Skin or Skim? Inside Investment and Hedge Fund Performance*

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Abstract

Using a comprehensive and survivor bias-free dataset of US hedge funds, we document the role that inside investment plays in managerial compensation and fund performance. We find that funds with greater investment by insiders outperform funds with less "skin in the game" on a factor-adjusted basis and exhibit high return persistence. These results suggest that managers earn outsize rents by operating trading strategies further from their capacity constraints when managing their own money. Our findings have implications for optimal portfolio allocations of institutional investors and models of delegated asset management.

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Delegated asset managers are commonly seen as being compensated through fees imposed on outside investors. However, access to profitable, but limited, internal investment opportunities can also be a form of compensation for managers. Consider the hedge fund industry, which manages more than $3 trillion in assets, of which $400 billion can be attributed to investments from insiders and related parties.[1] This large allocation of insider capital suggests that an important, and previously overlooked, component of hedge fund compensation is the channel of returns on personally invested capital. This paper examines insiders' decisions to allocate private capital to funds under their control, and the impact of this "skin in the game" on returns received by outside investors.

The role of managerial discretion over internal capital allocation across funds can be seen in the case of Renaissance Technologies.[2] The company's Medallion Fund is one of the most successful funds in history and is predominately a fund for insider investment (as we confirm in Figure I). News accounts of Renaissance Technologies emphasize how the company prioritizes strategies with greater excess returns and lower scalability in the Medallion Fund, while shifting strategies with lower return profiles (for reasons of scalability or staleness in execution) to other funds in the family characterized by greater outside investor participation and lower fees. Discretion over private capital investment can be seen in many fund families (as we show in Figure II), and has been the subject of considerable investor and regulatory interest.[3]

This paper first proceeds by extending the Berk and Green (2004) framework to include several key features that better capture institutional features of compensation structures in hedge funds. In our model, managers face capacity constraints in determining the optimal level of invested capital, can choose to endogenously create new funds with different strategies, and can allocate internal capital across funds. When managing personal capital,

[1] For the size of the industry, see figures provided by the Securities and Exchange Commission: https://www.sec.gov/reportspubs/special-studies/im-private-fund-annual-report-081514.pdf Inside investment is estimated using the inside ownership measure from Form ADV.

[2] See, for instance https://www.bloomberg.com/news/articles/2016-11-21/how-renaissance-s-medallion-fund-became-finance-s-blackest-box

[3] See Mary Jo White, SEC Chair on Oct. 16, 2015: "Examiners observed that some hedge fund advisers may not be adequately disclosing conflicts related to advisers' proprietary funds and the personal accounts of their portfolio managers. Examiners saw, for example, advisers allocating profitable trades and investment opportunities to proprietary funds rather than client accounts in contravention of existing policies and procedures." Also see BlueCrest: https://www.ft.com/content/4eb275f2-a4dd-11e5-a91e-162b86790c58.

managers internalize the fact that raising additional capital is dilutive to existing investors in the sense that it causes the strategy to operate closer to its capacity constraint, lowering the returns for all existing investors.

This basic framework yields several key predictions about the relationship between inside investment and fund performance. We predict that when firms face a menu of investment strategies with different excess return and scalability: 1) Inside investment will be concentrated in particular funds within a family; 2) Funds with a greater percentage of inside investment are smaller, as they are further from their capacity constraint; and 3) Because they are operated further from their capacity constraint, funds with greater inside capital outperform on a risk-adjusted basis. Taken together, our model predicts that greater inside investment better aligns incentives between managers and investors and induces managers to limit the size of their funds, resulting in higher alpha even in equilibrium.

We examine these predictions on the relationship between inside investment and fund returns through a novel usage of a comprehensive and survivor bias-free dataset, Form ADV, provided by the Securities and Exchange Commission (SEC). This regulatory form requires all hedge funds with assets over $100m to disclose the fraction of fund assets held by insiders yearly at the fund level. We merge Form ADV data with numerous commercially available datasets on hedge fund returns to understand the connection between "skin in the game" and fund returns.[4]

We analyze the relationship between inside investment and hedge fund performance using a panel regression. Using both the Fama and French (1992) and Carhart (1997) factors, as well as the Fung and Hsieh (2004) seven factors, we control for factor exposure of returns at the fund level. We find that inside investment—as measured either by percentage or gross investment—remains an important predictor of excess returns even when comparing different funds *within* firms. An investor who changes their allocation from a fund with the mean inside investment to one with a standard deviation increase in inside investment will see a rise in excess returns of 1.46% annualized. This significant and economically large magnitude indicates that inside investment is an important, and previously neglected, cross-sectional predictor of hedge fund returns.

[4]Including HFR, CISDM, eVestment, BarclaysHedge, and EurekaHedge.

Having established the superior performance of insider investment funds, we investigate the main drivers of this result by examining standard return predictability and fund flow-performance specifications. We find that funds with little inside capital operate according to standard Berk and Green (2004) logic: good returns are followed by large fund inflows, so there is little predictability in excess returns. However, we find that funds with greater inside investment do not follow this pattern. For this subset of funds, very high returns do *not* lead to excess inflows; instead excess returns appear to be substantially persistent for this subgroup of funds. This pattern is consistent with the idea that that managers manage and limit fund inflows into funds with greater amounts of their own managerial capital in order to operate the fund further away from its capacity constraint. The joint behavior between fund flows, performance, and inside investment suggests that capacity constraints are an important driver of hedge fund performance; and that managers of hedge funds choose to deploy less capital (and so gain greater alpha) when their own personal capital is involved.

Next, we examine the heterogeneity across funds. Consistent with the role of managerial discretion over capacity constraints, our results are driven by funds engaged in specialist roles, arbitrage strategies, and equity funds that might be expected to deploy trading strategies subject to diminishing returns to scale. We also investigate alternate explanations for our result, such as superior information on the part of fund managers and agency conflicts. Our tests suggest that these alternate factors are unlikely to fully explain our result. While we cannot fully rule out the relationship between inside investment and other fund attributes, understanding inside investment through the lens of fund capacity constraints appears to best explain our results.

Finally, we investigate whether insiders are able to "cream skim" outside investors through fund formation and strategic capital allocation. Specifically, we use an event study framework to analyze firms that begin as a single-fund firm and create a new fund. This transition is illustrated in Figure III. The generation of a second fund provides a test case to analyze the effects of inside investment on fund performance, because insiders have a discretionary choice of private capital allocation: 1) Keep their money in the old fund, and invite outsiders to invest in the new fund; or 2) Move internal capital into the new

fund. The two cases present differing predictions on the performance level of the initial fund: when inside capital remains in the original fund, we expect the original fund to outperform relative to when insiders move their capital out of the newly formed fund. We find evidence consistent with this hypothesis, suggesting the possibility of "skimming" motives on the part of fund managers.

Our results come with several caveats which we emphasize here. Though we establish inside ownership as an important predictor of excess returns and highlight the role for capacity constraints in understanding this result from a theoretical and empirical perspective, it is possible that other mechanisms operate in addition to the ones we emphasize. We discuss in section II.C possible mechanisms behind our result. It is possible that inside investors are better informed about the skill of various fund managers and deploy capital accordingly; alternatively, high-skin-in-the-game funds may be less subject to agency conflicts and engage in superior research analysis (see Berk and van Binsbergen (2017)). Inside investment may also serve as a signal to outside investors by providing costly evidence of managerial commitment. Finally, it is possible that higher returns from high skin-in-the-game funds are a proxy for some risk factors (unrelated to either the Fama-French, Carhart, or Fung-Hsieh factors, such as tail risk as mentioned in Agarwal et al. (2017)). While more research is needed to establish the precise reasons for the outperformance of high inside-investment firms, we emphasize that our work provides novel evidence that managerial ownership is an important predictor of cross-sectional fund performance in ways consistent with a basic model including capacity constraints and inside investment.

Our work is related to literature assessing the role of inside investment as a predictor of cross-sectional returns among mutual funds. The papers closest to ours are Khorana et al. (2007), Evans (2008), Chen et al. (2008), and Cremers et al. (2009) Ibert (2017), which find evidence that greater insider investments improve mutual fund performance. By contrast, we explore inside investment in the context of hedge funds, which feature substantially greater amounts of internal investments in a less regulated industry. Other papers investigating skin in the game in hedge funds include Ackermann et al. (1999), which documents substantial managerial investment in hedge funds and Qiu et al. (2016), which finds no relationship between inside investment and hedge fund failure rates. Papers examining

hedge fund personal stakes and outcomes include Brown et al. (2008), which uses a single cross-section of hedge fund inside investment and finds that high-skin-funds exhibit worse returns and are more likely to exhibit conflicts of interest. Ozik and Sadka (2015) analyzes the role of managerial investment on fund flows. Our paper differs by providing a much more comprehensive series of managerial investments drawn from regulatory filings, and investigating the role of inside investment in a complete dynamic panel of hedge funds. We find substantial evidence that high-skin-funds outperform, and explore the mechanisms of this result within a Berk and Green (2004) style context.

Other research in mutual funds has investigated the role of skill and ability of delegated asset managers. Recent papers such as Kosowski et al. (2006), Berk and van Binsbergen (2015), Koijen (2014) find evidence of mutual fund managerial skill in portfolio selection, with Berk and van Binsbergen (2015) emphasizing a value-add measure of managerial skill and Koijen (2014) adopting a structural approach. Fama and French (2010) suggests instead that few managers outperform on a factor-corrected basis, while French (2008) suggests delegated asset managers add little value. This paper instead focuses on the managerial skills of hedge funds managers, and find suggestive evidence that high-skin-funds systematically outperform on a risk-adjusted basis.

This paper also relates to the literature examining the role of fund families. Related papers include Massa (2003), which documents strategy differentiation across funds in a family; Berk et al. (2017), which examines the allocation of talent across funds within a family; while Sialm and Tham (2017) analyzes the relationships between the performance of funds and their overall management companies. Our research expands on this literature by highlighting the differential allocation of internal capital within a family of funds and the link to within-family performance.

Our work is also related to the literature on financial compensation and incentives. Previous papers have explored the compensation contract structure of investment advisors (such as Das and Sundaram (2002)), or investigated empirically the relationship between manager pay and performance (such as Ibert et al. (2017), and Ma et al. (2016)). The closest papers to ours examine the role of managerial contract structure on hedge fund performance, such as Agarwal et al. (2009) and Burasachi et al. (2014), and the connection between

managerial compensation and fund size (such as Yin (2016)). Relative to this literature, we emphasize that managers have another option for personal compensation—investing their own private capital—and examine both the theoretical and empirical implications.

Underpinning the motivation of this paper, our model and analysis of managerial skill is also related to the equilibrium modeling approach of Berk and Green (2004), and Berk and van Binsbergen (2017), evidence on capacity constraints, as in Ramadorai (2013), and funding constraints as in Homberta and Thesmar (2014). We build on this literature by by decomposing capital contributions into insider and outsider sources and including the returns on internally invested capital as a part of the overall compensation of the fund manager. Our work is also related to the information spillover model in Glode and Green (2011), which also focuses on hedge funds and examines return persistence in a theoretical context.

In the context of the literature on financial intermediation compensation, we emphasize that access to superior investable opportunities helps explain why financial intermediaries—particularly hedge funds—appear to be so highly compensated even in the face of stiff competition. Our findings are relevant in understanding the recent rise in inequality among the top 1%, who are disproportionately financial managers of capital (See Kaplan and Rauh (2013), Philippon and Reshef (2012), and Alvaredo et al. (2013)).

Finally, our work also contributes to the broader literature on ownership, firm performance, and agency conflicts. Berle and Means (1932), Jensen and Meckling (1976), Fama and Jensen (1983), and Holmstrom (1985) have analyzed the consequences of firm capital structure and internal ownership on governance and agency conflicts as well as firm performance. Demsetz and Lehn (1985) and Himmelberg et al. (1999) find little evidence that managerial ownership affects firm performance, while Randall et al. (1988) emphasize the non-monotonicity of the relationship between board of directors' ownership and firm performance. Porta et al. (2002) find that corporate ownership is more concentrated in climates of weaker investor protection. Our work extends this literature, which has largely analyzed non-financial companies, by focusing on delegated asset managers and emphasizing the conflict between managers and investors regarding the internal capital structure

and fund formation decisions of hedge fund managers in the presence of capacity constraints. Decisions of funds to open up additional funding to outside capital (in order to earn management fees) have material consequences on the returns of existing investors. We find, both in our model and in the data, that firms extract considerable surplus through the allocation of internal capital to funds which do not hit their capacity constraint, representing a potential conflict of interest between hedge fund managers and investors.

The remainder of the paper is organized as follows. Section 1 outlines our data and empirical strategy, and also comments briefly on the nature of corporate governance in hedge funds as well as mechanisms. Section 2 presents our main results, while Section 3 concludes. The Appendix contains further details on our model and auxiliary results.

I Data and Empirical Strategy

I.A Data

Our dataset combines regulatory Form ADV filings with commercial hedge fund return series from HFR, eVestment, BarclaysHedge, Eurekahedge, and CISDM. Form ADV is a required regulatory disclosure form used to register with both the Securities and Exchange Commission (SEC) and state securities authorities. Reporting under Form ADV is governed by the US Investment Advisers Act of 1940, as amended by Dodd-Frank. Disclosure requirements under this form have changed over the years. In the period from 1996–2011, funds with assets under management below $25 million, or fewer than 15 clients, were generally exempt from registration. Hedge funds in this period frequently used complex fund structures to evade disclosure even when assets were above this threshold.

Private fund reporting increased in 2005, when the SEC went to court to force funds to count all investors as clients. Though courts ultimately struck down the SEC's interpretation, disclosure through Form ADV increased throughout this period. Our primary sample is formed after 2011, after changes in required disclosure imposed by Dodd-Frank. Under prevailing regulations, all investment advisors—including hedge funds—are now required

to file a Form ADV with the SEC if they (1) reach a $100 million threshold for assets under management for a typical fund, (2) reach a $150 million threshold if the firm has only private clients, (3) have over $25 million in assets and are not subject to examination in their home states (states that do not require examination currently include New York and Wyoming). Subsequent to their initial filing, firms must refile once a year (as long as their assets under management exceed $25 million), or if there have been changes in material information since the last filing.

We obtain Form ADV from the SEC over the period 2011–2016. We link Form ADV information together with information on hedge fund returns obtained from a combination of five datasets: HFR, eVestment, BarclaysHedge, Eureka Hedge, and CISDM. We begin the merge with HFR, eVestment and BarclaysHedge, which contain for many firms an SEC identifier common to both the commercial hedge fund datasets and Form ADV. If we do not have an SEC identifier, we next look for close matches (selecting only perfect matches) among firm and fund names in both datasets, after eliminating extraneous stop words (such as LLC, LP, etc.).

Over this period, Form ADV was updated to include questions about the internal investment of their funds. Figure IV shows a sample Form ADV for Renaissance Technologies.[5] Panel A captures firm-level information for the filing firm, Renaissance Technologies LLC. Panel B identifies a specific fund as listed in Section 7.B.(1), in this case Medallion Fund, L.P. Panel C of IV displays the precise question we draw on from Section 7.B.(1), question 14 of Form ADV: "What is the approximate percentage of the *private fund* beneficially owned by you and your *related persons*." This question asks funds to disclose the percentage of investment stakes in the fund which can be attributed in ultimate ownership to "related persons."

Summary Table I shows basic summary information about both our core Form ADV dataset, while Table II reports information on our merged sample. The broad ADV sample is able to establish key statistics about the overall size and scope of the entire hedge fund industry beyond prior work. Figure V demonstrates our merge rate across the range of

[5]Form ADV is publicly available through the SEC's website, https://www.adviserinfo.sec.gov/.

firm ownership. We find that funds with complete inside investment (100 percent) and no inside investment (0 percent) exhibit worse merge rates into our ADV dataset. These funds also pose additional identification questions—either outsiders cannot invest, or insiders have chosen not to invest in these funds. For these reasons, we focus the remainder of our analysis on funds in the interior of the internal investment distribution: between one and 99 percent inside investment, inclusive.

A breakdown of "related parties" is provided in Table III, which illustrates all possible responses for which parties constitute related parties. The most common response is "Sponsor of GP,"[6] suggesting that the definition of related party most often corresponds to a vehicle used by the actual managers or general partners of the fund. Alternately, related parties can include other closely-related entities, such as asset investment by a broker/dealer. A separate set of questions asks the legal name of all related parties: these entities are typically closely related to the management company, share a supervised person three quarters of the time, and over half of the time share a common physical office. Despite the limitations of this measure in exactly calculating managerial stakes, we document that related parties are typically vehicles for fund investment by the general partners, and typically represent asset management on behalf of closely-related entities that can be considered "inside capital."

Panel B of Figure I illustrates the density of fund responses across different fund vehicles for our example of Renaissance Technologies, and demonstrates a clear dispersion of fractional inside investment across different funds within the firm family. Figure II illustrates other sample inside investment distributions across funds for selected well-known hedge funds. The common pattern is one in which hedge funds operate a variety of vehicles with varying degrees of inside investment. The dispersion of inside investment is consistent with our model (see Appendix A), which predicts that insiders do not deploy capital evenly across funds within their family, but instead preferentially allocate inside capital in certain funds as a function of the excess return and scalability of investment strategies.

[6] We verify that results hold when we subset on firms for which this is true.

Panel A of Figure VI illustrates the density of responses on inside investment across our full merged dataset. Panel B of Figure VI shows the distribution of assets under management attributable to inside investment, shown on a log-dollar scale.

I.B Conflicts and Disclosure

Hedge fund operating agreements demand few fiduciary obligations of managers to prioritize one fund over another, or to prioritize funds with their own internal capital on the same basis as funds with a greater preponderance of outside capital. As noted in Nowak (2009) and quoted in Morley (2014), the manager:

> is required to devote to the [fund] only that amount of time and attention that the [manager] in its sole discretion deems reasonably necessary to achieve the [fund's] objectives.

Discretion is typically left in the hands of the manager to handle any conflicts of interest across classes of investors, different funds in a family, or in accepting additional outside capital. Corporate governance within hedge funds is deliberately minimal due to strong exit rights among investors, and restrictions on investment to classes of accredited or well-informed investors.

I.C Mechanisms

Our model (see Appendix A) yields sharp predictions on the relationship between inside investment and fund returns and size. In this section, we outline the key mechanisms underlying the relationship between inside investment and fund performance from our model, as well as other complementary explanations.

1. *Size Performance Tradeoff:* Our model explanation for the role of inside investment as a predictor of cross-sectional fund performance relies on the tradeoff between managerial compensation through fee income on delegated asset management and returns on privately invested capital. With limited commitment, managers cannot

credibly commit to not increasing the size of their fund in the future to the point that the excess returns to investment strategies are driven down to zero. Personal capital commitments better align the incentives of managers and outsiders, and provide greater incentives for managers to scale their funds less aggressively in a manner which results in greater returns for all investors.

2. *Moral Hazard:* Another possible mechanism driving the relationship between fund performance and inside investment is the possibility for managers to allocate additional attention or trade differently on funds which have greater amounts of privately invested capital. While our main proposed explanation highlights one aspect of this—the ability for managers to preferentially manage fund size on funds managing private capital—managers can potentially change other attributes of funds managing private capital. These include allocating additional attention or superior managerial quality to these funds, or executing superior trading strategies. Potentially, funds can take different risks on funds managing private capital than on funds managing the capital of outside investors.

3. *Superior Information:* An alternate, and complementary, explanation for the relationship between inside investments and fund performance is that inside investors are simply better informed about managerial ability within the fund family, and allocate their capital to the better fund managers.

4. *Signaling:* One potentially offsetting role for managerial capital allocation to funds lies in the role of public signaling. Fund managers, particularly for less established funds, may need to demonstrate private capital commitments in order to convince outside investors of fund quality. When managers are required to hold costly private stakes in order to demonstrate quality and earn management fees on outside capital; inside investment could potentially be a poor predictor of ultimate fund performance. As Form ADVs are commonly used by outside investors to assess fund quality, managerial stakes in this context are unlikely to be purely "cheap talk" but reflect verifiable and costly personal commitments.

These channels need not be mutually exclusive; for instance, the greater the role of moral hazard or risk-shifting effects in driving managers to exert effort or allocate trades differentially depending on private capital investments; the more private information there will be on the success of different funds within a family.

In subsequent analysis, we will first establish the role of inside investment as a predictor of cross-sectional hedge fund performance, focusing on return variation within the fund family. We find support for our main hypothesis that managerial control over fund sizing appears to help describe the superior performance of insider-managed funds, but cannot exclude the possibility that other mechanisms also play a role.

I.D Empirical Strategy

I.D.1 Main Specification

Our main specifications tests the relationship between inside investment stakes and fund-level returns. The starting point of our analysis is the investing decisions of an institutional investor interested in allocating across the broad investable universe of fund managers.

We estimate the impact of ownership on returns on a fund-by-fund level, adjusting for factor exposure:

$$r_{it} - r_{ft} = \alpha_{iT} + \gamma Ownership_{it} + \hat{\beta}_{1,iT} RMRF_t + \hat{\beta}_{2,iT} SMB_t + \hat{\beta}_{3,iT} HML_t + \varepsilon_{it} \quad (1)$$

where we examine ownership as proxied by both the percentage of the fund which consists of insider investment, as well as the gross insider exposure. We value-weight this regression by assets under management to better proxy the portfolio allocation decision of an institutional investor (we also examine equal-weighted returns). The key variable of interest is γ, which captures the predictive role of greater inside investment on excess returns.

We are particularly interested in this analysis using firm and year fixed effects, as well as other fund level controls X_{it}:

$$\begin{aligned} r_{it} - r_{ft} = \alpha_{iT} + \gamma Ownership_{it} + \hat{\beta}_{1,iT} RMRF_t + \hat{\beta}_{2,iT} SMB_t + \hat{\beta}_{3,iT} HML_t \\ + \delta FIRM_i + \eta Year_t + \mathbf{X'_{it}}\phi + \varepsilon_{it} \end{aligned} \tag{2}$$

This allows us to control for other year, firm, and fund factors driving excess returns. The interpretation of γ in this case is the amount of excess return attributed to investing in a high-skin fund *relative to* a low-skin fund within the same company, year, and fund type.

In addition to the above factor model, we also use the Fung and Hsieh (2004) seven-factor model:

$$\begin{aligned} r_{it} - r_{ft} = \alpha_{iT} + \gamma Ownership_{it} + \hat{\beta}_{1,iT} S\&P_t + \hat{\beta}_{2,iT} SC - LC_t + \hat{\beta}_{3,iT} 10Y_t \\ + \hat{\beta}_{4,iT} CredSpr_t + \hat{\beta}_{5,iT} BdOpt_t + \hat{\beta}_{6,t} FXOpt_t + \hat{\beta}_{7,t} ComOpt + \mathbf{X'_{it}}\phi + \varepsilon_{it} \end{aligned}$$

The interpretation of γ in this equation is similar, and allows us to examine the role of additional "skin in the game" on fund performance.

Finally, to test for size, we perform a comparable analysis regressing the assets under management of funds against the fraction of inside investment:

$$AUM_{it} = \psi Ownership_{it} + \delta FIRM_i + \eta Year_t + \varepsilon_{it} \tag{3}$$

The ψ coefficient here captures the relationship of size and fractional inside investment, within firm and year.

I.D.2 Fund-Flow Sensitivity and Return Predictability

Following prior literature, such as Chevalier and Ellison (1997), we define fund flows using net flows $r_{i,t}$ as:

$$FLOW_{it} = \frac{AUM_{it} - (1 + r_{i,t}) \cdot AUM_{i,t-1}}{AUM_{i,t-1}} \tag{4}$$

Using this definition, we also test standard fund-flow sensitivities:

$$FLOW_{i,t\to t+1} = \beta(1 + r^e_{i,t-1\to t}) + \varepsilon_{i,t} \tag{5}$$

The coefficient of interest, β, captures the sensitivity of fund flows to excess returns (incorporating a factor adjustment), avoiding chronological overlap. We also examine return predictability:

$$r^e_{i,t\to t+1} = \beta r^e_{i,t-1\to t} + \varepsilon_{i,t} \tag{6}$$

We next turn to our main results testing the relationships outlined in this section.

II Results

II.A Regression Results

We start with regressions that control more closely for fund factor exposure. Our model suggests that, within a firm, funds with a greater proportion of inside capital will outperform because managers internalize the capacity constraints of the investment strategy when accepting new capital. Funds with greater inside capital retain greater alpha, in equilibrium, because managers maximize profits by not accepting additional outside capital to the capacity limit of the investing strategy.

To analyze the role of inside investment and risk-adjusted returns, we examine in Table IV fund-level regressions as outlined in our Empirical Strategy Section above. In Panel A, we focus on the standard four-factor model to correct for factor exposure and regress excess returns against measures of inside investment. Column 1 of Table IV regresses the percent of a fund's assets under management that can be attributed to insider investment against excess returns. Inside investment is statistically associated with excess returns, even unconditionally. This relationship persists in our preferred specification in column 2, which controls for year and firm effects. Additional fund level controls include: a size

control (log of gross asset value), the fund's inception year, and the fund's strategy. Our estimates in that column suggest that a fund with a 1 percentage point increase in inside investment experiences a 0.55 basis point higher excess return; relative to another fund in the same family and year of observation with the same strategy, size, and inception year.

Scaling our result; we find a 1.46% increase in alpha per year for a fund with a standard deviation increase in the amount of inside investment relative to another fund in the same firm with similar characteristics. These results are quite large quantitatively, and suggest a strong importance for internal investment as a predictor of cross-sectional fund performance. The larger magnitude and significance of results when controlling for firm fixed effects suggests the importance of discretionary fund allocation by insiders: there is high dispersion of fund returns within firms in our sample, and insiders choose which investment strategies to pursue in which funds, and which funds to invest in. Our results suggest that their private capital is more likely deployed in funds that outperform others within the family.

We find similar results in columns 3 and 4, which examine the *gross* amount of inside investment, rather than the fractional amount (also controlling for size and other fund-level characteristics). We also find substantially larger estimates in Panel B, which uses the Fung and Hsieh (2004) measure of hedge fund returns. In this specification, we find that inside investment is associated with internal investment (as measured on a percentage or gross level) unconditionally, as well as in conjunction with fund and firm results. Our results in these specifications are large in magnitude, and suggest that a fund with an additional percent skin in the game can expect 1.1 basis points higher excess return, monthly.

Following prior literature, we present the main results value-weighted in order to better match the composition of the investable universe and mirror the decision of an outside investor. All results in Table IV are value-weighted using the Gross Asset Value field in Form ADV, which is present for all funds. Table V presents equally-weighted results, which yields very similar results.[7]

These results are subject to several important caveats. First, while these results suggest that fund-level inside investment predicts superior excess returns, the relationship might

[7]Results are also similar when weighting by AUM as measured using the commercial hedge fund datasets.

not be causal. It may well be that our measure of inside skin in the game is a proxy for other fund-level characteristics. Another important caveat is that we are not able to fully control for whether our results are driven by some element of risk or are instead due to agency conflicts within the firm. Despite our attempts to control for risk using the benchmark fund factors, it is also possible that the outperformance of high skin-in-the-game funds is due to a novel risk factor. To further analyze the mechanisms driving our main result, we examine fund decisions along other dimensions.

II.B Main Mechanism: Capacity Constraints

Having established that investment by insiders predicts fund outperformance, we next consider the possible drivers of this relationship. In order to investigate the source of relative outperformance of high investment funds, we are guided by our model (discussed in Appendix A), which yields key predictions on the mechanisms behind inside investment and fund performance.

First, we consider how lagged excess returns relate to asset flows to funds. Figure VII plots a non-parametric relationship between lagged returns and fund inflows by funds with a greater or lesser degree of insider investment. Insider funds are defined as those with a greater-than-average ($>$ 20.8 percent) amount of fraction of fund assets attributable to insiders. Flows are winsorized at a 1% level, and the range of excess returns is restricted from -20–20%.[8]

The figure illustrates that outsider funds exhibit a standard fund flow-performance relationship as documented in prior research on hedge funds and mutual funds. However, insider funds demonstrate a different profile: insider funds that experience very positive excess returns do not exhibit subsequent high inflows, consistent with the idea that high performing funds with greater insider capital manage funds further away from their capacity constraint.

Complementing the results on flow performance, Figure VIII plots a non-parametric relationship between excess returns over time. Outsider funds demonstrate low return

[8]For all flow-based analysis, we exclude eVestment from our sample due to unreliable NAV information from this data provider.

predictability: high excess returns are followed by lower returns in the subsequent period, consistent with the standard Berk and Green (2004) logic that high returns encourage fund inflows, driving down returns in future periods. High-performing insider funds, however, exhibit more persistent returns over time: high excess returns are followed by high returns over time.

Table VII illustrates the flow performance and return predictability specifications, as outlined in equations 5 and 6. The independent variable in these specifications is the same (lagged excess returns); the dependent variable is either fund flows or subsequent excess returns.

While the flow and performance relationship in the regressions appears comparable for both high- and low-inside ownership funds; we find very high return persistence among inside investment funds (column (3)).The joint relationship between inside investment, flow performance, and return predictability—particularly for high-performing funds—provides some evidence that the ability of fund insiders to manage capacity constraints helps account for their outperformance. By limiting fund inflows in periods in which funds experience high returns, insider funds are able to maintain persistently high excess returns over time. In doing so, funds are foregoing management fees on additional capital in lieu of greater excess returns on privately invested capital.

II.C Robustness

II.C.1 Heterogenous Treatment Effects

Figure X illustrates the main effect (as in column 2 of Panel A Table IV) by fund categories. Panel A of this figure plots the coefficient of inside investment against excess return by categories as measured in our set of commercial hedge fund datasets. The main effects are driven by funds that engage in specialist absolute return strategies, arbitrage strategies, and equity funds. Within equity funds (Panel B), effects are driven by long-short funds and those focused on emerging markets. These fund strategies more plausibly feature capacity constraints in their investment strategies. By contrast, effects are insignificant among fund-of-funds and CTAs, which are typically associated with lower capacity constraints.

In Figure IX we examine a quantile regression in which we examine the relationship between inside investment and fund performance across the distribution of inside investment. We plot the coefficient for percentage inside investment when regressed against Fama-French excess returns (controlling also for size) across the quantiles of the distribution of inside investment. We find that our results are largely being driven by funds with higher levels of inside investment; those funds for which inside capital provides a substantial component of the capital base, for which we expect to see the highest-powered incentives.[9]

In Table VI we examine our basic regression across different fund size levels. We re-run our specification (2) from Panel A in Table IV across the quantiles of the fund size distribution. We find significant effects for the top three fund size quantiles (corresponding to fund sizes of at least $43 million).

II.C.2 Fund Size

We also analyze the role of size and inside investment. Again, we hypothesize in our model that a key mechanism driving the superior performance of insider funds is their smaller size, due to decreasing returns to scale in investment technologies. To test this hypothesis, in Table VIII, we regress the size of the fund against a measure of proportional inside investment. In column 2 of Panel A, we focus on our matched dataset and find that an additional percent of inside investment is associated with a $6 million smaller fund. This relationship persists when we examine a specification where the dependent variable is the log of assets under management in column 4.

We are also able to run this specification on the Form ADV dataset only, in Panel B. These specifications use the field "Gross Asset Value" derived from fund-level information in Form ADV. Gross asset value differs from assets under management in that it does not subtract out the value of short positions from the portfolio, and so overestimates true firm

[9]Our findings are weaker if we exclude high inside-investment funds from our sample. When we impose a $500m cutoff and restrict to funds with inside investment of $< 50\%$, we find similar results as in the analysis in Kruttli et al. (2017) based on a linkage of Form PF-ADV. However, our focus is on the larger universe of hedge funds, including those smaller funds not required to file Form PFs and those funds with substantial inside investment stakes.

size. Despite the limitations of this measure, using this field as a dependent variable enables us to avoid losing observations on the merge between our Form ADV dataset and the commercial hedge fund datasets. Results are very similar when not restricting on funds that merge into commercial hedge fund datasets: we find in column 2 that within a firm, funds with an additional percent of inside investment are around $10 million smaller in gross asset value. These results provide additional support for the model: inside investment funds are both smaller and outperform, suggesting that managers do not hit the limits of the capacity constraints of their investment strategy when their own private capital is deployed. The reluctance to accept additional outside capital on these funds explains why they continue to outperform and gain excess returns, even in equilibrium.

II.D Superior Manger Information

An alternate and complementary mechanism in explaining our main result that greater insider investment predicts higher excess returns is that managers have superior private information on the abilities of fund managers than do outside investors, and so deploy personal capital to the superior managers. To test this hypothesis, we estimate the following specification in Table IX:

$$r^{e}_{i,t-1\to t} = \beta InsiderInflow_{i,t-1} + \gamma OutsiderInflow_{i,t-1} + \varepsilon_{it} \tag{7}$$

This specification tests whether *changes* in insider investment predict excess returns. We find that changes in neither inside nor outside flows predict excess returns. While this test is not fully conclusive regarding the channel of superior inside information, this result suggests that insiders do not appear to be able to time their capital allocation decisions in ways that predicts future excess returns. Put differently: levels of inside investment, rather than changes, predict future returns. In conjunction with the results on fund flows and performance, this result is perhaps unsurprising: fund insiders appear to frequently extract funds from their best performing funds, rather than further invest, in order to continue to operate funds further from their capacity constraint and gain excess returns.

II.E Event Study

The results from the previous section provide evidence of a role for insider investment in driving fund returns and suggest that the possibility of insider investment should be seen as a critical component of the compensation of managers in addition to management and incentive fees. They raise the prospect that fund managers may seek to further take advantage of this relationship by further steering clients into lower performing funds.

We explore this possibility in Figure XI, which conducts an event study in the aftermath of the creation of a new fund among firms which previously only had one. The creation of an additional fund presents two possibilities for fund managers: they can either keep their internal capital invested in the original fund (using the new fund to attract new capital); or they can shift their own capital to the new fund (and market the original fund to investors). If the amount of insider capital is an important determinant of fund performance, we expect different fund performance in the *original* fund under the two cases. If managers are shifting their capital outside of the fund, we expect the performance of the original fund to deteriorate (since managers are no longer as invested in success of the fund). If, on the other hand, managers keep their capital in the original fund, the performance of the original fund should remain strong.

To test this possibility, we focus on all cases in which a hedge fund, which previously only operated one fund, opens a second. We isolate two cases: one in which the new fund has less internal investment than the original (the new fund has "low skin"), and another in which the new fund has more internal investment than the original. We plot cumulative returns of the fund for the two-year window both before and after the fund creation date.

Our results suggest that fund performance is relatively similar before the event date for the original fund, regardless of whether the firm subsequently creates a new fund with high or low internal investment. Differences grow more pronounced in the aftermath of fund creation. We find that when the new fund has "low skin"—suggesting that managers keep their internal capital in the original fund—fund performance suffers relative to when the newly create fund has "high skin." We expect to see this difference because managers are more invested in the success of the initial fund if their capital remains deployed in the

fund. If their own capital has moved to a different fund, performance tends to suffer in the window after fund creation.

Though these results are not fully conclusive, they are suggestive of the possibility of "skimming" motives on the part of fund managers. If managers are able to shift their internal investments across funds within the same family, they seem able to focus their investments on successful funds, while steering outside capital into the lower performing funds. These results therefore provide additional context to our model and previous empirical results, suggesting that active decisions made by fund managers regarding fund creation and where capital is deployed play a role in determining returns for outside investors.

To be clear, this analysis does not distinguish whetherthis is due to insiders having better information on which fund managers can outperform relative to outsiders, or because managers devote more effort when greater amounts of personal capital are on the line. Despite the multiple possible explanations, we emphasize that our result provides novel evidence on the role of inside investment in shaping fund performance as new funds are created.

II.F Firm-Level Equity

In addition to the choice of investing personal capital in the fund alongside outside investors, managers also have the option of investing in equity at the firm level. Analysis of the ownership structure of the partnerships that comprise typical hedge funds has been limited due to scarce data. In this section, we use Form ADV data to shed light on the ownership structures of hedge funds.

Figure XII illustrates the imputation process for firm-level equity. We use fractional ownership codes, found on Schedules A and B of Form ADV. These ownership fields track both direct and indirect owners, allowing us to examine the ultimate beneficial owners of hedge fund structures, even when shielded behind shell structures such as LLCs. A limitation of our analysis is that ownership codes are fractionally allocated (i.e., ownership fields will track an owner with a stake between 10%-25% of the firm's equity). We tabulate

for this reason a minimum and maximum estimate of the firm's equity, illustrated in Panel A of Figure XII.

Panel B of this figure plots a histogram of the Herfindahl-Hirschman index (HHI) measure of dispersion in firm-level ownership. Many hedge funds feature no dispersion in ownership (are beneficially owned by only one individual or entity); however many firms have fractional ownership.

In order to investigate the implications of dispersion in firm-level ownership and its relation with fund-level inside investments, we regress both measures in conjunction in Table X. Column 3 of this table suggests that inside investment at the fund level remains a significant predictor of excess returns, even when controlling for measures of firm-level ownership. In addition to fund-level inside investment, we find that the number of equity owners (as a measure of the dispersion in a hedge fund family's ownership structure) negatively predicts excess returns. While this result would be consistent with the idea that dispersion in a firm's equity structure is a sign of agency frictions and internal firm conflict, other explanations might also potentially explain the relationship between the dispersion in firm-level equity ownership and fund performance. Despite the limitations of our measures of firm-level equity, we emphasize that our paper is the first to our knowledge to examine measures of insider capital allocations for a comprehensive sample of hedge funds at the level of fund allocation, as well as firm-level equity contributions.

III Conclusions

The ability to access and allocate capital to profitable, but highly limited, investment opportunities within the companies they oversee is a substantial element of fund manager compensation. However, this has rarely been explored in empirical and theoretical analysis of delegated asset management. We explore how the possibility of inside investment alters fund performance in the context of an equilibrium model along the lines of Berk and Green (2004). Our model highlights the tradeoff between management fees earned by managing funds close to their capacity constraint, and earning excess returns on private capital invested in strategies further from capacity constraint;, as well as the role of inside

investments in better aligning incentives between managers and investors. Our model yields clear predictions on the role of inside investment and fund performance: we predict that when intermediary firms have access to a variety of different strategies that vary along the dimensions of excess return and scalability, managers will differentially allocate private capital across funds at their disposal to maximize private returns. The model predicts that we should find a dispersion of inside investment across funds, and that greater inside investment should predict excess returns and smaller fund size.

We take these predictions to the data using a comprehensive and survivor bias-free dataset of hedge fund characteristics taken from Form ADV. We document novel patterns of inside investment in hedge funds by related parties, which typically include sponsors of the general partners and closely-related entities, and find confirmation of our hypothesis that firms—including several prominent hedge funds—typically operate a variety of funds with varying degrees of internal investment.

To better understand the relationship between inside investment and returns, we begin with an implementable hedge fund investment strategy that selects high inside-investment funds. We find this strategy outperforms a portfolio invested in funds with low insider allocations. We further analyze the role of inside ownership by regressing excess returns (controlling for the Fama-French factors and the Carhart factor, as well as the Fung-Hsieh seven factors) against measures of ownership. We find that funds with higher internal investment have greater excess returns, even when we control for firm fixed effects. Our results are large in magnitude, that a fund with a one standard deviation increase in inside investment relative to the mean will provide an additional 1.46% of excess returns annually.

We find that high inside-investment funds have both different fund flow-performance and return predictability characteristics compared with funds largely catering to outside investors. In response to very positive excess returns, they do not accept as many inflows of capital as do outsider funds, and in tandem experience greater persistence of high excess returns. The joint relationship between internal investment, fund flows, and performance suggests that funds better manage capacity constraints when managers have personal capital at stake, leading to superior performance. This finding is consistent with our model

explanation that insider funds operate at a smaller scale because managers internalize the costs of fund expansion.

We also find suggestive evidence that fund managers are able to strategically deploy fund creation and private capital allocation to further "skim" investors. We find performance follows inside investments – when internal assets are shifted to newly created funds they tend to outperform; however when managerial commitment remain with the original fund, the returns tend to persist. Overall, we find that funds that rely more on insider money outperform funds that do not "eat their own cooking."

These results, taken as a whole, provide powerful support for our hypothesis that hedge funds face capacity constraints in their operations, and differentially allocate capital across their funds to maximize profits, depending on the mix of inside and outside capital. Our results suggest that the capital structure of hedge funds has a substantial impact on operating performance. When funds rely on outside capital, managers are compensated primarily from managerial fees and leave little value to outside investors. Greater reliance on internal financing better aligns incentives of managers and outside investors, leading them to leave substantial "slack" in fund size and operate strategies on a lower scale, thereby receiving excess returns, even in a competitive equilibrium.

Our results contribute to ongoing debates regarding the presence of managerial alpha and financial rents. Many observers are puzzled at the apparently outsize rents earned by financial intermediaries such as hedge funds, even in the wake of apparently strong competition and the role of fund inflows on diminishing returns. In turn, these managerial rents have driven top-end wealth and income inequality (see Kaplan and Rauh (2013)). We suggest a possible reconciliation of these facts can be found in examining the option that fund managers have of not only of earning management and performance fees, but also of deploying their own capital in funds they manage.

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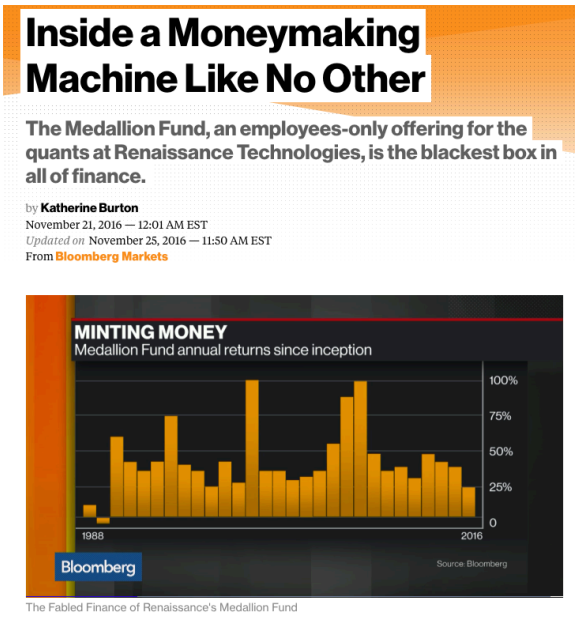
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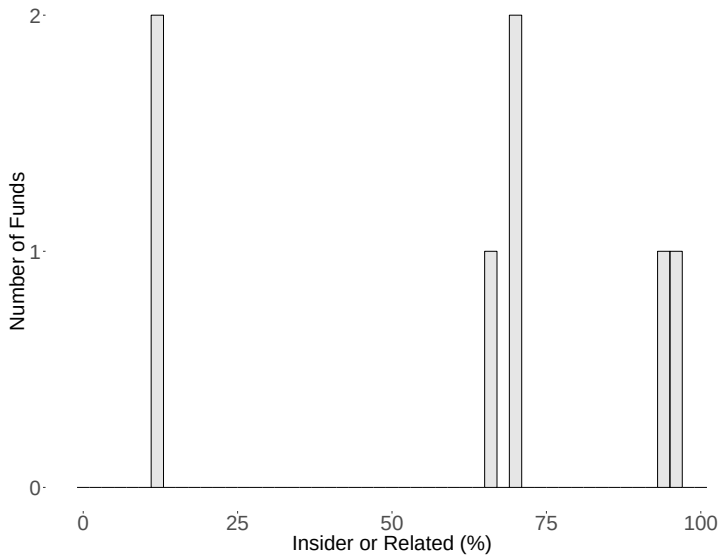
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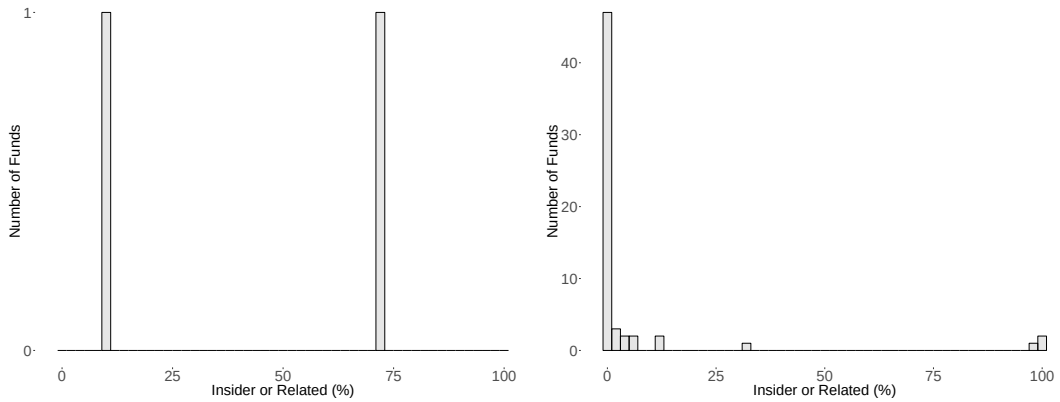
Panel A: Bloomberg Article Highlighting Rentech Returns



Panel B: Within-Fund Investment Distribution

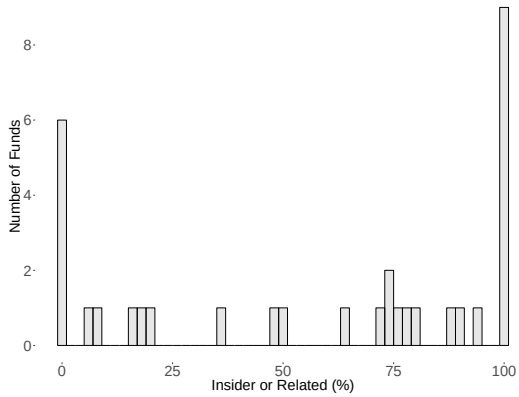
FIGURE I **Anecdotal Evidence, Relating Performance to Insider Investment**

This figure highlights the performance and heterogeneity of insider ownership. Panel A shows a Bloomberg article from November 21, 2016 discussing Renaissance Technologies' highly successful insider fund, the Medallion Fund. Panel B is a histogram of percent insider capital across all funds (> $100m) within Renaissance Technologies from Form ADV showing the heterogeneity of insider investment.

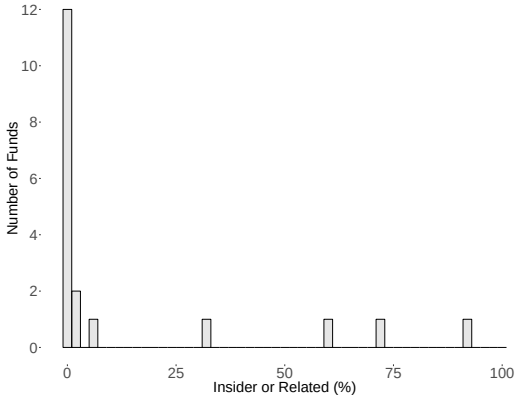


(a) Appaloosa LP

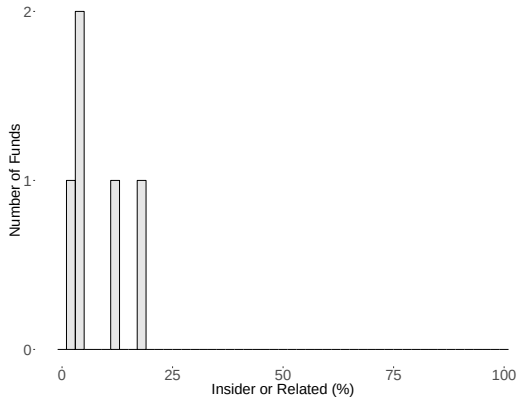
(b) AQR Capital Management



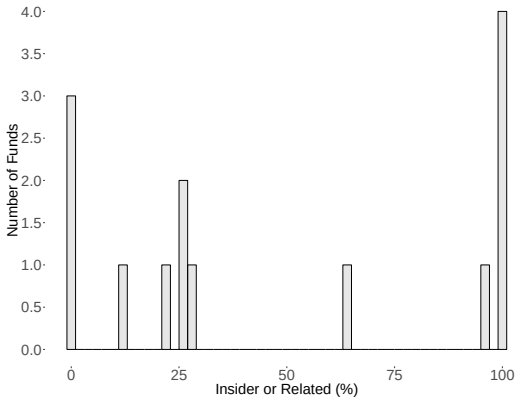
(c) BlueCrest Capital Management



(d) Citadel Advisors LLC



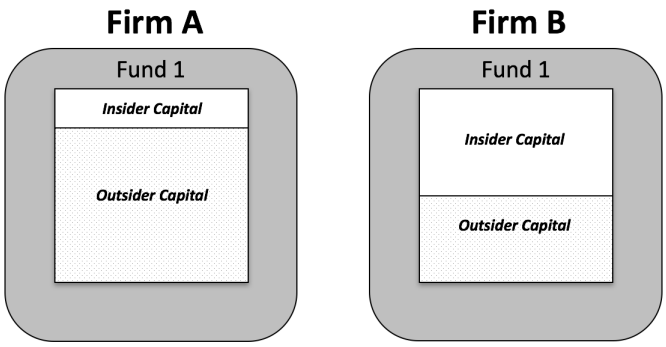
(e) Third Point LLC



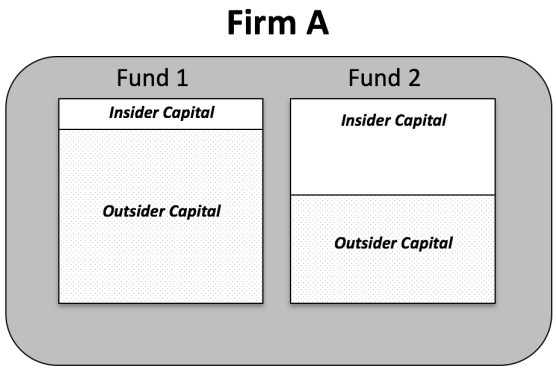
(f) Two Sigma Investments, LP

FIGURE II **Heterogeneity of Insider Investment Across Numerous Funds**

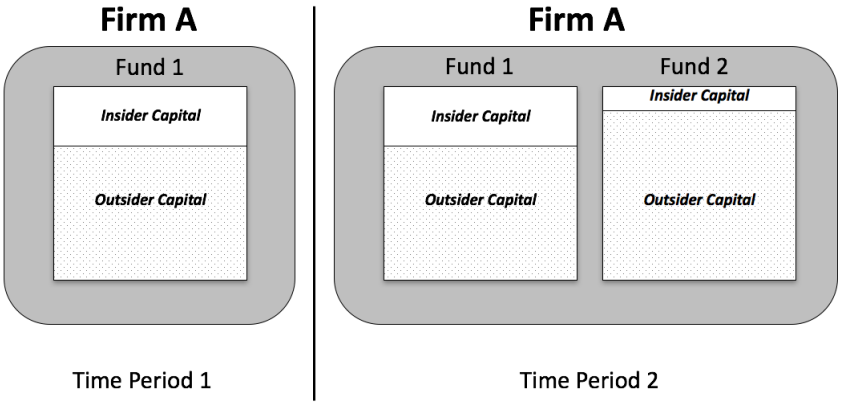
This figure shows the heterogeneity of insider investment for a set of sample firms. The horizontal axis corresponds to the percent of insider investment and the vertical axis corresponds to the count of funds. The histograms correspond to 2016 ADV filings, and excluded any funds less than $100 million.



Panel A: One Firm, One Fund (1F1F)



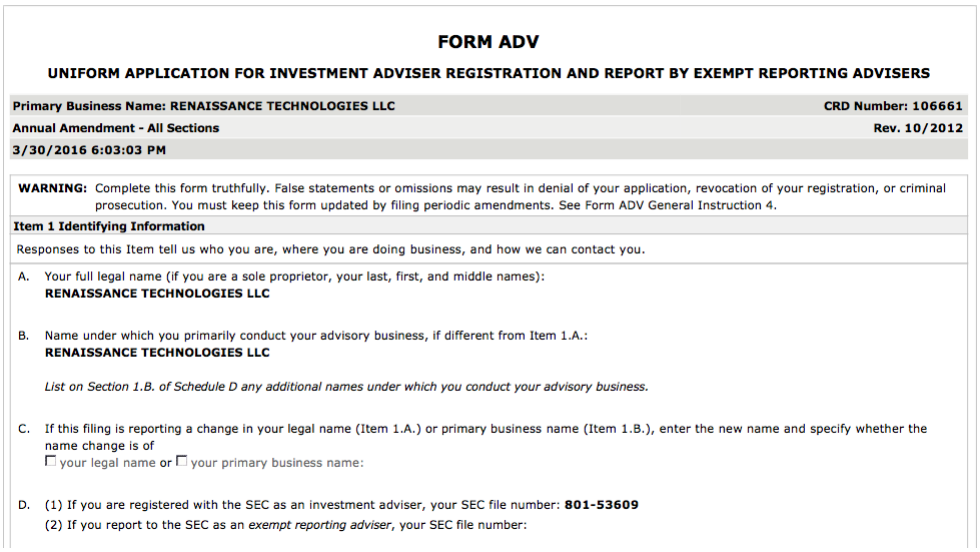
Panel B: Different Insider Investment, Within Firm



Panel C: Event Study Analysis

FIGURE III **Firm and Fund Analysis**

This figure outlines the difference between firm and fund in the context of this paper and emphasizes the different setups we analyze. Panel A describes a one firm one fund (1F1F) structure and the comparison of incentives between two hypothetical firms. Panel B describes a firm with two separate funds with different insider capital. Our within firm analysis compares Fund 1 against Fund 2, within firm. Panel C shows the time evolution of Firm A, transitioning from a one fund to multi-fund firm.



FORM ADV

UNIFORM APPLICATION FOR INVESTMENT ADVISER REGISTRATION AND REPORT BY EXEMPT REPORTING ADVISERS

Primary Business Name: RENAISSANCE TECHNOLOGIES LLC — **CRD Number: 106661**

Annual Amendment - All Sections — **Rev. 10/2012**

3/30/2016 6:03:03 PM

WARNING: Complete this form truthfully. False statements or omissions may result in denial of your application, revocation of your registration, or criminal prosecution. You must keep this form updated by filing periodic amendments. See Form ADV General Instruction 4.

Item 1 Identifying Information

Responses to this Item tell us who you are, where you are doing business, and how we can contact you.

A. Your full legal name (if you are a sole proprietor, your last, first, and middle names):
RENAISSANCE TECHNOLOGIES LLC

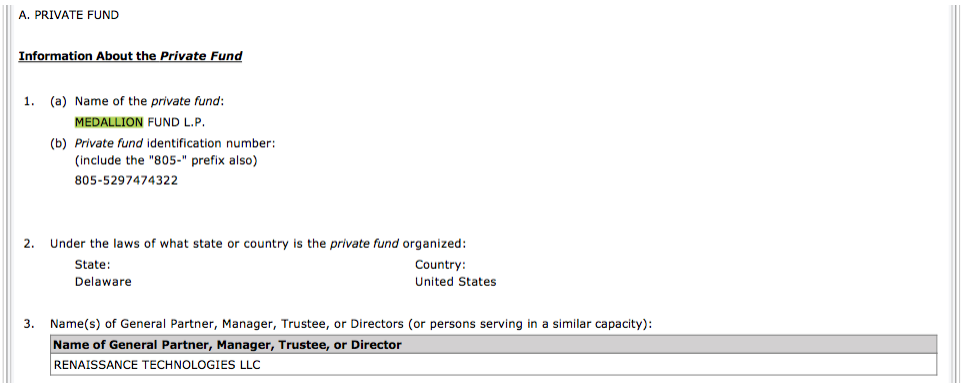
B. Name under which you primarily conduct your advisory business, if different from Item 1.A.:
RENAISSANCE TECHNOLOGIES LLC

List on Section 1.B. of Schedule D any additional names under which you conduct your advisory business.

C. If this filing is reporting a change in your legal name (Item 1.A.) or primary business name (Item 1.B.), enter the new name and specify whether the name change is of
☐ your legal name or ☐ your primary business name:

D. (1) If you are registered with the SEC as an investment adviser, your SEC file number: **801-53609**
(2) If you report to the SEC as an *exempt reporting adviser*, your SEC file number:

Panel A: Section 1, Form ADV



A. PRIVATE FUND

Information About the *Private Fund*

1. (a) Name of the *private fund*:
MEDALLION FUND L.P.
(b) *Private fund* identification number:
(include the "805-" prefix also)
805-5297474322

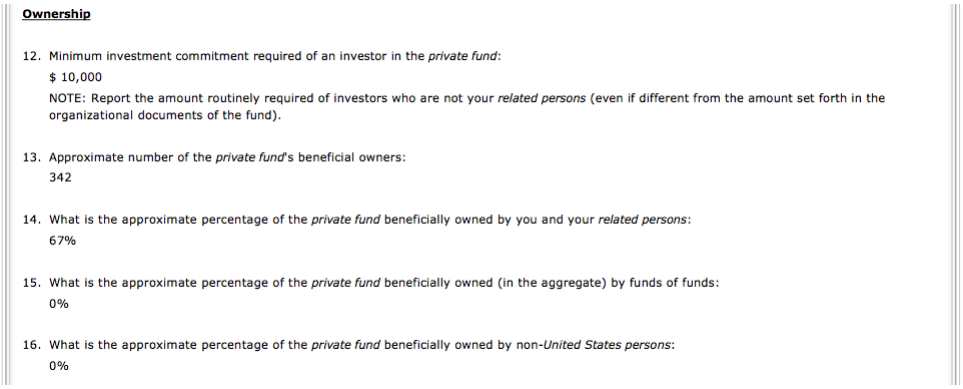
2. Under the laws of what state or country is the *private fund* organized:

State:	Country:
Delaware	United States

3. Name(s) of General Partner, Manager, Trustee, or Directors (or persons serving in a similar capacity):

Name of General Partner, Manager, Trustee, or Director
RENAISSANCE TECHNOLOGIES LLC

Panel B: Section 7.B.(1), Fund Identity, Form ADV



Ownership

12. Minimum investment commitment required of an investor in the *private fund*:
$ 10,000
NOTE: Report the amount routinely required of investors who are not your *related persons* (even if different from the amount set forth in the organizational documents of the fund).

13. Approximate number of the *private fund*'s beneficial owners:
342

14. What is the approximate percentage of the *private fund* beneficially owned by you and your *related persons*:
67%

15. What is the approximate percentage of the *private fund* beneficially owned (in the aggregate) by funds of funds:
0%

16. What is the approximate percentage of the *private fund* beneficially owned by non-*United States persons*:
0%

Panel C: Section 7.B.(1), Ownership Reporting, Form ADV

FIGURE IV **Sample Form ADV — Renaissance Technologies**

This figure shows three excerpts from the SEC's Form ADV for a sample firm, Renaissance Technologies LLC. Panel A shows basic information to identify firms. Panel B shows basic fund information for our sample fund, Medallion Fund L.P., and is found in Section 7.B.(1). Panel C shows ownership data such as minimum investment, number of investors, and basic composition of investors, and is reported at the fund level. We rely primarily on question 14, at the fund level, when studying insider ownership. Form ADVs can be searched at https://www.adviserinfo.sec.gov/

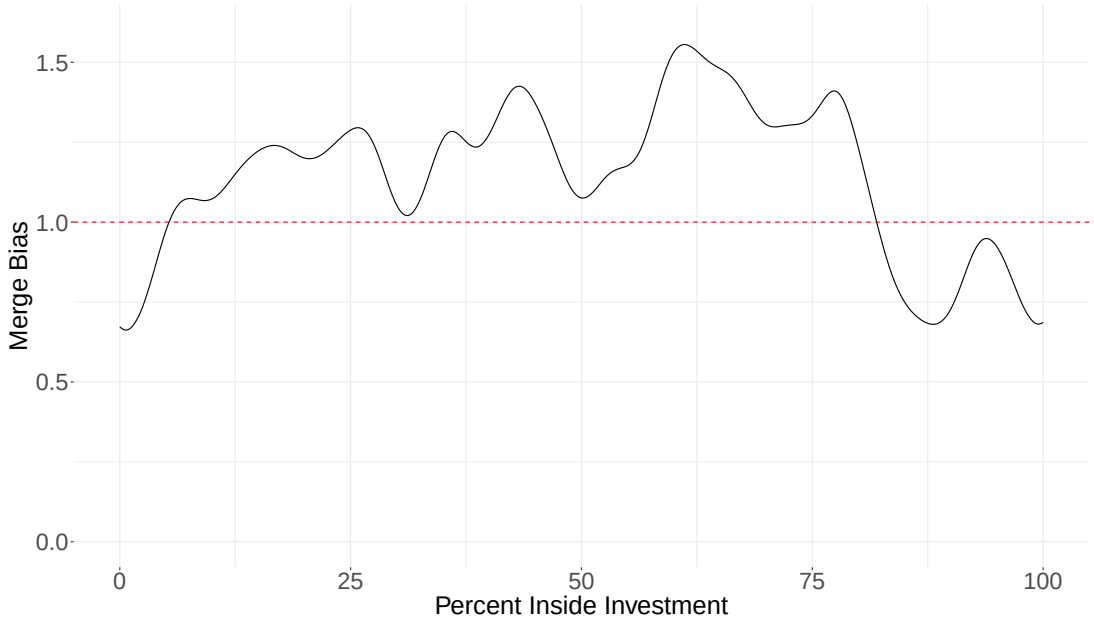
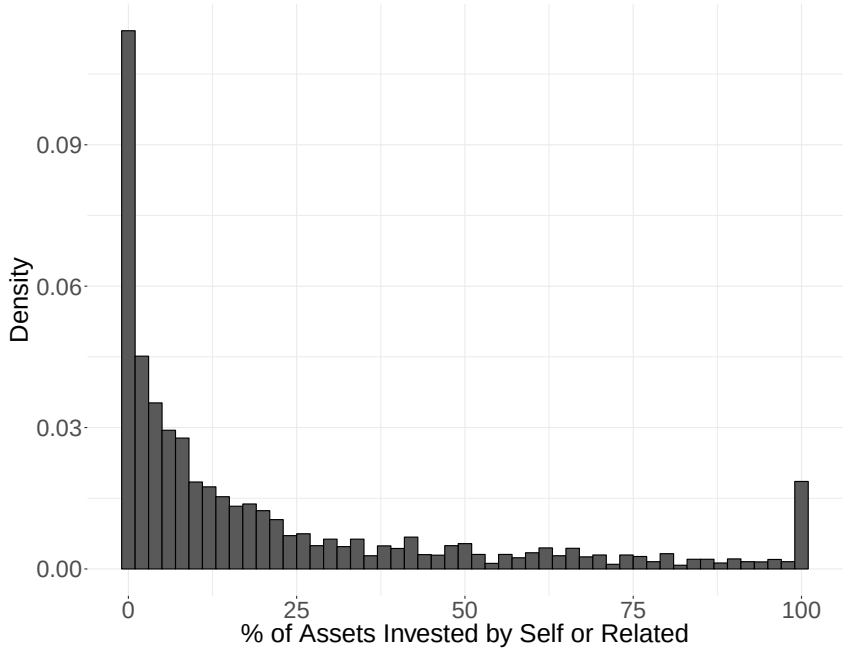
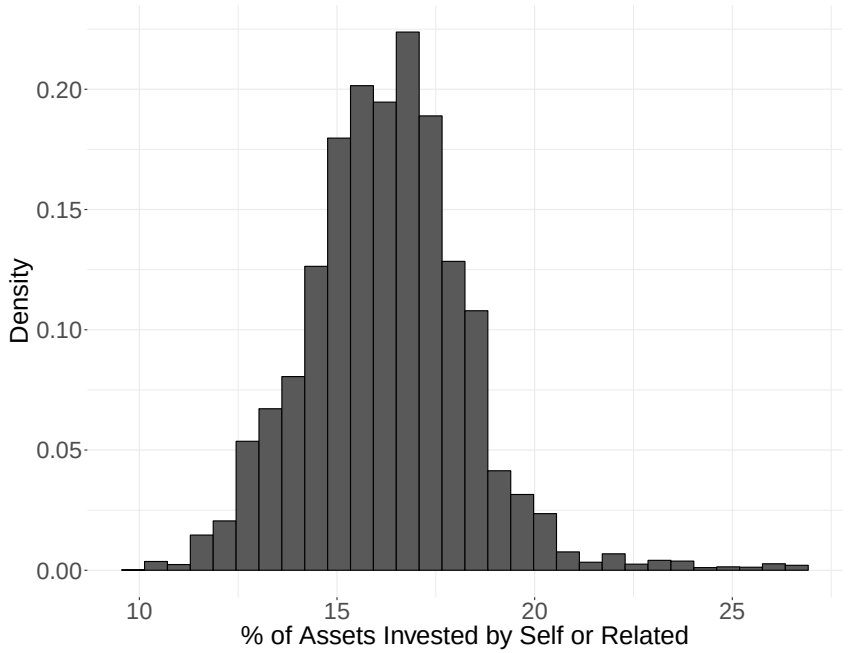


FIGURE V **Bias Analysis of Merged Sample**

This figure plots the merge rate between the insider investment observations from Form ADV and the hedge fund commercial return databases (outlined in the Data section). It is generated by dividing the empirical distribution of the merged sample against the unmerged sample of funds. The red, dotted line, highlights the unbiased boundary. Larger than one indicates a higher match rate relative to the average match rate. Observations for 0% and 100% inside investment have been omitted to be consistent with the analysis. See Appendix for further bias analysis.



Panel A: Distribution of Insider Investment Across Funds, Percentage of Total Assets



Panel B: Distribution of Insider Across Funds, NAV

FIGURE VI **Distribution of Insider Investment from Merged Sample**

This figure plots the insider investment into hedge funds from the merged sample of hedge fund returns and ADV forms. Panel A is a histogram of insider investment, and is in units of percent of total investment. This displays the "dumbbell" insider investment pattern common across fund types. Panel B is a histogram of log(NAV) of insider investment for the merged sample.

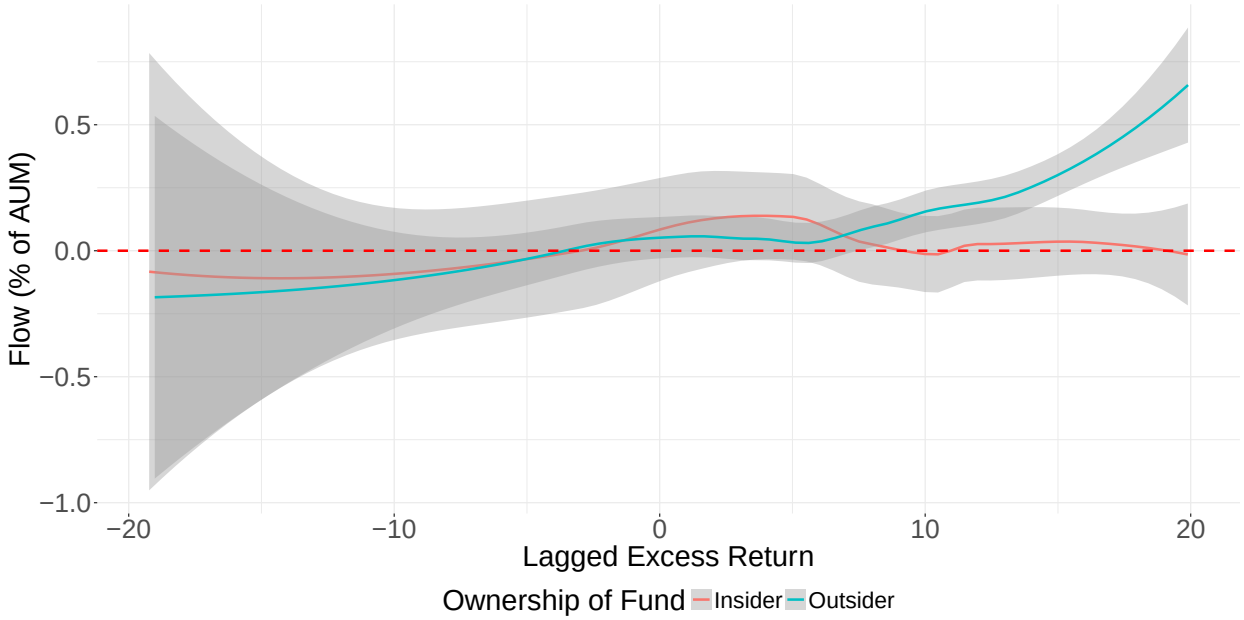


FIGURE VII **Flow Performance of Funds by Insider Status**

This figure plots a kernel density of the relationship between lagged excess return and contemporaneous flow. The flow measure is defined as: $FLOW_{it} = \frac{AUM_{it} - (1+r_{i,t}) \cdot AUM_{i,t-1}}{AUM_{i,t-1}}$. Excess returns are defined using the Fama-French 4 factors. Funds are divided by the average level of inside investment into insider funds ($>$ 20.8% Inside Investment) and outsider funds. Grey bars correspond to 95% confidence intervals.

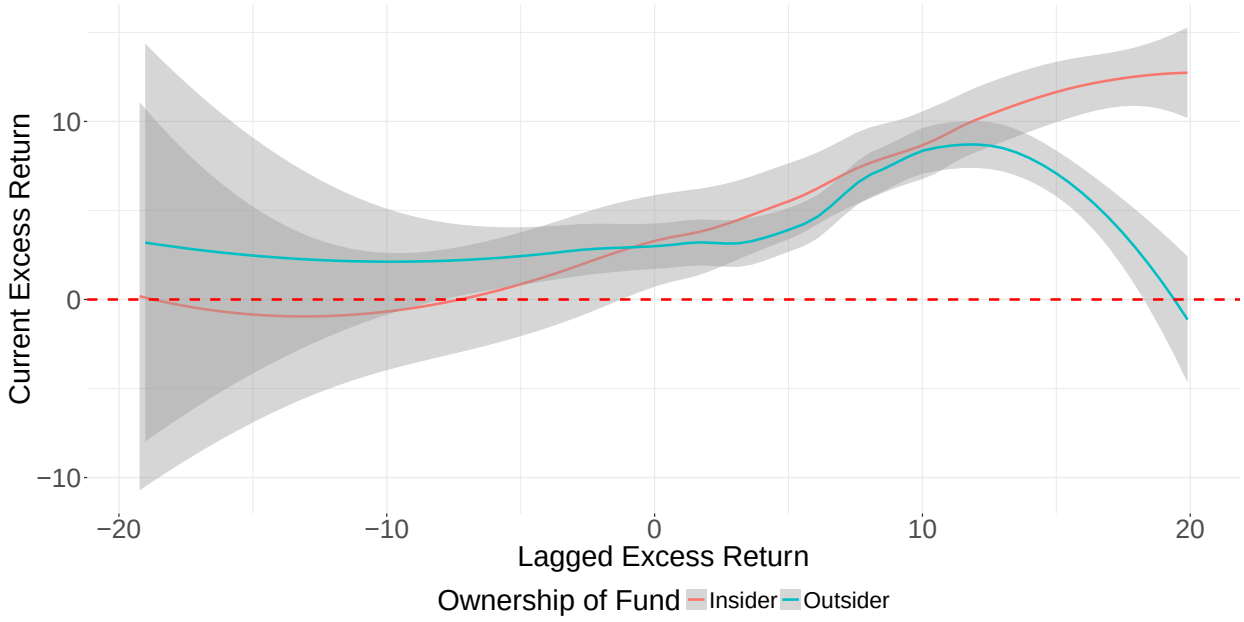


FIGURE VIII **Return Predictability Funds by Insider Status**

This figure plots a kernel density between lagged and contemporaneous excess return. Excess returns are defined using the Fama-French 4 factors. Funds are divided by the average level of inside investment into insider funds ($>$ 20.8% Inside Investment) and outsider funds. Grey bars correspond to 95% confidence intervals.

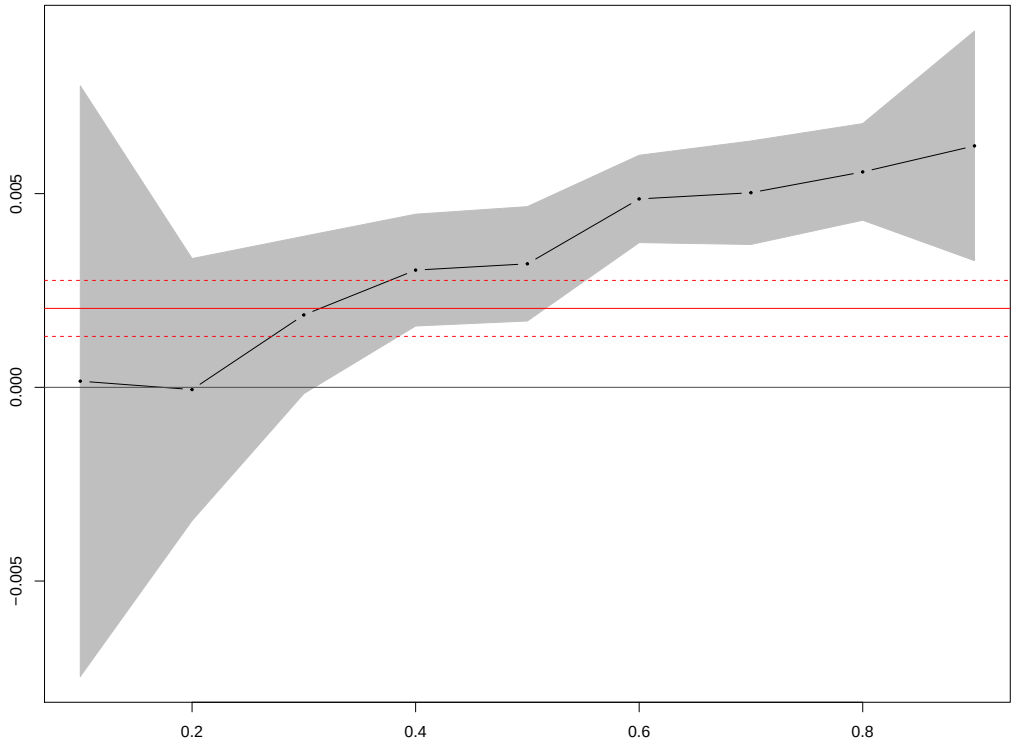
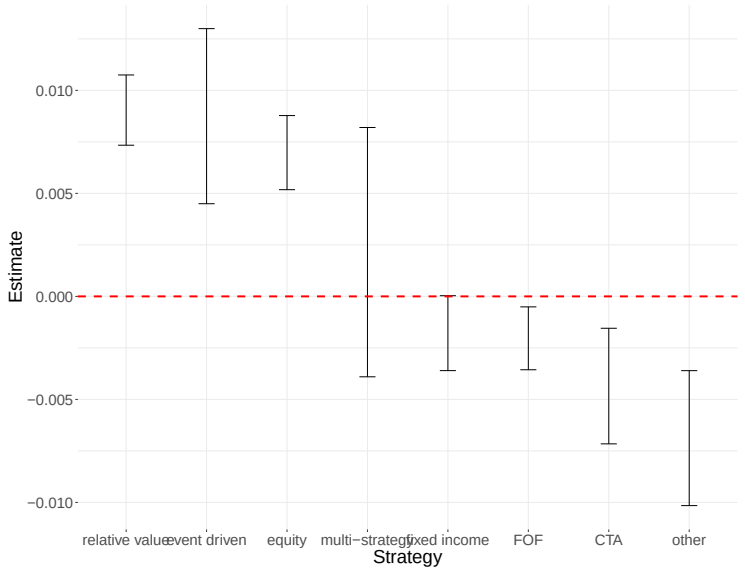
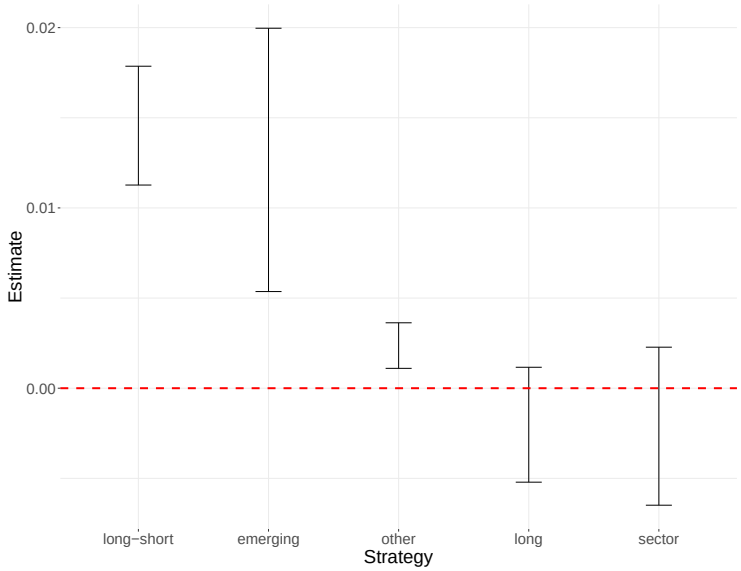


FIGURE IX **Quantile Regression of Inside Investment on Excess Returns**

This figure plots results from a quantile regression of percentage inside investment against fund-level Fama-French corrected excess returns, controlling also for fund size. Across each of the five quantiles of percentage inside investment, we examine the slope of the relationship between inside investment and excess returns. The shaded grey area illustrates the 95% confidence interval. We find that our results are driven by funds at high levels of inside investment.



Panel A: Effects by Fund Type



Panel B: Effects by Fund Type among Equity Funds

FIGURE X **Main Effects by Fund Type**

This figure illustrates the main specification, as shown in column (2) of Panel A Table IV, broken out by fund category. Funds are categorized based on descriptions in commercial hedge fund datasets listed in the Data section. The error bars indicate 95% confidence interval for the estimated coefficients.

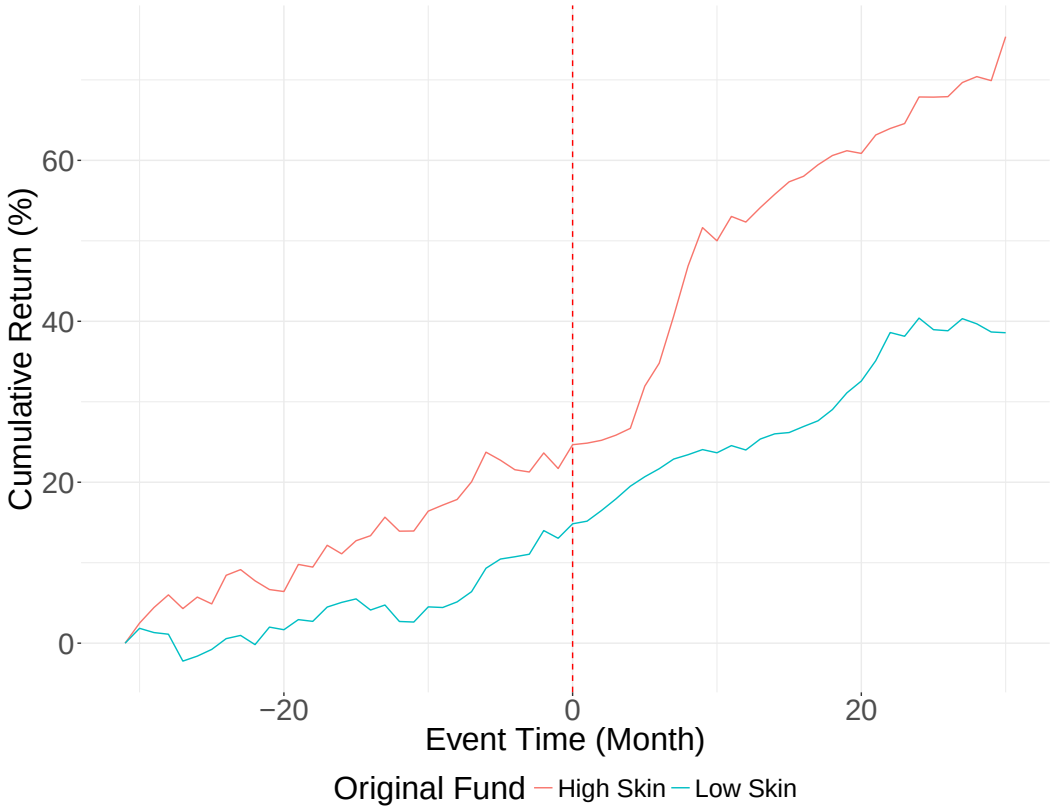
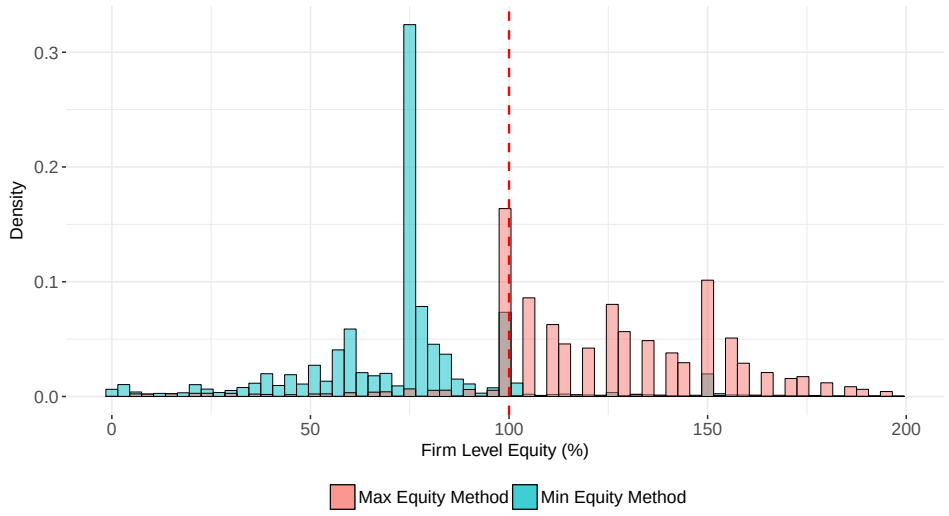
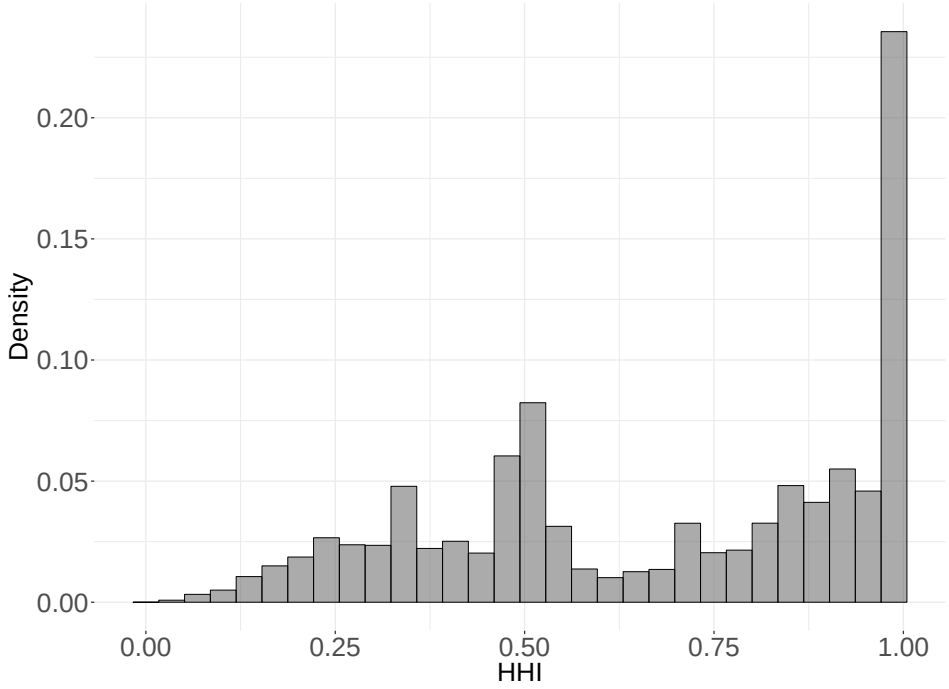


FIGURE XI **Event Study, Transition From One Fund to Multiple Funds**

This figure plots the net cumulative returns of a firm which launches an additional fund after previously only having one. Event times correspond to months from the fund creation date. The lines plot the cumulative performance of the original fund; with the red line tracking a fund in which inside investment increases in the original fund after new fund creation (suggesting that the newly created fund is marketed to outside investors). The blue line tracks the performance of funds in which inside investment the original fund falls after new fund creation (suggesting that the original fund is marketed to outside investors). The post-fund creation rise in returns of the red line indicates that fund performance improves when inside investment is strengthened in the fund. In a Difference-in-difference regression, the interacted term of High Inside$\times$Post has a coefficient of 0.874 and a standard error of 0.162, which is significant at the 1% level.



Panel A: Estimates of Firm Level Equity Ownership



Panel B: HHI of Firm-Level Equity Ownership

FIGURE XII **Firm-Level Equity Ownership**

This figure illustrates the firm-level equity ownership estimates of all hedge funds in the Form ADV data. Panel A presents both minimum and maximum estimate of aggregate equity ownership of hedge funds from recursively linking Schedule A B. Panel B presents the concentration of equity ownership at the firm-level and described by the HHI of ownership.

TABLE I **Summary Statistics: ADV Data**

This summary table describes data on investment advisors taken from Form ADV in 2016. Data is only taken from funds which are registered as hedge funds; firms must have at least one hedge fund and a minimum level of assets of $10 million. Panel A describes firm level information at the level of the management company. Panel B describes information available at the level of individual funds. Note that some assets may be double-counted due to the inclusion of fund of funds. Inside Invesment corresponds to ownership by management or related parties, the key variable explored in this paper.

Panel A: Firm Level Variables

Names	Total	Median	Mean	Std.Dev
Custodial AUM ($m)	8,525,754.0	775.5	6,458.9	28,332.9
Regulatory AUM ($m)	18,084,715	1,166.7	13,700.5	72,114.3
Discretionary AUM ($m)	17,518,589	1,030.8	13,271.7	71,040.1
Non-Discretionary AUM ($m)	566,126	0	428.9	2,585.1
Number of Employees	139,264	13	57.2	199.0
— Support Staff	81,033	5	33.3	132.9
— Advisors	58,231	7	23.9	75.6
Number of Firms	2,433			
Firms with Only One Fund	682			

Panel B: Fund Level Variables

Names	Total	Median	Mean	Std.Dev
Gross Asset Value ($m)	6,177,174.0	127.8	632.7	3,060.7
Gross Assets, Inside Investment ($m)	772,663	3.8	79.1	553.2
Gross Assets, Fund of Funds ($m)	1,160,354.0	0	118.9	873
Gross Assets, Non-US Investors ($m)	2,492,344.0	4.7	255.3	1,698.6
Number of Owners		19	66.8	544.3
Minimum Investment ($m)		1	7.5	70.3
Inside Investment (%)		3	16.7	28.6
Fund of Funds (%)		0	15.9	29.5
Non-US Investors (%)		4	30.7	39.0
Number of Hedge Funds	9,763			
Number of Fund of Funds	2,322			

TABLE II **Summary Statistics: Merged Data**

This summary table describes data on the primary dataset based on a merged dataset of Form ADV and commercial hedge fund data providers (Eureka, HFR, BarclaysHedge, eVestment, and CISDM). Data is taken as of 2016. Data is only taken from funds which are registered as hedge funds; firms must have at least one hedge fund and a minimum level of assets of $10 million. Panel A describes firm level information at the level of the management company. Panel B describes information available at the level of individual funds. Note that some assets may be double-counted due to the inclusion of fund of funds. Panel B reports additional variables not included in Table 1. Inside Invesment corresponds to ownership by management or related parties, the key variable explored in this paper.

Panel A: Firm Level Variables

Names	Total	Median	Mean	Std.Dev
Custodial AUM ($m)	1,377,236.0	592.9	4,918.7	15,802.9
Regulatory AUM ($m)	2,434,374.0	967.2	8,694.2	36,653.3
Discretionary AUM ($m)	2,356,987.0	891.2	8,417.8	35,657.3
Non-Discretionary AUM ($m)	77,386.9	0	276.4	1,802.6
Number of Employees	22,504	12	43.0	179.3
— Support Staff	13,459	5	25.7	117.5
— Advisors	9,045	6	17.3	63.2
Firms with Only One Fund	162			
Number of Firms	613			

Panel B: Fund Level Variables

Names	Total	Median	Mean	Std.Dev
Gross Asset Value ($m)	512,843.5	79.5	320.6	1,727.6
— Equity	203,412.5			
— Relative Value	108,608.6			
— Fund of Funds	53,330.4			
— Multi-Strategy	48,415.9			
— Fixed Income	29,412.6			
— CTA	25,859.8			
— Event Driven	22,231.0			
— Other	21,028.0			
— Options	544.8			
Gross Assets, Inside Investment ($m)	52,243.7	11.5	49.7	221.6
Gross Assets, Fund of Funds ($m)	78,466.0	0	50.5	244.9
Gross Assets, Non-US Investors ($m)	170,624.3	0	121.2	855.7
Number of Owners		43	116.5	570.4
Minimum Investment ($m)		1	0.9	1.2
Inside Investment (%)		11	22.8	25.4
Fund of Funds (%)		0	10.1	19.0
Non-US Investors (%)		0	19.4	32.3
Number of Hedge Funds	823			
Number of Fund of Funds	175			
Management Fee		1.5	1.4	0.5
Performance Fee		20	16.0	7.0
Leverage Ratio		1	1.4	0.9

TABLE III **Related Party Information**

This table illustrates the identity of related parties. The rows need not sum to one: firms select as many options apply to identify all related parties.

Statistic	Mean	SD
Sponsor of GP	0.767	0.423
Other Investment Advisor	0.490	0.500
Commodity Pool	0.417	0.493
Broker/Dealer	0.156	0.363
Insurance	0.053	0.223
Sponsor of LP	0.045	0.208
Trust	0.039	0.195
Bank or Thrift	0.039	0.194
Accountant	0.022	0.148
Pension	0.022	0.148
Lawyer	0.020	0.141
Real Estate	0.019	0.137
Municipal Advisor	0.017	0.131
Futures Merchant	0.012	0.109
Swap Dealer	0.006	0.075
Swap Participant	0.001	0.027
Share Supervised Persons	75%	
Share Office	60%	

TABLE IV **Relationship between Inside Investment and Excess Return—Value-Weighted**

This table shows the panel regression between the excess monthly return of an investment advisor and percent investment from an insider or related party, skin. Column one regresses percent inside investment against excess returns without additional controls. Column two adds additional firm and year fixed effects, as well as fund controls (fund origination year and strategy). Column 3 and 4 repeat this exercise for a different measure of inside investment—total gross inside investment in the firm. Specifications are repeated for the standard four-factor model (Panel A) and Fung and Hsieh (2004) factor models (Panel B). All results are value-weighted using fund Gross Asset Value from Form ADV, and standard errors are clustered at the fund level.

Panel A: **Fama-French Excess Returns**

	Risk Adjusted Excess Returns (FF)			
	All	Controls	All	Controls
	(1)	(2)	(3)	(4)
Skin (percent)	0.0047**	0.0055***		
	(0.0018)	(0.0014)		
Skin (log of gross)			0.0525**	0.0707***
			(0.0243)	(0.0146)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Log(Fund Size)	No	Yes	Yes	Yes
Fund Controls	No	Yes	No	Yes
Observations	63,978	63,978	63,978	63,978
R^2	0.0012	0.1096	0.0013	0.1096

Panel B: **Fung-Hsieh Excess Returns**

	Risk Adjusted Excess Returns (FH)			
	All	Controls	All	Controls
	(1)	(2)	(3)	(4)
Skin (percent)	0.0060***	0.0110***		
	(0.0022)	(0.0038)		
Skin (log of gross)			0.0902***	0.1824***
			(0.0219)	(0.0539)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Log(Fund Size)	No	Yes	Yes	Yes
Fund Controls	No	Yes	No	Yes
Observations	63,978	63,978	63,978	63,978
R^2	0.0022	0.1022	0.0033	0.1040
Note:				*p<0.1; **p<0.05; ***p<0.01

TABLE V **Relationship between Inside Investment and Excess Return—Equal-Weighted**

This table shows the panel regression between the excess monthly return of an investment advisor and percent investment from an insider or related party, skin. Column one regresses percent inside investment against excess returns without additional controls. Column two adds additional firm and year fixed effects, as well as fund controls (fund origination year and strategy). Column 3 and 4 repeat this exercise for a different measure of inside investment—total gross inside investment in the firm. Specifications are repeated for the standard four-factor model (Panel A) and Fung and Hsieh (2004) factor models (Panel B). All results are equal-weighted, and standard errors are clustered at the fund level.

Panel A: **Fama-French Excess Returns**

	Risk Adjusted Excess Returns (FF)			
	All	Controls	All	Controls
	(1)	(2)	(3)	(4)
Skin (percent)	0.0018**	0.0031***		
	(0.0008)	(0.0008)		
Skin (log of gross)			0.0238	0.0499***
			(0.0146)	(0.0127)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Log(Fund Size)	No	Yes	Yes	Yes
Fund Controls	No	Yes	No	Yes
Observations	63,978	63,978	63,978	63,978
R^2	0.0003	0.0938	0.0002	0.0937

Panel B: **Fung-Hsieh Excess Returns**

	Risk Adjusted Excess Returns (FH)			
	All	Controls	All	Controls
	(1)	(2)	(3)	(4)
Skin (percent)	0.0017**	0.0035***		
	(0.0007)	(0.0008)		
Skin (log of gross)			0.0244	0.0726***
			(0.0149)	(0.0143)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Log(Fund Size)	No	Yes	Yes	Yes
Fund Controls	No	Yes	No	Yes
Observations	63,978	63,978	63,978	63,978
R^2	0.0003	0.1048	0.0003	0.1049
Note:				*p<0.1; **p<0.05; ***p<0.01

TABLE VI **Cuts by Fund Size**

This table illustrates our main specification (column (2) of Panel A in Table IV) across the fund size distribution. We cut by the quantiles of fund size, which correspond to the buckets: [$10m-$43m), [$43m, $102m), [$102m, $340m), [$340m+). All results are value-weighted by Gross Asset Value, and standard errors are clustered at the fund level.

	Quartile 1	Quartile 2	Quartile 3	Quartile 4
	(1)	(2)	(3)	(4)
Skin (Percent)	0.0007	0.0072***	0.0042**	0.0043**
	(0.0014)	(0.0022)	(0.0020)	(0.0019)
Year FE	Yes	Yes	Yes	Yes
Inception Year FE	Yes	Yes	Yes	Yes
Strategy FE	Yes	Yes	Yes	Yes
Observations	16,017	15,975	15,998	15,988
R^2	0.1027	0.1066	0.1062	0.1153
Note:				*p<0.1; **p<0.05; ***p<0.01

TABLE VII **Flow Performance and Return Predictability**

This table shows the panel regression of fund flow-performance and return predictability regressions. In both cases, the key dependent variable is lagged return (excess of the Fama-French factors). The independent variable in columns 1-2 is Fund Inflows, where flows are defined as: $FLOW_{it} = \frac{AUM_{it} - (1+r_{i,t}) \cdot AUM_{i,t-1}}{AUM_{i,t-1}}$. The specification in this regressions is: $FLOW_{i,t \to t+1} = \beta(1 + r^e_{i,t-1 \to t}) + \varepsilon_{i,t}$. Columns 3-4 are return predictability specifications, in which the independent variable is next period excess return: $r^e_{i,t \to t+1} = \beta r^e_{i,t-1 \to t} + \varepsilon_{i,t}$. Funds are divided by the average level of inside investment into insider funds ($>$ 20.8% Inside Investment) and outsider funds. Flows are winsorized at a 1% level. All results are value-weighted using Net Asset Value, and standard errors are clustered at the fund level.

	Flow		Current Return	
	(1)	(2)	(3)	(4)
Lag Excess Return	0.001	0.002	0.265**	0.082
	(0.002)	(0.003)	(0.111)	(0.063)
log(AUM)	−0.018	0.070**	2.130	−0.781
	(0.017)	(0.033)	(1.370)	(0.957)
Constant	0.363	−1.270*	−30.537	25.749
	(0.334)	(0.657)	(25.782)	(19.022)
Sample:	Insider	Outsider	Insider	Outsider
Observations	279	552	279	552
R^2	0.010	0.066	0.114	0.010
				*p<0.1; **p<0.05; ***p<0.01

TABLE VIII **Inside Investment and Fund Size**

This table shows the panel regression between size and inside skin in the game. Panel A conducts analysis on the matched sample connecting Form ADV with commercial hedge fund datasets (where the key dependent variable is assets under management, taken from the commercial hedge fund datasets, reported as the log of AUM or in millions). Panel B performs analysis on the complete ADV dataset, using as the dependent variable Gross Asset Value. All specifications regress the fraction of the fund which consists on insider investment against a measure of size, measured yearly. Columns (1) and (3) across all specifications perform this regression with no additional controls; columns (2) and (4) add firm and year fixed effects. Standard errors are in parenthesis.

Panel A: **Results on Matched Dataset**

	Dependent variable:			
	AUM (in $m)		Log(AUM)	
	(1)	(2)	(3)	(4)
Percent Skin in Fund	-3.54^{***}	-6.48^{***}	-0.01^{***}	-0.02^{***}
	(0.79)	(1.28)	(0.002)	(0.003)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Fund Controls	No	Yes	No	Yes
Dataset	Matched	Matched	Matched	Matched
Observations	3,558	3,558	3,558	3,558
R^2	0.01	0.90	0.03	0.87

Panel B: **Results on ADV Dataset**

	Dependent variable:			
	Gross Asset Value (in $m)		Log(Gross Asset Value)	
	(1)	(2)	(3)	(4)
Percent Skin in Fund	-6.34^{***}	-10.14^{***}	-0.01^{***}	-0.02^{***}
	(1.07)	(1.59)	(0.001)	(0.001)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Fund Controls	No	Yes	No	Yes
Dataset	Matched	Matched	Matched	Matched
Observations	35,960	35,960	35,960	35,960
R^2	0.002	0.57	0.03	0.57
Note:				*p<0.1; **p<0.05; ***p<0.01

TABLE IX **Fund Flows and Performance**

This table shows the panel regression between size and inside skin in the game. Panel A conducts analysis on the matched sample connecting Form ADV with commercial hedge fund datasets (where the key dependent variable is assets under management, taken from the commercial hedge fund datasets, reported as the log of AUM or in millions). Panel B performs analysis on the complete ADV dataset, using as the dependent variable Gross Asset Value. All specifications regress the fraction of the fund which consists on insider investment against a measure of size, measured yearly. Columns (1) and (3) across all specifications perform this regression with no additional controls; columns (2) and (4) add firm and year fixed effects. Standard errors clustered at the fund level.

	Excess Return		
	(1)	(2)	(3)
Insider Flow (%)	−0.00002	−0.00001	−0.00018*
	(0.00003)	(0.00003)	(0.00011)
Outsider Flow (%)	0.00002	0.00002	0.00003*
	(0.00001)	(0.00001)	(0.00002)
Year FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	833	833	833
R^2	0.00283	0.00560	0.63798
Note:			*p<0.1; **p<0.05; ***p<0.01

TABLE X **Firm-Level Equity Ownership and Returns**

This table shows a panel regression with alternate measures of firm ownership. # of Equity Holders captures the total number of beneficial owners listed in Form ADV for the firm's equity. HHI of Firm Equity captures a Herfindahl-Hirschman index measure of concentration of equity ownership. Standard errors are clustered at the fund level and are shown in parenthesis.

	Monthly Excess Return (FF)			
	(1)	(2)	(3)	(4)
Skin (Percent)	0.0043**	0.0046**	0.0048**	0.0039**
	(0.0019)	(0.0018)	(0.0019)	(0.0019)
# of Equity Holders	−0.0002		−0.0058	−0.0038
	(0.0057)		(0.0083)	(0.0050)
HHI of Firm Equity		−0.1660	−0.2061	−0.1440
		(0.1559)	(0.1881)	(0.0904)
log(Gross Assets)	0.0057	−0.0013	0.0027	0.0148
	(0.0247)	(0.0219)	(0.0250)	(0.0139)
Year	Yes	Yes	Yes	Yes
Log(Size)	Yes	Yes	Yes	Yes
Fund Controls	No	No	No	Yes
Observations	59,588	59,588	59,588	59,588
R^2	0.0230	0.0237	0.0238	0.0420
Note:				*p<0.1; **p<0.05; ***p<0.01

A Internet Appendix: Model

To fix ideas, we outline a simple, rational, two period partial equilibrium model that highlights how the internal capital allocation decisions of hedge fund managers interact with measured performance. We model active portfolio managers as maximizing their profits by selectively opening and allocating insider capital between a family of funds under their control. Insiders rationally allocate internal capital across strategies to maximize total profits.

Our simple model has several salient features that differ from previous works. First, we disaggregate capital from insiders and outsiders. This captures the idea that insiders compensation is tied to both management fees earned on outside capital and returns on insider capital. We also model for endogenous fund generation in the form of multiple investment strategies and managerial discretion to differentially allocate insider capital across these strategies. For clarity, both in notation and results, we focus on a two period model. Finally, costs in our model are convex in *gross returns*, as this helps match stylized facts we observe in the data.

A.1 Capital: Insider and Outsider

There are two types of investors in this model: insiders and outsiders.

An *insider* is an investor with highly specialized arbitrage skills.[10] This maps into practice to someone who has access to a positive alpha strategy (i.e., portfolio managers, hedge fund employees, and closely related parties). An investor can invest either in their strategy, the appropriate passive benchmark portfolio, or combination of both.

An *outsider* refers to anyone who is not an insider. They can be thought of as limited partners who delegate their capital to manager through a fund. By definition, outsiders do not posses such specialized skills. As such, outsiders can invest their capital in the appropriate passive benchmark portfolio, delegate their capital to these insiders to access investment strategies, or a combination of both.

[10] We take a similar view to Shleifer and Vishny (1997) that arbitrage is typically carried out by a few, highly specialized investors.

Capital is denoted by q and any superscript notation denotes who supplies the capital. Total capital, insider capital, and outsider capital are denoted by q^T, q^I and q^O, respectively. Total capital is defined as:

$$q^T \equiv q^I + q^O \tag{8}$$

We exclude the possibility of leverage and define total capital as. Further, we exclude the possibility of short-selling, so $q^I, q^O \geq 0$.[11]

A.2 Investment Technology

An active manager specializes in N strategies indexed by n. Each strategy has limited investible capacity. The more capital invested in a strategy at time t, either from an insider or outsider, results in a lower gross excess return. Formally, we define the gross return to strategy n at time $t+1$, for an investment of $q_{n,t}$ by:

$$R_{n,t+1} = \alpha_n - C_n\left(q^T_{n,t}\right) \tag{9}$$

The excess return is above an appropriate passive benchmark, which all investors are assumed to have access to. The first term, α_n, captures the maximum alpha to strategy n and is by assumption positive ($\alpha_n > 0$). The second term is a cost function, $C_n\left(q^T_{n,t}\right)$, which depends on the *total* capital invested at period t in strategy n. The cost function is strictly non-negative ($C \geq 0$), increasing and convex ($C' > 0$, and $C'' > 0$). Further, at no investment, $C(0) = 0$, and in the limit, $\lim_{q^T_t \to \infty} C'(q^T_{n,t}) = \infty$.[12] The assumption of decreasing returns to scale is motivated by research suggesting a negative relationship between size and performance, such as Fung et al. (2008).

It is important to emphasize that different strategies have different α_n and cost functions C_n. For simplicity of this model and to make our analysis concrete, we assume a specific functional form for this cost: $C_n\left(q^T_{n,t}\right) = \frac{a_n}{2}\left(q^T_{n,t}\right)^2$. The scale cost is non-negative, $a_n \geq 0$, and captures how well the strategy scales.[13] A smaller scale cost indicates that a strategy

[11] Including leverage subject to a collateral constraint does not affect our model results.

[12] This results in a decreasing returns to scale in the gross excess return and a departure from the Berk and van Binsbergen (2017), where costs are linear in the return equation.

[13] Costs are orthogonal to risk factors and collinear with α_n.

scales better. An example of the tradeoff between strategies with different excess return and scale is show in Figure A.1.

To simplify notation, we assume that capital is allocated at time t and suppress time subscripts on all capital variables q. All returns are assumed to occur at $t+1$, and time subscripts are omitted for returns as well.

A.3 Baseline Model: One Strategy

We focus first on the case in which firms have only one strategy $N = 1$, and omit the subscript indexing of strategies. We first identify the *value add* of managers, as discussed in Berk and van Binsbergen (2015). The insider value add, V^I, is defined as the profit from investing in their own strategy in addition to fees collected on managed outsider capital. We assume that the management fee f, is a fraction of outside capital invested, and take these as given. Outsider value add is similar to the insider value add, but subtracting the fees:[14]

$$V^I = q^I\left(R\left(q^T\right)\right) + q^O f \tag{10}$$

$$V^O = q^O\left(R\left(q^T\right)\right) - q^O f \tag{11}$$

A.3.1 Case 1: Unconstrained Inside Capital

We first consider the case where insider capital is unconstrained. How much would an insider invest in their own fund? Absent outside investors, the insiders' objective can be written as:

$$\arg\max_{qI} \quad V^I_{t+1} = q^I_t\left(\alpha - C\left(q^I_t\right)\right)$$

With a solution:

$$\bar{q}^{I*}_t = \sqrt{\frac{2\alpha}{3a}} \tag{12}$$

Notice that, $\bar{q}^{I*} = q^T$, insider are sufficiently capitalized and refuse outside capital. Substituting back into 10, the value add to insider, we get $\frac{2\alpha q^I}{3}$, and corresponds to the maximum achievable benefit from the strategy.

[14] More realistically, hedge fund fees also incorporate a performance fee on returns above a certain hurdle rate, assuming the fund's value exceeds a high water mark, as well as exit fees.

A.3.2 Case 2: Fully Constrained Inside Capital

Next we consider the case where insider capital is fully constrained, and are unable to pledge any of their capital to a strategy. How much much outsider capital would they accept? Outsiders will continue to invest until the benefit from investing in the strategy is equal to zero. The maximum q^O is given by:

$$\bar{q}_t^{O*} = \sqrt{\frac{2\left(\alpha - f\right)}{a}} \tag{13}$$

Notice that the value add to outsiders is driven to zero and that insiders only earn from management fees. Further, the insider earns only on through management fees.

A.3.3 Case 3: Constrained Inside Capital

We next consider the interior case where an insider has only one investment strategy but is capital constrained. That is, $q_t^I \in \left[0, \bar{q}_t^{I*}\right)$. How much outside capital should the insider accept? The insiders choose the amount of outside capital to maximize the objective, subject to the outsider capital providers' participation constraint. These conditions are given by:

$$\arg\max_{q^O} \quad q^I\left(\alpha - C\left(q^T\right)\right) + fq^O \tag{14}$$

$$V^O = q^O\left(\alpha - C(q^T)\right) - fq^O \geq 0 \tag{15}$$

When $q^O > 0$, and the insider collects a proportional and fixed management fee, f, for their services. The model is solved by:

$$q^{O^*} = \begin{cases} \sqrt{\frac{2(\alpha-f)}{a}} - q^I & if\ \alpha - f < \frac{f^2}{2a(q^I)^2} \\ \frac{f}{aq^I} - q^I & if\ \left(\frac{f}{aq^I} - q^I\right)\left(\alpha - f - \frac{f^2}{2a(q^I)^2}\right) > 0 \\ 0 & else\ \sqrt{\frac{f}{a}} < q^I \end{cases}$$

The first region is the case where both insiders and outsider allocate to the the strategy. Insiders are highly capital constrained, and outsiders can allocate capital up to the point where their participation constraint is binding. As a result, the value add to outsiders is equal to zero. In this region, insiders can increase their capital level, which would directly replace the level of outsider capital.

The second region is the case where an insider can maximize their own value add by limiting the level of outsider capital. Outsiders would prefer to contribute more capital but this would not maximize the value add to insiders. As a result, the remaining outside investors earn a positive value add from investing in the strategy.

The final region is the case where the outsider's participation constraint is binding. The insider has reduced the gross return of the strategy to the point where the marginal benefit to an additional dollar from an outsider is less than the marginal cost of fees and the capacity constraint. As a result, no outsider would contribute to this strategy. Notice that there an insider may continue to contribute to this strategy, as they do not pay fees.

Proposition 1 *There exists a positive fee where outsider value add equal zero for all levels of investment.*

Proof The optimization problem reduces to:

$$\arg\max_{q^O, f} \quad q^I \left(\alpha - C\left(q^T\right)\right) + f q^O \tag{16}$$

$$s.t.\ V^O \quad = \quad q^O \left(\alpha - C(q^T)\right) - f q^O \geq 0 \tag{17}$$

With the solution corresponding to $f = \frac{2}{3}\alpha$. The insider will choose management fees, f, to capture the entire surplus from investing. As a result, outsiders participation constraint will be binding.

Proposition 2 *For a non-binding management fee and positive level of outside investment, total capital is weakly decreasing as a portion of insider capital.*

Proof Consider an investment strategy managed by an insider with a non-binding the fee, $0 < f < \frac{2}{3}\alpha$, and a positive level of outside investment, $q^O > 0$. Outsider capital q^T is decreasing in the level of insider investment. This can be seen directly:

$$\frac{dq^{O^*}}{dq^I} = \begin{cases} -1 & if\ \alpha - f < \frac{f^2}{2a(q^I)^2} \\ -\frac{f}{aq^{I2}} - 1 & if\ \left(\frac{f}{aq^I} - q^I\right)\left(\alpha - f - \frac{f^2}{2a(q^I)^2}\right) > 0 \end{cases}$$

Proposition 3 *Value add to insider is weakly increase as a fraction of insider investment*

Proof Plugging in the optimal level of outsider capital q^{O^*} into the value add to insider, we get:

$$V^I = \begin{cases} f\sqrt{\frac{2(\alpha-f)}{a}} & if\ \alpha - f < \frac{f^2}{2a(q^I)^2} \\ (\alpha - f)\, q^I - \frac{f^2}{2aq^{I2}} + f\sqrt{\frac{2(\alpha-f)}{a}} & if\ \left(\frac{f}{aq^I} - q^I\right)\left(\alpha - f - \frac{f^2}{2a(q^I)^2}\right) > 0 \\ q^I\left(\alpha - \frac{a}{2}q^{I2}\right) & else\ \sqrt{\frac{f}{a}} < \bar{q}_t^{I*} \end{cases}$$

Taking the value add to insiders derivative with respect to insider capital, we get:

$$\frac{dV^I}{dq^I} = \begin{cases} 0 & if\ \alpha - f < \frac{f^2}{2a(q^I)^2} \\ (\alpha - f) + \frac{f^2}{aq^{I3}} & if\ \left(\frac{f}{aq^I} - q^I\right)\left(\alpha - f - \frac{f^2}{2a(q^I)^2}\right) > 0 \\ \alpha - \frac{3a}{2}q^{I2} & else\ \sqrt{\frac{f}{a}} < \bar{q}_t^{I*} \end{cases}$$

Proposition 4 *For a non-binding management fee and positive level of outside investment, gross fees are weakly increasing as a portion of insider capital.*

Proof This is immediate when substituting the optimal level of outsider capital, q^{O^*}, substituting into the gross return equation, and taking the first derivative with respect to q^I.

A.4 Extension: Two Strategies

Up to now we have considered the case of one strategy. We extend the analysis to an insider which has access to two strategies, $N = 2$. Consider the insider with access to the following returns:

$$R_1 = \alpha_1 - C_1\left(q_1^T\right)$$
$$R_2 = \alpha_2 - C_2\left(q_2^T\right)$$

Without loss of generality, assume that $\alpha_1 > \alpha_2$. The interesting case is if, $a_1 < a_2$. This means that strategy one has a higher alpha, and also a lower higher scale cost as compared to strategy two.

Capital between the two strategies and investors is given by $q_n^T = q_n^I + q_n^O$ with $n \in \{1, 2\}$. For insiders $q^I = q_1^I + q_2^I$, for outsiders $q^O = q_1^O + q_2^O$, and in aggregate $q^T = q_1^T + q_2^T$. Shorting an insider's management service is ruled out, so $q_n^I \geq 0$ and $q_n^O \geq 0$.

A.4.1 Case 1: Constrained Inside Capital, One Fund

The insider's total value add is now the sum of value add from each strategy, $V_1^I + V_2^I$. Given this, how should an insider allocate their capital between strategies? If so, should the insider capital be allocated across strategies? Would an insider ever invest in the low alpha strategy? If so, what rule would govern this?

We first consider the case when an insider capital is in the range of $0 < q^I < \sqrt{\frac{2\alpha_1}{3a_1}}$. Intuitively, an insider would invest in the high alpha strategy up to the point where the marginal value add equals the low alpha strategy. Said differently, the insider would invest in strategy one for the initial range of q^I where:

$$\frac{dV_1^I}{dq_1^I} \geq \frac{dV_2^I}{dq_2^I} \tag{18}$$

While an the above inequality is satisfied, insiders maximize their value add by allocating their capital to the high-alpha strategy. That means $q_1^I = q^I$ and $q_2^I = 0$ for the initial insider capital region. The value add for this partial regions is equal to V_1^I, and is outlined in the previous section.

A.4.2 Case 2: Two Strategies, Sufficient Insider Capital, Two Funds

As an insider allocates capital towards strategy one, the marginal value of each additional dollar will decrease towards the marginal value of strategy two. That is at some point, $\frac{dV_1^I}{dq_1^I} = \frac{dV_2^I}{dq_2^I}$ for some $0 < \hat{q}_1^I < \bar{q}_1^{I*}$. Once an insider's capital level reaches the threshold of $\hat{q}_1^I$, they will optimally mix between their two strategies to equate their marginal values to insider capital.

An insider will continue to allocate to *both* strategies, equating the marginal value add from strategy 1 equal to the marginal value add from strategy 2. While we do not explicitly solve the optimal mixing scheme in this paper, we can see a sketch of this strategy in Figure A.2. An insider will continue to strategically allocate insider capital to both strategies for insider capital levels of:

$$q_1^I \in \left[\hat{q}_1^I, \sqrt{\frac{2\alpha_1}{3a_1}} + \sqrt{\frac{2\alpha_2}{3a_2}}\right)$$

If funds raise outside capital, they do so to maximize value added in each fund subject to the fund-specific participation constraint.[15]

[15] We rule out the possibility that outside investors receive negative value add in some funds in order to participate in others.

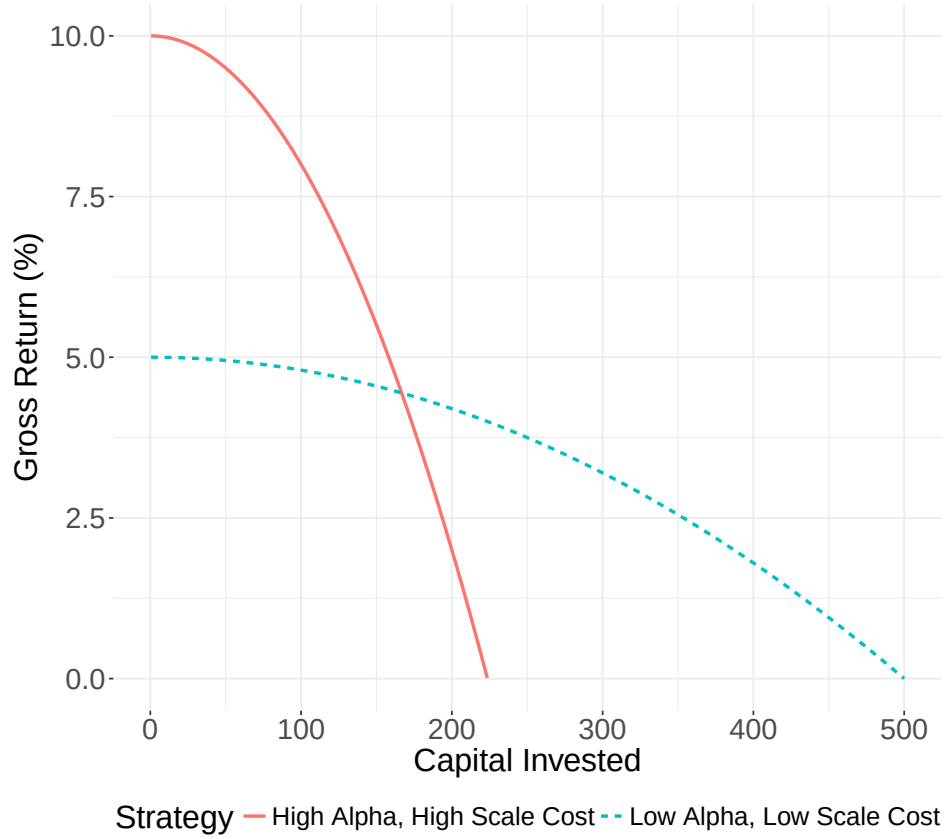
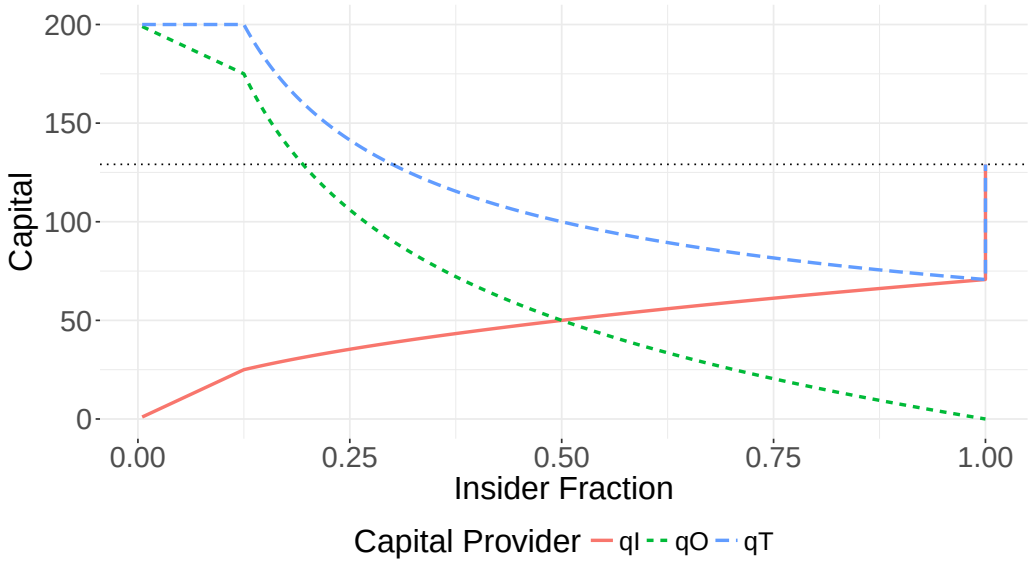
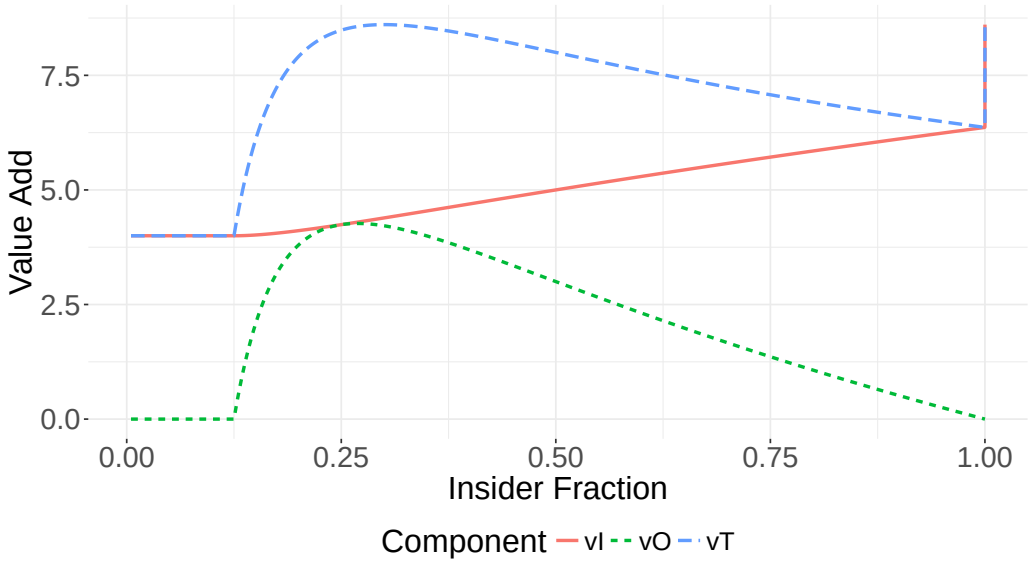


FIGURE A.1 **Gross Return Profiles of Different Strategies**

The above figure shows two strategies. The horizontal axis is the total dollar invested q_t^T in a given strategy, while the vertical axis is $R_{n,t+1}$. The red line refers to a high alpha, high scale costs, while the blue dotted line refers to the low alpha, low scale cost strategy. The first strategy is parameterized by $\alpha = 10\%$, and $a = 4 \times 10^6$, while the second is parameterized by $\alpha = 5\%$, and $a = 4 \times 10^7$. The highest alpha, per strategy, is highest at a zero dollar investment.



Panel A: Capital Sources



Panel B: Components of Value Add

FIGURE A.2 **Capital and Value Add**

This figure illustrates the distributions of fund size and returns by fraction of inside investment. Panel A illustrates that the total size of the fund is decreasing in the fraction of inside capital—the fund operates at a smaller capital capacity the more insiders are invested. Panel B shows that net returns to outsiders are higher the greater the proportion of inside investment. Parameters used in this example is $\alpha = 10\%$ and $a = 4 \times 10^6$.

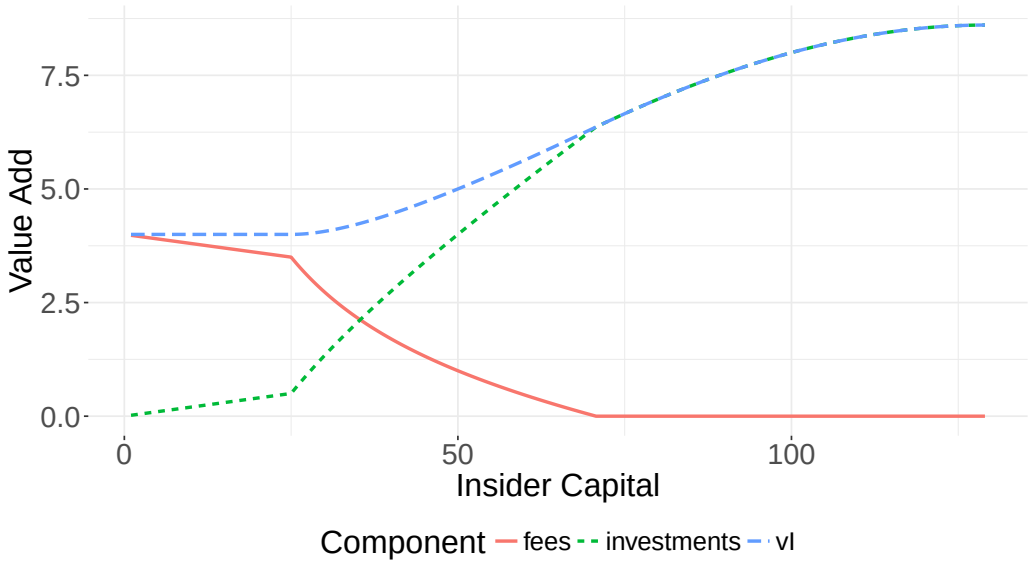
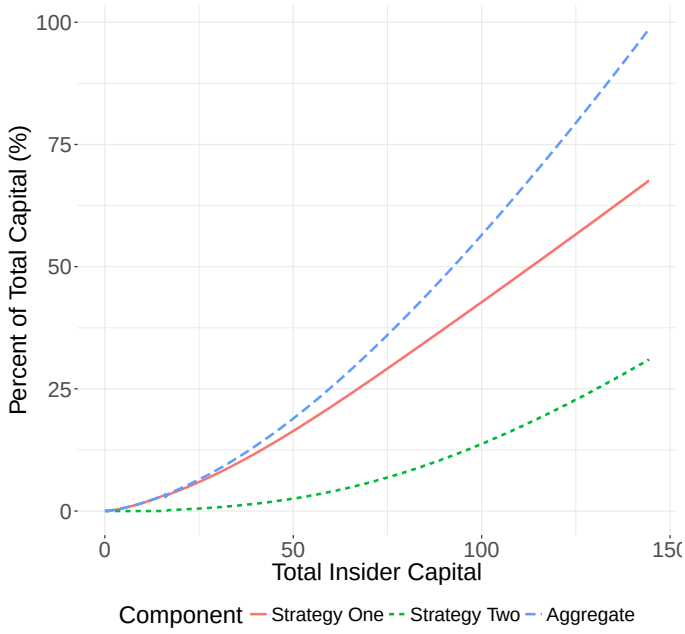
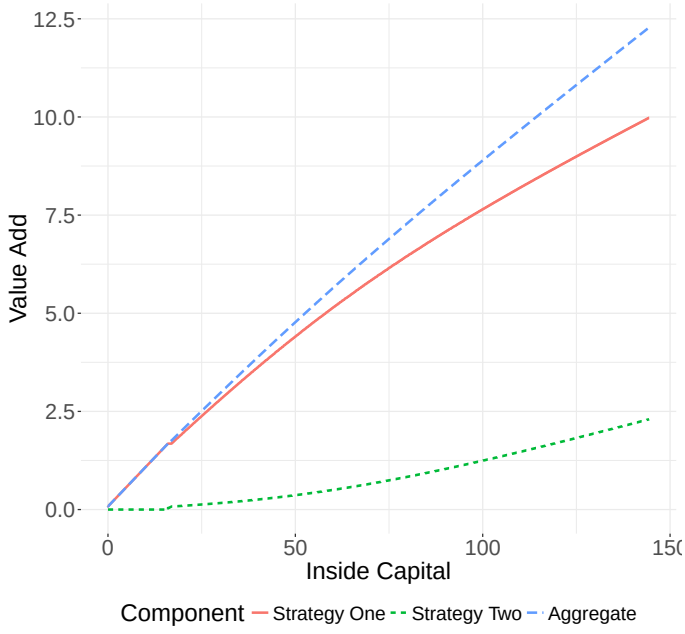


FIGURE A.3 **Value Add to Insider and Components**

This figure illustrates the value add to insiders and outsiders over the range of insider investment. Outsiders have zero value add when insiders have no capital in the fund, or are fully invested. They share in rents when insiders are partially invested in the fund, but also accept outside capital. Parameters used in this example is $\alpha = 10\%$ and $a = 4 \times 10^6$.



Panel A: Percent of Inside Capital Allocated Across Funds



Panel B: Value Add Between Two Strategies

FIGURE A.4 **Percent Inside Allocation and Value Add of Two Strategies**

This figure shows the optimal percent insider invested in each strategy across the total insider capital. Parameters for the high alpha strategy is $\alpha = 10\%$ and $a = 4 \times 10^8$. Parameters for the low alpha, is $\alpha = 5\%$ and $a = 4 \times 10^7$

Internet Appendix B: Model Details

Important Notation

$R_{n,t+1}$	Gross excess return over the relevant benchmark portfolio, after accounting for scale effects of investing in strategy n.
α_n	Gross alpha for the first dollar invested in strategy n. This is the maximum gross excess return over the relevant benchmark. This is taken to be exogenous.
$r_{n,t+1}$	Net return from strategy n.
q_n^T	Total capital invested in strategy n. By definition, $q_n^T \equiv q_n^I + q_n^O$.
q_n^I	Insider capital invested in strategy n. This is taken to be exogenous.
q_n^O	Outsider capital invested in strategy n. This is taken to be exogenous.
$\bar{q}_n^{I*}$	The maximum amount of capital an insider choses to invest in a strategy if unconstrained.
V_n^I	Value add to insiders from strategy n. This equals the profit from returns and fees.
V^O	Value add to outsiders from strategy n. This equals the profit from returns minus fees.
$C_n\left(q^T\right)$	Scale factor of investment strategy. For concreteness, we use $C_n\left(q^T\right) = \frac{a_n}{2}\left(q_n^T\right)^2$ in this paper.
a_n	Scale factor of strategy that is associated with strategy n. This is taken to be exogenous.
f	Management fee as a fraction of the assets delegated by the outsider to the insider.
N	Total number of strategies available to an investor.
n	Refers to an individual strategy n. A strategy has a unique α_n, a_n, and thus $C_n\left(q_n^T\right)$.

Internet Appendix C: Additional Results

TABLE XI **Inside Investment and Hedge Fund Fees**

This table shows a yearly panel regression of inside investment and fees. We focus on the main fee components of hedge funds; the management fee levied on assets under management, as well as a performance fee charged on proportional returns which clear a pre-defined hurdle rate. Columns (1) and (2) present a univariate regression; while columns (3) and (4) add a variety of fund and firm-level controls. Standard errors are clustered at the fund level.

	Management Fee	Performance Fee	Management Fee	Performance Fee
	(1)	(2)	(3)	(4)
Skin (Percent)	−0.0030*	0.0040	−0.0014	0.0056
	(0.0016)	(0.0153)	(0.0014)	(0.0128)
Log(Fund Size)	No	No	Yes	Yes
Year FE	No	No	Yes	Yes
Inception Year FE	No	No	Yes	Yes
Strategy FE	No	No	Yes	Yes
Observations	5,925	5,848	5,925	5,848
R^2	0.0137	0.0002	0.3216	0.5405
Note:				*p<0.1; **p<0.05; ***p<0.01