Cross-Asset Information Synergy in Mutual Fund Families*

Jun Kyung Auh† and Jennie Bai‡

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Abstract

Despite common wisdom that equities and bonds are segmented, the organization structure of fund families can offset frictions regarding asset market segmentation. We find that equity funds and corporate bond funds linked within a mutual fund family (sister funds) exhibit a significant co-movement in holdings of commonly-held firms' equities and bonds. In contrast, we do not find such a pattern for funds in different families. We show that the holding co-movement is driven by information sharing among sister funds, and such funds make more profit-enhancing investment decisions on common holdings, compared to stand-alone funds. Our findings suggest that collaboration between equity funds and bond funds improves fund performance.

Keywords: information synergy, mutual fund families, equity fund, bond fund, market segmentation

JEL classification: G11, G20, G23, G31.

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†Finance Department, School of Business, Yonsei University. 50 Yonsei-ro School of Business 504, Seodaemun-gu, Seoul, Korea. Phone: 646-808-9214. Email: junkyung.auh@yonsei.ac.kr.

‡Finance Department, McDonough School of Business, Georgetown University. 3700 O Streets NW, Hariri 588, Washington DC 20037. Phone: 202-687-5695. Email: jennie.bai@georgetown.edu.

Corporate bonds and equities issued by the same firm are different contingent claims on the same cash flows, hence theoretically their values should be correlated (Merton, 1974). Previous studies however suggest that bonds and equities are segmented due to institutional and informational frictions. For example, equity returns and bond returns have low correlations at the firm level (e.g., Collin-Dufresne, Goldstein, and Martin, 2001; Kapadia and Pu, 2012); equity returns and bond returns are driven by different risk factors (e.g., Choi and Kim, 2018; Chordia et al., 2017; Bai, Bali, and Quan, 2019); and equities and bonds have different investors (see the Flow of Funds report, 2017).[1]

In this paper, we investigate the relationship of equities and bonds in a unique environment: mutual fund families whose subsidiary equity funds and bond funds holding the same firm's assets, which we designate as a cross-holding by sister funds. Mutual funds are the only major overlapping investors in equities and bonds, holding 33 percent of equities and 25 percent of corporate bonds of U.S. corporations. In the 13.5-trillion mutual fund market, fund families consisting of both equity funds and corporate bond funds control 93% of the total assets under management in 2016. If equity and bond funds cross-holding the same firm's assets are also housed in the same fund family, do they coordinate investment under shocks to the same underlying firm? Do mangers of sister funds pass on information about commonly-held firms? If so, can the fund family as a whole derive profit from sharing information internally?

The answer is not as certain as it seems to be. Despite increasing studies on mutual fund family, the entire literature is dominated by studies on equity funds, only a few on bond funds, and zero on the interaction of equity funds and bond funds.[2] Second, equity and bond funds act for the best value of shareholders and creditors respectively. Given that the objectives of shareholders and creditors often diverge (Jensen and Meckling, 1976; Myers, 1977), the holdings of equity and bond funds on the same firm may not co-move. Furthermore, equity and bond investors are significantly different regarding risk appetites and investment objectives, and such investor segmentation may also hinder cross-asset

[1] The Flow of Funds report released by the Federal Reserve Board shows the composition of investors for corporate bonds (Table L.213) and equities (Table L.223) in the United States. Bonds are dominated by institutional investors, in particular patient long-term investors such as insurance companies, whereas equities are mainly held by individual investors (household sector). As of the end of our sample, 2016Q2, the primary holders of corporate bonds are insurance companies (36%), mutual funds (25%), and pension funds (15%), whereas the primary holders of equities are households (43%), mutual funds (33%), and pension funds (15%).

[2] There is evidence on cross-fund subsidization and cross-fund learning, but all supporting evidence is limited to equity funds, focusing on mechanisms of collaboration different from this paper. See Gaspar, Massa, and Matos (2006); Bhattacharya, Lee, and Pool (2013); Nanda, Wang, and Zheng (2004); Brown and Wu (2016); Sialm and Tham (2016); Choi, Kahraman, and Mukherjee (2016).

coordination. Recent studies, for example, Goldstein, Ng, and Jiang (2017), show that the flows of corporate bond mutual funds behave quite differently from those of equity mutual funds. Lastly, what we have heard from Wall St. also suggests a lack of communication between equity funds and bond funds even in the same family, probably due to a culture gap and using different trading platforms.[3]

We provide the first evidence that accentuates the importance of the interactions of equity funds and bond funds, which is largely understudied and possibly ignored by both academia and market participants. Employing a unique dataset by matching the firms held by equity funds and bond funds in the survivor-bias-free mutual fund database from the Center for Research in Security Prices (CRSP), we show that there is information flow across the same fund family's equity funds and bond funds; that is, the organization structure of fund families can offset frictions regarding asset market segmentation. In particular, we find that the holdings of equity funds and bond funds on the commonly-held firms (cross-holdings) tend to co-move only when both funds belong to the same fund family (sister funds), but not when they belong to different families (stand-alone funds).

Moreover, synthesizing information on cross-holdings of sister funds helps both funds and their families make more profit, confirming information synergy across equities and bonds. Specifically, sister funds with information synergy tend to have a 9.0∼11.6 percent higher chance to reduce (increase) their holdings before future negative (positive) returns. Also, equity returns can be predicted solely from the holding changes of sister bond funds, but not from those of stand-alone bond funds. Our findings provide the original evidence provoking the collaboration between equity funds and bond funds in the fund families, which is important for investors, fund managers, and fund managing companies.

It is worth clarifying that our research focuses not on the relationship between equity funds and bond funds in response to the fundamental shocks of commonly-held firms; rather, we study whether the relationship between equity funds and bond funds, measured by their investment decisions in commonly-held firms, could be different conditional on belonging to the same fund family. Given a particular fundamental shock, shareholders and bondholders may both benefit, both suffer, or one benefits but the other suffers.[4] Notwithstanding different patterns of responses, the pattern in the co-

[3]We interviewed both equity fund managers and bond fund managers from several largest investment companies. Common opinions are that bond funds and equity funds do not and probably should not communicate. Quoting one of them, "At every firm I've worked with, there is a huge cultural gap between fixed income and equity, and the two often use completely different systems."

[4]For example, a downgrading (upgrading) event hurts (benefits) both shareholders and bond holders. Events like spinoffs (Maxwell and Rao, 2003), M&As (Billett and Mauer, 2004), seasoned equity offerings (Eberhart and Siddique,

movement of equity holdings and bond holdings on average should be the same, regardless of whether equity funds or bond funds come from the same fund family or from different families.

We start by analyzing the relationship of investment decisions among sister funds using the change of their holdings. We find that the holding change of equity funds on a firm's equities are significantly and positively related to that of sister bond funds on the same firm's bonds. These results are not only statistically significant at the 1% level, but also economically meaningful. When the holding change on a particular firm by bond funds increases by 100 percent, sister equity funds on average increase their contemporaneous equity holdings on the same firm by 59.4∼62.6 percent. The holding change co-movement among sister funds is robust after controlling for firm characteristics, the fixed effects of firm, fund family, time, and their interactions, indicating that the findings are not due to the selection effect by fund families or holding firms.

These findings reject a hypothesis that equity funds and bond funds in the same fund family do not coordinate investment decisions for reasons related to the segregation between equities and bonds. However, we cannot jump to the conclusion that there is internal collaboration across sister funds. The significant cross-holding relationship only suggests that a positive relation exists between the holdings of equity funds and bond funds on the same underlying firms, but this is not necessarily related to information sharing. Without internal collaboration, equity funds and bond funds can still simultaneously respond to firm-specific public information and adjust their holdings accordingly.

To separate these two explanations, we switch our sample from cross-holdings of sister funds to those of stand-alone funds. Specifically, we randomly match equity funds and bond funds that hold the same firm's assets but belong to different but similar fund families, generating counter-factual sister fund relationship. We find that the holdings of fictitious sister funds on average also tend to co-move in the same direction, however, the cross-holding relationships are economically and statistically negligible compared to the cases of sister funds. When the holding changes on a particular firm by bond funds increase by 100 percent, randomly matched equity funds on average increase their equity holding changes on the same firm between -2 to 7 percent, as opposed to 62 percent for sister equity funds. This striking difference between the cross-holding relationship for stand-alone funds and for sister funds advocates that sister funds in the same family conduct internal information sharing across

2002) can incur bondholders' wealth losses as a result of the conflicts of interest.

equities and bonds.

The internal collaboration can go through various channels, and does not pin down the nature of information being shared. Information sharing may discover something that could have not been known otherwise, or it could be a mere exchange of redundant knowledge but nonetheless causing the holding decision co-movement. To this end, we provide evidence that sister funds and their fund families can derive profit from cross-asset information synergy. This is a challenging task since conventional measures such as proxies of fund performance (raw or risk-adjusted returns) fail to apply to our case. Either fund or fund-family performance reflects the overall performance, not specifically the performance due to sharing internal information. Thus, we cannot use the returns of funds or fund families.

To overcome this challenge, we design three novel tests to verify the benefits of cross-holding by sister funds. The first test examines whether cross-holding helps sister funds to make more profitable investment decisions. When equity funds and bond funds synthesize their internal information, chance is high that they can adjust holdings in a timely manner to enhance profit. We identify a profit-enhancing adjustment when an equity fund increases (reduces) its holding one quarter before that equity experiences a positive (negative) return. We show that sister equity funds have 9.0∼11.6 percent higher chance to make profitable decisions on cross-held assets relative to stand-alone funds.

This result sheds light on whether integrating bond market information allows equity fund managers to generate superior return predictability. The mutual fund literature (e.g., Chen, Jegadeesh, and Wermers, 2000) shows that the increase of aggregate equity fund holdings have predictive power on equity returns. We contribute to this finding by documenting that aggregate changes of bond holdings can also predict the underlying firm's equity returns. However, the predictability based on the bond market information is conditional: it happens only when the firm's assets are cross-held by sister funds. This finding suggests that the predictive power comes from information synergy via sister fund cross-holdings. Employing bond holdings to predict equity returns has one crucial advantage: it allows us to clearly observe the predictive power from the cross-holding channel, while alleviates the concern on equity funds' stock-picking skills or timing ability.

Lastly, we utilize two event studies to illustrate potential learning channels between sister funds. The first event is downgrading. Given that creditors are more sensitive to downside risk (Bai et al.,

2019), it's likely that they collect additional information than shareholders when a firm is subject to downgrades. We find that the overall equity holdings by both sister funds and stand-alone funds do not respond to the downgrading events. However, if the firm is also held by sister bond funds, sister equity funds reduce their holdings one quarter in advance and continue reducing the holdings during the event quarter. The findings are particularly stronger when a downgrade happens from investment grade to speculative grade. The second event exploits negative earning surprise when the analysts' prediction is positive. In this case, we show the learning flows in the opposite direction: bond funds learn from sister equity funds and reduce holdings in advance. The combined findings of proactive adjustments in sister funds and no (not significant) adjustment in stand-alone funds confirm our information hypothesis that sister funds benefit from cross-asset information synergy.

Our paper is related to three strands of the literature. First, we contribute to the extant literature on market segmentation and hedging across equities and corporate bonds (e.g., Greenwood, Hanson, and Liao, 2018; Kapadia and Pu, 2012; Choi and Kim, 2018; and Kwan, 1996). Greenwood et al. (2018) suggests that if markets for different asset classes are tightly integrated, then a shock that affects the pricing of a risk factor in one asset class will have a similar effect on other asset classes exposed to the same risk; when markets are more segmented, however, prices of risk in one market may be disconnected from those in other markets. We confirm their market segmentation model with a new evidence. We show that segmentation exists across equities and bonds, but not so under some organizational structures such as fund families. That is, sister funds from the same fund family do coordinate on their holdings of the same firm's equities and bonds; managers of sister funds do share internal information and adjust investment decisions accordingly to make more profit. This cross-asset information synergy is consistent with the findings of Addoum and Murfin (2018). They show investors in the equity market does not timely capture price-relevant signals from the debt market, and demonstrate a profitable trading strategy on equities using debt-side information.

The second related literature documents performance competition and cross-fund subsidization within fund families (see Evans, Prado, and Galacho, 2017 for a summary), but all studies focus on equity mutual funds alone. We contribute to this literature by focusing on information synergy between equity funds and bond funds, introducing an additional discussion whether an organization structure of fund families can offset frictions regarding asset market segmentation. We show that both sister equity and bond funds and their fund family can benefit by exploiting the internal information

not available to stand-alone funds. Such win-win situation differentiates itself from the win-lose status due to the fund family subsidization.[5]

Relatedly, there are studies on cross-fund learning within families (Nanda, Wang, and Zheng, 2004; Brown and Wu, 2016; Sialm and Tham, 2016; and Choi, Kahraman, and Mukherjee, 2016); again, they are limited to learning or spillover across equity funds. The literature suggests that cross-fund learning may result from common skills or resources shared by funds in the family, for example, funds share a common manager. In our study, we find that management teams of equity funds and bond funds in the same family are segregated, that is, rarely any manager takes charge of equity funds and bond funds simultaneously. Such findings confirm the anecdotes we interviewed on Wall St. It is still likely that sister funds' managers have access to the same pool of financial analysts, trading desks, legal counselors, and outside experts. But these channels should lead to homogeneous information on the same firm. Our paper emphasizes that equity funds and bond funds may have different information foci and even different interpretations of the same information, thus synthesizing information helps enhance the performance of both sister funds and their family.

Finally, our work relates to discussions regarding dual ownership and shareholder-creditor interests. For example, Jiang, Li, and Shao (2010) find that syndicated loans with dual holders (those holding both syndicated loans and the same firm's equities) have lower loan yield spreads, suggesting that incentive alignment between shareholders and bondholders helps reduce the cost of loans. Bodnaruk and Rossi (2016) show that targeting firms in Mergers and Acquisitions (M&A) who has a larger equity ownership by dual holders tend to have lower M&A equity premia, also dual holders are more likely to vote in favor of a merger proposal. Our results indicate that, in spite of such conflicts of interests, dual holding can be beneficial to investors in the context of information synergy.

The remainder of the paper is organized as follows. Section I outlines our hypotheses. Section II introduces the data and construct the key variables. Section III presents our main results on the cross-holding behavior of sister funds, and Section IV justifies such behavior by showing the profit derived from cross-holding. Section V conducts further analyses and Section VI discusses micro channels of information sharing. A brief conclusion follows.

[5]For example, Gaspar et al. (2006) show that fund families strategically transfer performance across member funds to favor those more likely to increase overall family profits, and Bhattacharya et al. (2013) show that affiliated funds of mutual funds provide an insurance against liquidity shocks to other funds in the family but incur the cost for fund investors.

I. Research Hypotheses

Information is often gathered at the fund family level (e.g., Elton, Gruber, and Green, 2007) and is potentially coordinated and exploited by different funds in the same family. The literature has shown that different equity funds under the same fund family have the tendency to share information of underlying equities (see Choi et al., 2016; Brown and Wu, 2016). The literature, however, is silent about whether there also exists information sharing across equity funds and bond funds under the same fund family. This is odd given that most mutual fund families contain both equity funds and bond funds.

Using the CRSP survivor-bias-free mutual fund data, Panel (a) of Figure 1 shows that there are 528 mutual fund families during the sample period of 2008Q1-2016Q2 (on average at a given quarter).[6] Among them, 124 fund families (23%) contain equity funds and bond funds simultaneously, 220 fund families (42%) contain only equity funds, and 13 fund families (3%) contain only bond funds. Although the multi-asset-class fund families account for about a quarter of total number of fund families, their portion in terms of asset under management (AUM) dominates. Panel (b) of the same figure indicates that those fund families consisting of both equity funds and bond funds cover on average 82% of the \$9.4 trillions assets in the whole mutual fund market, ranging from 42% of 2.4 trillions AUM in 2008 to 93% of 13.5 trillions AUM in 2016.[7]

For equity funds and bond funds belonging to the same fund family, they do not necessarily hold overlapping firms. We use the terms 'cross-holding' or 'co-holding' to refer the situation where equity funds and bond funds hold corresponding assets of the same firm. We introduce two cross-holding measures at the fund family level. Without loss of generality, we measure the degrees of sister fund cross-holding from the perspective of corporate bond funds. For all bond funds in the fund family f at time t, we count the unique number of firms in their holdings and calculate the proportion of firms whose equities are also held by sister equity funds in the same family, $IW\ Cohold_{ft}$ (issuer-weighted). The second measure is similar except that we use the market value of holdings, instead of the number

[6] These samples are raw information from CRSP, and therefore, it is much larger than the selected sample for our analysis which we introduce in Section II.

[7] Note that Panel (b) of Figure 1 indicates that there is a jump in mutual fund holdings around 2010. This is due to CRSP's data completeness problem, and does not reflect the reality. CRSP mutual fund data comes from two sources (Lipper and Thomson-Reuters) until 2010 when Thomson-Reuters acquired Lipper. Some part of holding file from Lipper before 2010 is currently missing, and this causes the sudden jump in the figure. However, our results remain qualitatively unchanged even if we drop the earlier incomplete sample in pre-2010.

of firms. Specifically, we calculate the ratio of the total market value for firms commonly-held by bond and equity funds over the total market value for all firms held by bond funds in fund family f at time t, $VW\ Cohold_{ft}$ (value-weighted). In order to clearly observe fund families' discretionary cross-holding decision pattern, we hereafter require our sample firms to have public equity and tradeable bonds.

Panel (a) of Figure 2 depicts the average value of issuer-weighted co-holding (in solid line) and the average value of value-weighted co-holding (in dotted line), as well as the band of the 25th and 75th percentiles of issuer-weighted co-holding (in shade) across all fund families containing sister funds during the time period 2008Q1 - 2016Q2. The average issuer-weighted co-holding is 27%, ranging from the 25th percentile value of 12% to the 75th percentile value of 39%, and the average value-weighted co-holding is 28%. In terms of number of firms, bond funds in a fund family on average hold 106 firms, and about 35 firms also cross-held by equity funds in the same fund family. When we measure the degree of co-holding with respect to the holding of equity funds, the ratios tend to be lower as shown in Panel (b), on average 12% and 14% for issuer-weighted and value-weighted respectively, that is, 30 out of 249 firms cross-held by bond funds in the same family. The lower co-holding in equity funds is probably due to the fact that equity funds hold more firms and have larger assets under management.

[Insert Figure 1 and Figure 2 about here.]

When equity and bond funds come from the same family, their holdings of commonly-held firms may co-move due to multiple reasons. One possible reason is the common reaction to firm fundamental shocks, which can affect both equity prices and bond prices, and hence affect equity and bond funds' investment decision. Another main reason is that sister funds share information internally and the information advantage drives co-movement. This does not necessarily mean that managers of sister funds have private information. Very likely, they both have public information, but belonging to different fund families may hinder the exchange of information. Alternatively, shareholders and creditors have different information foci and/or different interpretations even to the same public signal, and incorporating such difference can augment the information content on the underlying firm and hence boosts the overall performance. These are the motivation for the collaboration hypothesis below.

Hypothesis 1 (**Collaboration**): *In a fund family, the holdings of equity funds and bond funds on commonly-held firms' equities and bonds are significantly correlated.*

The literature has documented supporting evidence for collaboration and competition across *dif-*

ferent equity funds, but has no evidence for interactions across *equity funds and bond funds*. The main hindrance is likely market segmentation across equities and corporate bonds. Greenwood et al. (2018) build a model showing that capital moves quickly within an asset class, but slowly between asset classes. Kapadia and Pu (2012) identify pricing discrepancies across firms' equity and bonds, which supports a lack of integration across equities and bonds. The segmentation could be due to multiple reasons. For example, equities and bonds have different levels of liquidity which leads to different velocities of information dissemination; the equity market and bond market have different composition of investors which leads to varying information foci and motivations to change their holdings; shareholders and creditors also have conflicts of interest which may impede the integration across assets. With these considerations, we present a second hypothesis, the segmentation hypothesis.

Hypothesis 2 (**Segmentation**): *Even with the possibility of collaboration within the fund family, market segmentation hinders information sharing across equity funds and bond funds, leading to an insignificant relationship in their holdings on commonly-held firms' equities and bonds.*

To distinguish the collaboration and segmentation hypotheses, we specify the following model of dynamic holding change:

$$\Delta H_{i,f,t}^{Equity} = \alpha + \theta \cdot \Delta H_{i,f,t}^{Bond} + \gamma \cdot Z_{i,t} + FE + \varepsilon_{i,f,t}, \tag{1A}$$

or

$$\Delta H_{i,f,t}^{Bond} = \alpha + \theta \cdot \Delta H_{i,f,t}^{Equity} + \gamma \cdot Z_{i,t} + FE + \varepsilon_{i,f,t}, \tag{1B}$$

where $\Delta H_{i,f,t}$ is the percentage change in quantity (number of shares) of firm i's equities or bonds held by fund family f during the quarter t, $\Delta H_{i,f,t} = (H_{i,f,t} - H_{i,f,t-1})/H_{i,f,t-1}$. In this test, we consider only fund families having both equity funds and bond funds cross-holding the same firm's assets, that is, a subset of sister funds holdings. Also, in order to ensure that the estimation of the model is a consequence of funds' own decisions, we restrict firms to have both public equity and tradable bonds with transaction histories in TRACE. We include the fixed effect of firm, fund family, industry, and time (calendar-quarter). In some specifications, we also consider the two-way fixed effect of the intersection of fund family and time. The control variables include the proxies of a firm's riskiness such as firm size, leverage, book-to-market ratio, which may potentially affect a fund's holding decision.

The estimated coefficients θs in Equations (1A) and (1B) tell the different degree of how the

changes of bond holdings are associated with the changes in equity holdings, and vice versa. If both θs in Equation (1A) and (1B) are insignificant, we have the confidence to support the segmentation hypothesis. If the θs are significant, however, we cannot conclude that there is information flow across sister funds. The significant coefficient only suggests that some relation exists between the holdings of equity funds and bond funds on the same underlying firms, but not necessarily related to information sharing across sister funds. Either sister or stand-alone equity and bond funds can still simultaneously respond to the public information and adjust their holdings accordingly, due to the fundamental link between equities and bonds of the same firm. To discriminate against the common reaction channel, we posit the following hypothesis.

Hypothesis 3 (**Information**): *The co-movement between the change of equity funds' holdings and that of bond funds' holdings on the same firm's assets is significantly different for sister funds relative to stand-alone funds, since sister funds can synthesize internal information that is not available to stand-alone funds.*

This hypothesis is tested against more generic alternatives. In fact, the support for collaboration hypothesis is not necessarily related to information sharing; collaboration can also be due to common reactions to firm fundamental news, or due to an operational, mechanical, random, or other alternative explanation. For example, a fund management company decides to withdraw from a specific market, then both its equity funds and bond funds liquidate their holdings of commonly-held firms. However, the information channel specifically involves internal communication about commonly-held firms. For example, a credit downgrade elevates a firm's cost of capital and hence impairs the value of equities and bonds, but creditors could be more sensitive to downside risk, especially at a close distance to default (Bai et al., 2019). In this case, bond funds (creditors) are likely to collect more information, and equity funds (shareholders) can benefit from getting such information from sister bond funds. Therefore, Hypothesis 3 separates non-information channels for the co-movement from the information-driven channel.

We propose Model II to rule out the common reaction channel and other channels not related with the sister-fund relationship in explaining the co-movement:

$$\Delta H_{i,f,t}^{Equity} = \alpha' + \theta' \cdot \Delta H_{i,f',t}^{Bond} + \gamma' \cdot Z_{i,t} + \varepsilon_{i,f,t}, \tag{2A}$$

or
$$\Delta H_{i,f,t}^{Bond} = \alpha' + \theta' \cdot \Delta H_{i,f',t}^{Equity} + \gamma' \cdot Z_{i,t} + \varepsilon_{i,f,t}, \tag{2B}$$

where the dependent variable $\Delta H_{i,f,t}$ is the percentage change of firm i's equity or bond shares held by fund family f during quarter t. The independent variable $\Delta H_{i,f',t}$ refers to the percentage change of the same firm i's bond or equity shares held by another fund family $f'(f' \neq f)$ during quarter t, that is, the holding change by stand-alone funds in a different fund family instead of by sister funds in the same fund family. Model II has specifications similar to Model I except that the cross-holding relationship is estimated between fictitious, counter-factual sister funds which are in fact two stand-alone funds from two different fund families.

If the common reaction to firm fundamental shocks (public signals) is the main driver, we expect θ' to be similar in the magnitude and the sign to θ in Model I, because both equity and bond funds should respond to the same public information regardless whether they are sister funds or stand-alone funds. However, if the co-movement of holdings is mainly due to internal information sharing across sister funds, we expect θ' to be either insignificant or statistical significant but much smaller in magnitude relative to θ in Model I. The estimation of θ' also provides an implication on Hypothesis 2. If both θ' in Model II and θ in Model I are insignificant, the result can provide additional support that equities and bonds are segmented.

It is worth noting that even though we show that the co-movement across sister funds holding changes are due to internal collaboration channel (significant θs), it does not immediately imply information synergy. 'Synergy' is defined as the interaction of two or more forces producing a combined effect *greater* than the sum of their individual effects. In our context, it implies that sharing information across sister funds helps augment the information set of commonly-held firms. We explicitly test information synergy in Section IV. Showing the existence of synergy will further clarify the internal information channel because either the common reaction channel or non-informational collaboration channels should not invoke notable profits for funds or fund families.

II. Data

Our main data is the survivor-bias-free mutual fund dataset from the Center for Research in Security Prices (CRSP). The database provides a map between funds and fund families. Using this, each fund

can be matched to its fund family at a given time. This feature is advantageous for our study to identify sister funds. For each equity (corporate bond) fund at time t, we determine that the fund has a sister fund cross-holding if there is at least one corporate bond (equity) fund within the same fund family holding the same underlying firm's bonds (equities) at the same time. To identify the cross-holding, we use the mapping information of security CUSIPs to issuing entities provided by Capital IQ to link bond and equity at the issuer level. The conventional method relies on the first 6-digit firm-level CUSIPs to link bonds and equities, but this method generates noisy and incomplete results since many firms tend to issue bonds via a special financing conduit with a completely different first 6-digit CUSIP. Capital IQ, on the contrary, provides useful information about the ultimate issuer of each security (bond or equity) and thus allows us to circumvent this problem. Furthermore, we manually examine the matching via issuer names and account for their merger and acquisition histories.

Based on the raw CRSP mutual fund data, we employ the following rules to construct our sample. First, we eliminate passive, index-tracking, variable-annuity funds from our sample to focus on the funds with active management. To make sure that all holding decisions are by the funds' own choices, we further impose two conditions on fund and asset characteristics: (i) we keep only fund families holding both equity funds and corporate bond funds in which cross-holding can occur, and (ii) we keep only firms whose equity securities are traded in stock exchanges and whose bond securities are tradable in over-the-counter market (firms that have at least one bond transaction in the past four quarters in TRACE).[8] Second, we restrict our sample to the U.S. domestic equity and corporate bond funds to identify cross-holdings.[9]

The resulting database spans from 2008Q1 to 2016Q2, including 137 unique fund families and 1,722 unique issuing firms.[10] Table 1 presents summary statistic for the fund families and main variables in our sample. Panel A shows that each fund family on average has 11 equity funds and 2 corporate

[8] We exclude fund families consisting of pure equity funds or pure bond funds. This is relatively a small sample in terms of asset under management. As explained in Section I, fund families consisting of both equity and bond funds control 93% of the $13.5-million mutual fund market.

[9] CRSP uses four alphabets to classify a fund's main asset class. ED** and IC** refer to the U.S. domestic equity and corporate bond, respectively. The corporate bond classification (IC**) is not perfect in CRSP. We extend the corporate bond fund classification when funds are classified as fixed income funds (I***) and more than 80% of their asset holdings are corporate bonds.

[10] The CRSP mutual fund database starts earlier than 2008. However it has an issue of not including historical corporate bond holding information. We detected this problem and communicated with CRSP. They confirmed this defect and suggested that there is no further way to improve the data quality. Given this concern, we start our sample from 2008Q1. Also, as mentioned previously, some of pre-2010 sample is incomplete in CRSP. We nonetheless include the 2008-2009 period to cover the financial crisis. Exclusion of the 2008-2009 sample does not affect our results.

bond funds at a given quarter. The aggregated equity funds holdings in a fund family ,on average, are twowelve times larger (12 bn.) than those of bond funds (1 bn.) in terms of AUM. But bond funds' portfolios are more diversified in spite of smaller portfolio size: equity funds hold equities of 50 issuers while bond funds hold bonds of 64 issuers at a given quarter.

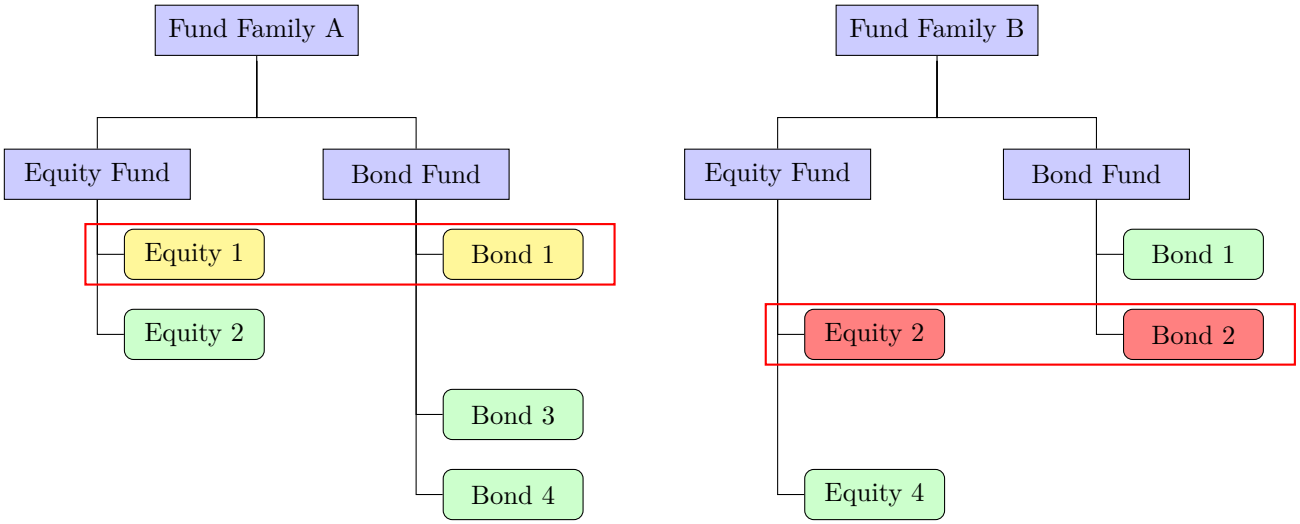
Panel B shows that the average change in equity holding per quarter is 28.08% with a standard deviation of 118.95%. The average change in bond holding per quarter is 5.15% with a standard deviation of 63.12%. Both holding changes have a median value of 0%, however they exhibit large variation towards both sides of changes. The average change in equity holdings per quarter is much larger than that in bond holdings, possibly due to the fact that the corporate bond market is much more illiquid than the equity market. Firms in our sample on average have 62.29 billion dollars of total asset, a leverage ratio of 0.31, and a book-to-market ratio of 0.53.

[Insert Table 1 about here.]

A. Identify Sister Funds and Stand-Alone Funds

The hypothetical figure below illustrates our data structure. In the figure, there are Fund Family A and Fund Family B. Suppose that both fund families have equity funds and corporate bond funds under their umbrellas. At a given time, each fund (equity or bond) has asset holdings corresponding to its asset-class mandate. For example, the equity fund of Fund Family A holds equities of Firm 1 and Firm 2, whereas the equity fund of Fund Family B holds equities of Firm 2 and Firm 4. For a given time, we define 'sister fund's cross-holding' at the firm-fund family level. In this example, Fund Family A has sister funds that cross-hold Firm 1's equity and corporate bonds, and Fund Family B also has sister funds that cross-hold Firm 2's equity and corporate bonds. We outline sister funds' cross-holdings in the red boxes.

Stand-alone funds' holdings refers to the rest. Specifically, from Firm 1's perspective, the bond fund of Fund Family B is a stand-alone fund since it holds Firm 1's bonds but the equity fund in the same family does not hold Firm 1's equities. Similarly, from Firm 4's perspective, bond fund (equity fund) of Fund Family A (or B) is also a stand-alone fund because its corresponding equity (or bond) fund does not hold Firm 4' equities (or bonds).



B. Key Variables

Our primary test variable is $\Delta H_{i,f,t}$, the percentage change in quantity (number of shares) of firm i's equities or bonds held by fund family f during the quarter t:

$$\Delta H_{i,f,t} = (H_{i,f,t} - H_{i,f,t-1})/H_{i,f,t-1}.$$

When the previous holding quantity is negative (short position), we use absolute number to reflect the direction of change. By construction, the percentage change has a lower bound of -100% but no upper bound. To avoid the possibility that extreme values drive the results, we winsorize the percentage change at 5% level. Alternatively, 1% winsorization yields qualitatively similar results. One could think of an alternative way to measure holding changes such as, in particular, percentage changes in value ($(V_t - V_{t-1})/V_{t-1}$). However, this measure reflects changes in market price of a unit of security as well as addition or reduction in holding quantities. Since our focus is funds' investment decision, using changes in number of shares would be more appropriate. It is also worth noting that ΔH, by construction, can be define only when there is a previous holding. Therefore, our analyses are specifically related to the addition or reduction of an existing holding, not to initial acquisitions of a holding.

C. Other Variables

In our analyses, we control for the following variables related to firm's risk which potentially affect the mutual fund investment decisions. Firm size is the logarithm of total assets. Leverage is the ratio of book debt value to the combination of book debt value and the market value of equity, in which the debt includes long-term debt and debt in current liabilities. The book-to-market ratio is defined as the book value of equities divided by its market value.

We also consider the influence of fund family characteristics on our main findings. In particular, we consider (i) fund family size which is defined as the total net assets managed by a fund family f across all funds in the family, (ii) fund family expense ratio which is the average of fund expense ratios within a fund family, where fund expense ratio is the ratio of total investment that shareholders pay for the fund's operating expenses, (iii) fund family management fee, which is the average of fund management fee scaled by average net assets, and (iv) fund family turnover ratio, which is the average of fund turnover ratios within a fund family, where fund turnover ratio is the minimum of aggregated sales or aggregated purchases of securities divided by the average 12-month total net assets of the fund.

III. Results: Cross-holding of Sister Funds

In this section, we examine investment decisions of equity and bond funds both in the same family and in different families in order to test the collaboration hypothesis and the segmentation hypothesis. Then, we try to discriminate the internal collaboration channel from alternative explanations such as the parallel reaction to the public firm-specific news.

A. The Holdings of Sister Funds

To understand the cross-holding relationship among sister funds, we examine the change of holdings as specified in Model I. The dynamic investment decisions capture sister funds' decision-making processes on their cross-holdings. We estimate the pooled regression in Equation (1A) and (1B).

Table 2 presents the results. For specification, we sequentially consider the fund family fixed effect

in Column (1), the combined fixed effect of fund family and time in Column (2), the combined fixed effect of fund family, time, and industry in Column (3), the two-way fixed effect of fund family × time in Column (4), the combined fixed effect of fund family × time and industry in Column (5), and the combined fixed effect of fund family × time and firm in Column (6). The specification in Column (6) sets the most rigorous control for any factor affecting the fund holdings due to firm-specific features or time-varying fund and fund family features. We calculate the robust standard errors clustered at the fund family level and report the corresponding t-statistics in parentheses.

Panel (a) shows that when the holdings on a particular firm by bond funds increase by 100 percent, sister equity funds on average increase their equity holdings on the same firm by 59.4∼62.6 percent. Given the mean value of the change of equity holdings is 28.08 percent, the impact from bond funds is economically large.

When considering the impact of the change of equity holdings on bond holding changes, we again find a significant and positive relationship across all specifications, as shown in Panel (b) of Table 2. When the holdings on a particular firm by equity funds increase by 100 percent, sister bond funds on average increase their bond holdings on the same firm by 19.2∼21.8 percent. Though the impact from equity funds to bond funds is far less compared to the impact from bond funds to equity funds as shown in Panel (a), we consider this impact economically meaningful since the average change of bond holdings over the whole sample is merely 5.15 percent. The difference in the magnitude potentially reflects the higher degree of trading frictions for corporate bonds relative to equities. In addition, the adjusted R-squared values in Panel (b) are larger than those in Panel (a), for example, 0.265 versus 0.203 under the specification in Column (6). Thus, even the equity funds have a much smaller impact on sister bond funds in magnitude, they do have more explanatory power in explaining the portfolio allocation decision of bond funds.

[Insert Table 2 about here.]

B. The Holdings of Funds within Counter-Factual Fund Family

We have shown that both equity-to-bond and bond-to-equity cross-holding relationships are significant and positive. These findings reject the segmentation hypothesis for sister funds within the same fund families. As discussed in Section I, however, we cannot jump to the conclusion that the

co-movement is driven by internal information sharing across sister funds. The significant coefficients, θs, only suggest that a positive relation exists between the holding decisions of equity funds and bond funds on the same underlying firms, but unnecessarily related to information flow. In fact, firms' equity prices and bond prices can respond to firm-specific shock in the same direction. Therefore, upon such a news, rational fund managers of equity and bond funds would accordingly make independent investment decisions. In this case, we are likely to observe co-movement in holding decisions as in Table 2. This common reaction mechanism is different from the internal information-sharing. To distinguish these two channels, we test Model II proposed in Section I.

In Model II, we randomly match an equity (bond) fund of a fund family to another bond (equity) fund in a different fund family, requiring both funds to hold the same firm's assets. As shown in Equation (2A) and (2B), we construct a holding change of firm i's equity by equity funds in the fund family f during quarter t, and a holding change of the same firm's bond holdings by bond funds in a different (randomly-matched) family f'. The public information about the firm should be available across all funds. Therefore, this setup provides an experiment in which we eliminate the effect of being linked within the same fund family while keeping all other firm-specific effects intact.

Using the hypothetical illustration in Section II, we illustrate our experiment design of Equation (2A) in the following chart. For example, bond fund in Fund Family B and equity fund in Fund Family A both hold Firm 1's assets. However, they are not a cross-holding of sister fund, thus they are identified as stand-alone fund holdings. The arrow lines exhibit such matches, generating fictitious sister fund' cross holdings. The design for Equation (2B) is similar except flipping the directions of the arrows.

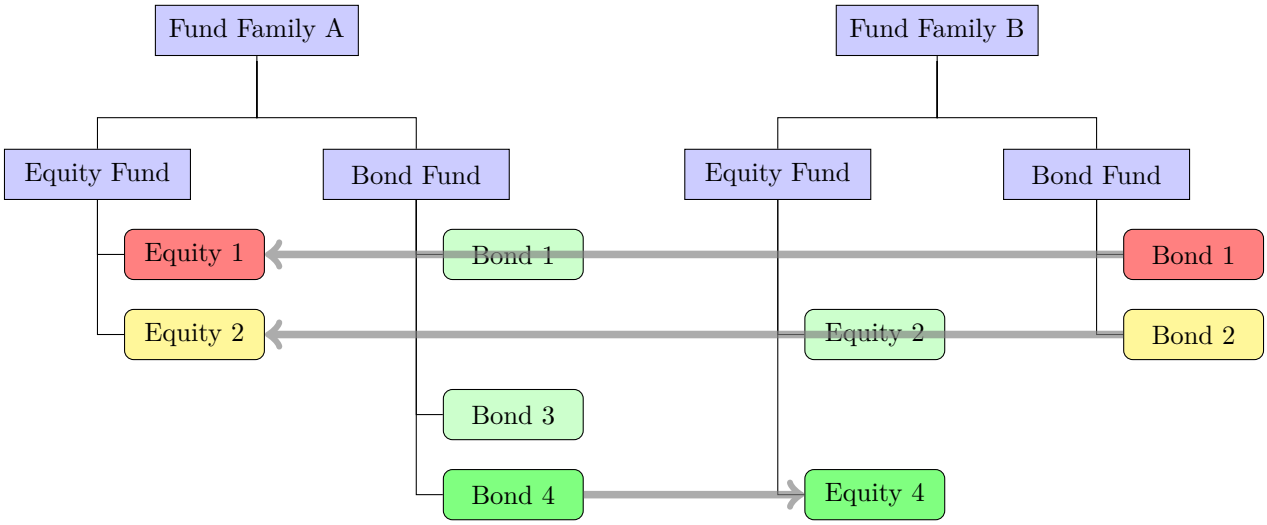


Table 3 reports the estimation results of Equation (2A).[11] Note that specifications are identical to those in Table 2 except using the sample of randomly matched funds. Also, since we compare holding decisions in counter-factual fund family, the fund-family fixed-effect is removed. In this practice, we use several different matching criteria. Panel (a) matches all the possible combinations of $f - f'$ ignoring heterogeneity across fund families. Panel (b) considers size criterion, requiring f and f' to be in the same quintile bucket of log-asset-size. Panel (c) employs most common fund characteristic (expense ratio, turnover, and management fee) criterion. In order to covert them to fund-family level, we compute value-weighted average across funds in each fund family. Panel (d) use both size and characteristic criteria.

In any matching procedures, Table 3 shows a stark contrast from the previous case in term of the estimates of θ'. Unlike such a strong co-movement in holding decisions between factual sister funds, these counter-factual sister funds show much smaller magnitude. Their statistical significance is also not comparable to factual cases. This result supports Hypothesis 3 such that the co-movement of holdings is not due to independent and parallel reactions to the public news about the underlying firm.

To visualize the difference, we apply the bootstrapping technique to draw 50 random matches. Figure 3 plots the distribution of the estimated coefficients, θ', and their t-statistics. In the bond-to-equity relationship as shown in Panel (a) of the same figure, θ's range from -0.07 to 0.16 with an average value of 0.03. This small magnitude suggests that the holding co-movement of stand-alone

[11] Results of Equation (2B) are not reported, because results with Equation (2A) is sufficient

funds are not economically significant. Furthermore, out of 50 random matches, only 5 iterations estimate θ' with a statistical significance stronger than 10% level (red "$\circ$" marker; otherwise blue "$\times$" marker).

The positive average value, in spite of the low value, together with some positive and statistically significant θ estimates in Table 3, suggests that equity and bond funds' holding changes are likely to co-move in the same direction, potentially reflecting common reactions to the news about firm fundamentals. However, its economic magnitude and statistical significance in the stand-alone fund relationship are not comparable to those in the sister fund relationship. The coefficient for sister funds, $\theta = 0.626$ (t-stat $= 28.59$) under the specification (1) in panel (a) of Table 2, dominates the average coefficient for stand-alone funds, $\theta = 0.03$.

Panel (b) in the same figure shows the reverse case, corresponding to Equation (2B). In the equity-to-bond relationship, θ' ranges from -0.04 to 0.06 with an average value of 0.010 and a standard error of 0.005. In this case, 6 iterations out of 50 matches show a significance stronger than 10%. The co-movement coefficient for sister funds is $\theta = 0.218$ (t-stat $= 35.75$). Such a comparison draws the same conclusion: the holding co-movement on stand-alone fund cross-holdings is economically incomparable to the one on sister funds.

In sum, this experiment finds that stand-alone equity and bond funds tend to adjust their allocations on the same firm's assets in the same direction, *i.e.*, to increase or decrease the holdings simultaneously. This confirms the a priori expectation that investment decisions of equity and bond funds positively co-move via common reactions to the firm's fundamental shocks. However, the co-movement shows substantially small economic magnitude with far weaker statistical significance. These findings are in sharp contrast to what we have shown for the cross-holding relationship among factual sister funds, supporting the information hypothesis that sister funds in the same family conduct internal collaboration.

[Insert Table 3 and Figure 3 about here.]

IV. Results: Benefits from Cross-holding

We have shown that sister funds in the same fund family adjust their holdings in commonly-held firms' assets in a different way from stand-alone funds in different fund families. The findings suggest that sister funds in the same family collaborate internally. In this section, we investigate the nature of information sharing and quantify the benefit of sister fund cross-holding. To this end, whether sister funds and their fund families can enhance the performance from cross-holding would provide an important implication. If they can derive a better profit, this would be strong evidence supporting cross-asset information synergy, an elevated statement beyond explanations related to collaboration or information sharing.

The literature conventionally utilizes the fund performance, raw or risk-adjusted return, to evaluate the profit based on specific strategies or fund features. This conventional method does not apply to our case. First, the performance of either fund or fund family captures the overall performance, not specifically the performance due to sister fund cross-holding; thus we cannot use the returns of funds or fund families. Second, one fund can be identified as both sister fund and stand-alone fund at a given time, depending on the holding firm; thus the performance due to sister fund cross-holding is directly related to holding firms. To overcome this challenge, we design the following novel tests to quantitatively verify the benefit of cross-holding. The first test examines whether cross-holding helps sister funds to make more profit-enhancing allocations. The second test investigates whether cross-holding helps predict equity returns. Lastly, we employ two event studies to show possible cases of learning between sister funds.

A. Profit-Enhancing Allocation

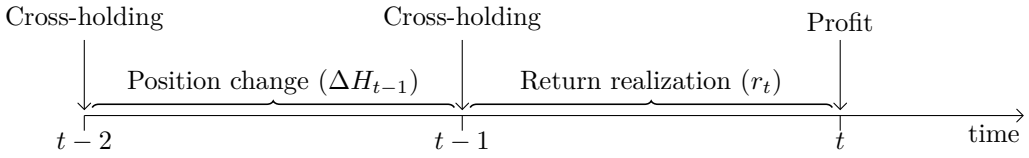
When equity funds and bond funds synthesize their price-relevant information, augmenting the information content and reducing the information cost, chances are higher that they can adjust holdings in a timely manner to enhance profit. We introduce the dummy variable $PROFIT$ to measure the profit-generating allocation. In particular, $PROFIT_{i,f,t}$ is equal to 1 if equity funds of fund family f enhances profits at the end of quarter t based on the position adjustment of firm i's equity holdings during the quarter t-1 before the return realization in quarter t, otherwise it is equal to 0. That is, an

equity fund reduces (increases) its holding of firm i before the equity experiences a negative (positive) return, as shown below:

$$PROFIT_{i,f,t} = \begin{cases} 1 & \text{if} \quad s(\Delta H_{i,f,t-1}) \cdot s(r_{i,t}) > 0 \\ 0 & \text{if} \quad s(\Delta H_{i,f,t-1}) \cdot s(r_{i,t}) \leq 0, \end{cases}$$

where $r_{i,t}$ is the equity return of firm i in quarter t and $s(\cdot)$ denotes the sign function that assigns 1 to a positive number and -1 to a negative number. For example, if $\Delta H_{i,f,t-1} > 0$, and followed by a positive return of firm i's equity, then $s(\Delta H_{i,f,t-1}) = 1$ and $s(r_{i,t}) = 1$, resulting in $PROFIT = 1$. The definition of $\Delta H_{i,f,t-1}$ is identical to the one in Equation (1A).

The timeline below shows the construction of $PROFIT$ for a given firm i and fund family f. In order for $PROFIT$ to be 1, the asset i's return in quarter t (r_t) must have the same direction as the holding changes in the previous quarter (ΔH_{t-1}) by fund family f.



We test whether the cross-holding relationship between sister funds leads to more profit-generation position adjustments in the following specification:

$$PROFIT_{i,f,t} = \alpha + \beta \cdot Cohold_{i,f,t-1} + FE + \varepsilon_{i,f,t}, \tag{3}$$

where $Cohold_{i,f,t-1}$ is a dummy variable that is equal to 1 if firm i's bonds are held by sister bond funds in fund family f during the quarter t-1, otherwise 0. Table 4 presents the results. We control for various heterogeneity across funds, firms, and time, with multi-dimensional fixed effects. Specifically, Column (1) uses individual fixed effects of firm and time, Column (2) uses individual fixed effects of firm, time, and fund family, Column (3) uses the two-way fixed effect of firm×time, and Column (4) uses both the two-way fixed effect of firm×time and individual fixed effect of fund family.

Using these linear models has a merit even with the binary dependant variable; that is, we do not need to rely on the numerical convergence of the estimation which tends to be problematic with multi-dimensional fixed effects. However, for robustness, we also estimate the conditional logit model with

the firm×time fixed effect in Column (5) with our binary outcome variable. The comparison of the logit model and linear models would allow us to see whether there exists a serious bias in estimating the coefficients via linear models.

Across all specifications in Table 4, we consistently find a significant β estimated in the range of $0.090 \sim 0.116$, with corresponding t-stat from 12.69 to 59.96.[12] The marginal effect estimation using the conditional logit model in Column (5) is also consistent with the linear model estimations, enhancing the confidence in using linear models. The estimation results suggest that sister funds cross-holding the same firm's assets have about $9.0 \sim 11.6$ percent higher chance to make profit-enhancing allocations than stand-alone funds, which indicates information synergy from sister fund cross-holding.

These results provide an important implication on the co-movement of investment decision by sister funds. In the earlier sections, we show that sister funds' co-movement is not merely due to public information. The results we provide in this section further clarify the cause of the co-movement: it is driven by sharing price-relevant information of commonly held firms, and such a collaboration generates information advantage compared to a case without cross-holdings. Any non-information-based explanation about the co-movement cannot explain this significant better profit-generating allocation.

We further investigate the duration of benefits from cross-holding. We conjecture that information synergy is more significant for position adjustments closer to the timing of cross-holding. Due to the fact that our holding information is at the quarterly frequency, the nearest holding change that we can use to verify as a profitable change is one quarter ahead. For example, if a firm's bonds were held earlier but not during the past adjacent quarter $t-1$, the value of information synergy on the profitable position adjustment during quarter t would decay over time. To verify this conjecture, we repeat the estimation of Equation (3) with more broad conditions for the $Cohold$ variable. Instead of one-quarter lagged cross-holding, we include cross-holding in the past 2 to 4 quarters. In the previous test, $Cohold_{t-1}$ requires the firm's assets to be held by sister funds during the quarter $t-1$. We relax this criteria such that assets can be held during the quarter $t-2$ up to $t-4$.

[Insert Table 4 and Figure 4 about here.]

[12] 73,327 observations are dropped for Columns (3)-(5) with firm×time fixed-effect because there is not enough variation within each fixed-effect group.

Using the specification corresponding to Column (3) in Table 4, Figure 4 reports the regression coefficients in Equation (3) with respect to number of quarters extended. We find that the information is still valuable when cross-holding happens up to four quarters earlier. However, the value of information synergy drastically decays, exhibiting a monotonically decreasing pattern. The chance of making more profit-generating allocations drops significantly from 10.8 percent to 2.8 percent and further to 1.5 percent when cross-holding happens from one quarter lagged to two quarters lagged and further to four quarters lagged.[13]

B. Predicting Future Returns from Cross-Holding

To provide more direct evidence, we investigate the predictive power on future equity returns from the cross-holding synthesized information. In the literature of mutual funds, Chen, Jegadeesh, and Wermers (2000) show that stocks purchased by funds have significantly higher returns than stocks they sell, i.e., the increase of aggregate equity holdings have predictive power on return of the equity. In the similar spirit, but in the context of cross-holding, we design a test to contrast equity return predictability of aggregated changes in bond cross-holdings by sister funds against that of stand alone funds. If there is internal information synergy from cross-holding, holding decisions of funds on one asset might predict the returns of another asset both issued by the same firm, only when they are cross-held by sister funds. To this goal, we propose the following specification:

$$Return_{i,t+1} = \alpha_i + \alpha_t + \theta_{XH} \cdot \Delta \bar{H}^{Bond}_{i,f \in XH,t} + \theta_{SA} \cdot \Delta \bar{H}^{Bond}_{i,f \in SA,t} + \gamma \cdot Z_{i,t} + \varepsilon_{i,t}, \tag{4}$$

where $Return_{i,t+1}$ is the firm i's one-quarter ahead equity return. We control the time variation and non-time-varying firm heterogeneity by time fixed-effects (α_t) and firm fixed-effect (α_i). We also include size, leverage, and book-to-market, $Z_{i,t}$, to control for time-varying firm characteristics that may have an impact on equity returns.

$\Delta \bar{H}^{Bond}_{i,f \in XH,t}$ is the average percentage change in quantity (number of shares) of firm i's bonds held by fund families which include sister equity funds cross-holding firm i's equities. We denote such fund families as fund families with sister fund cross-holdings, XH. $\Delta \bar{H}^{Bond}_{i,f \in SA,t}$ is the average percentage

[13] The estimation corresponding to 1 in the horizontal axis is identical to the regression coefficient reported in Column (3) of Table 4.

change of firm i's bond shares held by fund families which include stand-alone equity funds also holding firm i's equities. We denote these fund families as fund families with stand-alone funds, SA. Specifically,

$$\begin{aligned}\Delta\bar{H}^{Bond}_{i,f\in XH,t} &= \frac{1}{n_{XH}}\cdot\sum_{f\in XH}\Delta H^{Bond}_{i,f,t}\\ \Delta\bar{H}^{Bond}_{i,f\in SA,t} &= \frac{1}{n_{SA}}\cdot\sum_{f\in SA}\Delta H^{Bond}_{i,f,t},\end{aligned}$$

where $\Delta H^{Bond}_{i,f,t}$ is defined in Equation (1A) and in Table 2, and n_{XH} and n_{SA} are the number of fund families in corresponding sets. In other words, $\Delta\bar{H}^{Bond}$ captures average investment decisions of each type of fund family (XH or SA) for a given firm at a given time.

It is worth noting that the above test is stronger than a test to predict equity returns using equity holding changes of fund families. The relationship between the changes of holding an asset and future returns of the same asset has a direct implication on mutual funds' picking skills or timing ability, which is not necessarily related to the cross-holding benefit. In fact, all equity funds must change their holdings based on their predictions on equities regardless of cross-holding. This collective effort of equity funds makes it difficult for us to observe the predictability on equity returns from bond cross-holdings.

However, focusing on the holding change of cross-held bonds to predict equity returns can alleviate such a concern. If bond funds holding changes can predict the return of the same firm's equity, this cannot be due do bond funds' stock picking ability. In general, the changes of bond fund holdings do not target to predict equity returns. This fact potentially allows us to observe a clear contrast between bond funds with and without the cross-holding of sister equity funds. If holding changes in a bond by only XH fund families contains future return-relevant information on the cross-held equity, while those in the same bond by SA fund families do not, this predictive power most likely comes from cross-asset information synergy due to cross-holding.

Under the premise that cross-holding motivates information synergy by making the firm-level information more complete, we expect that, on average, the holding changes of bond funds on firm i can predict the same firm's future equity returns when the firm's bonds and equities are cross-held by the same fund family. We also expect that the holding changes of bond funds may not have such

predictive power if these bond funds belong to the fund families without cross-holdings. Therefore, the comparison of the coefficients θ_{XH} and θ_{SA} in Equation (4) is of our interest.

We further conjecture that the predictive power will be more accurate when we observe actions of a larger set of cross-holding fund families on a given firm. To test this, we require the number of cross-holding fund families (n_{XH}) to be larger than a certain threshold. As we impose a higher threshold, there are two forces going in the opposite direction. Mechanically, we will lose more observations because the hightend threshold would correspond to a smaller subset of assets cross-held, which may lower our testing power. Economically, however, such a threshold can make the magnitude of the results larger because the average ratio in Equation (4) would be more informative with a larger number of cross-holding fund families.

[Insert Table 5 about here.]

Table 5 presents the results from three subsamples based on different thresholds of the number of cross-holding fund families (n_{XH}). Specifically, we consider subsamples with at least one cross-holding family ($n_{XH} > 0$), with more than one cross-holding families ($n_{XH} > 1$), and with more than ten cross-holding families ($n_{XH} > 10$).

Across all subsamples, the results unanimously suggest that the holding change of bonds by cross-holding fund families whose sister (equity) funds hold the same firm's equities predict future equity returns. However, the holding changes of the same bonds by stand-alone fund families without cross-holding do not have any predictability. The results provide strong support for information synergy across sister funds. It is worth mentioning that our result is not driven by stock picking skills or market timing since we compare the holding change of the same firm's bonds between fund families with and without cross-holding.

Furthermore, as we restrict the sample with a higher threshold for the number of cross-holding fund families, we observe a much higher significance on the predictability: 0.013 (t-stat=2.43) under $n_{XH} > 0$, 0.016 (t-stat=2.45) under $n_{XH} > 1$, and 0.037 (t-stat=2.32) under $n_{XH} > 10$. As mentioned, a higher threshold corresponds to a smaller sample, hence we lose the testing power. However, this result suggests that observing more than 10 fund families actions is much more informative than observing only a few fund families' actions.

C. Event Studies

In this subsection, we present examples of how sister funds can exploit information from each other and produce a better profit. Though one of many potential cases, we believe that event studies help provide a good demonstration. First, we investigate how equity funds change their holdings in cross-held firms around credit downgrade events. Bai et al. (2019) show that bonds are capped in the upside payoffs and creditors are more sensitive to downside risk. Thus, it is possible that bondholders pay more attention and collect more information when a firm is likely to be downgraded, in particular when a downgrade happens from investment grade to speculative grade.

We compute the change in fund holdings over two quarters before and two quarters after the quarter that downgrading events occur. We then compare the behavior of equity funds that have cross-holding in their sister (bond) funds with that of stand-alone equity funds that also hold the same equity but without a cross-holding. By doing this, we assume that equity funds learn from their sister bond funds about the risk due to downgrade, and adjust their holdings correspondingly, while other equity funds adjust holdings without such a learning channel. To test this conjecture, we estimate the following model:

$$\Delta H^{Equity}_{i,f,t+\tau} = \alpha_{f,t} + \beta_\tau \cdot \mathbb{D}_{i,t} + \gamma_\tau \cdot \mathbb{D}_{i,t} \cdot Cohold_{i,f,t-2} + \lambda_\tau \cdot Z_{i,t+\tau} + \varepsilon_{i,f,t+\tau}, \ \ \tau \in [-2, 2], \tag{5}$$

where $\Delta H^{Equity}_{i,f,t+\tau}$ is the percentage change of firm i's equity shares held by fund family f during quarter $t+\tau$, and $\mathbb{D}_{i,t}$ is a dummy variable which equals to 1 when firm i is downgraded by either Standard & Poor's or Moody's in quarter t, and 0 otherwise. $Cohold_{i,f,t-2}$ is also a dummy variable that equals to 1 if firm i's bonds are cross-held in the same fund family f two quarters before the downgrade event, and 0 otherwise. For each event at quarter t, we use quarter $t-2$ as the reference because our event window also starts at this point. The vector $Z_{i,t+\tau}$ is a set of control variables used in Model I corresponding to Equation (1A).

[Insert Figure 5 and Figure 6 about here.]

The parameters of interest are β_τ and γ_τ. The former, β_τ, measures the overall trend of equity holding changes around the downgrading event, whereas the latter, γ_τ, measures the behavior of equity funds with cross-holding around the event. Figure 5 plots the holding changes during our event window

(two quarters before and after the downgrading event, $\tau \in [-2, 2]$). Panel (a) shows that when a firm is downgraded, the changes in equity holdings on average do not react actively until $\tau = 2$.

However, if the downgraded firm is also held by sister bond funds, the differentiating trend, γ, is significantly negative one quarter before the event and during the event quarter, with the estimated coefficients of -0.46 ($\tau = -1$) and -0.58 ($\tau = 0$) as shown in Panel (b) of the figure. The negative γ indicates that sister equity funds reduce their holdings one quarter in advance and continue reducing the holdings during the event quarter, but after the event, the holding position is not adjusted much. The combined findings of proactive adjustment in sister equity funds and no (not significant) adjustment in stand-alone equity funds confirm our information hypothesis that sister funds benefit from cross-asset internal information synergy.

A downgrade has the most profound influence when a firm is re-categorized from investment grade to speculative grade. This is because most institutional investors in the corporate bond market employ rating-based investment policies: some policies prevent the institution from holding speculative grades, others require the institution to make up the capital surplus by a significant margin. Thus, we repeat the above experiment with the subsample of this specific type of downgrades, and report the results in Figure 6. Both panels plot the cross-holding trend γ_τ, except Panel (a) focuses on downgrades within investment grades while Panel (b) focuses on downgrades from investment to speculative grade, also known as 'fallen angel' events.

When downgrades occur within investment grades, the equity holding changes of sister funds are negative one quarter before the event and during the event, but not significantly different from zero (Panel (a) of Figure 6). However, upon the fallen angel downgrade events, the reduction is much more pronounced, arguably because sister bond funds generate more significant amount of negative information. Panel (b) of Figure 6 displays that a quarter before the downgrade, sister equity funds reduce their holdings by 58%, which is greater than the average holding change of overall sister equity funds (46% in Figure 5, and they continue to reduce holdings by 87% more than the average equity funds during the downgrade quarter. These results indicate that equity funds learn best from their sister bond funds, which triggers their holding reductions.

In the second event, we consider negative earning surprises: firms announce negative earnings when the analysts make positive predictions by the nearest quarter. Since equity is a residual claim, equity

analysts and managers of equity funds are more likely to focus on firms' earnings than bond investors. In this scenario, bond funds may likely learn from their sister equity funds, a reverse case to the first event. We specify the regression equation similar to Equation (5):

$$\Delta H^{Bond}_{i,f,t+\tau} = \alpha_{f,t} + \beta_\tau \cdot \mathbb{N}_{i,t} + \gamma_\tau \cdot \mathbb{N}_{i,t} \cdot Cohold_{i,f,t-2} + \lambda_\tau \cdot Z_{i,t+\tau} + \varepsilon_{i,f,t+\tau}, \ \ \tau \in [-2, 2] \tag{6}$$

where $\Delta H^{Bond}_{i,f,t+\tau}$ is the percentage change in quantity of firm i's bonds held by fund family f during the quarter $t+\tau$. $Cohold_{i,f,t-2}$ is an indication variable that gives 1 if firm i's equity is cross-held by sister bond funds in fund family f at the inception of each negative earning surprise event window ($\tau = -2$), and $\mathbb{N}_{i,t}$ is a dummy variable which equals to 1 when firm i experiences negative earning surprise as defined above, otherwise 0. The vector $Z_{i,t+\tau}$ is the same set of control variables used in Model I, Equation (1A).

We find that one quarter before and during the negative earning surprise, the change in bond holdings on average increases though not significantly, probably in response to the analysts positive predictions (Panel (a) of Figure 7). However, if the event firm is also held by sister equity funds, the differentiating trend, γ, is significantly negative one quarter before the event till two quarters after the event quarter, as shown in Panel (b) of Figure 7. This event study suggests that bond funds can also learn and benefit from sister equity funds when the latter tends to have more information.

[Insert Figure 7 about here.]

V. Additional Tests

A. The Lead-Lag Cross-holding Relationship

Section III.A shows that the cross-holding relationship of sister funds is significant when cross-holding happens contemporaneously. In this subsection, we further examine whether the lagged equity (bond) holding changes co-move with sister bond (equity) funds' holding changes. This analysis has an implication on the speed of information flow across sister funds. When information is generated by, for example, an equity fund on a particular firm, it may take a significant amount of time for its sister bond fund to learn from it.

We repeat the main test with the lagged holding changes:

$$\Delta H_{i,f,t}^{Equity} = \alpha + \theta_0 \cdot \Delta H_{i,f,t}^{Bond} + \theta_1 \cdot \Delta H_{i,f,t-1}^{Bond} + \theta_2 \cdot \Delta H_{i,f,t-2}^{Bond} + \gamma \cdot Z_{i,t} + FE + \varepsilon_{i,f,t}, \tag{7}$$

where all variables are defined in Table 2 except having the lagged timing (quarter t-1 and t-2). The results in Table 6 show that information flows primarily at the contemporaneous base. Although the 1-quarter lagged holding changes exhibit statistical significance in some specifications, their economic magnitudes are negligible, $\theta_1 = 0.03$, compared to $\theta_0 = 0.62$ under the contemporaneous cross-holding relationship. Since the holding information is only available at the quarterly frequency, we can only observe the changes within the same quarter. It is possible that it takes less time for firm specific information flows across sister funds. However, our results provide a lower bound of information speed, illustrating that most communication happens within a quarter.

[Insert Table 6 about here.]

B. Factors Influencing Information Flow

In the earlier analyses, we control for the heterogeneity of firms and fund families by using time-varying firm characteristics and the firm/family fixed effects. It is also worth investigating what firm or fund family characteristics affects the cross-holding relationship of sister funds.

In this section, we first examine on what types of firms sister funds are more likely to share information. We repeat the regression in Equation (1A) with subsamples sliced by terciles of each of three firm characteristics: size, leverage, and book-to-market, while keeping the rest of two as control variables. Table 7 reports the results. We generally find that the cross-holding relationship becomes stronger if the holding firms have smaller size, lower leverage and lower book-to-market ratio. Alternatively speaking, sister funds are less likely to internally coordinate and benefit from such sharing when the underlying firms are big, heavily indebted and hold heavier asset (high book-to-market). Intuitively, information for such firms are more likely available to both shareholders and creditors, leaving little leeway for information synergy.

[Insert Table 7 and Table 8 about here.]

Second, we examine under what types of fund families sister funds are more likely to share infor-

mation. Following the literature of mutual fund families, we consider four fund family characteristics: size, expense ratio, management fee, and turnover ratio, where size is the total net assets summed across all funds while expense ratio, management fee, and turnover ratio is the average values across funds in a fund family weighted by funds net assets. For this test, we also construct subsamples sliced by terciles of each fund family characteristic and repeat the regression in Equation (1A) for each subsample. Results presented in Table 8 and they do not appear any noticeable patterns. Although the co-movement behavior is monotonically increasing with expense ratio, strong magnitudes appear in all terciles. For other characteristics, we do not observe a monotonic pattern.

VI. Discussion on Micro Channels for Information Sharing

In this subsection, we consider potential micro channels by which the information sharing across sister fund mangers may occur. Before any discussion, we first and foremost need to answer one question: is it legal for equity funds and bond funds to share information if they act best for the benefits of shareholders and creditors of the same underlying firm?[14]

A. Is There a Chinese Wall?

Individual mutual funds are organized as independent corporate entities overseen by boards and the directors (i.e., advisers) of mutual fund board hire service providers, including most importantly investment managers (Morley, 2014; Investment Company Institute, 2017). Generally speaking, fund managers and its advisers have fiduciary duties to each fund's investors, so in an abstract sense they should not be permitted to sacrifice the interests of one fund in order to benefit another. There is no statute or regulation prohibiting an adviser or a fund manager from sharing information across various funds. That said, information sharing can sometimes raise conflict of interest issues for which common law doctrines of fiduciary duty could hold an adviser/manager liable. As a practical matters, most advisers believe that the risk of an actual lawsuit is low, and they manage the risk mainly through internal procedures that ensure that conflicts of interest never become especially stark or

[14] We encountered this question from a premier investor in a series of interviews with market participants in the mutual fund industry. Without related knowledge, we consulted legal scholars on mutual fund governance. Statement presented in the next two paragraphs are collective insights from dialogues with John Morley from Yale Law School, Mark Roe from Harvard Law School, Ann Lipton from Tulane Law School, and William Birdthistle from Chicago Kent-College of Law.

publicly salient. Indeed, many advisers are comfortable using a single research outfit to serve all of their different funds.

Although legal commentators have pointed out and complained about these conflicts, they have never prevailed in forcing advisers to put in place different boards for each fund or different fund managers. Morley (2014) explains why fund investors are so willing to permit the conflicts an adviser faces when it simultaneously manages different funds. Mehran and Stulz (2007) also examines the economics of conflicts of interest in financial institutions and shows that investors can benefit from the existence of such conflicts. In the case of mutual fund, the organization structure of mutual fund families make board oversight of multiple funds within a fund complex an efficient and effective approach to governance.

In short, there is no Chinese wall between equity funds and bond funds within a mutual fund family. Advisers and managers of both types of funds should do fiduciary duty to their own fund investors, which is shareholders and creditors of commonly-held firms in the case of sister funds cross-holding. But such fiduciary duty does not mean that sister funds cannot share information.

B. Potential Information Sharing Channels

The economics literature on mutual funds has suggested that information sharing cross equity funds may result from common skills or resources shared by funds within the same family. The most supporting evidence is that equity funds in a family may share a common manager, and managers in a family may share information, opinions, and expertise with each other even if they manage different equity funds. We thus first examine this micro channel. If sister equity and corporate bond funds share common managers, then it is reasonable to observe the co-movement of holding changes of sister funds.

Contrary to such an expectation, we find only separated management teams for equity funds and bond funds in the same family. We collect the management team information for each fund under the fund families in our sample and manually check if any fund manger are shared among sister funds.[15] On average, there are a total of 4890 domestic equity funds per quarter in our sample and only 59

[15] Note that our primary analysis is conducted at the level of firm and fund family. Here to identify management team, we need to do it at the fund level.

funds share no more than two managers with sister bond funds, a ratio of 1.20%; there are a total of 638 domestic bond funds per quarter and 23 funds share one manager with sister equity funds, a ratio of 3.58%. Out of 137 fund families (on average per quarter), there are less than 10 fund families in which there is at least one pair of bond and equity sister fund sharing fund managers, in most cases only one manager is shared.

Overall, we find that it is common for fund managers to supervise homogenous assets, either equities or corporate bonds in a fund family, but uncommon for them to supervise heterogenous assets, equities and corporate bonds. Those funds sharing the same managers tend to belong to boutique fund families, which have a smaller number of funds and a smaller scale of management team. It is also worth noting that mega fund families such as BlackRock, Goldman Sachs, Fidelity, and JP Morgan, have completely separately management teams for equity funds and bond funds; there is not a single case that two types of funds share even one manager. These findings confirm what we have heard from Wall St. that there exists a large cultural gap between equity and bond funds.

Ruling out the common manager channel, we seek alternative interpretations. It is still likely that sister funds' managers access to the same pool of financial analysts, trading desks, legal counselors, and outside experts. But these channels should provide homogeneous information of the same underlying firm to managers of both equity funds and bond funds. Why do we still observe information synergy? One possibility is that managers of equity funds and bond funds may have different interpretation or sensitivity to the same information, and such difference lead to information synergy. In Section IV, we show that sister equity funds reduce holdings on firms to be downgraded one quarter in advance and during the event quarter. There we suggest that creditors are in particular sensitive to downside risk, hence mostly likely they collect more information or collect information in a more timely manner, thus their sister equity funds can benefit.

The second micro channel we conjecture is that when the physical locations of fund managers overlap, information sharing would be more active. However, most of our funds in the sample exhibit identical locations or locations with a close distance to each other (e.g., two locations in New York City) except for only a few cases where an equity fund is located in a completely different location from a bond fund (e.g., San Francisto versus New York City). Therefore, the fund level location does not allow us to conduct meaningful tests between those two types of cross holdings.

Additionally, one could think of other possible channels regarding fund managers' social connections. For example, fund managers of sister funds may have attended the same school at the same time or have worked together previously in the same fund. Furthermore, a fund family's compensation scheme can be another mechanism for information sharing. If a fund manager's compensation is partly determined by overall fund family's performance, this would incentivise managers of this fund family to share price relevant information with others (Evans, Prado, and Galacho, 2017). However, a formal analysis of these mechanisms is beyond the scope of this paper, leaving it to future research.

VII. Conclusion

In this paper, we investigate how different funds specialized in different asset classes interact when they are linked within the same fund family. We first document that there is a significant co-movement in investment decisions between equity and bond funds which cross-hold the same firm's assets and come from the same fund family. This fact can be interpreted in many different ways. One interpretation is that equity funds and bond funds holding the same underlying firms actively adjust their holdings in response to firm fundamentals, hence their holdings are correlated. Alternatively, one can argue that there is free riding on information generation for funds in the same family. Another interpretation suggests that equity funds and bond funds in the same family can share information internally and even synthesize their information on the same underlying firms to enhance profits. Our tests discriminate these explanations and demonstrate that such a co-movement is due to information sharing, in particular information synergy across asset classes through equity funds and bonds funds in the same fund family. Our findings provide a casual explanation for the recent phenomenon of mutual fund families trying to expand across multiple asset classes.

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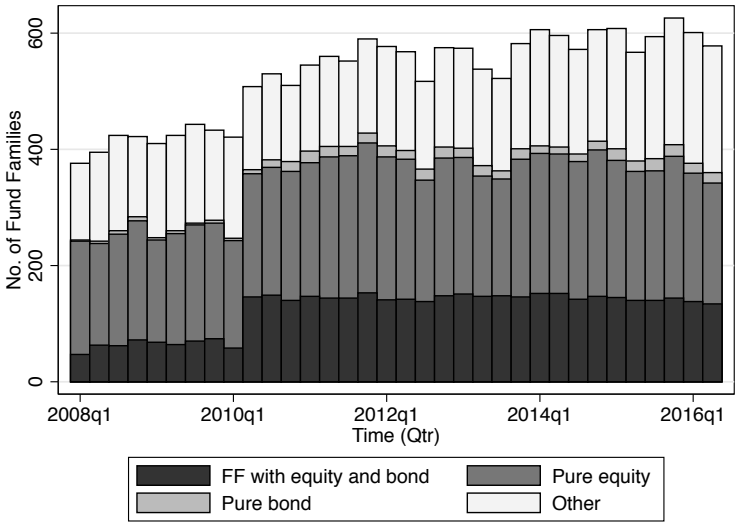
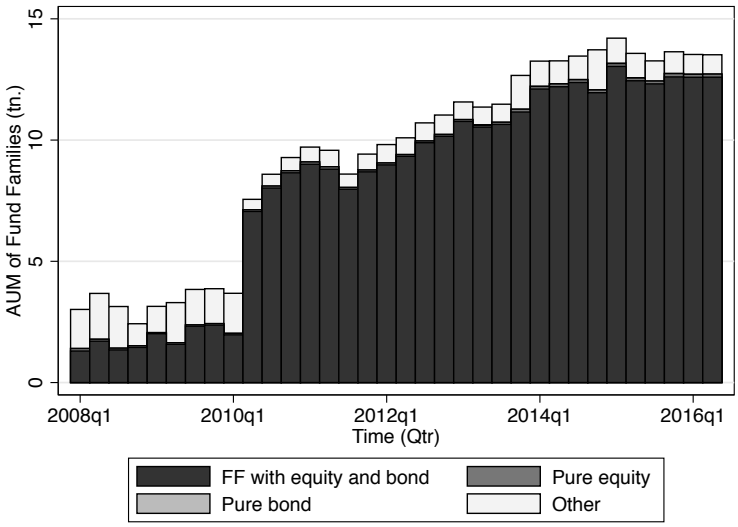
Figure 1. Overall Landscape of Mutual Fund Families

The figures show the number of fund families (panel a) and the value of assets under management of fund families (panel b) according to fund family structure. The sample contains the U.S. mutual fund families in the CRSP Mutual Fund database. We classify fund families into four categories: those with both equity funds and corporate bond funds, those with only equity funds (*Pure equity*), those with only corporate bond funds (*Pure bond*), and others combinations such as multiple asset-class funds or single asset-class funds other than equities and bonds. The sample period is from 2008Q1 to 2016Q2.



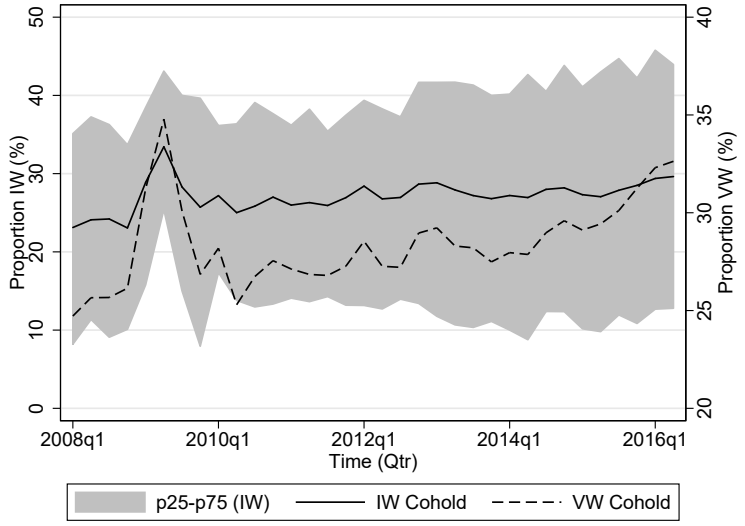
(a) Fund family count



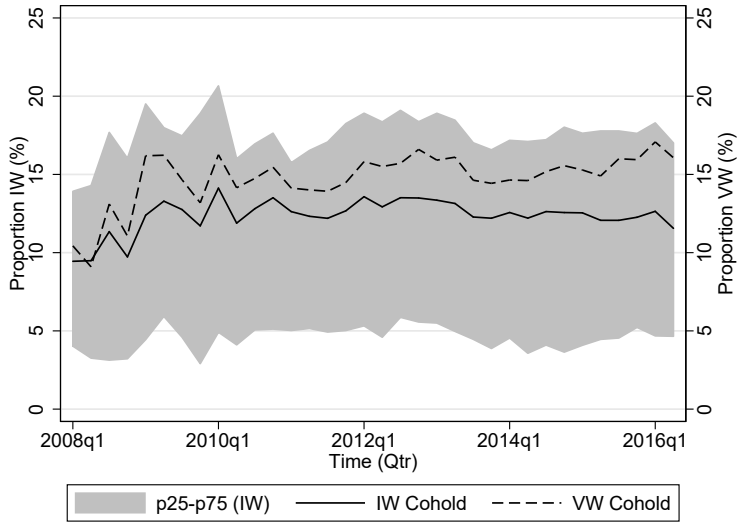
(b) Assets under management

Figure 2. Cross-Holding over Time

The figures show the time-series of two cross-holding measures: issuer-weighted (IW) and value-weighted (VW). The sample contains mutual fund families that contemporaneously have domestic equity funds and corporate bond funds holding assets issued by public firms. Panel (a) defines the measures from the perspective of corporate bond funds. For all bond funds in a fund family at a specific quarter, we count the unique number of firms in their holdings and calculate the proportion of firms whose equities are also held by sister equity funds in the same family, the issuer-weighted cross-holding measure, *IW Cohold*. We report the mean (the solid line) and the 25th to 75th percentile (the shade) across all fund families in each time point. The value-weighted cross-holding measure, *VW Cohold*, is defined in a similar way except using the market value of holdings (aggregate bond values at the firm level) instead of the number of firms. We report the mean value (the dashed line using the right y-axis) across all fund families over the sample period 2008Q1 to 2016Q2. Panel (b) employs the same method except that the ratio is defined from the perspective of equity funds. For example, the value-weighted cross-holding measure is the ratio of the market values of equities whose issuers' corporate bonds are co-held by sister bond funds in the same family to the total values of equities held by the fund family.



(a) Cross-holding from the perspective of corporate bond funds

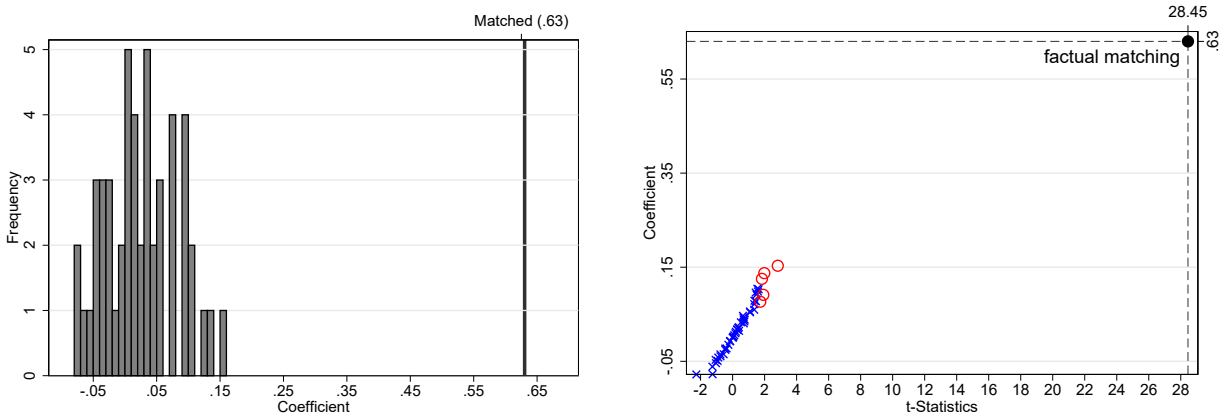


(b) Cross-holding from the perspective of equity funds

Figure 3. Simulated Coefficients from Random Matching

The figures compares the cross-holding relationship of sister funds and that of stand-alone funds. Sister funds are equity funds and corporate bond funds holding the same firm's equities and bonds and coming from the same mutual fund family. Stand-alone funds are equity funds and bond funds holding the same firm's assets but coming from different fund families. The cross-holding relationship of sister funds is examined in Equation (1A) and (1B); and that of stand-alone funds is examined in Equation (2A) and (2B). Panel (a) presents the histogram distribution of estimated coefficients θ' and their t-statistics in Equation (2A) with specification (1) in Table 2. We estimate θ' from 50 random matching across stand-alone funds. For reference, we also present the estimate of θ (vertical line) and its t-statistic (solid black dot "•") in the matched sample. Panel (b) presents the same information for Equation (2B)) which consider the equity→bond relationship. In the t-stat figures, the "○" (red) markers indicate estimated coefficients with at least 10% significance and the "×" (blue) markers indicate those with weaker than 10% significance.

(a) Dependent Variable: ΔH^{Equity}



(b) Dependent Variable: ΔH^{Bond}

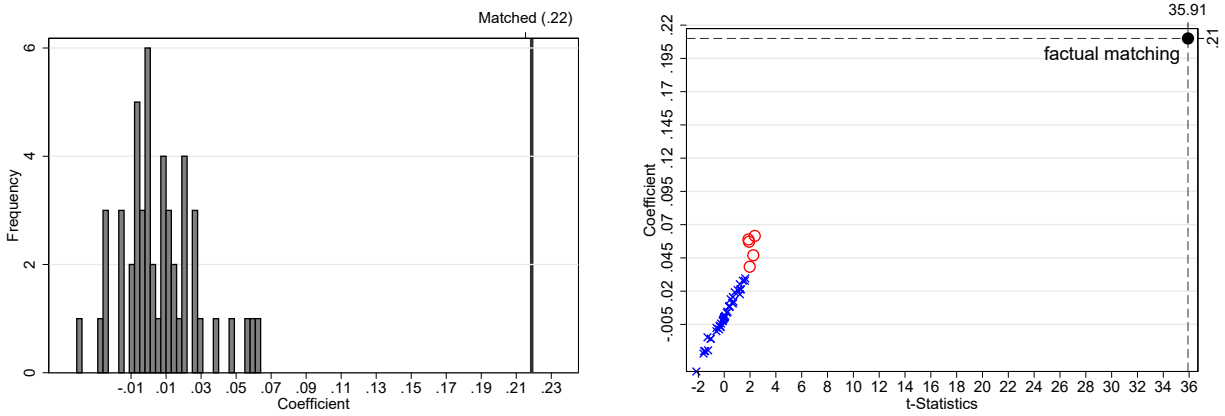


Figure 4. Propensity of Profit-Generating Position Adjustment

This figure shows the propensity of profit-generating position adjustment under different cross-holding timing τ:

$$PROFIT_{i,f,t} = \alpha_\tau + \beta_\tau \cdot Cohold_{i,f,t-\tau} + FE + \varepsilon_{i,f,t},$$

where $PROFIT_{i,f,t}$ is an indication variable that is equal to 1 if the equity funds of fund family f makes a profit at the end of quarter t based on the position adjustment of firm i's equity holdings during quarter t-τ which is before the return realization in quarter t, otherwise 0. Expressed in formula, $PROFIT_{i,f,t} = 1$ if $s(\Delta H_{i,f,t-\tau}) \cdot s(r_{i,t}) > 0$, where $r_{i,t}$ is the equity return of firm i in quarter t and $s(\cdot)$ denotes the sign function. If $\Delta H_{i,f,t-\tau} > 0$, then $s(\Delta H_{i,f,t-\tau}) > 0$. The profit-generating position adjustment implies that an equity fund reduces (increases) its holding τ-quarter before the equity experiences a negative (positive) return, see the illustration in Panel (a) of Table 4. $Cohold_{i,f,t-\tau}$ is an indicator that is equal to 1 if the firm i's bonds are held by sister bond funds in fund family f during the quarter t-τ, otherwise 0. We use the two-way firm and time fixed effect. Each point in the figure shows the estimated coefficient β_τ and the shade covers 90% confidence interval. In particular, $\tau = 1$ relates to the result in Column (3) of Table 4.

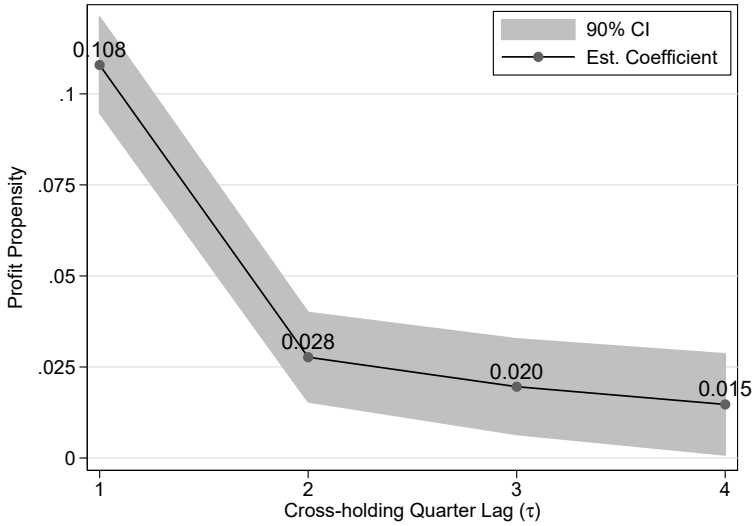
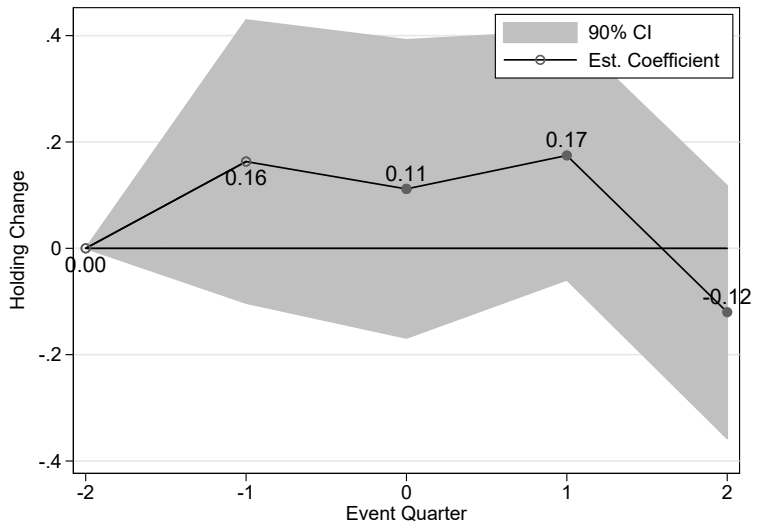


Figure 5. Equity Holding Change around Firms' Downgrading

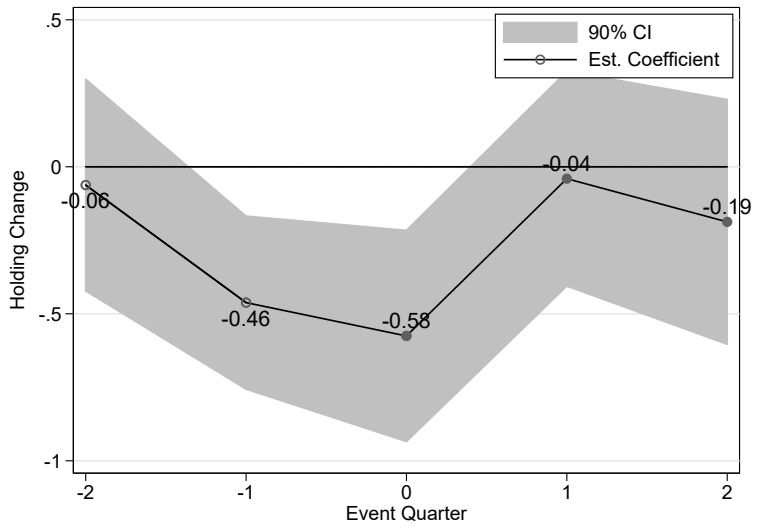
The figures present how the decision on equity holding has changed two quarters before and after a firm's downgrading in regression (5):

$$\Delta H^{Equity}_{i,f,t+\tau} = \alpha_{f,t} + \beta_\tau \cdot \mathbb{D}_{i,t} + \gamma_\tau \cdot \mathbb{D}_{i,t} \cdot Cohold_{i,f,t-2} + \lambda_\tau \cdot Z_{i,t+\tau} + \varepsilon_{i,f,t+\tau}, \ \ \tau \in [-2, 2],$$

where $\Delta H^{Equity}_{i,f,t+\tau}$ is the percentage change in quantity (number of shares) of firm i's equities held by fund family f during the quarter $t+\tau$. $Cohold_{i,f,t-2}$ is an indication variable that gives 1 if firm i's bonds are co-held by sister bond funds in fund family f at the inception of each downgrading event window ($\tau = -2$). $\alpha_{f,t}$ is the two-way fund family $\times$ time (quarter) fixed effect. $\mathbb{D}_{i,t}$ is an event-time dummy variable. $Z_{i,t+\tau}$ is a vector of issuer-level control variables including firm size (defined as the logarithm of total assets), leverage (defined as the ratio of total debt to the sum of total debt and market value of equity), book-to-market ratio, and industry fixed effect (the first 2-digit of SIC code). Standard errors are clustered at the fund family level. Panel (a) displays the overall trend, β_τ, with 90% confidence interval, and Panel (b) displays the differential cross-holding trend, γ_τ, with 90% confidence interval.



(a) Overall Trend (β_τ)



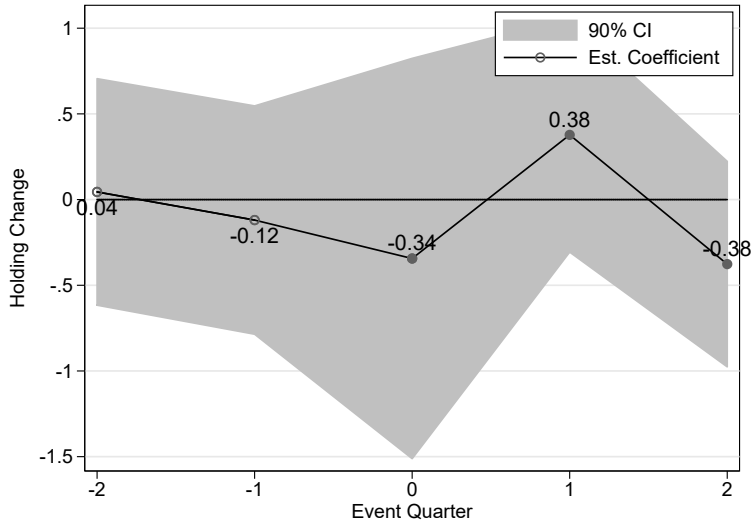
(b) Differential Cross-holding Trend (γ_τ)

Figure 6. Equity Holding Change around Firms' Downgrading by Downgrading Type

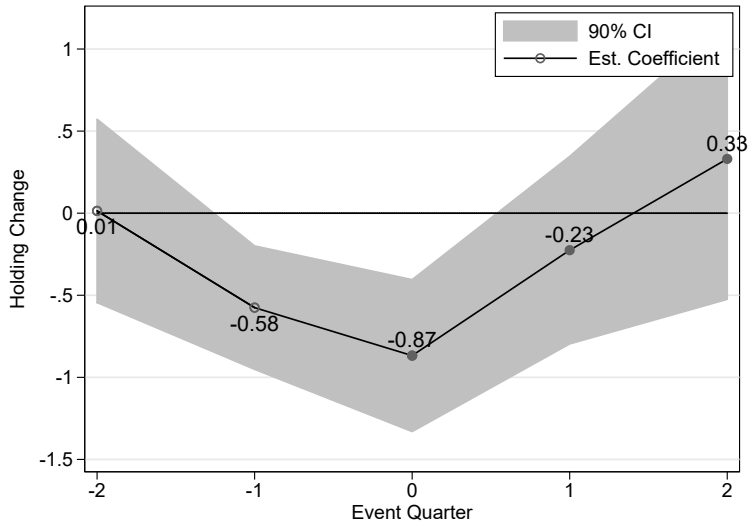
In this figure, we repeat the experiment in Figure 5 except refining the test by consider two types of downgrading events. Panel (a) shows the results for downgrading within investment grade. Panel (b) shows the results for downgrading from investment grade to speculative grade. Both panels display the differential cross-holding trend, γ_τ, with 90% confidence interval, which is estimated in the regression:

$$\Delta H^{Equity}_{i,f,t+\tau} = \alpha_{f,t} + \beta_\tau \cdot \mathbb{D}_{i,t} + \gamma_\tau \cdot \mathbb{D}_{i,t} \cdot Cohold_{i,f,t-2} + \lambda_\tau \cdot Z_{i,t+\tau} + \varepsilon_{i,f,t+\tau}, \ \ \tau \in [-2, 2].$$

Here $\Delta H^{Equity}_{i,f,t+\tau}$ is the percentage change in quantity (number of shares) of firm i's equities held by fund family f during the quarter $t+\tau$. $Cohold_{i,f,t-2}$ is an indication variable that gives 1 if firm i's bonds are co-held by sister bond funds in fund family f at the inception of each downgrading event window ($\tau = -2$). $\alpha_{f,t}$ is the two-way fund family $\times$ time (quarter) fixed effect. $\mathbb{D}_{i,t}$ is an event-time dummy variable. $Z_{i,t+\tau}$ is a vector of issuer-level control variables including firm size (defined as the logarithm of total assets), leverage (defined as the ratio of total debt to the sum of total debt and market value of equity), book-to-market ratio, and industry fixed effect (the first 2-digit of SIC code). Standard errors are clustered at the fund family level.



(a) Downgrade within Investment Grade (γ_τ)



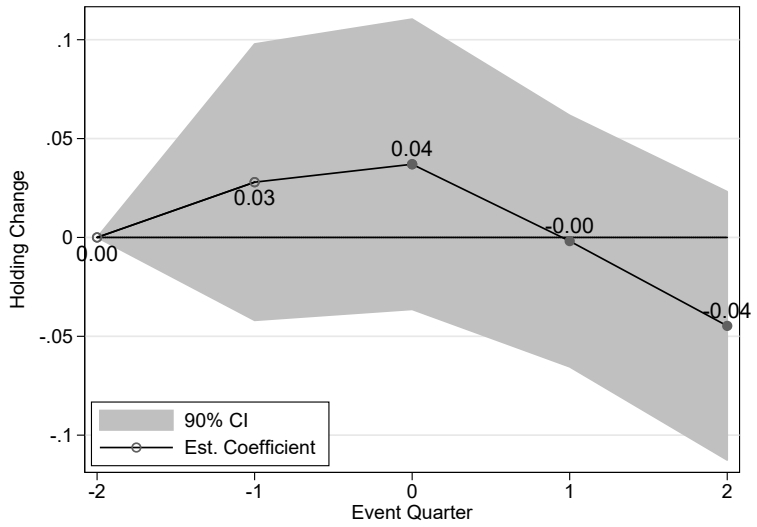
(b) Downgrade from Investment Grade to Speculative Grade (γ_τ)

Figure 7. Bond Holding Change around Firms' Negative Earning Surprise

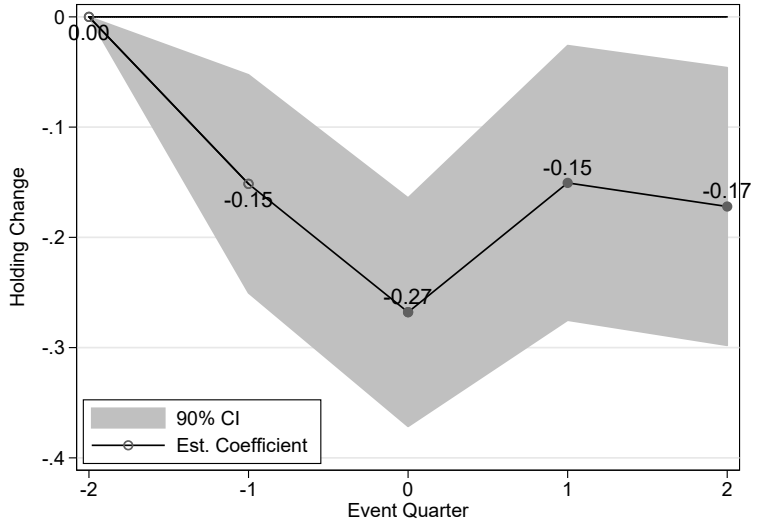
The figures present how the decision on bond holding has changed two quarters before and after a firm's negative earning surprise, as specified in Equation (6).

$$\Delta H^{Bond}_{i,f,t+\tau} = \alpha_{f,t} + \beta_\tau \cdot \mathbb{N}_{i,t} + \gamma_\tau \cdot \mathbb{N}_{i,t} \cdot Cohold_{i,f,t-2} + \lambda_\tau \cdot Z_{i,t+\tau} + \varepsilon_{i,f,t+\tau}, \ \tau \in [-2, 2],$$

where $\Delta H^{Bond}_{i,f,t+\tau}$ is the percentage change in quantity of firm i's bonds held by fund family f during the quarter $t+\tau$. $Cohold_{i,f,t-2}$ is an indication variable that gives 1 if firm i's equity is cross-held by sister bond funds in fund family f at the inception of each negative earning surprise event window ($\tau = -2$). Negative earning surprise events refer to situations in which a firm announces negative earning (EPS) while a positive earning is expected by the most recent analysts' forecasts. $\alpha_{f,t}$ is the two-way fund family × time (quarter) fixed effect. $\mathbb{N}_{i,t}$ is an event-time dummy variable. $Z_{i,t+\tau}$ is a vector of issuer-level control variables including firm size (defined as the logarithm of total assets), leverage (defined as the ratio of total debt to the sum of total debt and market value of equity), book-to-market ratio, and industry fixed effect (the first 2-digit of SIC code). Standard errors are clustered at the fund family level. Panel (a) displays the overall trend, β_τ, with 90% confidence interval and Panel (b) displays the differential cross-holding trend, γ_τ, with 90% confidence interval.



(a) Overall Trend (β_τ)



(b) Differential Cross-holding Trend (γ_τ)

Table 1. Summary Statistics

This table presents summary statistics for funding families in Panel A and for main variables in Panel B. The universe of fund families (FF) reported in this table are those with both equity funds and corporate bond funds in the CRSP Mutual Fund database from 2008Q1 to 2016Q2. Panel A counts the number of equity funds or corporate bond funds per fund family, the number of issuers and the market value of holding assets in equity or bond funds per fund family at each quarter, then reports their distribution over the whole sample. Panel B reports the distribution of variables related to investment decision. First, $H^{Equity}_{i,f,t}$ is the market value of firm i's equities held by fund family f scaled by the total assets under management of the fund family at quarter t, $H^{Bond}_{i,f,t}$ is the market value of firm i's corporate bonds held by fund family f scaled by the total assets under management of the fund family at quarter t Second, $\Delta H^{Equity}_{i,f,t}$ is the percentage change in quantity (number of shares) of firm i's equities held by fund family f during the quarter t, $\Delta H^{Bond}_{i,f,t}$ is the percentage change in quantity (number of shares) of firm i's corporate bonds held by fund family f during the quarter t. Also the panel includes the market value of holdings per firm and the total holdings for each fund family, as well as the distribution of firm characteristics such as size (total assets in billion dollars), leverage (total debt/ total asset), book-to-market.

	Mean	SD	p10	p25	p50	p75	p90
Panel A: *Fund Family × Qtr. level*							
Num of equity funds per FF	11.3	13.0	2.0	4.0	8.0	15.0	23.0
Num of bond funds per FF	2.0	1.4	1.0	1.0	1.0	2.0	4.0
AUM in equity funds per FF (bn.$)	12.1	36.6	0.1	0.3	2.3	8.9	20.9
AUM in bond funds per FF (bn.$)	1.0	2.5	0.0	0.0	0.2	0.8	2.4
Num of issuers in equity funds per FF	249	185	46	90	208	371	526
Num of issuers in bond funds per FF	106	83	23	39	79	156	228
Panel B: *Fund Family × Firm × Qtr. level*							
ΔH^{Equity} (%)	28.07	118.90	-68.35	-22.30	0.00	20.93	141.01
ΔH^{Bond} (%)	5.15	63.12	-66.67	-12.58	0.00	0.00	83.86
H^{Equity} (%)	0.92	3.26	0.00	0.00	0.06	0.50	2.17
H^{Bond} (%)	0.19	1.60	0.00	0.00	0.00	0.02	0.24
Firm AUM in FF (mn.$)	41.44	215.23	0.16	0.79	4.12	19.43	74.07
Firm size (bn.$)	62.29	226.33	1.81	4.02	10.54	34.73	104.60
Firm leverage	0.31	0.20	0.09	0.16	0.27	0.43	0.61
Firm book-to-market ratio	0.53	8.79	0.14	0.29	0.51	0.85	1.22

Table 2. The Dynamic Holding Relationship for Sister Funds

This table presents the dynamic holding relationship for sister funds. Sister funds are equity funds and corporate bond funds holding the same firm's equities and corporate bonds and coming from the same mutual fund family. Panel (a) shows the estimation results of Equation (1A):

$$\Delta H_{i,f,t}^{Equity} = \alpha + \theta \cdot \Delta H_{i,f,t}^{Bond} + \gamma \cdot Z_{i,t} + FE + \varepsilon_{i,f,t}$$

where $\Delta H_{i,f,t}^{Equity}$ is the percentage change in quantity (number of shares) of firm i's equities held by fund family f during the quarter t, $\Delta H_{i,f,t}^{Bond}$ is the percentage change in quantity (number of shares) of firm i's corporate bonds held by fund family f during the quarter t, and $Z_{i,t}$ is a vector of firm-level control variables including firm size (defined as the logarithm of total assets), leverage (defined as the ratio of total debt to the sum of total debt and market value of equity), and book-to-market ratio. The industry fixed effect is defined by the first 2-digit of SIC code. Panel (b) shows the estimation results of Equation (1B). Standard errors are clustered at the fund family level and t-statistics are shown in parentheses with the significance at the 1% (***), 5% (**), and 10% (*) levels.

(a) Dependent Variable: ΔH^{Equity}

	(1)	(2)	(3)	(4)	(5)	(6)
ΔH^{Bond}	0.626***	0.621***	0.622***	0.594***	0.595***	0.597***
	(28.68)	(30.12)	(30.13)	(28.41)	(28.38)	(28.13)
Log(Asset)	0.008	0.010*	0.009	0.011*	0.010	0.027
	(1.60)	(1.86)	(1.42)	(1.96)	(1.48)	(1.38)
Leverage	-0.188***	-0.205***	-0.192***	-0.198***	-0.181***	-0.197***
	(-5.94)	(-6.12)	(-5.81)	(-5.78)	(-5.38)	(-4.78)
Book/Mkt	0.001***	0.001***	0.001***	0.002***	0.002***	0.001***
	(3.62)	(3.38)	(3.05)	(7.76)	(6.55)	(9.03)
Fund Family FE	Y	Y	Y	N	N	N
Time FE	N	Y	Y	N	N	N
Fund Family x Time FE	N	N	N	Y	Y	Y
Industry FE	N	N	Y	N	Y	N
Firm FE	N	N	N	N	N	Y
N.Obs	104,399	104,399	104,399	104,399	104,399	104,399
R-squared	0.145	0.150	0.150	0.201	0.201	0.203

(b) Dependent Variable: ΔH^{Bond}

	(1)	(2)	(3)	(4)	(5)	(6)
ΔH^{Equity}	0.218***	0.216***	0.216***	0.193***	0.193***	0.192***
	(35.74)	(36.35)	(36.44)	(32.45)	(32.42)	(32.52)
Log(Asset)	0.010***	0.010***	0.013***	0.012***	0.015***	0.071***
	(3.37)	(3.34)	(3.47)	(4.45)	(4.49)	(5.22)
Leverage	0.161***	0.161***	0.159***	0.145***	0.144***	0.058**
	(7.12)	(6.75)	(7.36)	(6.13)	(6.49)	(2.08)
Book/Mkt	-0.000	-0.000	-0.000	-0.001**	-0.001**	-0.001***
	(-0.75)	(-0.86)	(-0.97)	(-2.25)	(-2.53)	(-2.82)
Fund Family FE	Y	Y	Y	N	N	N
Time FE	N	Y	Y	N	N	N
Fund Family x Time FE	N	N	N	Y	Y	Y
Industry FE	N	N	Y	N	Y	N
Firm FE	N	N	N	N	N	Y
N.Obs	104,399	104,399	104,399	104,399	104,399	104,399
R-squared	0.148	0.155	0.157	0.257	0.259	0.265

Table 3. The Dynamic Holding Relationship within Counter-Factual Fund Families

This table presents the dynamic holding relationship for stand-alone funds, which are equity funds and bond funds holding the same firm's equities and bonds but coming from different mutual fund families. Panel (a)-(d) show the estimation results of Equation (2A):

$$\Delta H_{i,f,t}^{Equity} = \alpha' + \theta' \cdot \Delta H_{i,f',t}^{Bond} + \gamma' \cdot Z_{i,t} + FE + \varepsilon_{i,f,t},$$

where $\Delta H_{i,f,t}^{Equity}$ is the percentage change in quantity (number of shares) of firm i's equities held by fund family f during the quarter t, $\Delta H_{i,f',t}^{Bond}$ is the percentage change in quantity of firm i's corporate bonds held by randomly matched fund family f' ($f \neq f'$) during the quarter t, and $Z_{i,t}$ is a vector of firm-level control variables including firm size (the logarithm of total assets), leverage (the ratio of total debt to the sum of total debt and market value of equities), and book-to-market ratio. The industry fixed effect is defined by the first 2-digit of SIC code. Each panel employs different criteria for $f - f'$ matching. Panel (a) does not use any criteria, hence contains all possible matching. Panel (b) contains $f - f'$ matching only when f and f' are in the same logarithm-asset-size quintile. Panel (c) matches conditioning that f and f''s fund family characteristic (value-weighted expense ratio, turnover, and management fee across funds) are in the same quintile. Panel (d) matches $f - f'$ with size and characteristic. Robust standard errors are used and t-statistics are shown in parentheses with the significance at the 1% (***), 5% (**), and 10% (*) levels.

(a) Unconditional Matching

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta H_{f'}^{Bond}$	0.019***	0.026***	0.018***	0.025***	0.021***	0.027***
	(3.30)	(4.70)	(3.20)	(4.62)	(3.92)	(5.07)
Log(Asset)	-0.020***	-0.022***	-0.022***	-0.025***	-0.091***	-0.002
	(-10.14)	(-11.00)	(-7.27)	(-8.29)	(-4.06)	(-0.08)
Leverage	-0.086***	-0.064***	0.040	0.064**	0.255***	0.368***
	(-4.22)	(-3.20)	(1.36)	(2.17)	(3.64)	(5.25)
Book/Mkt	0.079***	0.074***	0.060***	0.052***	0.015	-0.042***
	(9.84)	(9.13)	(6.15)	(5.34)	(1.18)	(-3.33)
Time FE	N	Y	N	N	N	N
Industry FE	N	N	Y	N	N	N
Industry x Time FE	N	N	N	Y	N	N
Firm FE	N	N	N	N	Y	N
Firm x Time FE	N	N	N	N	N	Y
N.Obs	68,922	68,922	68,922	68,922	68,922	68,922
R-squared	0.003	0.027	0.020	0.044	0.109	0.136

(b) Size-Conditioned Matching

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta H^{Bond}\_f'$	0.020**	0.029***	0.019*	0.028***	0.023**	0.031***
	(1.98)	(2.83)	(1.90)	(2.77)	(2.36)	(3.16)
Log(Asset)	-0.020***	-0.022***	-0.023***	-0.025***	-0.086**	0.032
	(-5.43)	(-5.73)	(-3.99)	(-4.42)	(-2.02)	(0.70)
Leverage	-0.095**	-0.073*	0.044	0.069	0.254*	0.366**
	(-2.41)	(-1.88)	(0.79)	(1.26)	(1.78)	(2.56)
Book/Mkt	0.083***	0.077***	0.069***	0.061***	0.029	-0.038
	(5.15)	(4.77)	(3.49)	(3.07)	(1.13)	(-1.49)
Time FE	N	Y	N	N	N	N
Industry FE	N	N	Y	N	N	N
Industry x Time FE	N	N	N	Y	N	N
Firm FE	N	N	N	N	Y	N
Firm x Time FE	N	N	N	N	N	Y
N.Obs	19,477	19,477	19,477	19,477	19,477	19,477
R-squared	0.003	0.026	0.023	0.046	0.102	0.129

(c) Characteristic-Conditioned Matching

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta H_{f'}^{Bond}$	0.022	0.031	0.026	0.036	0.042	0.046
	(0.74)	(1.08)	(0.86)	(1.25)	(1.35)	(1.52)
Log(Asset)	-0.027**	-0.023**	-0.030	-0.029	0.009	0.096
	(-2.32)	(-1.97)	(-1.57)	(-1.48)	(0.07)	(0.63)
Leverage	-0.233**	-0.239**	-0.134	-0.121	-0.140	-0.047
	(-2.27)	(-2.37)	(-0.91)	(-0.82)	(-0.29)	(-0.09)
Book/Mkt	0.159***	0.150***	0.162***	0.154***	0.131	0.057
	(3.77)	(3.46)	(3.27)	(3.00)	(1.51)	(0.64)
Time FE	N	Y	N	N	N	N
Industry FE	N	N	Y	N	N	N
Industry x Time FE	N	N	N	Y	N	N
Firm FE	N	N	N	N	Y	N
Firm x Time FE	N	N	N	N	N	Y
N.Obs	2,183	2,183	2,183	2,183	2,183	2,183
R-squared	0.009	0.030	0.007	0.030	0.062	0.089

(d) Size×Characteristic-Conditioned Matching

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta H_{f'}^{Bond}$	0.026	0.036	0.031	0.043	0.052	0.057*
	(0.80)	(1.13)	(0.95)	(1.33)	(1.54)	(1.73)
Log(Asset)	-0.026**	-0.020*	-0.030	-0.026	-0.020	0.120
	(-2.15)	(-1.67)	(-1.49)	(-1.26)	(-0.15)	(0.77)
Leverage	-0.259**	-0.264**	-0.169	-0.159	-0.051	-0.065
	(-2.41)	(-2.47)	(-1.11)	(-1.03)	(-0.10)	(-0.12)
Book/Mkt	0.171***	0.151***	0.179***	0.157***	0.129	0.024
	(3.67)	(3.18)	(3.25)	(2.79)	(1.40)	(0.25)
Time FE	N	Y	N	N	N	N
Industry FE	N	N	Y	N	N	N
Industry x Time FE	N	N	N	Y	N	N
Firm FE	N	N	N	N	Y	N
Firm x Time FE	N	N	N	N	N	Y
N.Obs	2,020	2,020	2,020	2,020	2,020	2,020
R-squared	0.009	0.028	0.008	0.028	0.071	0.097

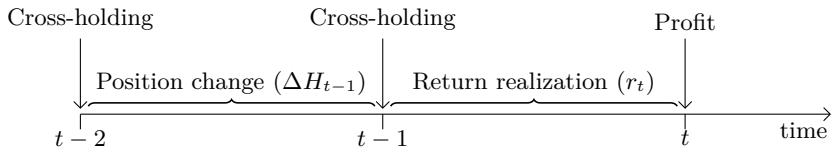
Table 4. Profit From Cross-Holding

This table presents the estimation results of Equation (3):

$$PROFIT_{i,f,t} = \alpha + \beta \cdot Cohold_{i,f,t-1} + FE + \varepsilon_{i,f,t},$$

where $PROFIT_{i,f,t}$ is an indication variable that is equal to 1 if the equity funds of fund family f make profits at the end of quarter t based on the position adjustment of equity holdings on firm i during the quarter t-1 which is before the return realization in quarter t, otherwise 0. Expressed in formula, $PROFIT_{i,f,t} = 1$ if $s(\Delta H_{i,f,t-1}) \cdot s(r_{i,t}) = 1$, where $r_{i,t}$ is the equity return of firm i in quarter t and $s(\cdot)$ denotes the sign function that assigns 1 to a positive number and -1 to a negative number. If $\Delta H_{i,f,t-1} > 0$, then $s(\Delta H_{i,f,t-1}) = 1$, otherwise -1. The profit-generating position adjustment implies that an equity fund reduces (increases) its holdings before the equity experiences a negative (positive) return. $Cohold_{i,f,t-1}$ is a dummy variable that is equal to 1 if firm i's bonds are held by sister bond funds in fund family f during the quarter t-1, otherwise 0. Panel (a) shows the timeline of the variable construction. Panel (b) presents the regression results. Columns (1)-(4) use the OLS model with different sets of fixed effects, while Column (5) shows the conditional marginal effect from the logit model with the firm×time fixed effect. Standard errors are clustered at the fund family level. t-statistics (z-statistics) are shown in parentheses for the OLS (Logit) model with significance at the 1% (***), 5% (**), and 10% (*) levels. For the Logit model, pseudo R-squared is reported.

(a) Timeline of Variable Construction



(b) Regression Results

	(1)	(2)	(3)	(4)	(5)
$Cohold_{t-1}$=1	0.111***	0.094***	0.108***	0.090***	0.116***
	(14.85)	(13.80)	(13.57)	(12.69)	(56.96)
Firm FE	Y	Y	N	N	N
Time FE	Y	Y	N	N	N
Fund Family FE	N	Y	N	Y	N
Firm x Time FE	N	N	Y	Y	Y
Model	OLS	OLS	OLS	OLS	Logit
N.Obs	645,657	645,657	572,330	572,330	572,330
R-squared	0.081	0.108	0.090	0.117	0.046

Table 5. Future Return Prediction from Cross-Holding

This table examines whether the changes of bond holdings by sister funds and/or stand-alone funds help predict a firm's future equity returns in the following regression:

$$Return_{i,t+1} = \alpha_i + \alpha_t + \theta_{XH} \cdot \Delta\bar{H}^{Bond}_{i,f\in XH,t} + \theta_{SA} \cdot \Delta\bar{H}^{Bond}_{i,f\in SA,t} + \gamma \cdot Z_{i,t} + \varepsilon_{i,t},$$

where $Return_{i,t+1}$ is the firm i's one-quarter ahead equity return. $\Delta\bar{H}^{Bond}_{i,f\in XH,t}$ is the average percentage change in quantity (number of shares) of firm i's bonds held by fund families which contain sister equity funds cross-holding firm i's equities. We denote such fund families as cross-holding fund families with sister funds, XH. $\Delta\bar{H}^{Bond}_{i,f\in SA,t}$ is the average percentage change of firm i's bond shares held by fund families which contain stand-alone equity funds also holding firm i's equities. We denote these fund families as fund families with stand-alone funds, SA. Specifically, $\Delta\bar{H}^{Bond}_{i,f\in XH,t} = \frac{1}{n_{XH}}\sum_{f\in XH}(\Delta H^{Bond}_{i,f,t})$ and $\Delta\bar{H}^{Bond}_{i,f\in SA,t} = \frac{1}{n_{SA}}\sum_{f\in SA}(\Delta H^{Bond}_{i,f,t})$, where n_{XH} or n_{SA} is the number of fund families in corresponding sets. α_i and α_t refers to the firm and time fixed effect, respectively, and $Z_{i,t}$ is a vector of firm-level control variables including firm size (the logarithm of total assets), leverage (the ratio of total debt to the sum of total debt and market value of equities), and book-to-market ratio. Standard errors are clustered at the fund family level and t-statistics are shown in parentheses with the significance at the 1% (***), 5% (**), and 10% (*) levels. Each column corresponds to the result based on the cross-holding intensity across fund families which is measured by the number of cross-holding fund families, n_{XH}.

	(1) $n_{XH} > 0$	(2) $n_{XH} > 1$	(3) $n_{XH} > 10$
$\Delta\bar{H}^{Bond}_{f\in XH}$	0.013**	0.016**	0.037**
	(2.43)	(2.45)	(2.32)
$\Delta\bar{H}^{Bond}_{f\in SA}$	0.003	0.005	0.017
	(0.64)	(0.97)	(1.44)
Log(Asset)	-0.001	-0.014	0.000
	(-0.12)	(-0.99)	(0.02)
Leverage	-0.319***	-0.305***	-0.377***
	(-7.22)	(-6.26)	(-4.25)
Book/Mkt	-0.022***	-0.022***	-0.031*
	(-2.90)	(-2.87)	(-1.67)
Firm FE	Y	Y	Y
Time FE	Y	Y	Y
N.Obs	10,204	8,718	1,935
R-squared	0.322	0.311	0.351

Table 6. The Lead-Lag Dynamic Holding Relationship for Sister Funds

This table presents the dynamic holding relationship for sister funds with lagged holding changes. Sister funds are equity funds and bond funds holding the same firm's equities and bonds and coming from the same mutual fund family. Panel (a) shows the estimation results of the following equation:

$$\Delta H^{Equity}_{i,f,t} = \alpha + \theta_0 \cdot \Delta H^{Bond}_{i,f,t} + \theta_1 \cdot \Delta H^{Bond}_{i,f,t-1} + \theta_2 \cdot \Delta H^{Bond}_{i,f,t-2} + \gamma \cdot Z_{i,t} + FE + \varepsilon_{i,f,t}.$$

where all variables are defined in Table 2 except having the lagged timing (quarter $t-1$ and $t-2$). Panel (b) shows the estimation results of the same equation with the dependent and primary independent variables switched. Standard errors are clustered at the fund family level and t-statistics are shown in parentheses with the significance at the 1% (***), 5% (**), and 10% (*) levels.

(a) Dependent Variable: ΔH^{Equity}

	(1)	(2)	(3)	(4)	(5)	(6)
ΔH^{Bond}_{t}	0.660***	0.653***	0.655***	0.622***	0.623***	0.626***
	(27.67)	(29.39)	(29.42)	(26.13)	(26.13)	(25.71)
ΔH^{Bond}_{t-1}	0.009	0.010	0.010	0.034***	0.034***	0.034***
	(0.71)	(0.82)	(0.83)	(3.60)	(3.59)	(3.54)
ΔH^{Bond}_{t-2}	0.008	0.007	0.007	-0.004	-0.003	-0.003
	(0.88)	(0.90)	(0.93)	(-0.53)	(-0.50)	(-0.45)
Log(Asset)	0.006	0.007	0.007	0.006	0.005	-0.002
	(1.37)	(1.43)	(1.13)	(1.13)	(0.82)	(-0.07)
Leverage	-0.173***	-0.174***	-0.158***	-0.159***	-0.137***	-0.107*
	(-5.65)	(-5.54)	(-4.56)	(-4.90)	(-3.89)	(-1.88)
Book/Mkt	0.004**	0.003*	0.004***	0.004**	0.005***	0.003
	(2.25)	(1.86)	(3.12)	(2.40)	(2.95)	(1.26)
Fund Family FE	Y	Y	Y	N	N	N
Time FE	N	Y	Y	N	N	N
Fund Family x Time FE	N	N	N	Y	Y	Y
Industry FE	N	N	Y	N	Y	N
Firm FE	N	N	N	N	N	Y
N.Obs	69,745	69,745	69,745	69,745	69,745	69,745
R-squared	0.157	0.163	0.164	0.215	0.216	0.218

(b) Dependent Variable: ΔH^{Bond}

	(1)	(2)	(3)	(4)	(5)	(6)
ΔH^{Equity}_{t}	0.245***	0.242***	0.242***	0.212***	0.211***	0.211***
	(27.40)	(27.40)	(27.49)	(23.67)	(23.65)	(23.69)
ΔH^{Equity}_{t-1}	-0.011***	-0.009***	-0.009**	-0.003	-0.003	-0.003
	(-2.72)	(-2.68)	(-2.60)	(-1.61)	(-1.59)	(-1.45)
ΔH^{Equity}_{t-2}	0.001	0.001	0.001	0.000	0.001	0.001
	(0.17)	(0.22)	(0.32)	(0.20)	(0.39)	(0.55)
Log(Asset)	0.011***	0.011***	0.014***	0.011***	0.015***	0.092***
	(3.49)	(3.58)	(3.43)	(4.03)	(4.15)	(4.78)
Leverage	0.161***	0.156***	0.162***	0.145***	0.150***	0.097**
	(5.79)	(5.50)	(5.74)	(5.21)	(5.33)	(2.59)
Book/Mkt	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***	-0.001***
	(-4.77)	(-6.21)	(-6.05)	(-7.40)	(-7.43)	(-6.36)
Fund Family FE	Y	Y	Y	N	N	N
Time FE	N	Y	Y	N	N	N
Fund Family x Time FE	N	N	N	Y	Y	Y
Industry FE	N	N	Y	N	Y	N
Firm FE	N	N	N	N	N	Y
N.Obs	61,618	61,618	61,618	61,618	61,618	61,618
R-squared	0.163	0.170	0.172	0.274	0.276	0.280

Table 7. Cross-Sectional Analysis by Firms

This table examines how the dynamic holding relationship for sister funds varies across the holding firms' characteristics such as size, leverage and book-to-market ratio. Sister funds are equity funds and corporate bond funds holding the same firm's equities and bonds and coming from the same mutual fund family. We construct the subsamples which are tercile portfolios: low (L), medium (M), and high (H), sorted by each firm characteristic, and run the experiment in Equation (1A):

$$\Delta H_{i,f,t}^{Equity} = \alpha + \theta \cdot \Delta H_{i,f,t}^{Bond} + \gamma \cdot Z_{i,t} + FE + \varepsilon_{i,f,t},$$

where $\Delta H_{i,f,t}$ is the percentage change of firm i's equity shares or corporate bond shares held by fund family f during the quarter t, and $Z_{i,t}$ is a vector of firm-level control variables including firm size (the logarithm of total assets), leverage (the ratio of total debt to the sum of total debt and market value of equities), and book-to-market ratio. The industry fixed effect is defined by the first 2-digit of SIC code. In all specifications, We use the two-way fund family×time fixed effect and the industry fixed effect. Standard errors are clustered at the fund family level and t-statistics are shown in parentheses with the significance at the 1% (***), 5% (**), and 10% (*) levels.

	Book-to-Market			Leverage			Size		
	(1) L	(2) M	(3) H	(4) L	(5) M	(6) H	(7) L	(8) M	(9) H
ΔH^{Bond}	0.624***	0.603***	0.540***	0.658***	0.610***	0.497***	0.858***	0.517***	0.439***
	(7.50)	(9.59)	(7.27)	(8.19)	(7.15)	(8.51)	(7.14)	(9.06)	(7.22)
Log(Asset)	-0.079	0.019	-0.027	-0.060	-0.037	-0.031			
	(-1.56)	(0.44)	(-0.84)	(-1.16)	(-0.67)	(-1.11)			
Leverage	-0.124	-0.904***	-0.025				-1.459***	0.088	-0.023
	(-0.38)	(-3.23)	(-0.14)				(-5.17)	(0.25)	(-0.10)
Book/Mkt				0.414***	-0.146	0.002***	0.002*	-0.000	0.034**
				(3.13)	(-1.07)	(2.73)	(1.76)	(-0.01)	(1.99)
Fund Family FE	N	N	N	N	N	N	N	N	N
Time FE	N	N	N	N	N	N	N	N	N
Fund Family x Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Industry FE	Y	Y	Y	Y	Y	Y	Y	Y	Y
Firm FE	N	N	N	N	N	N	N	N	N
N.Obs	34,833	34,774	34,792	34,819	34,785	34,795	34,814	34,808	34,777
R-squared	0.087	0.066	0.050	0.089	0.061	0.050	0.054	0.054	0.129

Table 8. Cross-Sectional Analysis by Fund Families

This table examines how the dynamic holding relationship for sister funds varies by the fund families' characteristics such as expense ratio, fund fee, turn over, and total size. All these characteristics are associated with individual fund within a fund family at a given time and they are aggregated up to the fund family level by fund-size-weighted averaging. Sister funds are equity funds and corporate bond funds holding the same firm's equities and corporate bonds and coming from the same mutual fund family. We construct the subsamples which are tercile portfolios: low (L), medium (M), and high (H), sorted by each fund family characteristic, and then run the following experiment:

$$\Delta H_{i,f,t}^{Equity} = \alpha + \theta \cdot \Delta H_{i,f,t}^{Bond} + \gamma \cdot Z_{f,t} + FE + \varepsilon_{i,f,t}$$

where $\Delta H_{i,f,t}$ is the percentage change of firm i's equity shares or corporate bond shares held by fund family f during the quarter t, and $Z_{i,t}$ is a vector of fund family variables including size (total net assets), expense ratio, management fee, and turnover ratio. In all specifications, We use the firm and time fixed effects. Standard errors are clustered at the fund family level and t-statistics are shown in parentheses with the significance at the 1% (***), 5% (**), and 10% (*) levels.

	Fund Size			Exp. Ratio			Fund Fee			Turnover		
	(1) L	(2) M	(3) H	(4) L	(5) M	(6) H	(7) L	(8) M	(9) H	(10) L	(11) M	(12) H
ΔH^{Bond}	0.718***	0.519***	0.637***	0.533***	0.652***	0.717***	0.689***	0.693***	0.503***	0.627***	0.609***	0.618***
	(6.45)	(7.06)	(5.59)	(7.90)	(6.78)	(5.56)	(6.57)	(5.72)	(6.46)	(5.68)	(5.84)	(5.85)
Exp. Ratio	-18.688	-8.886	260.655**				-11.771	8.758	4.451	-10.728	16.431	-33.481
	(-1.48)	(-0.64)	(2.35)				(-0.76)	(0.32)	(0.29)	(-0.85)	(0.78)	(-1.42)
Fund Fee	-0.535**	-0.180	0.347	0.486	-0.833**	-0.462*				-0.628**	0.218	-1.125***
	(-2.05)	(-0.75)	(0.31)	(1.54)	(-2.23)	(-1.94)				(-2.61)	(0.80)	(-3.62)
Turnover	0.036	0.125	-0.033	0.224	-0.196	0.038	0.215	-0.069	-0.008			
	(0.54)	(0.94)	(-0.12)	(1.27)	(-1.28)	(0.54)	(1.51)	(-0.46)	(-0.12)			
Total Asset				-0.000***	0.000***	-0.000***	-0.000***	0.000**	0.000**	0.000	-0.000***	-0.000
				(-4.62)	(7.41)	(-2.77)	(-3.97)	(2.63)	(2.06)	(0.37)	(-2.93)	(-0.25)
Fund Family FE	N	N	N	N	N	N	N	N	N	N	N	N
Time FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
FF x Time FE	N	N	N	N	N	N	N	N	N	N	N	N
Industry FE	N	N	N	N	N	N	N	N	N	N	N	N
Firm FE	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
N.Obs	23,057	22,966	22,849	22,988	22,935	22,949	23,108	22,886	22,878	23,025	22,954	22,893
R-squared	0.036	0.019	0.023	0.019	0.030	0.035	0.030	0.029	0.026	0.026	0.034	0.028