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Managerial investment in mutual funds: Determinants and performance implications[☆]

Abigail S. Hornstein [a,*], James Hounsell [b]

[a] *Wesleyan University, Middletown, CT, United States*
[b] *Centerstone Investors, New York, United States*

A B S T R A C T

We examine the determinants of managerial investments in mutual funds and the subsequent impacts of these investments on fund performance. By using panel data we show that investment levels fluctuate within funds over time, contrary to the common assumption that cross-sectional data are representative. Managerial investments reflect personal portfolio considerations while also signaling incentive alignment with investors. The impact of managerial investment on performance varies by whether the fund is solo- or team-managed. Fund performance is higher for solo-managed funds and lower for team-managed funds when managers invest more. These results are consistent with the higher visibility of solo managers, and less extreme investment returns of team-managed funds. Our results suggest investors may not benefit from all managerial signals of incentive alignment as managerial investments also reflect personal portfolio considerations.

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1. Introduction

Since March 2005 the SEC has required that mutual funds disclose annually the level of portfolio managers' ownership in self-managed funds. Managerial investments may directly affect a fund's performance through incentive alignment or career concerns, leading to a reduction in agency costs.[1] When the SEC proposed this disclosure requirement, some fund managers argued that this information would be a noisy, non-informative signal that investors might have difficulty understanding. Although these disclosures began a decade ago, there have been few studies to date of the determinants of managerial ownership in self-managed funds and also the subsequent relationship between mutual fund performance and managerial ownership. Managers may invest in self-managed funds to signal incentive alignment with shareholders or to fulfill personal portfolio preferences. Managerial ownership in a self-managed fund may directly affect the fund's performance if managers with more skin in the game invest more astutely, consistent with a reduction in agency costs (e.g., Jensen & Meckling, 1976;

 [1] We use the phrase "managerial investment" to capture the average level of investment per *individual* manager, not the total amount that may be invested by multiple managers in team-managed funds. This is consistent with Evans (2008) but is not the same as Khorana et al. (2007) and Fu and Wedge (2011) who use the phrase to capture total investments in a fund from all managers.

Mahoney, 2004). This governance view was cited by the SEC in 2004 in proposing and implementing the required disclosure of managerial investments.

Mutual fund families generally have one of four sets of policies governing managerial investment (Braham, 2010). First, some fund families have a co-investment requirement or expectation. Second, employees may be prohibited from owning individual stocks or other mutual funds. Next, some larger funds pay bonuses, at least partially, in fund shares that vest over multiple years. Finally, other mutual funds have no rules governing such investments. Khorana, Servaes, and Wedge (2007) find that managerial investments reflect personal portfolio allocation decisions, and this is consistent with an absence of formal policies regarding managerial investments at many mutual funds.

If the SEC's hypothesis of long-term incentive alignment were correct, then managerial investment levels would generally be non-decreasing across time and there should be a positive relationship between fund performance and the level of managerial ownership. In this light, Khorana et al. (2007), and Evans (2008) use a single cross-section of managerial ownership data to find that fund performance is strongly positively related to ownership stakes. Similarly, a 2009 Morningstar study shows that managers with more than $1 million invested in their own funds beat 58% of peers, on average, over the previous five years while funds with no manager investment outperformed only 46% of their peers (Braham, 2010).

On the other hand, Kumlin and Puttonen (2009) reported no significant relationship between managerial ownership and mutual fund performance in Finland. Furthermore, when Kumlin and Puttonen controlled for portfolio manager ownership as a percentage of taxable wealth, they found a negative relationship between portfolio manager ownership and fund performance.[2] Kumlin and Puttonen produced the only published study that has used panel data on managerial ownership stakes and data on overall managerial wealth, and, is also one of the few studies on this topic to use non-U.S. data. In a related, complementary study Fahlenbrach and Stulz (2011) found that U.S. banks with CEOs whose incentives were better aligned with their shareholders achieved worse performance than their peers due perhaps to actual corporate performance that was below prior expectations. These studies both lay the groundwork for questioning whether skin in the game can align managerial and shareholder incentives over the long-term and highlight the need for using panel data on managerial ownership in such analysis.

We use panel data on managerial ownership of self-managed mutual funds to examine two intertwined questions previously examined by others using cross-sectional data. Khorana et al. (2007) and Evans (2008) used data on managerial ownership from the first year in which data was available, 2005, which was a year where managers did not know ex ante their ownership stakes would ever be disclosed. We use panel data from subsequent years, 2006–2009, as managers may have behaved differently if they knew ex ante that their ownership stakes would be publicly disclosed. First, we examine whether managerial investments are driven by personal preferences or by incentive alignment. Khorana et al. (2007) found that managerial investments are motivated by personal preferences even as 57% of the managers in their dataset did not invest in their funds. Second, we examine how managerial investments affect subsequent fund performance. That is, if managerial investments serve to align effectively managerial and investor concerns, then fund performance should be stronger when managers invest more. Khorana et al. (2007) and Evans (2008) both found evidence in favor of the incentive alignment story.

The SEC assumption that skin in the game matters to investors rests on the assumption that investors can identify the "skin". When a fund has one manager, this is straightforward. However, most funds are team managed and most managers oversee simultaneously multiple funds. When a fund has a team management structure, an individual manager may feel that their actions are less observable and thus will be rewarded less by their employer and investors (Massa, Reuter, & Zitzewitz, 2010). Accordingly, managers who are part of team structures may have reduced incentives to invest in their own fund perhaps because team-managed funds tend to have more diversified portfolios that follow less extreme investment styles, and the fund's performance tends to be less extreme (Bar, Kempf, & Ruenzi, 2011). Thus, even if an individual manager's investments signal an alignment of interests, it is possible that fund performance may not be systematically related to the level of average managerial investments. Thus, there may be a mismatch between the underlying theory that there is an alignment of managerial and shareholder interests at a specific fund and what is best for the manager as a personal investor.

We hand-collected a panel dataset detailing managerial ownership at nearly 400 mutual funds across 2006–2009. SEC-mandated disclosures of managerial investments began in 2005, and thus 2006 is the first year for which managers knew ex ante their investments would be publicly disclosed. Our sample ends in 2009 both to parallel the end of the financial crisis and to pre-date the round of fund mergers and delistings that began in 2010.[3] Thus, our results also provide insights into how effective managerial investments could be at aligning managerial and investor interests at a time of market turmoil, which is precisely when investors might most value such managerial signals.

The average total managerial investment stake in a fund in our dataset is valued at $756,000 with the average mutual fund holding $1.5 billion in assets and having 1.8 managers. This low average ratio of average total managerial investment to fund size (0.05%) suggests that an alignment of interest story as laid out by Khorana et al. (2007) and Evans (2008) may not fully explain why managers invest in their mutual funds, and thus complicates the interpretation of a mutual fund manager's decision to invest in a self-managed fund. Moreover, we focus on average *individual* managerial investment and

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[2] In Finland, data on individuals' taxable income and wealth, as verified by the tax authority, are published annually.

[3] 3.7% of all funds listed in the mutual fund database delisted or merged in 2006; 2.0%, 2007; 0.7%, 2008; 2.1%, 2009; 19.9%, 2010; 19.5%, 2011; 3.7%, 2012; and 3.0% in 2013.

the numbers are even lower when we acknowledge that roughly 15% of all managers, including 18% of solo managers, do not invest in their own funds. Thus, the average managerial investment stake is $429,000 and represents 0.03% of assets under management.

Our first finding is that managerial investment levels fluctuate considerably across time. 38% of all investment levels are different than were observed in the prior year, with an even split between increases and decreases. This is contrary to the SEC's hypothesis of long-term incentive alignment, and a key assumption of Khorana et al. (2007), Evans (2008), and Fu and Wedge (2011) that a single cross-section of the managerial investment data would be representative. However, this is consistent with the findings of Kumlin and Puttonen (2009). The inter-temporal variation in the levels of ownership suggests that managers may view investment stakes as an asset within their own personal portfolios and not as a signal of incentive alignment (Dimmock, Gerken, & Marietta-Westberg, 2011).

Second, we examine the determinants of managerial investments. We begin by replicating the Khorana et al. (2007) OLS result that managerial investments reflect personal portfolio preferences. However, when we use a Tobit estimation, which we believe has not been used previously to analyze managerial investments, we obtain different results. The Tobit approach is used as managers are constrained to have non-zero holdings in their funds. We find in this analysis that managers chase past performance, which is consistent with personal preferences, while simultaneously also signaling incentive alignment as managers invest more when expense fees are higher and board oversight greater. This is a key result as it supports the motivation behind the SEC disclosure requirement and the existence of managerial coinvestment policies at some mutual funds. Nonetheless, if managerial investments are motivated by signaling concerns, it is possible that this may be a false signal and not lead to a positive impact on subsequent fund performance.

Thus, we next examine the impact on fund performance of managerial investments. When performance is measured as buy-and-hold returns we find no relationship between performance and managerial investments. However, when alpha is used to measure performance, we find a surprising negative association of performance with managerial investments. To untangle this, we examine how the performance-investment relationship varies among solo- and team-managed funds. We find that fund performance is significantly higher when solo managers own a higher share of the fund and is significantly lower among team-managed funds. This suggests that managerial investments may be interpreted by investors as a meaningful signal only when the manager can be clearly identified as is the case at solo managed funds, while managerial investments be more indicative of personal portfolio concerns at team managed funds.

We then conduct further tests to examine whether the impact of managerial investments upon fund performance reflects how recent changes in the level of managerial investment (i.e., increases or decreases). This confirms that managerial investment decisions reflect personal portfolio considerations. Our results confirm that team managed funds adopt less extreme investments, and are also consistent with Berk and Green (2004)'s argument that the lack of persistence in mutual fund performance does not indicate that managers lack investing skill or that markets are efficient. Rather, it simply indicates that capital is supplied competitively, driving down returns as funds receive more net inflows than can be invested at comparable yields.

To identify if observed changes in managerial investments reflect the fund's recent performance, we examine an interactive model. This analysis reveals managers are equally sensitive to losses and gains when performance is measured as buy-and-hold returns. However, when performance is proxied by alpha, we find that managers are more likely to decrease investments in response to recent poor performance. This suggests that managerial investments largely reflect personal portfolio considerations.

Our findings make an important contribution to the literature as we use panel data where managers knew ex ante that their investment stakes would be disclosed subsequently. We are able to trace how managerial investment stakes vary over time, and how such investments affect fund performance. Thus we add nuance to the understanding of earlier studies of managerial investments (Evans, 2008; Khorana et al., 2007) while also connecting this literature to the growing literature on team management structure (Bar et al., 2011; Massa et al., 2010).

The data are described in Section 2. The empirical analysis of managerial investment is reported in Section 3. The relationship between fund performance and managerial investment is examined in Section 4. We conclude in Section 5.

2. Data

We examine active equity funds included in the May 2009 "Value Line No-Load Fund Advisor Mutual Fund Directory". No load funds have consistently attracted the bulk of net inflows into all mutual funds, and accounted for an increasing share of total assets under management within the industry throughout the years since 2001 (ICI, 2011). A mutual fund is included in our dataset if it offers at least one no load class listed in the Value Line directory.[4]

We include only funds for which managerial ownership data could be obtained for at least two years, and then be matched with fund and fund family data from the CRSP Survivor-Bias-Free US Mutual Fund Database. A list of manager names was

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[4] Our approach to constructing the dataset does invite one criticism: that we may have introduced backfill or survival bias. It is possible that only the managers with better recent performance were observed in 2009 (e.g., Brown, Goetzmann, Ibbotson, & Ross, 1992). If that is the case, and the ownership stakes of the surviving managers was non-random, then there would be no bias, upward or downward, introduced by the survivorship. On the other hand, if the ownership of the surviving managers was higher, then the estimated coefficient on the ownership stake would be biased toward zero.

obtained from Morningstar for all funds that were team-managed and from CRSP for solo managed funds. Finally, data for each fund on each manager's ownership stake, the number of directors, and the number of insiders on the board was hand-collected from Semi-Annual Certified Shareholder Report and Prospectus filings.

The dataset includes 1452 observations on 439 funds, with 354–372 funds present each year, and this represents 31–34% of total assets or 5% of the mutual funds listed in CRSP each year. All analyses are conducted at the fund level because class-level assets are comingled for investment purposes.

2.1. Managerial ownership

The SEC requires all funds to disclose annually year-end managerial ownership as lying within one of the following bands designed by the SEC: $0; $1–$10,000; $10,001–$50,000; $50,001–$100,000; $100,001–$500,000; $500,001–$1,000,000; and over $1,000,000. We adopt the Khorana et al. (2007) process of assuming the mean of each band is a representative value of investments within the bin, and of $1,000,001 for the top bin.

While fund managers are required to disclose their year-end levels of investment in the funds, the disclosed levels may not necessarily be representative of their true level of investment. For example, managers may engage in window dressing whereby they increase their level of reported investment toward the end of the calendar year. Alternatively, a manager who expects to be paid an annual bonus in fund shares may decrease their investment in the fund in order to avoid having personal investments be overly concentrated in the fund. The results of a 2005 CFA salary survey suggest that the average manager who has invested in their fund at the average level obtained in our dataset has effectively tied up two or more years' worth of total compensation.[5] That may lead to an overly concentrated personal investment portfolio that is not optimal for the manager. As the idiosyncratic motivation behind each manager's decision of whether to invest in their own fund is not known, we simply acknowledge that the reported levels of investment may not be consistent with the true level of investment in the funds over the span of the entire calendar year. Nonetheless, in the absence of more complete reporting throughout the year, this data remains the best available way to measure managerial investments in mutual funds.

Descriptive statistics for the dataset are reported in Table 1. We find that the average ownership stake of $429,000 is higher than has been previously reported by others. This reflects the fact that roughly 16% of the fund-year observations have zero managerial investments, as compared to 57% in the Khorana et al. (2007) sample and 22% in the Evans (2008) sample. The decrease in non-investment may reflect the fact that the other studies used data from the first ever disclosures of managerial investments in 2005 when managers did not know ex ante that this data would be disclosed (Evans, 2008; Khorana et al., 2007) while we use data from the next four years. The frequency of non-investment is constant over the years we examine, which suggests that managers were more likely to invest once such investments were disclosed publicly.

Managerial investment varies markedly year-to-year as 38% of managers change their investment levels annually. The average ownership stake is measured as $421,000 in each of 2006 and 2007, $426,000 in 2008, and $449,000 in 2009. 11.8% of all managers, or one-third of managers changing their investment levels in a year, increase (decrease) their investment the year after a decrease (increase).

Finally, we explore how solo vs. team management of a fund affects managerial investments.[6] A 2003 survey of portfolio managers found that the median number of portfolios managed by each manager is 20 (Farnsworth & Taylor, 2006), and most funds have two or more co-managers. When a single manager oversees multiple funds, the manager's aggregate investment levels in funds operated by the fund family may become a proxy for whether the manager's interests are aligned with those of the fund family, but not signal a particular alliance with a specific individual fund (Dimmock et al., 2011). Separate analysis is conducted of solo and team-managed funds as solo managers may derive greater personal benefits from the informational value of signaling the level of their investment in the fund.

We find that an average of 1.8 managers oversees each fund. Massa et al. (2010) show that individual managers feel their efforts are less discernable in the team setting, and this suggests they would have diminished incentive to invest in the fund. We report in the last columns of Panel A the means of each variable conditioned on whether the fund is solo or team managed, and the t-test of the means. These data confirm that average managerial ownership stakes are higher in solo managed funds ($494,000) than in team managed funds ($475,000), although this is not a statistically significant difference. On the other hand, managerial investment is $0 in 18% of funds that are solo managed vs. 11% of team managed funds. Thus, managers appear less likely to invest in solo-managed funds, but they invest more money when they make such investments.

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[5] The CFA Institute used to conduct an annual compensation survey of portfolio managers but last conducted it in 2007, and is no longer willing to share this data. As a result, the latest available data regarding portfolio manager compensation is from the CFA Institute's 2005 study as reported in Khorana et al. (2007) and as complemented by data obtained from payscale.com in 2012. Khorana et al. (2007) report that the CFA Institute and Russell Reynolds Associate 2005 study found that the median total compensation of U.S. CFA members who serve as portfolio managers ranges from $176,000 to $310,000 with the bonus accounting for 12–40% of the total compensation. The payscale.com data suggest that portfolio managers receive base salaries of $47,000–$168,000 with total compensation ranging from $48,000 to $264,000. While these two sets of data may represent dissimilar samples from the universe of portfolio managers, they yield complementary interpretations: the higher value managerial investment bins correspond to multiple years of income for many managers.

[6] The sample of funds analyzed by Khorana et al. (2007) included both solo and team managed funds while Evans (2008) restricted her sample to include only solo managed funds.

Table 1

Summary Statistics. All variables are defined in the second column of Panel A. The variables are summarized by the overall sample, year, and by management structure (Panel A), and by range of managerial ownership by monetary value (Panel B). In Panel A *, **, and *** indicate that the difference between the two groups being compared, solo managed funds vs. team-managed funds, is significant at the 10%, 5%, and 1% levels respectively. The following variables are reported in levels: number of managers, total ownership, average total ownership, alpha, fund age, fund size, board size, and fund family size. Board independence is the ratio of the number of independent directors to the total board size. The following variables are reported in basis points: total ownership as percent, excess returns, expense ratio, and management fees. Dummy variables are summarized for percent of all funds with $0 investments, change in level of ownership, increased ownership, and decreased ownership.

Panel A: Inter-temporal variation in fund characteristics

Variable	Definition	Overall sample			By year				By management structure		
		Mean	Std. Dev.	Obs.	2006	2007	2008	2009	Solo	Team	*p*-Value of *t*-test of the means
# of observations						356	376	364	356		
Number of managers	Number of managers at the fund as listed in SEC filings.	1.845	1.212	1452	1.843	1.845	1.865	1.826	1	2.878	0.000***
Average total ownership	Average amount invested in fund by each manager; US$ mn. Values recorded using method described in the text.	0.429	0.383	1452	0.421	0.421	0.426	0.449	0.494	0.475	0.32
% of funds where managers have $0 investments	Fraction of all observations where total ownership is $0.	0.16	0.367	1452	0.163	0.16	0.154	0.163	0.177	0.105	0.000***
Change in level of ownership	Dummy variable to indicate whether the average ownership changed from the prior year.	0.375	0.484	1078		0.376	0.368	0.38	0.266	0.458	0.000***
Increase in level of ownership	Dummy variable to indicate whether the average ownership increased from the prior year.	0.192	0.394	1078		0.207	0.15	0.22	0.143	0.253	0.000***
Decrease in level of ownership	Dummy variable to indicate whether the average ownership decreased from the prior year.	0.183	0.387	1078		0.169	0.219	0.161	0.122	0.205	0.000***
Returns	Annual returns as recorded in CRSP; measured in percentage points.	1.967	3.448	1452	0.938	-0.104	4.123	2.206	2.067	1.91	0.361
Alpha	The estimated coefficient from a four-factor model using the three Fama and French (1992) factors and the Carhart (1997) momentum factor.	2.913	3.971	1452	1.711	3.557	1.086	5.302	3.195	2.599	0.003***
Expense ratio	Expense ratio as recorded in CRSP; measured in basis points.	1.016	0.395	1452	1.013	1.007	1.008	1.038	0.981	1.065	0.000***
Fund age	Years since fund was first opened to investors.	20.399	15.848	1452	18.989	19.811	20.676	22.149	19.85	20.534	0.375
Fund size	Log of average total net assets under management; US$ mn as reported in CRSP.	7.311	1.53	1452	7.318	7.459	7.332	7.127	7.316	7.21	0.154
Board size	Number of individuals on board of directors.	8.735	2.588	1452	8.789	8.67	8.714	8.769	8.886	8.457	0.001***
Board independence	Percent of directors who are independent.	0.779	0.208	1452	0.779	0.781	0.778	0.78	0.747	0.825	0.000***
Fund family size	Log of total average total net assets under management by fund family; US$ mn as reported in CRSP.	10.597	2.164	1452	10.632	10.756	10.599	10.392	10.953	10.192	0.000***

Panel B: Variation in fund characteristics based on level of average managerial ownership

Variable	Bin 0 $0	Bin 1 $1–$10,000	Bin 2 $10,001–$50,000	Bin 3 $50,001–$100,000	Bin 4 $100,001–$500,000	Bin 5 $500,001–$1,000,000	Bin 6 $1,000,001+
# of observations	163	25	71	60	299	202	230
Average total ownership	0	5000	30,000	75,000	300,000	750,000	1,000,001
Number of managers	1.706	2.12	1.859	1.717	2.04	2.51	1.273
Returns	2.206	2.894	3.131	2.581	2.025	2.481	2.495
Alpha	2.787	3.066	4.012	3.937	3.483	3.157	3.267
Expense ratio	0.908	0.99	0.877	0.979	1.054	1.086	1.043
Fund age	16.337	12.8	17.239	24.75	22.11	24.134	20.722
Fund size	6.988	6.182	6.737	7.219	7.179	7.654	7.71
Board size	8.595	9.36	9.761	9.033	8.829	8.5	8.502
Board independence	0.781	0.891	0.79	0.781	0.757	0.807	0.761
Fund family size	10.949	10.314	11.243	10.588	10.551	10.304	10.538

The managerial ownership distribution is relatively bifurcated (Table 1, Panel B). 15.1% of the fund-year observations in the dataset have average managerial ownership of zero and 24.3% are over $1,000,000. There is no consistent pattern between the fund characteristics and the level of managerial ownership.

2.2. Fund performance

Buy and hold returns for fund i are estimated per calendar year by compounding monthly returns from CRSP (MRET) over the entire year as:

$$\text{Annual Return}_{i,t} = \prod_{m=1}^{12}(1 + \text{monthly return}_{i,t,m}) - 1, \tag{1}$$

where monthly return$_{i,t,m}$ is the return of fund i in month m of year t. The monthly fund returns are first calculated as changes in monthly net asset values (TNA), including reinvested dividends from one period to the next.[7] We report annual returns, not monthly returns, as managerial investment data is available only at the annual level. The average annual return is 1.967 percentage points but there is considerable heterogeneity across fund-year observations as the standard deviation of returns is 3.448.

Alpha is an alternative measure of fund performance as it estimates the annual abnormal return associated with each fund. We estimate alpha using a four factor regression analysis of monthly data using the three Fama and French (1992) and Carhart (1997) factors: excess return on the CRSP value-weighted index, the difference in returns between portfolios of small and large stocks, the difference in returns between portfolios of high and low equity to book market portfolios, and momentum. Thus, alpha is estimated as the intercept in the equation

$$R_{it} - R_{ft} = \alpha_i + \beta_i^{MKT}MKT_t + \beta_i^{SML}SML_t + \beta_i^{HML}HML_t + \beta_i^{MOM}MOM_t + \varepsilon_{it}. \tag{2}$$

R_{it} denotes the net return of fund i in month t, R_{ft} is the one-month T-bill rate in the same month t, and MKT_t, SML_t, HML_t, and MOM_t are the four monthly portfolio factors for market, size, book-to-market and momentum as obtained from Ken French's website. The average estimated alpha is 2.913 bps with the standard deviation being 3.971 bps. The average value of alpha for solo-managed funds (3.195 bps) is highly statistically significantly different from the average value for team-managed funds (2.599 bps), consistent with team-managed funds having less extreme returns (Bar et al., 2011).

2.3. Independent variables

Expense ratio is as reported in CRSP and is measured in basis points. Fund age is the number of years since the fund was first opened to investors. Fund size is the log of average monthly total net assets under management while family size is the sum of fund size for all funds within a fund family. Board size and independence are estimated based upon hand-collected data from Semi-Annual N-CSRS (Certified Shareholder Report) and 485 BPOS (Prospectus) filings with the SEC.

Our dataset is similar to those used in related studies. For example, the average fund size in this dataset is $1.5 bn over 2006–2009 vs. $1.41 bn in 2005 in Khorana et al. (2007) and $1.2 bn in 2001–2004 in Chen, Goldstein, and Jiang (2008).

3. Determinants of managerial investments

To identify determinants of managerial investments we estimate:

$$\begin{aligned}
\text{Ownership}_{i,t} = {} & \beta_0 + \beta_1 \text{Performance}_{i,t-1} + \beta_2 \text{Expense fees}_{i,t} + \beta_3 \text{Fund age}_{i,t} + \beta_4 \text{Fund size}_{i,t-1} + \beta_5 \text{Board size}_{i,t} \\
& + \beta_6 \text{Board independence}_{i,t} + \beta_7 \text{Fund family size}_{i,t} + \text{Fund family FE} + \text{Year} \times \text{Objective FE} \\
& + \text{Management team FE} + \varepsilon_{i,t}.
\end{aligned} \tag{3}$$

The observed impact on ownership levels of fund performance would be positive if managers chase past performance. Expense fees are included as managers may feel a need to invest more to justify higher fees. The age and size of a fund and the size of the fund family may affect fund performance. Board size and independence are included to capture the intensity of managerial monitoring. In aggregate we will argue that personal preferences will be proxied by past performance and incentive alignment will be proxied by the measures of expense fees.

Thus, we have our first two testable hypotheses:

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[7] Net asset values are net of all management expenses and 12b-fees.

Table 2

OLS analysis of managerial investment levels. This table reports ordinary least squares regressions results in which the level of managerial investment is the dependent variable. Managerial investment is estimated as the mid-point of each disclosure range and as the lowest possible value for the largest range (more than $1 million). Managerial investment is predicted using past performance proxied by lagged annual returns (Models 1–3) or alpha (Models 4–6), expense fees, fund age, lagged fund size, board size and independence, and family size. Year-fund objective, fund family and managing team fixed effects are included in all regressions. Standard errors are clustered by fund family and are reported in parentheses.

Model	1 Baseline 1	2 Solo managed 2	3 Team managed 3	4 Baseline 4	5 Solo managed 5	6 Team managed 6
Lagged returns	5.287	4.658	7.046			
	(5.11)	(6.64)	(7.91)			
Alpha				1.61	0.015	6.678
				(5.10)	(6.86)	(8.44)
Expense fees	278.7*	206.8	522.4	267.2*	192.3	526.9
	(152.7)	(206.3)	(405.1)	(150.5)	(204.0)	(408.9)
Fund age	5.335	7.07	6.02	5.262	6.9	6.407
	(5.53)	(8.32)	(9.17)	(5.51)	(8.49)	(8.99)
Lagged fund size	28.53	51.43	42.25	29.43	53.05	47.27
	(64.24)	(92.06)	(54.70)	(66.22)	(95.33)	(55.07)
Board size	2034	2132	135.9	2029	2133	11.78
	(1353.0)	(1540.0)	(958.2)	(1352.0)	(1537.0)	(957.8)
Board independence	3416*	3314	11,838	3366*	3267	15,394
	(1948)	(2157)	(21,561)	(1911)	(2100)	(22,468)
Family size	−21.91	86.55	−90.46	−14.76	92.68	−81.62
	(61.77)	(116.40)	(75.81)	(61.20)	(119.70)	(70.40)
Intercept	−6286	−8991	−12,386	−6251	−9011	−15,857
	(3811)	(5677)	(20,746)	(3781)	(5686)	(21,576)
Adjusted R^2	0.812	0.822	0.792	0.812	0.821	0.791
N	1080	582	498	1080	582	498

* denotes significance at the 10% level; **, 5%; and ***, 1%.

H1. $\widehat{\beta_1} > 0$ will signal that managers are pursuing personal preferences (i.e., portfolio maximization) by investing more in funds with higher recent performance.

H2. $\widehat{\beta_2} > 0$ will signal incentive alignment as managers, like investors, want fees to be minimized.

Both hypotheses will also be subject to further examination using subsets of the population based on whether the fund is solo or team-managed. We carry out this separate analysis as managerial effort is easier to discern among solo funds, and the degree of managerial sensitivity to fees may be related to the degree to which the manager's effort can be observed.

Three types of fixed effects are included in this model to capture unobserved heterogeneity: fund family fixed effects to capture formal fund family policies and informal fund culture (Tufano & Sevick, 1997); interactive year-fund objective fixed effects to capture unobserved characteristics that affect a given market segment in a particular year; and management team fixed effects since most mutual funds are team managed.[8] All error terms are clustered at the fund family level.

3.1. OLS results

In Table 2, we report results from OLS estimation of Eq. (3). We begin by examining if the Khorana et al. (2007) results from OLS estimation of 2005 cross-sectional data that managerial investments reflect personal portfolio considerations persist in subsequent years. We obtain similar results using panel data as managerial investments appear to be unrelated to past performance, irrespective of whether performance is measured as excess returns (Columns 1–3) or as alpha (Columns 4–6). We obtain some limited support for the alignment of interests hypothesis as higher managerial investment is weakly associated with higher expense fees. Managerial investment is also weakly associated with board independence. Altogether, these results suggest that managerial investments generally reflect personal portfolio considerations and not characteristics of the fund or fund family.

3.2. Tobit estimation

Managers may prefer to have a negative loading on their own fund within their portfolio for the sake of diversification but are constrained to have a non-negative loading. This is consistent with both diversifying labor and wealth income, and the idea that managerial investment in the overarching investment management firm might support the incentive alignment

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[8] When solo-managed funds are analyzed separately, these fixed effects can be interpreted as managerial fixed effects.

Table 3

Tobit analysis of managerial investment levels. This table reports Tobit regression results in which the level of managerial investment is the dependent variable. Managerial investment is estimated as the mid-point of each disclosure range and as the lowest possible value for the largest range (more than $1 million). Managerial investment is predicted using past performance proxied by lagged annual returns (Models 1–3) or alpha (Models 4–6), expense fees, fund age, lagged fund size, board size and independence, and family size. Year-fund objective, fund family and managing team fixed effects are included in all regressions. Standard errors are clustered by fund family and are reported in parentheses.

Model	1 Baseline	2 Solo Managed	3 Team Managed	4 Baseline	5 Solo Managed	6 Team Managed
Lagged returns	5.982***	5.475***	6.014***			
	(0.410)	(0.182)	(0.734)			
Alpha				3.988***	3.002***	6.282***
				(0.157)	(0.125)	(0.230)
Expense fees	318.4***	229.4***	633.4***	310.9***	217.7***	637.7***
	(0.238)	(0.179)	(0.273)	(0.124)	(0.166)	(0.137)
Fund age	6.832***	8.377***	8.954***	6.597***	7.964***	9.363***
	(0.007)	(0.011)	(0.009)	(0.006)	(0.011)	(0.007)
Lagged fund size	−31.29***	−56.08***	47.39***	−30.07***	−55.53***	51.98***
	(0.023)	(0.022)	(0.021)	(0.012)	(0.024)	(0.020)
Board size	2127***	2224***	95.47***	2098***	2204***	−2.474***
	(0.091)	(0.073)	(0.092)	(0.043)	(0.073)	(0.072)
Board independence	3742***	3665***	−17,906***	3673***	3599***	−15,271***
	(0.223)	(0.229)	(0.199)	(0.109)	(0.235)	(0.188)
Family size	−20.63***	102.6***	−164.2***	−9.276***	109.1***	−148.2***
	(0.015)	(0.018)	(0.016)	(0.008)	(0.018)	(0.019)
Intercept	−6802***	−9698***	17,672***	−6748***	−9688***	15,041***
	(0.196)	(0.173)	(0.202)	(0.090)	(0.175)	(0.168)
Psuedo R^2	0.175	0.186	0.178	0.175	0.186	0.178
N	1080	582	498	1080	582	498

* Significance at 10% level.

** Significance at 5% level.

*** Significance at 1% level.

theory the SEC attributes to investments in a self-managed fund (Dimmock et al., 2011). Accordingly, we use Tobit to estimate Eq. (3) (Table 3).[9]

Now we report the results of testing Hypotheses 1 and 2. We use two different measures of past performance–buy and hold returns (Models 1–3) and alpha (Models 4–6), and explore each model for all funds (Models 1 and 4), among only solo-managed funds (Models 2 and 5), and among only team-managed funds (Models 3 and 6). We begin with our first hypothesis regarding whether managerial investments reflect personal wealth considerations. We observe that managers chase past performance, whether measured as buy and hold returns (Models 1–3) or as alpha (Models 4–6). The impact of higher past performance is substantially greater in team managed funds than in solo managed funds. This is consistent with the fact that team-managed funds tend to have more diversified portfolios that follow less extreme investment styles, and the fund's performance tends to be less extreme (Bar et al., 2011). Thus, managerial investments are consistent with personal portfolio considerations.

Next we explore the second hypothesis that managers may signal incentive alignment through their investments. Managers do signal an alignment of interests with investors as investments are significantly higher when funds charge higher fees, and the effect of higher expense fees on managerial investments is roughly twice as large at team managed funds as at solo managed funds.

In all tests we also control for observable characteristics of the fund's governance and fund family. We find that solo managers invest substantially more when they are monitored more closely while the reverse is true for team managers. This suggests that solo managers' efforts can be more easily observed by boards, and the managers thus face greater incentives to invest in the funds. We also find that team managers invest significantly less in a fund when the fund family is larger. This is consistent with the stylized fact that managers at larger fund families oversee simultaneously more funds, and thus managers may invest a lower dollar amount in each fund. Moreover, larger fund families may have more diverse portfolios of funds, and the manager may have higher aggregate investment levels in funds operated by the fund family to signal that the manager's interests are aligned with those of the fund family while diversifying their personal portfolio away from a specific self-managed fund (Dimmock et al., 2011).

These results strongly suggest that managerial investment may be motivated simultaneously by personal portfolio considerations and a desire to signal interest alignment. The consistent finding that the determinants of managerial investment are not the same for solo and team managed funds highlights the greater visibility and accountability of solo managers. Moreover, the substantially greater coefficients found in the team managed setting for the impact on levels of ownership

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[9] The Tobit model is appropriate here as the reported value of managerial investment is presumed to be the desired value of managerial investment. If the desired value of managerial investment is negative than it is reported as a zero investment.

of lagged fund performance, expense fees and fund size suggest that managers at team managed funds are more likely to chase past performance and that they may face greater pressure to signal incentive alignment. We will explore later if these are credible signals of incentive alignment or if they are offset by the personal portfolio considerations.

4. The impact of managerial ownership on performance

Fund performance may be associated systematically with managerial ownership. However, depending on the nature of how managers perceive their own investments and how investors respond to the disclosures of these investments, it is unclear a priori whether fund performance would be systematically positively or negatively related to managerial investment. As Kacperczyk, Nieuwerburgh, and Veldkamp (2014) show that managerial skill may be time-varying, managers with better track records may sell their investments to lock in gains, thus causing the observed year-end ownership data to be downward biased. We therefore use lagged ownership levels in empirical analysis of fund performance.[10]

4.1. Model

First, the basic panel data model to examine how fund performance of fund i in year t is affected by managerial ownership in the prior year is:

$$Performance_{i,t} = \beta_0 + \beta_1 Ownership_{i,t-1} + \beta_2 Expense\ ratio_{i,t} + \beta_3 Fund\ age_{i,t} + \beta_4 Fund\ size_{i,t-1} + \beta_5 Board\ size_{i,t}$$
$$+ \beta_6 Board\ independence_{i,t} + \beta_7 Fund\ family\ size_{i,t} + Fund\ family\ FE + Year \times Objective\ FE$$
$$+ Management\ team\ FE + \varepsilon_{i,t}. \qquad (4)$$

Fund performance is measured separately as excess returns and as alpha to capture different dimensions of fund performance relative to the market.

The focal independent variable, ownership, is operationalized in three different ways for separate analyses of this model. First, the estimated lagged dollar value of the ownership stake is scaled as a percent of assets under management in the fund that year to capture the magnitude of the managerial investments. Second, the assumed value of managerial ownership may be biased due to the fact that these values are estimated as the midpoints of unevenly sized bands. We therefore use dummy values for each bin instead of the estimated values. Finally, a dummy for managerial non-ownership is used to test a complementary theory: if managerial investment has an impact, then does managerial non-investment have the opposite effect? This dummy variable takes the value of 1 any time the average managerial investment in the fund is $0. The second and third measures of managerial ownership are used in robustness tests.

The expense ratio, fund age, fund size and fund family size are included in the model to capture how known fund characteristics affect the fund's performance. Board size and independence are included to capture how well the manager is monitored on a regular basis. All models include fund family fixed effects to capture management policy structures, interactive year-fund objective fixed effects to control for the fund's competitive environment, and management team fixed effects to capture individual managerial characteristics. Errors are clustered at the fund family level to reflect potential coordination of policies within each family.

The model is first estimated for the full dataset in Section 4.2. Next we examine the impact of changes in managerial investment levels (Section 4.3) and by different types of funds (Section 4.4). Next, in Section 4.5 we explore the impact of the financial crisis. Throughout these rounds of analysis, a positive estimated coefficient for the focal variable of interest, managerial ownership, could be interpreted as an alignment of interests. That is, in this round of analysis we examine our third hypothesis:

H3. $\widehat{\beta_1} > 0$ will signal that fund performance is improved by a greater degree of managerial investment, which proxies for managerial alignment with investor interests.

4.2. Baseline results

We begin by examining the broad relationship between mutual fund performance and managerial ownership (Table 3) where managerial investments are scaled by fund size. Fund performance is measured in two ways: as buy and hold returns (Models 1–6), and then as alpha using a four factor model as per Khorana et al. (2007) (Models 7–12). There is limited evidence that solo managed funds have higher performance due to higher levels of managerial investment (Model 2) but this does not persist once non-investors are excluded from the sample (Model 5) and is not present when performance is measured as alpha (Models 8 and 11). However, there is consistent evidence that team managed funds have lower performance due to higher levels of managerial investments (Models 3, 6, 9 and 12).

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[10] Qualitatively similar results are obtained if contemporaneous ownership levels are used instead.

On average, when all funds are examined together, the effect on performance of managerial investment appears negative (Models 7 and 10) which reflects the strongly significant negative effect among team managed funds even in the absence of non-investors. We note that the results are still observed when we conduct sub-sample analysis in which non-investor managers are excluded (Models 4–6 and 10–12). Altogether, these results suggest that the impact of managerial ownership may be more meaningful when a fund has a solo manager, who may feel a greater need to signal incentive alignment.

Our results suggest that when a fund is solo managed, the level of investment can serve as an informational signal for investors, which is consistent with Evans (2008) and the alignment of interests hypothesis.[11] That the opposite result is obtained for team managed funds suggests the impact of managerial investment depends upon managers believing their individual efforts can be identified and rewarded by investors. This result contrasts sharply with the earlier findings of Khorana et al. (2007) that fund performance and managerial investments were positively related among both solo and team-managed funds. On the other hand, the negative coefficient on managerial ownership in team managed funds is consistent with the findings of Kumlin and Puttonen (2009).

We see now that the effect on fund performance of managerial investments depends upon how the managerial investments affect the daily performance of the fund. Given that solo managed funds have a positive relationship between fund performance and managerial ownership while team managed funds have a negative relationship, we argue that the incentive alignment story holds at solo managed funds but not for team managed funds. Rather, these results suggest that when managers co-lead a fund, they are more likely to chase past performance and thus the managerial investment stakes are negatively related to subsequent fund performance.

We now interpret the estimated coefficients on the control variables, as reported in Table 4. Expense ratios are generally insignificantly related to excess returns. Older funds do appear to have slightly lower returns although this is not observed consistently.[12] We find that fund performance is negatively related to fund and fund family sizes, consistent with a number of studies that have found an inverse relation between performance and fund size (e.g., Adams, Mansi, & Nishikawa, 2011; Yan, 2008).

Mutual fund boards have limited responsibilities, chiefly relating to the continuity and terms of fund adviser contracts. Thus, the finding that larger boards are often associated with slightly higher returns may suggest that the larger board size leads to greater managerial scrutiny and thus less extreme investments. While Ding and Wermers (2009) found evidence of better performance by funds with more independent boards, Ferris and Yan (2007) found no relationship between board independence and performance. We find limited evidence that fund performance is slightly higher for funds with more independent boards.

All results are robust to the exclusion of funds where managerial tenure is less than two years. This threshold was chosen in order to ensure managers would have disclosed ownership levels at least twice, thus permitting identification of how managers changed their levels of investment.

4.3. Alternative explanations

To begin reconciling these results with those reported previously by Khorana et al. (2007) and Evans (2008), we first attempt to identify whether there is a non-linearity to the relationship between fund performance and managerial ownership by examining the separate impact of each level of managerial investment. The advantage of this procedure is that no assumptions are needed regarding the true level of an individual manager's ownership stake. It is also possible that managers believe investors make asset allocation decisions based on the disclosure of managerial investments. If that is the case then fund managers may game the system by investing at or near the bounds of a range, particularly at the lower bound. We therefore use a set of dummy variables to denote each interval of disclosed managerial investment.[13] This set of results reveals that there is no consistent relationship between fund performance and managerial investment, which suggests that a fund's performance does not reflect the magnitude of the manager's investments. Thus, the fact that we observe high levels of managerial investment by some managers may reflect a fund family's employment policies, or, perhaps, that more conservative investment strategies are adopted by managers after investing personal funds in the mutual fund.

Next, complementary evidence is obtained from an examination of the impact of managerial non-investment. If managerial investment is consistently associated with lower fund performance, than managerial non-investment should be associated with insignificantly different or stronger fund performance. However, we find fund performance is not affected by the manager's decision to not invest in the fund (Appendix Table 1).

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[11] Evans reports (footnote 16) that the positive relationship between fund performance and managerial investment is identified only when managerial investments are lagged, not contemporaneous. However, while we lag managerial ownership by one year in all results reported herein, all results are similar when we use contemporaneous levels of managerial ownership.

[12] While older funds tend to be larger funds, these two variables are not overly correlated in this sample (correlation = 0.22).

[13] These results can be obtained from the authors.

Table 4

Fund performance and managerial investment. This table reports ordinary least squares regressions results in which the fund's performance [measured using annual returns or alpha] is the dependent variable. Alpha is the abnormal fund return estimated using a four-factor model. The dependent variable, performance, is measured as buy and hold returns in Columns 1–6 and as alpha in Columns 7–12. In all models shown in this table, managerial investment is estimated as the mid-point of each disclosure range and as the lowest possible value for the largest range (more than $1 million) and then divided by total fund size. Total ownership is thus the value of all managerial investments in a fund as a percentage of assets under management. Fund performance is explained using lagged managerial ownership, expense fees, fund age, lagged fund size, board size and independence, and family size. Year-fund objective, fund family and managing team fixed effects are included in all regressions. Standard errors are clustered by fund family and are reported in parentheses.

	Performance measured as annual returns						Performance measured as alpha					
	All funds			Exclude non-owners			All funds			Exclude non-owners		
	1	2	3	4	5	6	7	8	9	10	11	12
	Baseline	Solo managed	Team managed	Baseline	Solo managed	Team managed	Baseline	Solo managed	Team managed	Baseline	Solo managed	Team managed
Lagged total ownership	−32.25	63.70**	−106.7***	−40.41	55.22	−109.3***	−94.09**	−20.34	−149.7***	−105.1***	−27.21	−152.4***
	(66.98)	(28.59)	(22.50)	(65.29)	(38.82)	(23.43)	(40.69)	(27.19)	(19.75)	(36.91)	(41.56)	(22.82)
Expense ratio	0.51	0.48	(0.22)	(0.62)	(0.57)	(0.91)	(1.49)	(1.31)	(0.19)	(1.20)	(1.25)	0.39
	(1.298)	(1.244)	(3.160)	(1.241)	(1.286)	(3.440)	(1.047)	(1.391)	(2.161)	(0.957)	(1.284)	(2.186)
Fund age	0.009	−0.008	−8.29E−05	0.002	−0.006	−0.051**	−0.011	0.019	−0.045	−0.002	0.031	−0.213***
	(0.024)	(0.050)	(0.024)	(0.043)	(0.071)	(0.022)	(0.027)	(0.045)	(0.067)	(0.039)	(0.056)	(0.043)
Lagged fund size	−0.072	0.094	−0.19	−0.254	−0.066	−0.303	−0.788**	−0.663*	−1.193***	−1.060**	−0.805	−1.256***
	(0.252)	(0.348)	(0.369)	(0.371)	(0.567)	(0.416)	(0.306)	(0.371)	(0.432)	(0.464)	(0.703)	(0.466)
Board size	−1.808	−2.916*	2.528	1.265	−0.532	5.11	22.71***	23.57***	8.677	44.82***	42.54***	19.94*
	(1.322)	(1.612)	(7.538)	(3.108)	(3.891)	(8.842)	(8.292)	(7.930)	(7.192)	(14.910)	(13.790)	(7.703)
Board independence	−4.365	−6.055**	27.75	−3.933	−6.03	−37.56	20.96	23.40*	−587.6**	51.30**	51.15***	14.87
	(3.422)	(2.603)	(198.200)	(5.098)	(4.566)	(28.450)	(12.870)	(13.02)	(253.00)	(20.26)	(17.94)	(21.79)
Fund family size	−1.056*	−1.221	−1.033	−1.152*	−0.951	−1.133	−2.261**	−2.261	−2.113**	−2.962***	−2.597*	−3.467**
	(0.562)	(0.916)	(0.779)	(0.654)	(0.886)	(1.353)	(0.904)	(1.378)	(0.975)	(1.053)	(1.301)	(1.373)
Intercept	13.97**	24.76**	−23.03	12.66	17.9	42.07**	−26.85	−35.82	601.8**	−81.84**	−100.7**	−4.372
	(6.341)	(11.60)	(190)	(9.446)	(15.44)	(16.55)	(25.38)	(33.56)	(249)	(39.61)	(48.45)	(16.78)
Adjusted R^2	0.772	0.76	0.796	0.772	0.77	0.779	0.899	0.881	0.927	0.893	0.872	0.924
N	1080	582	498	917	478	439	1080	582	498	917	478	439

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

4.4. Changes in managerial ownership levels

The broad literature on insider ownership in corporations suggest that changes in levels of insider ownership may be informative of insiders' expectations for subsequent corporate performance as insider sales could reflect advance knowledge of relevant information. Alternatively, such ownership changes might simply reflect personal financial considerations. Cohen, Malloy, and Pomorski (2012) distinguish between routine and opportunistic insider trades in the context of publicly listed firms by examining the frequency and timing of past ownership changes. This approach cannot be used in the mutual fund context because while insider transactions in publicly listed firms must be reported within a narrow time frame measured in days, insider transactions in mutual funds are not reported at all. Instead, the aggregate level of managerial ownership in a mutual fund is disclosed just once annually.

In an attempt to capture the informational flavor of insider sales, three dummy variables are now created. The first is called "change" and takes the value of 1 if a manager changed the level of ownership in a fund in a given year, and the next two variables, "increase" and "decrease" take the value of 1 if and only if the level of managerial ownership in a given year increased or decreased, respectively. For example, to measure performance over the calendar year 2008 (January 1, 2008–December 31, 2008), we would use the change in ownership from December 31, 2006 to December 31, 2007.

We now conduct two further rounds of analyses: the dummy variable for change of ownership level is included in the regression model, and second this variable is replaced separately with dummies for increased or decreased ownership levels.[14] Our empirical model is thus rewritten as

$$Performance_{i,t} = \beta_0 + \beta_1 Ownership_{i,t-1} + \beta_2 Change_{i,t-1} + \beta_3 Expense\,ratio_{i,t} + \beta_4 Fund\,age_{i,t} + \beta_5 Fund\,size_{i,t-1}$$

$$+ \beta_6 Board\,size_{i,t} + \beta_7 Board\,independence_{i,t} + \beta_8 Fund\,family\,size_{i,t} + Fund\,family\,FE + Year$$

$$\times\,Objective\,FE + Management\,team\,FE + \varepsilon_{i,t} \tag{5}$$

in order to permit testing of our fourth hypothesis.

H4. $\widehat{\beta_1} > 0$ and $\widehat{\beta_2} \neq 0$ will signal that fund performance is improved by a greater degree of managerial investment, and that the extent of this improvement is moderated by whether the managerial investment is rising or falling.

We also use this model to test the fifth hypothesis where the change in ownership variable is replaced with a dummy for increase (decrease) in investment levels.

H5. $\widehat{\beta_1} > 0$ and $\widehat{\beta_2} > 0$ ($\widehat{\beta_2} < 0$) if we use the increase (decrease) dummy.

The new baseline results, reported in Table 5, again reveal that fund performance is higher when a solo team manager invests more (Model 2) and lower when total ownership is higher at team managed funds (Model 6). Moreover, we now find that changes in the level of ownership are not associated with performance, which is contrary to what is reported in the literature on insider purchases and sales at corporations.

We now investigate the related question of whether increases and decreases in the level of managerial investment cause symmetric or asymmetric changes in fund performance. These questions are addressed by separate analyses in which a dummy variable for increase or decrease in managerial investment are added to the estimation equation (Table 6). Using corporate data, Lakonishok and Lee (2001) and Jeng, Metrick, and Zeckhauser (2003) report that insider purchases are informative of subsequent performance while insider sales are not. This suggests that the "increase" dummy would have a positive and statistically significant coefficient, and the "decrease" dummy would be statistically insignificant. We find no support for this hypothesis with the "increase" and "decrease" dummies both statistically insignificant for all specifications. These results suggest that in general the level of managerial investment is associated with fund returns and the stability of the level of investment does not have an effect. Thus, the general result based on corporate performance may not carry over wholesale into the mutual fund universe.

We assume that year-to-year changes in managerial ownership reflect active changes in investment. However, it is possible that the recorded year-to-year change in managerial ownership levels reflects a passive change whereby the value of the manager's ownership changes in direct proportion to the fund's performance in a given year.[15] Thus, a manager's ownership stake could jump from one of the SEC recording bins to the next following a good year or vice versa. We therefore examine whether ownership increases (decreases) are concentrated in the years when the fund has good (bad) performance. First, the univariate data show that while 77% of the years in which managerial ownership changes from the prior year are years in which the fund had positive returns, 56% of these observations were years when managerial ownership increases and 44% were decreases. Similarly, of the 23% of the years when managerial ownership changed and the fund had poor performance (as captured by negative returns), 49% of managerial stakes increased while 51% decreased. Thus, the univariate data suggest changes in managerial investments are not driven by fund performance.

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[14] We also conducted separate sub-sample analyses of funds where managerial investment increased or decreased. These results are similar to those included in the paper and are therefore not reported herein, but are available upon request.

[15] We thank a referee for proposing this test.

Table 5

The impact of changes in managerial investment on fund performance. This table reports ordinary least squares regressions results in which the fund's performance [measured using annual returns or alpha] is the dependent variable. Alpha is the abnormal fund return estimated using a four-factor model. The dependent variable, performance, is measured as buy and hold returns in Columns 1–3 and as alpha in Columns 4–6. In all models shown in this table, managerial investment is captured as the mid-point of each disclosure range and as the lowest possible value for the largest range (more than $1 million) and then divided by total fund size. A dummy variable, change in ownership level, denotes any fund-year observation in which the average value of managerial ownership was different from that of the prior year. Total ownership is the value of all managerial investments in a fund as a percentage of assets under management while change is based on average managerial investments in a fund. Fund performance is explained using lagged managerial ownership, the change in ownership level dummy, expense fees, fund age, lagged fund size, board size and independence, and family size. Year-fund objective, fund family and managing team fixed effects are included in all regressions. Standard errors are clustered by fund family and are reported in parentheses.

	Performance measured as annual returns			Performance measured as alpha		
	1 Baseline	2 Solo managed	3 Team managed	4 Baseline	5 Solo managed	6 Team managed
Lagged total ownership	18.21	45.03*	−339.2	−70.91	−23.86	−637.6***
	(53.86)	(23.11)	(254.40)	(53.03)	(28.36)	(102.20)
Change in ownership level	0.084	0.506	−0.01	−0.172	−0.176	−0.045
	(0.226)	(0.361)	(0.308)	(0.209)	(0.295)	(0.274)
Expense ratio	0.61	0.348	−0.356	−1.364	−1.284	−0.645
	(1.248)	(1.19)	(3.347)	(1.021)	(1.364)	(2.019)
Fund age	0.004	−0.001	−0.001	−0.015	0.018	−0.04
	(0.023)	(0.047)	(0.025)	(0.026)	(0.043)	(0.072)
Lagged fund size	0.061	0.027	−0.173	−0.679**	−0.666*	−1.355**
	(0.232)	(0.343)	(0.399)	(0.296)	(0.373)	(0.52)
Board size	−2.409**	−1.861	1.986	21.99***	23.36***	8.219
	(1.042)	(1.827)	(8.069)	(7.972)	(7.831)	(7.227)
Board independence	−4.898	−4.741*	39.63	20.48	23.11*	−601.0**
	(3.149)	(2.634)	(194.4)	(12.47)	(13.0)	(258.8)
Fund family size	−1.075*	−1.142	−1.07	−2.287**	−2.276	−2.156**
	(0.57)	(0.934)	(0.786)	(0.919)	(1.394)	(0.978)
Intercept	14.46**	20.58*	−33.85	−25.89	−34.88	617.6**
	(5.981)	(12.32)	(185.2)	(24.63)	(33.65)	(255.1)
Adjusted R^2	0.771	0.76	0.792	0.896	0.88	0.927
N	1078	582	496	1078	582	496

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

Alternatively, we could argue that the only years in which the observed change in managerial ownership truly reflects managerial preferences are the years where the manager invests for the first time ("new owner") or where the manager's investments drop to zero ("new nonowner"). We are unable to implement a testing strategy to explore the impact of these observations due to the scarcity of them: just 29 fund-year observations are new owners while 33 observations are new non-owners. Nonetheless, the univariate data are informative. The new owners have an average managerial investment of $386,426 with the range including the lowest and highest bins of recorded managerial ownership. Among, new non-owners, their prior year average managerial ownership level averaged $402,841 and their range also included the lowest and highest bins. We do note that we earlier reported complementary evidence from an analysis of the impact of managerial non-ownership. That is, if ownership aligns managerial interests with that of the fund, non-ownership should cause a divergence. However, as was discussed in Section 4.3, we do not observe any relationship between fund performance and managerial non-ownership.

4.5. Fund type

Certain types of funds (e.g., index funds) have very narrow mandates, and thus managers of these funds may have less discretion with regard to asset selection and portfolio turnover. On the other hand, some fund objectives are sufficiently broad (e.g., equity or international) that the scope for managerial impact might be higher. Finally, the failure rate for mutual funds varies markedly by fund type (Bogle, 2005) and the "window dressing" and market timing scandals have occurred primarily in small caps funds. We therefore use the Lipper fund objective codes to sub-divide the dataset into more homogenous clusters of funds for this round of analysis.

Three types of funds are analyzed separately for robustness: non-index, international or global, and domestic funds. We find that the team managed funds consistently experience lower performance when managerial investments are higher while the impact of investments upon performance is generally non-existent among solo managed funds. These results

Table 6

Asymmetry: the impact of increases or decreases in managerial investment on fund performance. This table reports ordinary least squares regressions results in which the fund's performance [measured using annual returns or alpha] is the dependent variable. Alpha is the abnormal fund return estimated using a four-factor model. The dependent variable, performance, is measured as buy and hold returns in Columns 1–6 and as alpha in Columns 7–12. In all models shown in this table, managerial investment is captured as the mid-point of each disclosure range and as the lowest possible value for the largest range (more than $1 million) and then divided by total fund size. Two dummy variables are included to denote funds that had an increase or decrease in ownership level where an increase (decrease) is a fund-year observation in which the average value of managerial ownership was higher (lower) than that of the prior year. The increase dummy is used in Models 1–3 and 7–9 while the decrease dummy is used in Models 4–6 and 10–12. Total ownership is the value of all managerial investments in a fund as a percentage of assets under management while change is based on average managerial investments in a fund. Fund performance is explained using lagged managerial ownership, the increase or decrease in ownership level dummy variables, expense fees, fund age, lagged fund size, board size and independence, and family size. Year-fund objective, fund family and managing team fixed effects are included in all regressions. Standard errors are clustered by fund family and are reported in parentheses.

	Performance measured as annual returns						Performance measured as alpha					
	1 Baseline	2 Solo managed	3 Team managed	4 Baseline	5 Solo managed	6 Team managed	7 Baseline	8 Solo managed	9 Team managed	10 Baseline	11 Solo managed	12 Team managed
Lagged total ownership	19.64	48.15**	−344.4	18.65	45.26*	−346.5	−71.83	−24.41	−643.7***	−68.98	−23.21	−640.8***
	(53.34)	(22.62)	(254.80)	(54.53)	(26.32)	(263.60)	(53.72)	(27.63)	(98.17)	(51.78)	(27.62)	(108.0)
Increase dummy	0.114	0.646	−0.067				−0.069	−0.12	−0.067			
	(0.261)	(0.458)	(0.304)				(0.205)	(0.375)	(0.266)			
Decrease dummy				−0.032	−0.094	0.072				−0.159	−0.122	0.023
				(0.271)	(0.468)	(0.326)				(0.195)	(0.247)	(0.282)
Expense ratio	0.602	0.35	−0.315	0.617	0.461	−0.298	−1.37	−1.302	−0.597	−1.388	−1.316	−0.619
	(1.243)	(1.209)	(3.3)	(1.255)	(1.267)	(3.308)	(1.017)	(1.37)	(1.999)	(1.038)	(1.397)	(2.034)
Fund age	0.004	−0.004	0.001	0.004	−0.006	0.0004	−0.015	0.019	−0.038	−0.016	0.018	−0.04
	(0.023)	(0.049)	(0.028)	(0.022)	(0.049)	(0.026)	(0.027)	(0.045)	(0.075)	(0.026)	(0.045)	(0.07)
Lagged fund size	0.067	0.04	−0.186	0.06	0.045	−0.185	−0.680**	−0.671*	−1.367***	−0.667**	−0.669*	−1.357***
	(0.231)	(0.34)	(0.403)	(0.23)	(0.336)	(0.406)	(0.291)	(0.369)	(0.515)	(0.291)	(0.371)	(0.506)
Board size	−2.367**	−1.632	2.342	−2.479**	−2.631*	2.175	22.07***	23.44***	8.482	22.16***	23.63***	8.161
	(1.076)	(1.859)	(7.874)	(1.009)	(1.547)	(7.861)	(7.977)	(7.823)	(6.892)	(7.973)	(7.924)	(7.197)
Board independence	−4.82	−4.302	37.05	−5.013	−5.698**	45.63	20.61	23.19*	−599.2**	20.78*	23.49*	−593.9**
	(3.128)	(2.853)	(194.3)	(3.133)	(2.717)	(201.3)	(12.46)	(12.99)	(259.6)	(12.46)	(13.03)	(268.5)
Fund family size	−1.068*	−1.121	−1.071	−1.079*	−1.202	−1.067	−2.283**	−2.27	−2.155**	−2.268**	−2.254	−2.153**
	(0.572)	(0.926)	(0.787)	(0.571)	(0.912)	(0.782)	(0.914)	(1.4)	(0.978)	(0.917)	(1.385)	(0.977)
Intercept	14.24**	19.45	−31.68	14.76**	23.79**	−40.13	−26.23	−35.19	615.6**	−26.72	−36.05	610.6**
	(6.059)	(12.41)	(186.10)	(5.901)	(11.45)	(192.4)	(24.55)	(33.73)	(256.5)	(24.64)	(33.62)	(264.9)
Adjusted R^2	0.771	0.761	0.792	0.771	0.758	0.792	0.896	0.88	0.927	0.896	0.88	0.927
N	1078	582	496	1078	582	496	1078	582	496	1078	582	496

* Significance at 10% level.
** Significance at 5% level.
*** Significance at 1% level.

strongly confirm the findings on how managerial style varies between solo and team managed funds as developed by Bar et al. (2011) and Massa et al. (2010).[16]

4.6. Dynamic panel estimation

The results reported above were all obtained through fixed effects estimation of the panel data model specified in Eq. (4). One potential concern is that the independent variables may be endogenous and that there may also be serial correlation. Flannery and Hankins (2013) examine the impact of such econometric concerns on estimations using corporate finance data. They report that it is generally most efficient to use fixed effects with OLS estimation (as we reported in Sections 4.1–4.5) but that dynamic panel estimation techniques may sometimes be preferable. In that light we also replicate all models analyzed above using Arellano Bond estimation and obtain qualitatively similar results.[17]

5. Conclusion

We examine the determinants of managerial investments and subsequent performance consequences using panel data. This analysis uses data from a period when managers knew ex ante that their investments would be observed, and this may explain why our results both complement and diverge from the results of earlier papers. Chiefly, while Khorana et al. (2007) found managerial investments reflect personal portfolio concerns we find that managerial investments also signal incentive alignment, which is consistent with the Dimmock et al. (2011) argument that managerial investments are simply an asset within the manager's personal portfolio. Next, while Khorana et al. (2007) and Evans (2008) found a positive relationship between fund performance and managerial investments, consistent with the incentive alignment hypothesis, we obtain evidence that this relationship depends critically upon the managerial structure of the fund. That is, solo and team managed funds respond very differently to managerial investments, with the effect positive at solo managed funds and negative at team managed funds due to the visibility and accountability of individual managers.

We thus make four contributions to the literature. First, the literature on managerial investment in mutual funds has thus far used only cross-sectional data from 2005 and presumed that this would be representative of investment levels in subsequent years. By creating a panel dataset spanning four years we are able to document that there is considerable year-to-year variation in the level of managerial investment. Second, we then show that managerial investment reflects both personal portfolio concerns and an alignment of interests with investors. The observed relationship between portfolio manager ownership and fund characteristics is consistent with the hypothesis that more skin in the game increases the alignment of fund managers' interests with those of their shareholders.

Third, the consistent split between the determinants of managerial investments at solo and team managed funds highlights the importance of clear chains of responsibility. It suggests that managers who feel accountable – that is, solo managers or visible team managers – may behave differently from managers who feel they wield less power at the fund or receive less credit for the fund's performance. Thus, we extend the growing evidence that named fund managers, particularly solo managers, achieve more extreme fund returns and believe that their actions are more easily observed by investors (e.g., Bar et al., 2011; Massa et al., 2010).

Finally, we find that fund performance is higher when solo managers invest in their own funds and significantly lower when team managers co-invest in the funds, and that this result is robust across multiple specifications. The observed relationship between portfolio manager ownership and fund characteristics is inconsistent with the hypothesis that more skin in the game increases the alignment of fund managers' interests with those of their shareholders. The results reported herein suggest that managerial investment may be an inefficient marketing tool for a fund, and, from the individual manager's perspective, such an investment may be performance-chasing. The level of managerial investment thus does appear to carry predictive power regarding fund performance although the directionality is not what the SEC had expected in mandating the disclosure of these investments.

The results reported herein also strongly parallel those of the broad empirical literature on the relationship between managerial ownership and firm performance even as the mutual fund and corporate settings differ along multiple dimensions. Although most studies on managerial ownership in the corporate context have found a positive relationship indicating managerial alignment at low ownership levels, many have also found that the relationship is non-monotonic (e.g., McConnell & Servaes, 1990; Morck, Shleifer, & Vishny, 1988). On the other hand, Demsetz and Villalonga (2001) find no relationship between managerial ownership and firm performance.

While we document a strong relationship between performance and managerial ownership, we do not determine the direction of causality. It is unclear whether better intra-year fund performance causes managers to decrease their year-end ownership stake and, presumably, diversify their investments, consistent with the idea that some managers have greater skills (Chevalier & Ellison, 1999) and Kacperczyk et al. (2014)'s finding that the top managers are able to time their purchases and sales to lock in gains and minimize losses. Alternatively, on the contrary, managerial over-confidence may lead managers to invest more in their funds and then refrain from selling stocks (e.g., Malmendier & Tate, 2005).

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[16] These results are available upon request.
[17] These results are not reported for space reasons but are available upon request.

Appendix A.

Table A1

Table A1

Fund performance and managerial non-investment. This table reports ordinary least squares regressions results in which the fund's performance [measured using annual returns or alpha] is the dependent variable. Alpha is the abnormal fund return estimated using a four-factor model. The dependent variable, performance, is measured as buy and hold returns in Columns 1–3 and as alpha in Columns 4–6. In all models shown in this table, managerial non-investment is captured as a dummy variable to reflect $0 investment from all managers in a fund. Fund performance is explained using lagged managerial non-ownership dummy, expense fees, fund age, lagged fund size, board size and independence, and family size. Year-fund objective, fund family and managing team fixed effects are included in all regressions. Standard errors are clustered by fund family and are reported in parentheses.

	Performance measured as annual returns			Performance measured as alpha		
	1 Baseline	2 Solo managed	3 Team managed	4 Baseline	5 Solo managed	6 Team managed
Non-investment dummy	−0.2	−0.311	0.103	0.025	−0.222	−0.216
	(0.473)	(0.520)	(0.935)	(0.433)	(0.558)	(0.699)
Expense ratio	0.557	0.33	0.166	−1.254	−1.303	0.425
	(1.28)	(1.291)	(3.019)	(1.007)	(1.335)	(2.461)
Fund age	0.006	0.002	−0.012	−0.021	0.017	−0.065
	(0.024)	(0.048)	(0.023)	(0.026)	(0.043)	(0.06)
Lagged fund size	0.023	−0.067	0.212	−0.522[*]	−0.600[*]	−0.655
	(0.24)	(0.337)	(0.507)	(0.276)	(0.332)	(0.61)
Board size	−2.825	−2.745	1.367	21.40[***]	22.69[***]	7.739
	(1.978)	(2.741)	(8.692)	(7.969)	(7.613)	(7.982)
Board independence	−5.649	−6.204	90.01	19.88	22.17[*]	−485.8[*]
	(4.134)	(4.119)	(217.9)	(12.33)	(12.61)	(252.2)
Fund family size	−1.076[*]	−1.124	−1.086	−2.307[**]	−2.268	−2.202[**]
	(0.572)	(0.913)	(0.817)	(0.921)	(1.371)	(1.048)
Intercept	16.14[**]	24.17[*]	−86.19	−25.55	−32.87	498.1[**]
	(7.863)	(14.48)	(208.5)	(24.47)	(32.59)	(246.6)
Adjusted R^2	0.771	0.771	0.771	0.771	0.771	0.771
N	1080	582	498	1080	582	498

[*] Significance at 10% level.
[**] Significance at 5% level.
[***] Significance at 1% level.

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