarity. This section shows direct evidence that TAFs transmit equity market shocks to bond returns. TAFs can explain a large fraction of the increase in *aggregate* stock-bond correlation over the last decade.

5.1 Cross-sectional evidence

We exploit the heterogeneity in exposure to TAF rebalancing in the cross section of bonds. This heterogeneity comes from two layers: some bond mutual funds are held more by TAFs, and some bonds are held more by these bond mutual funds. In both layers, the ranking of illiquidity should matter: Section 3 shows that TAFs prioritize the selling of liquid affiliated funds, and Ma et al. (2022) show that bond funds prioritize the selling of liquid bonds. Taking all of these into account, our rebalancing exposure measure for bond b at time t is given by:

$$Exposure_{b,t} = \sum_i \sum_j E[\widehat{RIT}_{i,j,t+1} | R^E_{t+1} - R^B_{t+1} = 1\%] w_{j,b,t} (b_0 + b_1 IlliquidityRank_{j,b,t}) \quad (12)$$

The calculation is looped over all TAFs $\{i\}$ and all bond mutul funds $\{j\}$. Within the loop, the first term $E[\cdot]$ gives expected rebalancing-induced trading by TAF i of fund j if the equity market has 1% higher return than the bond market. The calculation is based on Equation 6, where next period's returns on all equity funds are set to 1% and returns on all bond funds set to 0%.

The rest of the term $w(b_0+b_1 IlliquidityRank)$ calculates how much would bond mutual fund j sells bond b, conditional on \$1 of outflow. The first component w is straightforward: if the bond accounts for a larger share of the portfolio, it would get liquidated more, assuming that the fund proportionally liquidates all holdings. Ma et al. (2022) show that bond funds do not liquidate all holdings perfectly proportionally in response to outflows. Instead, bond funds follow a liquidity pecking order to avoid liquidation costs on illiquid bonds, captured by b_0 and b_1. Illiquidity rank of bond b in bond fund j's portfolio is constructed in the same way as Ma et al. (2022), and we also use b_0 and b_1 directly from their paper.

To sum up, Equation 12 provides a bottom-up approach to predict the time t exposure of bond b to TAFs' rebalancing activities if there is 1 p.p. discrepancy between equity market return and bond market return in period $t+1$. We now examine whether this exposure has actual power in predicting bond return sensitivity to contemporaneous equity market returns.

We estimate the following panel regression using a panel of bond-month observations:

$$R_{b,m} = \beta(R^E_m - R^B_m) \times Exposure_{b,q-1} + \gamma Controls + FE + e_{b,m} \tag{13}$$

$R_{b,m}$ denotes the return of bond b in month m. $(R^E_m - R^B_m)$ denotes the difference between aggregate equity market return and aggregate bond market return in month m. $Exposure_{b,q-1}$ measures bond b's exposure to rebalancing-induced trading as of the immediate quarter before, measured by Equation 12. To ease interpretation, we normalize $Exposure$ to have

unit standard deviation. Control variables include bond characteristics such as credit rating, duration, and bid-ask spread.

Panel A of Table 7 shows the results for Treasury bond returns.[9] We include CUSIP fixed effects and rounded maturity-by-month fixed effects. Effectively, we compare Treasury bonds with the same years to maturity at the same time. In both columns, the coefficient on $(R^E - R^B)$ is statistically zero, confirming that rebalancing exposure itself does not correlate with risk or other determinants of returns.

In Column 1, the coefficient on the interaction term is positive, although not statistically significant. When the equity market has 1% higher return than the bond market , bonds with one-standard-deviation higher exposure to TAF rebalancing are associated with 0.193 basis points of higher returns. Column 2 adds a triple interaction with an indicator for the COVID-19 period in March 2020. It shows that, conditional on the same exposure to TAF rebalancing, the co-movement between bond returns and $(R^E - R^B)$ was substantially stronger during COVID-19 than during other periods, by a statistically significant 1.089 basis points. There are two explanations. First, RIT was particularly large and the market was particularly illiquid during COVID-19, which trigger more strategic complementarity, which we have shown in the previous section. Second, arbitrage capital from dealers and hedge funds was particularly constrained (O'Hara et al., 2025).

Panel B of Table 7 shows the results for investment-grade corporate bond returns.[10] We include credit rating letter-by-month fixed effects, rounded maturity-by-month fixed effects and Fama-French 12 industry-by-month fixed effects. Effectively, we compare corporate bonds with the same credit rating, same maturity and issued by firms in the same industry and at the same time, purging out a large set of unobserved confounding effects.

[9] We include Treasury notes and bonds. We exclude bills, floating-rate notes, TIPS, and strips.

[10] We include U.S. dollar bonds issued by non-financial U.S. firms and eligible to be reported in TRACE. We focus on straight bonds and exclude convertible bonds, preferred securities and putable bonds.

The results are qualitatively similar to those of Treasury bonds: when there is 1% increase in equity market returns relative to bond market returns, corporate bonds with higher exposure to TAF rebalancing experience higher returns, particularly during the COVID-19 crisis. The coefficients are significantly larger than those of Treasury bond returns, consistent with the fact that corporate bonds are less liquid and subject to larger price impacts per unit of liquidity shock.

To further illustrate the price impacts, we follow Ma et al. (2022) and track yields on different portfolios of bonds during COVID-19. Relative to Ma et al. (2022) – who show that bonds with higher exposure to mutual fund outflows experienced larger yield increases during COVID-19 – we add an additional layer of sorting based on our rebalancing exposure measure. Effectively, we compare bonds with similar exposure to mutual funds, but those whose mutual funds had larger exposure to TAF rebalancing versus those mutual funds did not. Figure 7 shows yields on bonds with above-median versus below-median rebalancing exposure, *conditional* on the bonds with upper-quartile mutual fund ownership. Yields are measured as relative to their rating-duration-matched peers.[11] Panel A and B show the results for Treasury bonds and investment-grade corporate bonds, respectively. In both cases, bonds with higher rebalancing exposure had much higher yield increases during COVID-19 than those with lower rebalancing exposure, even though both are at the upper quartile of mutual fund ownership. In other words, exposure to TAF rebalancing is an important driver behind the price impact of mutual fund exposure documented in Ma et al. (2022).

5.2 Aggregate stock-bond correlation

The cross-sectional analysis above uses granular fixed effects to compare near-identical bonds. Although this approach facilitates identification, it may under-state the aggregate effect. In

[11] Specifically, for a given bond, its peers are designated as those with the same rating letter (AAA, AA, A, BBB, BB, B, CCC) and with the same duration bucket (1-3Y, 3-5Y, 5-10Y, 10+Y).

particular, recent literature shows that investors are less elastic at more aggregate levels (Li and Lin, 2022; Chaudhary et al., 2025). This means that the cross-sectional estimate, which reflects elasticity at the individual bond level, may under-estimate the effects on aggregate bond returns. This section directly quantifies the price impacts of TAF rebalancing-induced trading using aggregate elasticity estimates from existing literature.

We begin by aggregating rebalancing-induced trading from Equation 6 for all equity funds and all bond funds in each quarter. They are shown by the navy bars and the maroon bars in Figure 8. Our analyses in 4 show that there is significant amplification by other investors, due to strategic complementarity. To be conservative, we assume that strategic complementarity only occurs for bond funds, and the sizes of the amplifying trades are given by Equation 11 and shown in Figure 5. For simplicity, we assume that these purchases and sales of equity funds and bond funds translate one-for-one to purchases and sales of the aggregate equity market and the aggregate bond market.

The price impacts are the product of the size of these purchases and sales relative to the the size of the market and the price multiplier, which is the reciprocal of market elasticity.[12] Gabaix and Koijen (2021) estimates that the aggregate equity market has a price multiplier of 5, meaning that \$1 of purchase would lead to \$5 increase in the value of the aggregate stock market. Ma et al. (2022) estimates that the aggregate bond market has a price multiplier of 1.37. We call these price impacts – due to TAF rebalancing-induced trades and the additional strategic trades they trigger – rebalancing-induced returns.

To quantify the contribution of TAF rebalancing on stock-bond correlation, we perform a simple counterfactual analysis. We ask: what would the stock-bond corelation have looked like, if the TAFs did not rebalance at all? This is achieved by subtracting the calculated rebalancing-induced returns from the actual returns, separately for equities and for bonds.

[12] Aggregate equity market size is given by the total market capitalization of S&P 500 stocks (TOTVAL) from CRSP Stock Database. Aggregate bond market size is given by the total amount of Treasury notes and bonds outstanding (TMPUBOUT) from CRSP Treasury Database.

We then compare the 5-year rolling-window stock-bond correlation for the actual returns versus for the counterfactual returns, where rebalancing-induced returns are subtracted.

The results are shown by the two lines in Figure 8. The black line is the actual stock-bond correlation. It was *negative* at -0.58 at the beginning of 2010 and increased by 0.69 to *positive* 0.11 by the end of 2023. The green line is the counterfactual stock-bond correlation without TAF rebalancing-induced trades and the amplifying trades by other investors. The counterfactual correlation is visibly lower than the actual one. In fact, our analysis shows that stock-bond correlation would have still stayed negative in 2023 if there were no TAF rebalancing. The gap between the actual and the counterfactual correlation is the contribution by TAF rebalancing. The contribution was initially small – because TAFs were still small relative to the market – but has steadily increased over time and reached 0.12 by 2023. In other words, TAF rebalancing and the amplifying trades by other investors have contributed to 17% (0.12 / 0.69) of the increase in stock-bond correlation over the past decade.

In recent years, more and more 401(k) plans have switched their menu options from mutual funds to collective investment trusts (CITs), which have similar portfolio holdings as mutual funds but face less regulation and therefore charge less fees (Shnitser, 2025). Therefore, our estimated rebalancing trades by target allocation mutual funds overlooks similar activities by target allocation CITs and under-states the total magnitude of rebalancing.[13] To deal with the limited data on holdings by CITs, for each target allocation CIT, we match it to the target allocation mutual funds in the same fund family with the same Morningstar Category and assumes that it conducts the exact same rebalancing trades relative to AUM. Using data on target allocation CITs' AUM, we can then calculate the dollar amount of rebalancing trades by CITs. After incorporating CITs' activities, the contribution of rebalancing-induced trading to stock-bond correlation is even bigger, at 0.18.[14] In other words, rebalancing by

[13]Target allocation CITs invest in other CITs, not mutual funds. Therefore, our *RIT* measure for each bond mutual fund is not subject to omitted rebalancing by CITs.

[14]We take the conservative approach and assume that other investors do not strategically respond to rebalancing by target allocation CITs. Whether there is strategic complementarity or not depends on the

target allocation mutual funds and CITs explain 26% of the rise in stock-bond correlation over the last decade.

6 Conclusion

This paper documents a new source of fragility for the bond market: equity market shocks transmitted by target allocation funds' rebalancing activities. When equities experience large negative returns, TAFs sell bond funds to buy equity funds, so that their equity-bond allocations stay on target. In anticipation of rebalancing-induced selling, other investors of bond mutual funds strategically sell in order to avoid bearing the liquidation costs, amplifying redemptions by TAFs. To meet these redemptions, bond mutual funds sell their holdings of underlying bonds, transmitting shocks from the equity market to Treasury and corporate bond returns. We show evidence that target allocation rebalancing has contributed significantly to aggregate stock-bond correlation.

Recent bond market turmoil in response to the tariff war provides another piece of evidence of this mechanism. The equity market fell tremendously at the announcement of tariff hikes, as the expected cash flows of global companies are expected to shrink significantly. What was unexpected was large yield increases of long-term Treasury bonds in the next few days. According to our mechanism, because of the large drops in equity values, target allocation funds needed to sell large quantities of bond mutual funds, which in turn needed to sell large quantities of underlying bonds to meet redemptions.

There has been a secular rise in TAFs, in particular target date funds. According to their current growth trajectory, TAFs are expected to again double in size over the next decade. Moreover, the bond portion of TAF holdings is expected to increase, due to an aging pop-

exact redemption policy set by the bond CITs. Whereas bond mutual funds are required to meet redemptions at current NAV, bond CITs can implement alternative policies, e.g. swing pricing.

ulation. As a result, we should expect to see even more cross-market transmission through TAFs and the impact on stock-bond correlation will likely increase even further in the future.

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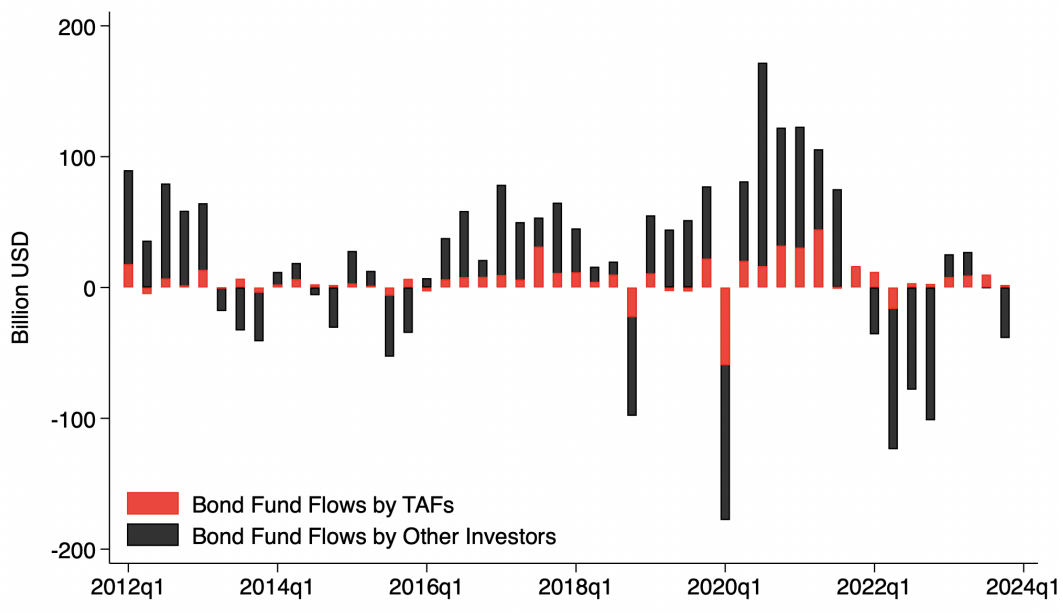
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Figures

Figure 1: **Aggregate Flows to Bond Mutual Funds.** These figures show aggregate quarterly bond mutual fund flows by TAFs (red) and other investors (black). Panel A plots the flows in dollar. Panel B plots the flows as percentage of holdings.

Panel A: Bond Fund Flows in Dollar



Panel B: Bond Fund Flows as Percentage of Holdings

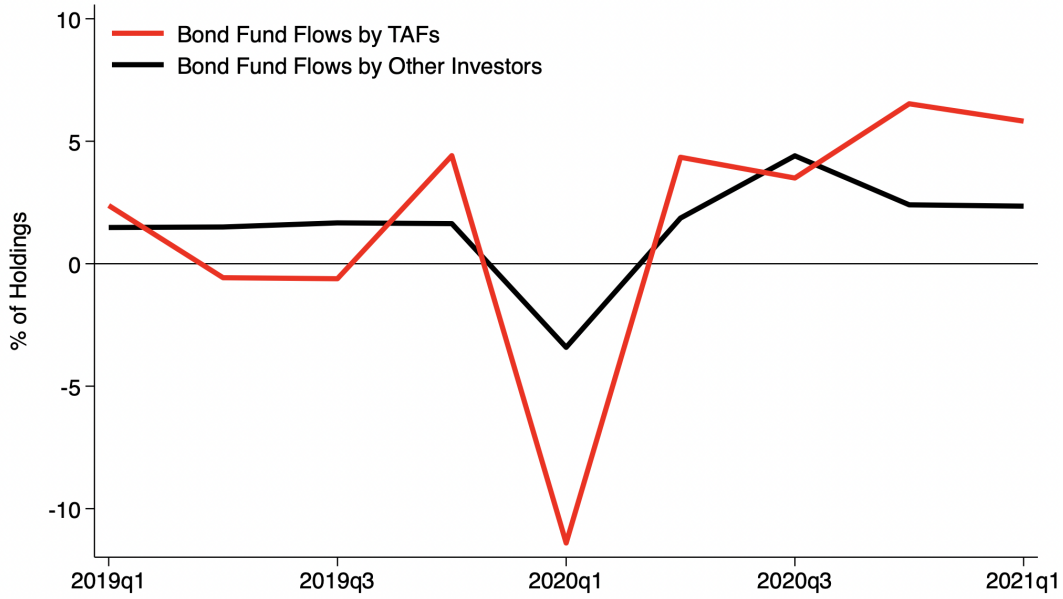
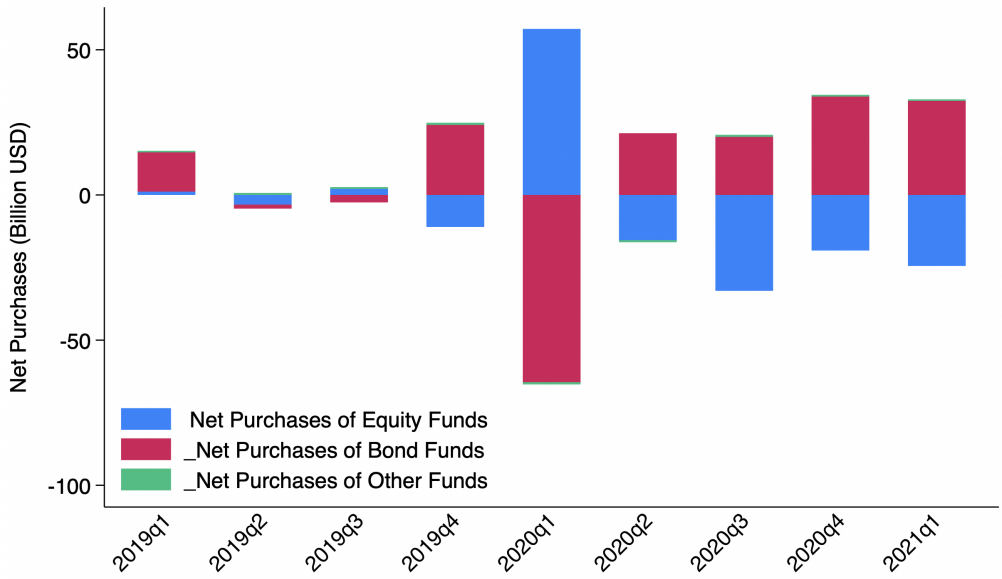


Figure 2: **Aggregate Trading by Target Allocation Funds.** These figures plot aggregate quarterly trading by target allocation funds during the COVID-19 crisis (Panel A) and over all periods (Panel B).

Panel A: COVID-19



Panel B: All Periods

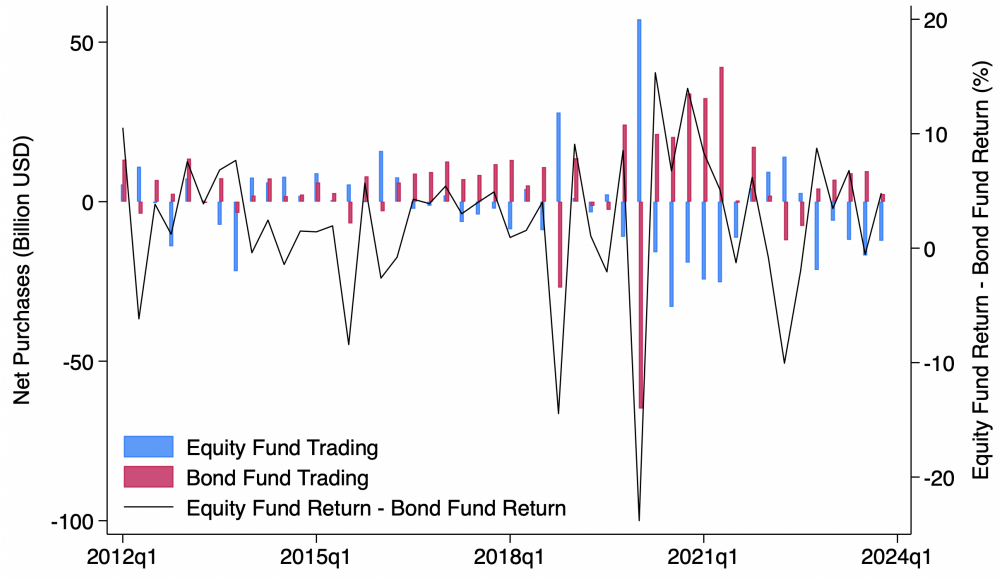
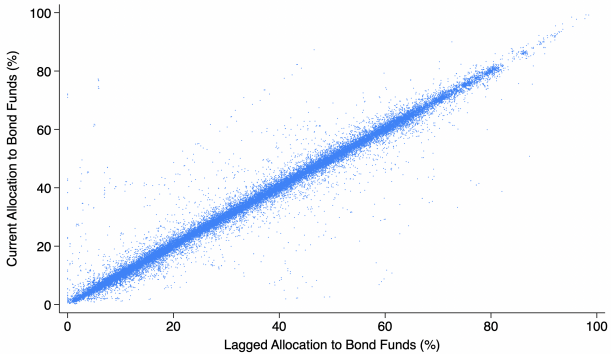


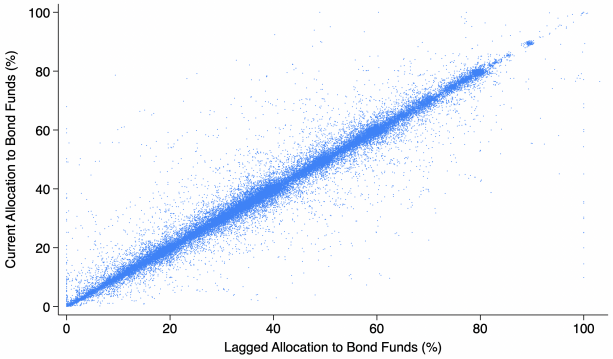
Figure 3: **Target Allocation Stickiness.** These figures show stickiness in TAFs' portfolio allocations at the quarterly frequency. Panel A shows current versus lagged overall allocation to bond funds ($\frac{TotalBondFundHolding}{TotalHolding}$), where each observation represents TAF-quarter. Panel B shows current versus lagged allocation to individual funds within the bond portfolio ($\frac{IndividualBondFundHolding}{TotalBondFundHolding}$), where each observation represents TAF-fund-quarter.

Panel A: Asset Class Level ($\frac{TotalBondFundHolding}{TotalHolding}$)

Target Date Funds

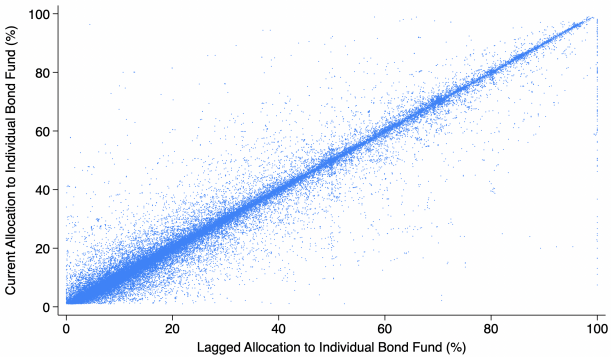


Conventional Target Allocation Funds



Panel B: Individual Fund Level ($\frac{IndividualBondFundHolding}{TotalBondFundHolding}$)

Target Date Funds



Conventional Target Allocation Funds

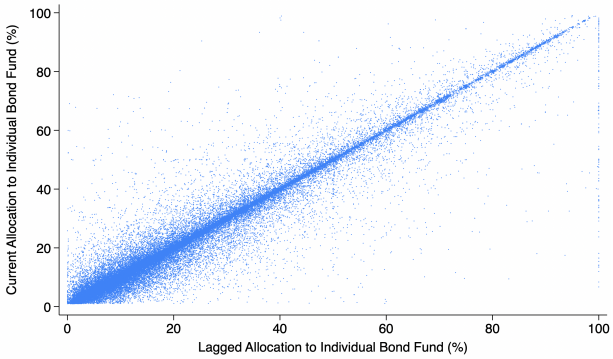
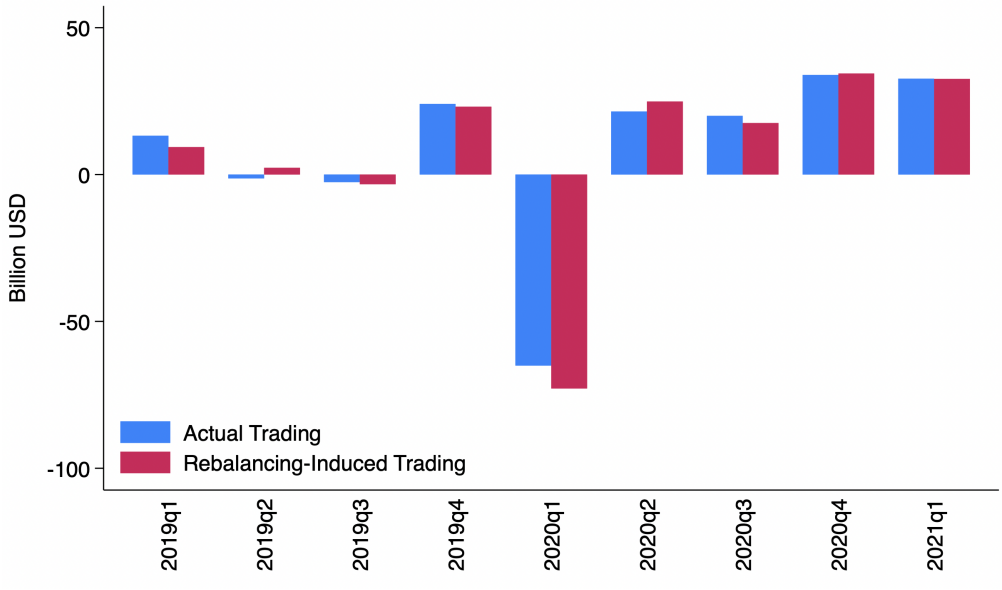


Figure 4: **Aggregate Actual v.s. Rebalancing-Induced Trading.** These figures show aggregate trading of bond mutual funds (Panel A) and equity mutual funds (Panel B) by TAFs. The blue bars show actual trading. The red bars show rebalancing-induced trading (without liquidity adjustment) predicted by lagged holdings and realized returns, according to Equation 1.

Panel A: TAF Trading of Bond Mutual Funds



Panel B: TAF Trading of Equity Mutual Funds

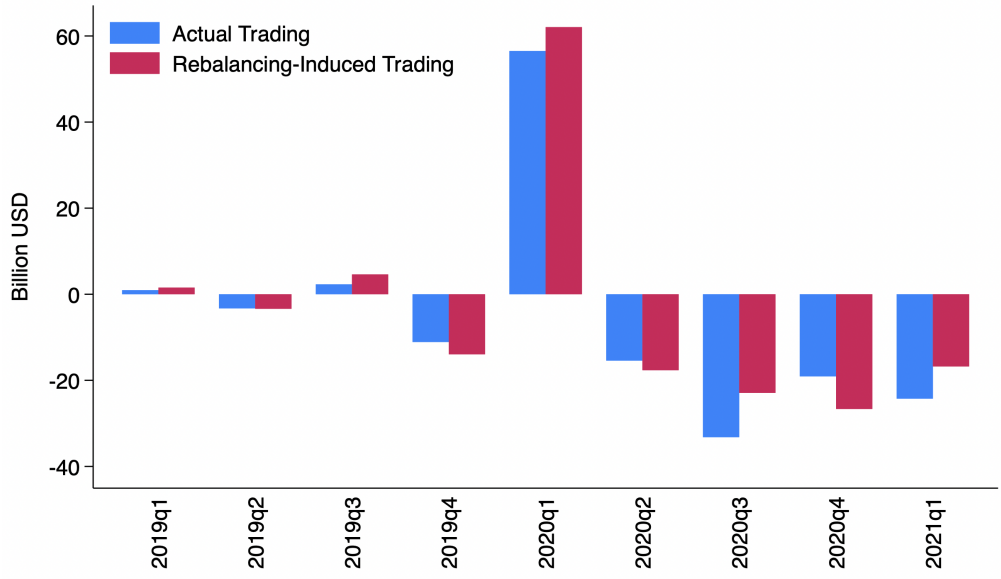


Figure 5: **Amplification of Bond Fund Outflows due to Strategic Complementarity.** This figure shows the decomposition of aggregate flows to bond mutual funds. The dark red bars show flows due to direct trading by TAFs. The bright red bars show strategic flows from other investors in response to TAF rebalancing, estimated from Equation 11. The black bars show the residual flows.

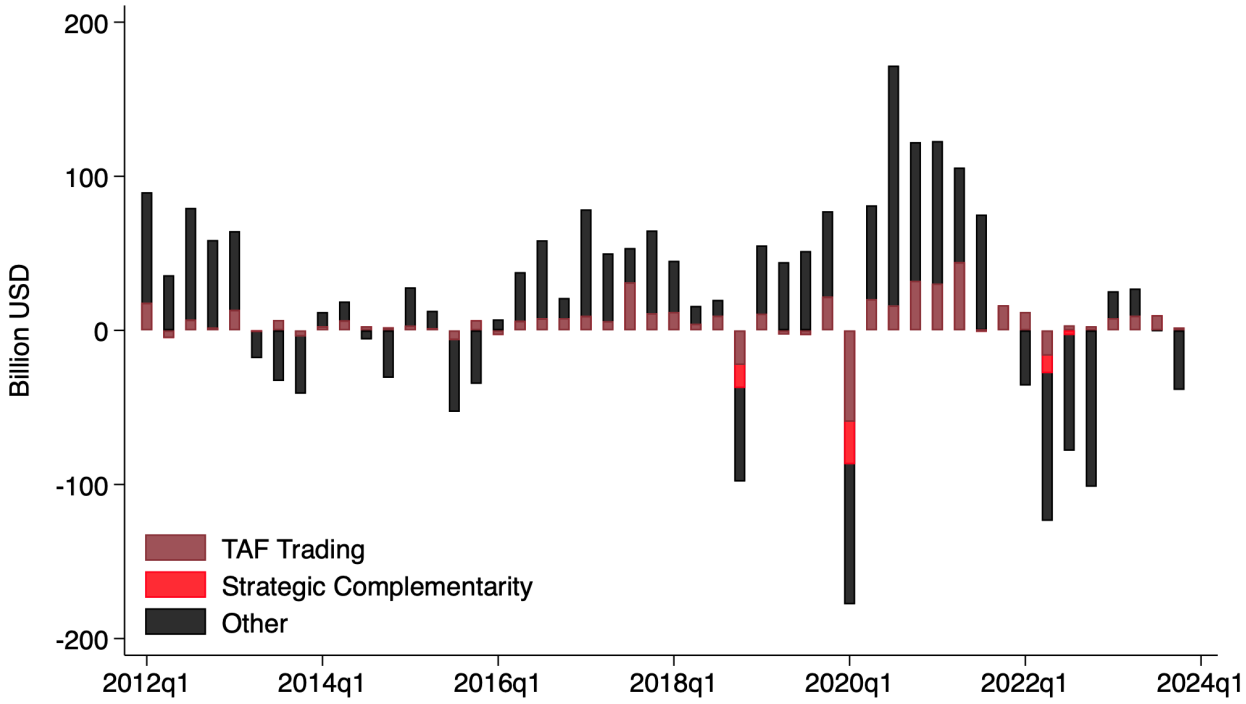


Figure 6: **Concave Bond Fund Flow to Equity Market Performance Relationship.** This figure plots average bond mutual fund flows binned by equity market returns. Flows are residualized against alpha, lagged flows, log TNA, log age, expense ratio, and rear load. The red dots show bond mutual funds with more than 10% of ownership by TAFs. The blue dots show other bond mutual funds with zero or small ownership by TAFs.

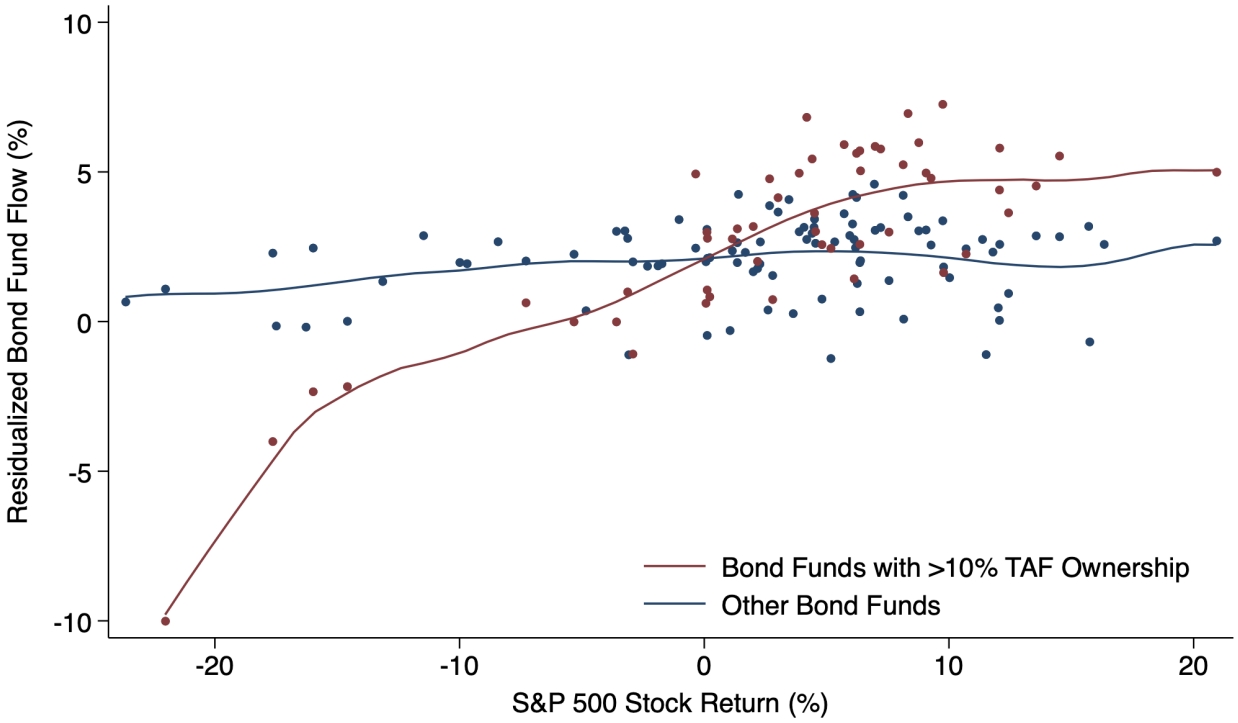
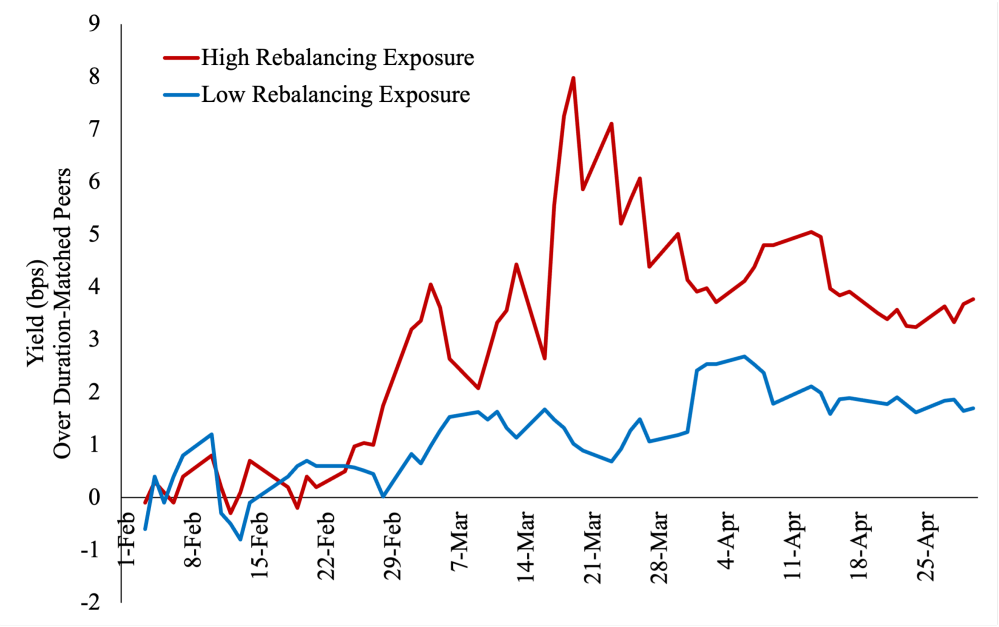


Figure 7: **Rebalancing Exposure and Bond Yields during the COVID-19 crisis.** These figures show yield dynamics for Treasury bonds (Panel A) and investment-grade corporate bonds (Panel B) whose mutual fund ownership are at the upper quartile of the distribution as of January 2020. These high-mutual-fund-ownership bonds are further sorted into two groups, based on their exposure to TAF rebalancing (Equation 12). For each bond on each date, its yield is normalized by the average across its peers with the same rating letter and the same duration bucket.

Panel A: Yields on Treasury Bonds with High Mutual Fund Ownership



Panel B: Yields on Corporate Bonds with High Mutual Fund Ownership

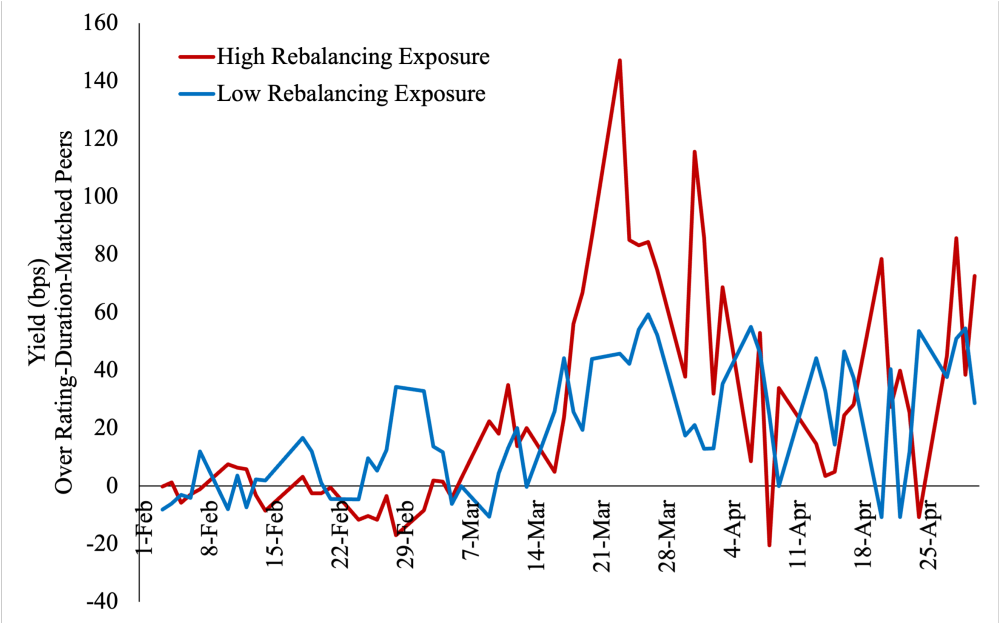
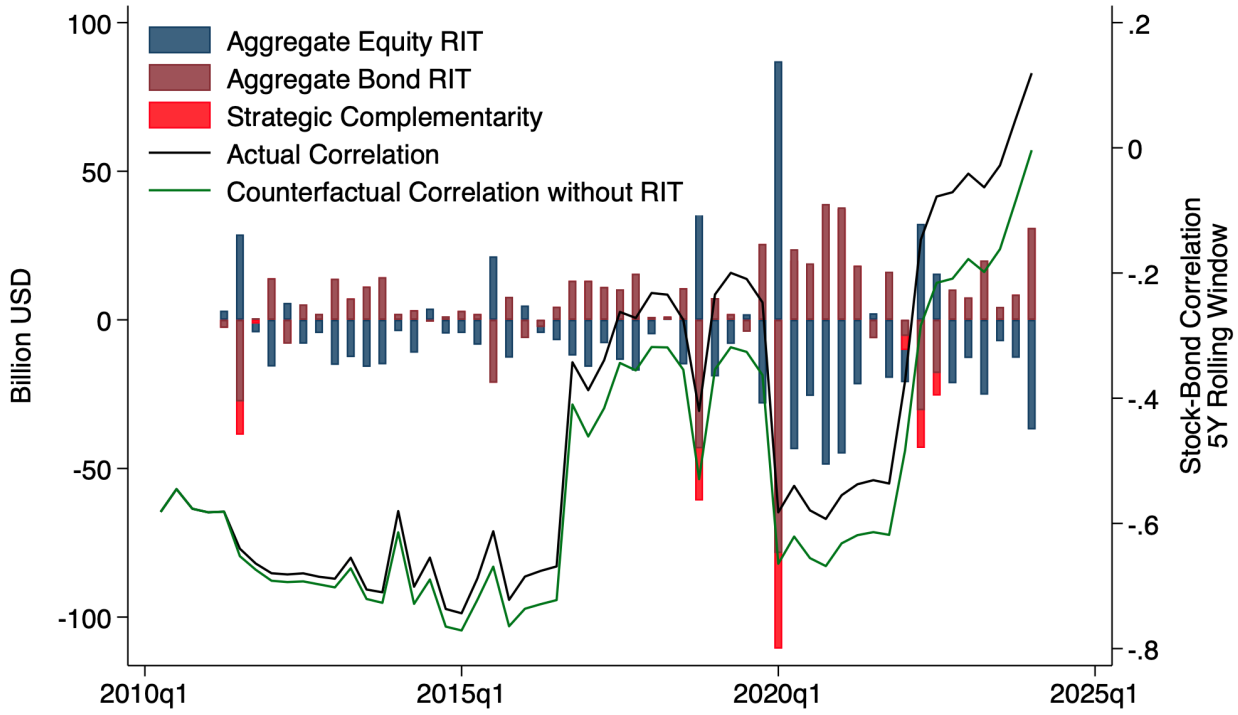


Figure 8: **TAF Rebalancing and Aggregate Stock-Bond Correlation.** This figure shows aggregate rebalancing-induced trading and its impact on aggregate stock-bond correlation. The navy (maroon) bars show rebalancing-induced trading of equity (bond) mutual funds by TAFs. The red bars show strategic flows from other investors in response to TAFs' rebalancing of bond mutual funds. The black line shows actual quarterly correlation between S&P 500 Index returns and Bloomberg Aggregate Bond Index returns, measured using 20-quarter rolling window. The green line shows correlation between counterfactual equity and bond market returns that subtract the price impacts of rebalancing-induced trading, estimated from Section 5.2.



Tables

Table 1: **Summary Statistics.** These tables show summary statistics of target allocation funds (Panel A) and bond mutual funds (Panel B). The data are quarterly from 2012Q4 to 2023Q4.

Panel A: Target Allocation Fund Statistics

	N	Mean	SD	P10	P50	P90
TNA (mn $)	33423	1966	5421	14	291	4693
Return (%)	33423	1.69	5.74	-5.59	2.38	7.35
Flow (% of TNA)	33423	3.65	15.62	-4.49	-0.04	13.74
Holdings of Bond Mutual Funds:						
Number of Distinct Funds	33423	4.54	2.81	1.00	4.00	8.00
Share of Overall Portfolio (%)	33423	33.79	21.43	7.47	32.56	63.39
Credit Rating (AAA = 1, CCC- = 19)	33423	4.66	2.11	2.47	4.35	7.20
Share of Affiliated (%)	33423	79.01	37.48	0.00	100.00	100.00

Panel B: Bond Mutual Fund Statistics

	N	Mean	SD	P10	P50	P90
TAF Ownership (% of TNA)	46856	7.73	20.63	0.00	0.00	27.95
Rebalancing-Induced Trading (% of TNA)	46856	0.03	3.17	-0.10	0.00	0.06
TAF Trading (% of TNA)	46856	0.07	3.24	-0.03	0.00	0.01
Flow (% of TNA)	46856	0.84	16.01	-10.10	-0.49	12.04
Flow ex TAF (% of TNA ex TAF)	46856	0.80	18.18	-10.81	-0.52	13.04
Credit Rating (AAA = 1, CCC- = 19)	46856	5.98	3.99	1.01	5.05	12.83
Alpha (%)	46856	-0.24	0.84	-1.16	-0.06	0.42
TNA (mn $)	46856	2792	11988	29	396	5310
Age (year)	46856	15.53	11.07	2.58	13.58	30.58
Expense Ratio (%)	46856	2.00	1.06	0.63	1.95	3.24
1[Rear Load]	46856	0.20	0.40	0.00	0.00	1.00

Table 2: **Predictability of TAF Rebalancing of Bond Mutual Funds.** These tables examine the predictability of TAFs' trading of bond mutual funds through Regression 3:

$$Trading_{i,j,t} = \beta RIT_{i,j,t} \times IlliquidityRank_{i,j,t-1} \times IlliquidPeriod_t + \gamma Controls + FE + \epsilon_{i,j,t}$$

$Trading_{i,j,t}$ denotes TAF i's net purchases of bond mutual fund j in quarter t, normalized by lagged holdings. $RIT_{i,j,t}$ measures TAF i's rebalancing-induced trading (Equation 1) of bond mutual fund j in quarter t, normalized by lagged holdings. $IlliquidityRank_{i,j,t}$ measures bond mutual fund j's illiquidity rank in TAF i's portfolio in quarter t (Equation 4). $illiquidPeriod_t$ is an indicator of whether the average corporate bond bid-ask spread in quarter t is in the upper quartile of its time series distribution. Panel A includes all TAFs, Panel B focuses on TDFs, and Panel C focuses on conventional TAFs. t-statistics are shown in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: All Target Allocation Funds

Dependent Variable:	Actual Trading (% of Holding)				
				Affiliated Bond Funds	Unaffiliated Bond Funds
	(1)	(2)	(3)	(4)	(5)
Rebalancing-Induced Trading (% of Holding)	1.027*** (8.409)				
Negative RIT		0.900*** (4.477)	1.012*** (3.768)	1.004*** (3.479)	1.050*** (3.075)
× Illiquidity Rank			-0.087 (-0.336)	-0.173 (-0.398)	-0.043 (-0.195)
× Illiquidity Rank × 1[Illiquid Period]			-0.186 (-1.411)	-0.289** (-2.281)	0.202 (0.497)
Positive RIT		1.107*** (18.454)	1.138*** (9.182)	1.126*** (7.352)	0.987*** (6.772)
× Illiquidity Rank			0.108 (0.596)	0.017 (0.076)	0.198 (1.118)
× Illiquidity Rank × 1[Illiquid Period]			-0.111 (-1.363)	-0.132 (-1.413)	-0.128 (-0.708)
TAF FE × Quarter FE	Y	Y	Y	Y	Y
Bond Fund FE × Quarter FE	Y	Y	Y	Y	Y
Controls	flow-induced trading, illiquidity rank × illiquid period				
Standard Errors	clustered by TAF, by bond fund, by quarter				
Observations	116995	116995	116597	89524	24147
R2	0.850	0.851	0.852	0.858	0.846
Distinct TAFs	1294	1294	1294	1101	566
Distinct Bond Funds	992	992	992	695	481

Panel B: Target Date Funds

Dependent Variable:	Actual Trading (% of Holding)				
				Affiliated Bond Funds	Unaffiliated Bond Funds
	(1)	(2)	(3)	(4)	(5)
Rebalancing-Induced Trading (% of Holding)	1.065*** (9.453)				
Negative RIT		1.065*** (6.071)	1.125*** (4.738)	1.150*** (4.135)	0.999** (2.653)
× Illiquidity Rank			-0.374 (-0.713)	-0.396 (-0.661)	0.124 (0.236)
× Illiquidity Rank × 1[Illiquid Period]			-0.057 (-0.072)	-0.346* (-1.851)	0.129 (0.745)
Positive RIT		1.103*** (11.523)	1.059*** (5.030)	1.092*** (4.536)	0.975*** (6.207)
× Illiquidity Rank			0.131 (0.431)	0.101 (0.304)	0.244* (1.940)
× Illiquidity Rank × 1[Illiquid Period]			-0.027 (-0.039)	-0.027 (-0.036)	0.639 (0.607)
TAF FE × Quarter FE	Y	Y	Y	Y	Y
Bond Fund FE × Quarter FE	Y	Y	Y	Y	Y
Controls	flow-induced trading, illiquidity rank × illiquid period				
Standard Errors	clustered by TAF, by bond fund, by quarter				
Observations	70087	70087	69811	58416	9839
R2	0.875	0.875	0.876	0.877	0.898
Distinct TAFs	782	782	782	733	276
Distinct Bond Funds	428	428	428	337	145

Panel C: Conventional Target Allocation Funds

Dependent Variable:	Actual Trading (% of Holding)				
				Affiliated Bond Funds	Unaffiliated Bond Funds
	(1)	(2)	(3)	(4)	(5)
Rebalancing-Induced Trading (% of Holding)	0.984***				
	(4.080)				
Negative RIT		0.889**	1.012**	1.170**	0.978***
		(3.048)	(3.161)	(2.344)	(6.095)
× Illiquidity Rank			-0.147	-0.207	-0.187
			(-0.792)	(-0.654)	(-0.969)
× Illiquidity Rank × 1[Illiquid Period]			-0.192	-0.211*	0.232*
			(-0.791)	(-1.839)	(1.948)
Positive RIT		1.148***	1.111***	1.193***	0.953***
		(12.929)	(7.854)	(4.919)	(4.697)
× Illiquidity Rank			0.132	-0.010	0.256
			(0.652)	(-0.034)	(0.802)
× Illiquidity Rank × 1[Illiquid Period]			-0.101	-0.183	-0.067
			(-0.720)	(-0.798)	(-0.302)
TAF FE × Quarter FE	Y	Y	Y	Y	Y
Bond Fund FE × Quarter FE	Y	Y	Y	Y	Y
Controls	flow-induced trading, illiquidity rank × illiquid period				
Standard Errors	clustered by TAF, by bond fund, by quarter				
Observations	45734	45734	45614	30099	13996
R2	0.860	0.863	0.864	0.869	0.866
Distinct TAFs	512	512	512	368	290
Distinct Bond Funds	889	889	889	580	450

Table 3: **Actual v.s. Predicted TAF Trading across Bond Mutual Funds.** This table examines the predictability of total TAF trading across bond mutual funds through Regression 7:

$$\frac{\sum_i Trading_{i,j,t}}{TNA_{j,t-1}} = \beta \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} + \gamma Controls + FE + \epsilon_{j,t}$$

$\widehat{RIT}$ denotes rebalancing-induced trading predicted using real-time returns and accounts for illiquidity adjustment according to Equation 6. t-statistics are shown in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Dependent Variable:	Actual TAF Trading (% of TNA)			
Sample:	2020Q1		All Periods	
	(1)	(2)	(3)	(4)
Rebalancing-Induced Trading	0.921***	0.975***	0.990***	1.003***
(% of TNA)	(12.933)	(23.752)	(17.378)	(19.806)
Alpha (%)		0.019		0.008
		(0.389)		(0.783)
Lagged Flow (% of TNA)		0.005**		0.001**
		(2.335)		(2.602)
Log TNA		-0.158***		-0.067
		(-3.376)		(-1.363)
Log Age		0.214*		0.122
		(1.904)		(0.878)
Expense Ratio (%)		-0.040**		0.022
		(-1.992)		(1.341)
1[Rear Load]		0.251**		0.007
		(2.202)		(0.123)
Style FE		Y		
Fund FE				Y
Style FE × Quarter FE				Y
Observations	595	595	22972	22972
R2	0.818	0.945	0.549	0.699

Table 4: **TAF Rebalancing and Strategic Flows from Other Investors, COVID-19 Crisis.** These tables examine the relationship between predicted rebalancing by TAFs and flows from other non-TAF bond mutual fund investors during the COVID-19 crisis in 2020Q1, based on Regression 8:

$$\frac{Flow_{j,t} - Flow_{j,t}^{TAF}}{TNA_{j,t-1} - TNA_{j,t-1}^{TAF}} = \beta \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} \times IlliquidFund_{j,t} + \gamma Controls + FE + \epsilon_{j,t}$$

$\widehat{RIT}$ denotes rebalancing-induced trading predicted using real-time returns and accounts for illiquidity adjustment according to Equation 6. $IlliquidFund_{j,t}$ is an indicator of whether bond mutual fund j has above-median illiquidity in quarter t, measured by average credit rating of bond holdings. Panel A shows the baseline results. Panel B examines subsamples of bond mutual funds, sorted by illiquidity. Panel C shows robustness with alternative identifications of illiquid bond mutual funds. t-statistics are shown in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Baseline

Dependent Variable:	2020Q1 Flow ex Trading by TAF (% of 2019Q4 TNA ex Holding by TAF)	
	(1)	(2)
Rebalancing-Induced Trading (% of TNA)	0.684***	0.402***
	(3.326)	(2.853)
1[Fund Illiquidity > Median]	-0.658*	-0.918**
	(-1.921)	(-2.094)
RIT × 1[Illiquid Fund]		0.418**
		(2.017)
Alpha (%)	0.072	0.035
	(0.182)	(0.090)
Lagged Flow (% of TNA)	0.019	0.019
	(0.597)	(0.590)
Log TNA	-0.788	-0.782
	(-1.595)	(-1.582)
Log Age	1.648	1.640
	(1.182)	(1.172)
Expense Ratio (%)	-0.476**	-0.483**
	(-2.533)	(-2.595)
1[Rear Load]	2.951*	3.034*
	(1.903)	(1.990)
Style FE	Y	Y
Standard Errors	clustered by Lipper style	
Observations	1190	1190
R2	0.327	0.328

Panel B: Subsamples of Bond Mutual Funds

Dependent Variable:	2020Q1 Flow ex Trading by TAF (% of 2019Q4 TNA ex Holding by TAF)			
Sample:	Government Bond Funds	Investment-Grade Bond Funds	High-Yield Bond Funds	International Bond Funds
Rebalancing-Induced Trading (% of TNA)	0.150	0.493***	0.984	0.685*
	(0.409)	(4.015)	(1.316)	(1.802)
Controls	alpha, lagged flow, log TNA, log age, expense ratio, rear load, illiquidity			
Observations	122	570	317	181
R2	0.433	0.350	0.499	0.290

Panel C: Alternative Liquidity Measures

Dependent Variable:	2020Q1 Flow ex Trading by TAF (% of 2019Q4 TNA ex Holding by TAF)			
Liquidity Measure:	Average Credit Rating	Average Bid-Ask Spread	Share of Corporate Bonds	Share of High-Yield Bonds
Rebalancing-Induced Trading (% of TNA)	0.402***	0.362**	0.405***	0.592***
	(2.853)	(2.519)	(2.887)	(3.092)
RIT × 1[Illiquid Fund]	0.418**	0.571**	0.396**	0.209*
	(2.017)	(2.237)	(1.998)	(1.916)
Controls	alpha, lagged flow, log TNA, log age, expense ratio, rear load, illiquidity			
Style FE	Y	Y	Y	Y
Standard Errors	clustered by Lipper style			
Observations	1190	1190	1190	1190
R2	0.328	0.327	0.328	0.325

Table 5: **TAF Rebalancing and Strategic Flows from Other Investors, All Periods.** This table examines the relationship between predicted rebalancing by TAFs and flows from other non-TAF bond mutual fund investors using the full panel data from 2012Q4 to 2023Q4, based on Regression 8:

$$\frac{Flow_{j,t} - Flow_{j,t}^{TAF}}{TNA_{j,t-1} - TNA_{j,t-1}^{TAF}} = \beta \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} \times IlliquidFund_{j,t} \times IlliquidPeriod_t + \gamma Controls + FE + \epsilon_{j,t}$$

$\widehat{RIT}$ denotes rebalancing-induced trading predicted using real-time returns and accounts for illiquidity adjustment according to Equation 6. $IlliquidFund_{j,t}$ is an indicator of whether bond mutual fund j has above-median illiquidity in quarter t, measured by average credit rating of bond holdings. $IlliquidPeriod_t$ is an indicator of whether the average corporate bond bid-ask spread in quarter t is in the upper quartile of its time series distribution. t-statistics are shown in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Dependent Variable:	Flow ex Trading by TAF (% of TNA ex Holding by TAF)			
Sample:	RIT ≥ 0		RIT ≤ 0	
	(1)	(2)	(3)	(4)
Rebalancing-Induced Trading (% of TNA)	-0.270	-0.102	0.108	0.071
	(-1.322)	(-0.163)	(0.841)	(0.176)
RIT × 1[Illiquid Fund]		-0.063		0.094
		(-0.783)		(0.303)
RIT × 1[Illiquid Period]	0.176	0.189	0.556**	0.403**
	(0.539)	(1.083)	(2.148)	(2.215)
RIT × 1[Illiquid Period] × 1[Illiquid Fund]		0.152		0.218*
		(1.304)		(1.952)
Fund FE	Y	Y	Y	Y
Style FE × Quarter FE	Y	Y	Y	Y
Controls	alpha, lagged flow, log TNA, log age, expense ratio, rear load, illiquidity			
Standard Errors	clustered by Lipper style × quarter			
Observations	23587	23587	24452	24452
R2	0.482	0.484	0.412	0.413

Table 6: **Rebalancing-Induced Strategic Complementarity, Investor-Level Evidence.** This table examines rebalancing-induced strategic complementarity using holdings by individual non-TAF mutual funds and individual insurance companies, based on Regression 10:

$$\frac{Trading_{k,j,t}}{Holding_{k,j,t-1}} = \beta \frac{\sum_i \widehat{RIT}_{i,j,t}}{TNA_{j,t-1}} \times IlliquidFund_{j,t} + \gamma Controls + FE + \epsilon_{k,j,t}$$

$Trading_{k,j,t}$ denotes net purchases by investor k of bond mutual fund j in quarter t. $\widehat{RIT}$ denotes rebalancing-induced trading predicted using real-time returns and accounts for illiquidity adjustment according to Equation 6. $IlliquidFund_{j,t}$ is an indicator of whether bond mutual fund j has above-median illiquidity in quarter t, measured by average credit rating of bond holdings. FE includes investor-by-quarter fixed effects. t-statistics are shown in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Dependent Variable:	2020Q1 Trading (% of 2019Q4 Holding)		
Sample:	Non-TAF Mutual Funds	Insurance Companies	Funds + Insurers
	(1)	(2)	(3)
Rebalancing-Induced Trading (% of TNA)	0.505*	0.511***	0.513**
	(1.974)	(2.870)	(2.158)
RIT × 1(Illiquid Fund)	0.966	1.604*	1.297*
	(1.500)	(1.869)	(1.917)
Fund / Insurer FE	Y	Y	Y
Controls	alpha, lagged flow, log TNA, log age, expense ratio, rear load, illiquidity		
Standard Errors	clustered by fund / insurer		
Observations	270	363	633
R2	0.734	0.765	0.735
Distinct funds / insurers	33	79	112
Distinct bond mutual funds	158	178	284

Table 7: **Rebalancing Exposure and Cross-Sectional Bond Return Sensitivity to Equity Market Shocks.** These tables examine how exposure to TAF rebalancing (Equation 12) affects co-movement with equity market returns in the cross section of Treasury bonds (Panel A) and investment-grade corporate bonds (Panel B), based on Regression 13:

$$R_{b,m} = \beta(R^E_m - R^B_m) \times Exposure_{b,q-1} + \gamma Controls + FE + e_{b,m}$$

t-statistics are shown in parentheses. *, **, and *** denote p-values less than 0.10, 0.05, and 0.01, respectively.

Panel A: Treasury Bond Returns

Dependent Variable	Treasury Bond Return (bps)	
	(1)	(2)
(1) $R^E - R^B$ (%)		
(2) Rebalancing Exposure	0.007	0.003
	(0.246)	(0.186)
(1) × (2)	0.193	0.096
	(1.408)	(1.032)
(1) × (2) × 1[COVID]		1.089*
		(1.903)
Controls	duration, bid-ask spread, lagged return	
CUSIP FE	Y	Y
Maturity FE × Month FE	Y	Y
Standard Errors	clustered by month	
Observations	24892	24892
R2	0.986	0.988

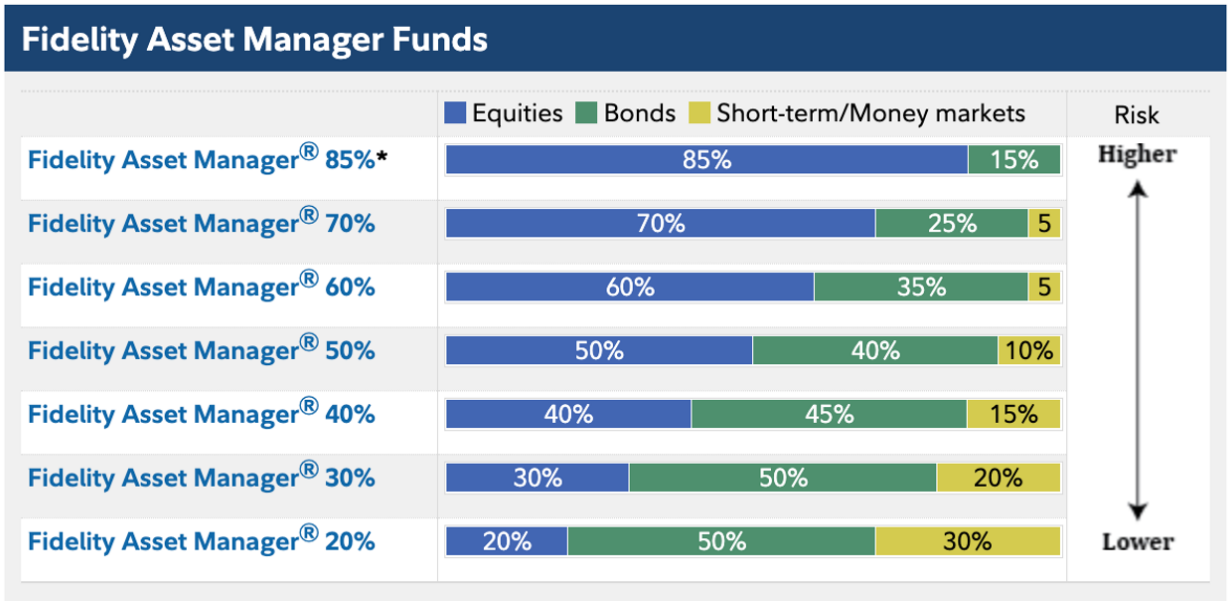
Panel B: Investment-Grade Corporate Bond Returns

Dependent Variable	Corporate Bond Return (bps)	
	(1)	(2)
(1) $R^E - R^B$ (%)		
(2) Rebalancing Exposure	-0.001	0.000
	(-0.107)	(0.084)
(1) × (2)	0.927	0.394
	(1.615)	(1.375)
(1) × (2) × 1[COVID]		5.902**
		(2.035)
Controls	credit rating, duration, bid-ask spread, lagged return	
CUSIP FE	Y	Y
Rating FE × Month FE	Y	Y
Maturity FE × Month FE	Y	Y
Industry FE × Month FE	Y	Y
Standard Errors	clustered by month	
Observations	203942	203942
R2	0.638	0.641

Appendix A Additional Figures

Figure A1: **Examples of Target Allocation Funds.** These figures show examples of conventional target allocation funds (Panel A) and target date funds (Panel B).

Fidelity Asset Manager Funds



Fidelity Freedom 2055 Fund

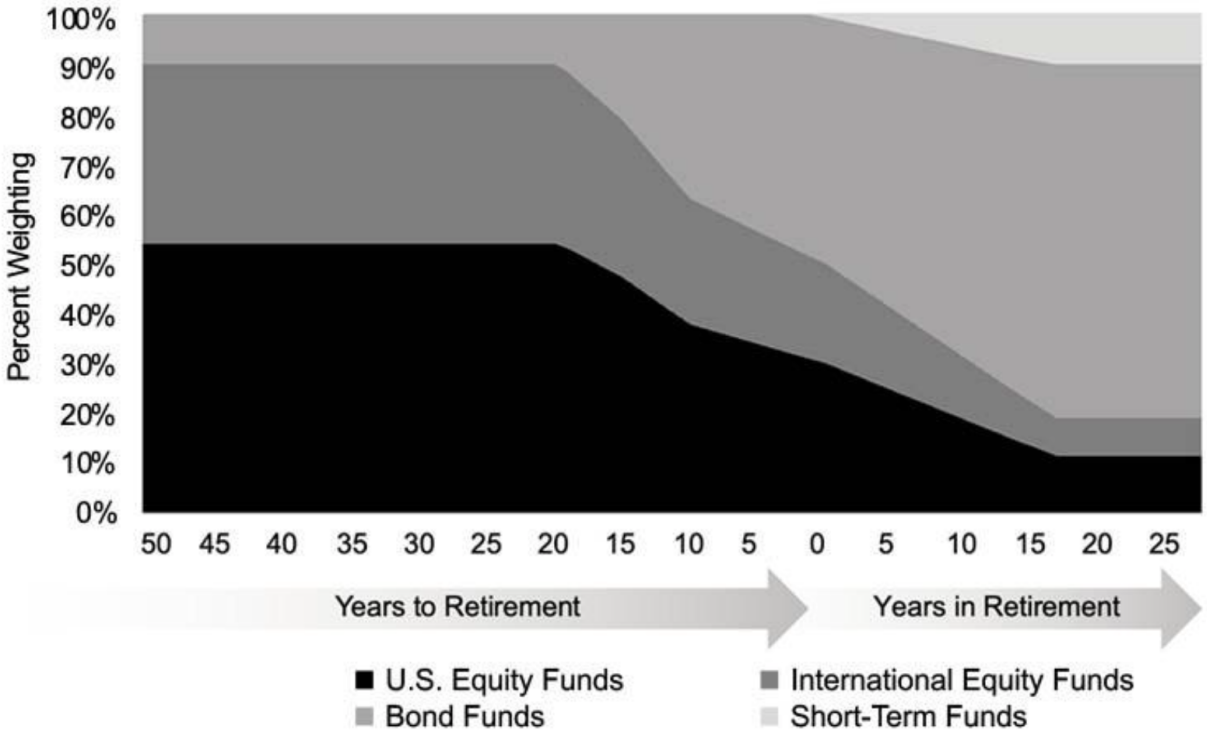
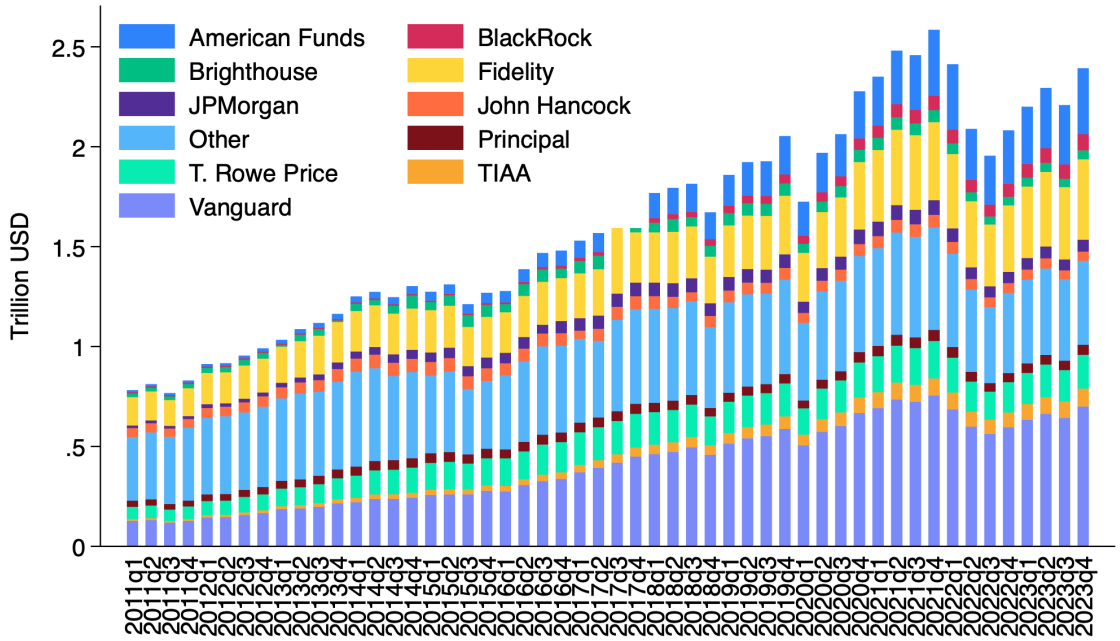


Figure A2: **Example of TAF Portfolio Allocation.** This table shows the portfolio allocation of Vanguard Target Retirement 2025 Fund, the largest TAF in our sample.

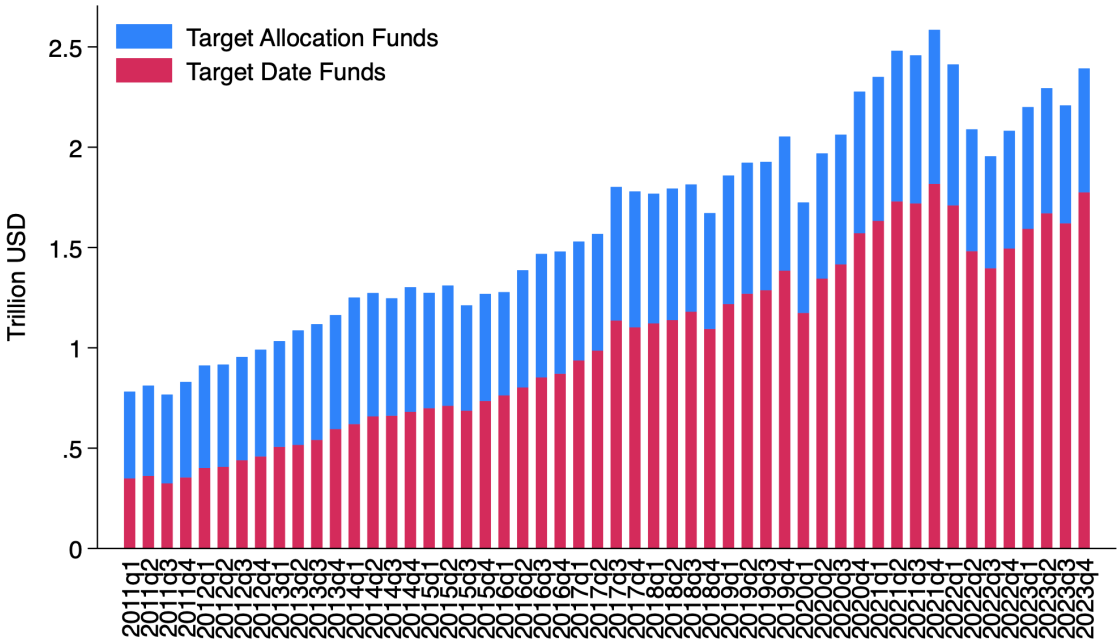
report_dt	security_rank	percent_tna	nbr_shares	market_val	security_name	cusip
31-Dec-18	1	37.11	2.30E+08	1.43E+10	Vanguard Total Stock Market Index Fund;Investor	92290830
31-Dec-18	2	26.68	9.83E+08	1.02E+10	Vanguard Total Bond Market II Index Fund;Investor	92203C10
31-Dec-18	3	24.73	6.26E+08	9.49E+09	Vanguard Total International Stock Index Fund;Inv	92190960
31-Dec-18	4	11.38	4.03E+08	4.37E+09	Vanguard Total International Bond Index Fund;Inv	92203J10
31-Dec-18	5	0.10	390061	39006161	CMT Market Liquidity Rate	
...	...	...	...	...	...	...
31-Mar-19	1	37.10	2.20E+08	1.55E+10	Vanguard Total Stock Market Index Fund;Investor	92290830
31-Mar-19	2	26.87	1.06E+09	1.12E+10	Vanguard Total Bond Market II Index Fund;Investor	92203C10
31-Mar-19	3	24.56	6.16E+08	1.03E+10	Vanguard Total International Stock Index Fund;Inv	92190960
31-Mar-19	4	11.43	4.29E+08	4.78E+09	Vanguard Total International Bond Index Fund;Inv	92203J10
31-Mar-19	5	0.03	144855	14488426	CMT Market Liquidity Rate	

Figure A3: **Aggregate Statistics of Target Allocation Funds.**

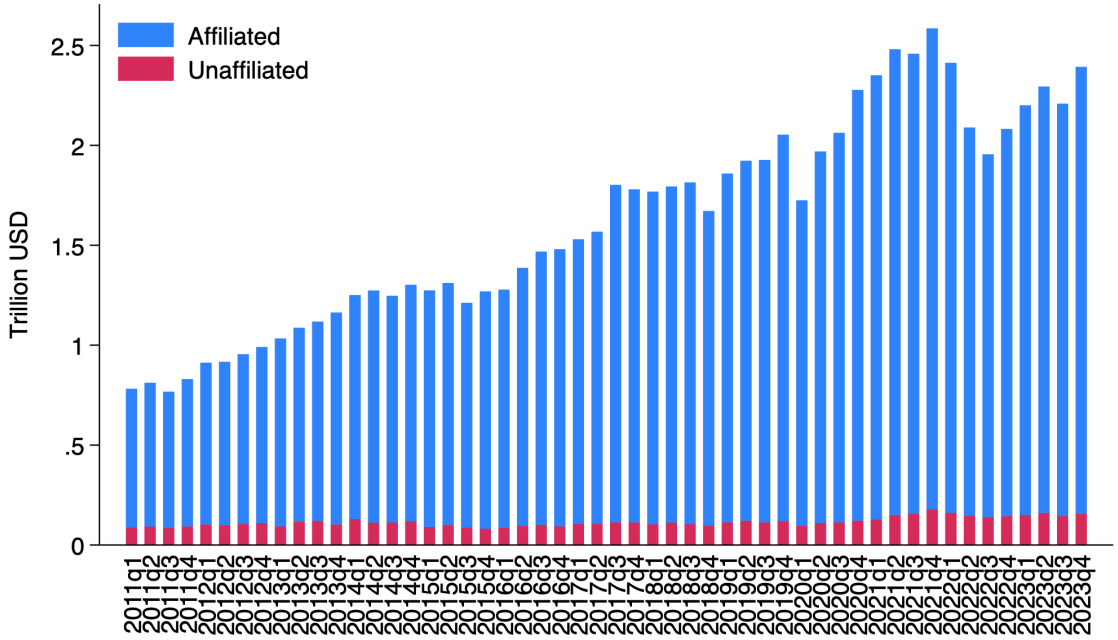
Panel A: By TAF Fund Families



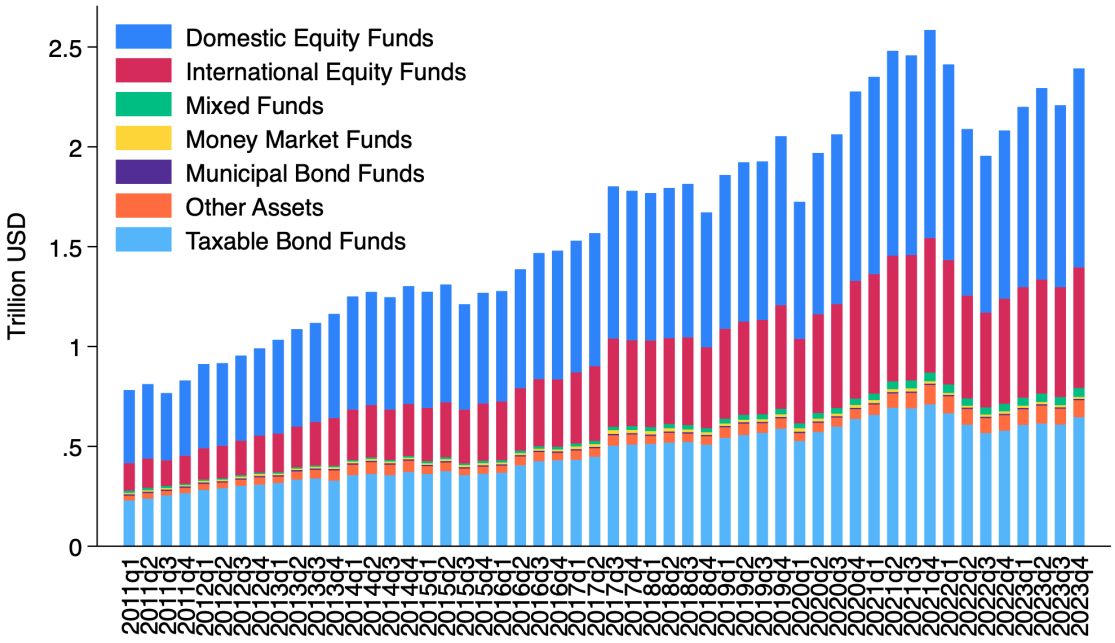
Panel B: By TAF Strategy



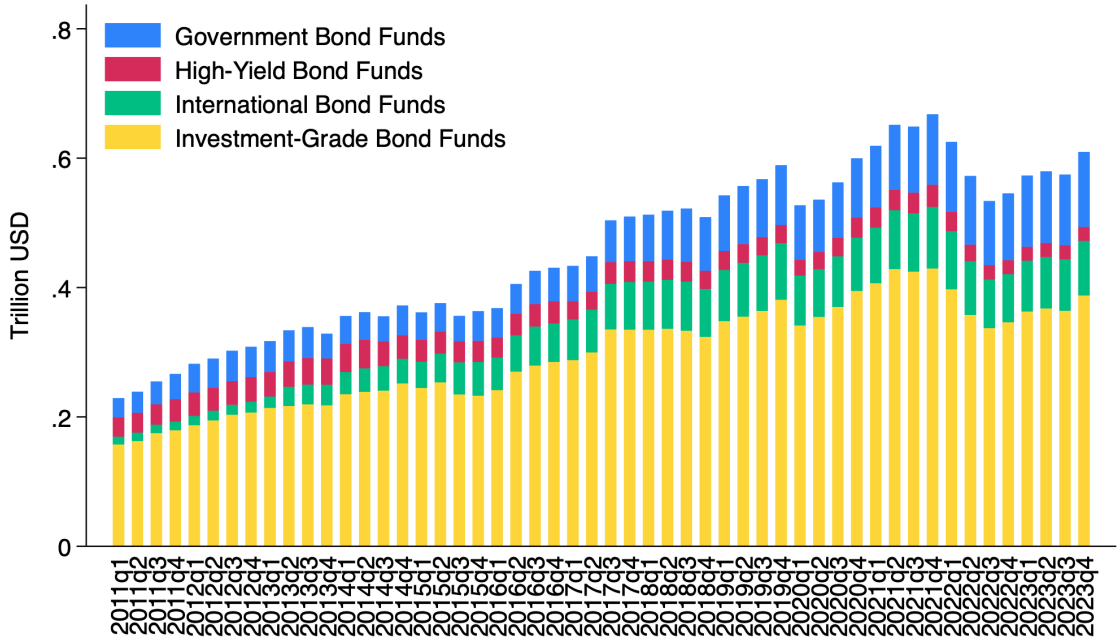
Panel C: By Affiliation of Funds Held



Panel D: By Asset Classes of Funds Held



Panel E: By Styles of Bond Funds Held



Panel F: By Activeness of Bond Funds Held

