Skin or Skim? Inside Investment and Hedge Fund Performance*

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Abstract

Using a comprehensive and survivor-bias free dataset of U.S. 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; exhibit greater return persistence; and feature lower fund flow-performance sensitivities. 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.

JEL classification: G23, G32, J33, J54
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I Introduction

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 over $3 trillion in assets under management, 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 the decision of insiders 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 through 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 which 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

[1] For the size of the industry, see figures collected 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.

strategies, and can allocate internal capital across funds. When managing personal capital, 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 on 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 fund, resulting in higher alphas even in equilibrium.

We study 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 $10om 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 first examine the importance and implications of investments by insiders through an implementable long-only trading strategy. We generate sorted portfolios based on observable information on inside investment, rebalancing yearly, and track the performance of investors who systematically invest in hedge funds with high levels of internal ownership. We find this strategy results in sizable risk-adjusted excess returns over time relative to a portfolio invested in low ownership funds.

Second, to further isolate the role of ownership on fund returns, we consider a panel regression. Using both the Fama and French (1992) and Carhart (1997) factors, as well

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

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 allocation from a fund with zero percent inside investment to one at the same firm with 100 percent inside investment would see a rise in excess returns of 36 basis points a month, or 4.3% annualized. This significant and economically large magnitude indicates that inside investment is an important, and previously neglected, cross-sectional predictor of hedge fund returns.

Third, 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, high returns do *not* lead to excess inflows; instead excess returns are persistent. 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 which 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, agency conflicts, front-running, and lower susceptibility to redemption risk. 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 which 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 on 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 have 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. 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. 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 is a proxy for some risk factor (unrelated to either the Fama-French, Carhart, or Fung-Hsieh factors). 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 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 connects to several lines of research. First, we contribute to the broader literature on financial compensation and incentives, such as Das and Sundaram (2002), Ibert et al. (2017), and Ma, Tang and Gomez (2016). While previous work has studies the role of managerial contract structures on hedge fund performance (such as Agarwal, Daniel

and Naik (2009) and Burasachi, Kosowski and Sritrakul (2014)), we emphasize that managers have another option for personal compensation: investing their own private capital. 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 compensation. In turn, 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 Raugh (2013), Philippon and Reshef (2012), and Alvaredo et al. (2013)).

Our work also relates to the broader literature on assessing managerial ability among delegated asset managers. We connect to a part of this literature which analyzes managerial alpha from the perspective of tests of the efficient market hypothesis. In the recent literature, Kosowski et al. (2006), Fama and French (2010), Koijen (2014), and Berk and van Binsbergen (2015) assess the distribution of managerial alpha. The papers closest to ours among mutual funds are Khorana, Servaes and Wedge (2007), Evans (2008), Chen, Goldstein and Jiang (2008), and Cremers et al. (2009), which analyze insider investments by mutual fund managers.

Our work also relates to research examining the role of fund families. Related papers include Massa (2003), which documents strategy differentiation across funds in a family; Berk, van Binsbergen and Liu (2017), which examines the allocation of talent across funds within a family; and Sialm and Tham (2017), which analyzes relationship between the performance of funds and their overall management companies. 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), as well as evidence on capacity constraints as in Ramadorai (2013).

Finally, our work also contributes to the broader literature on ownership, firm performance, and agency conflicts. Starting with Berle and Means (1932), Jensen and Meckling (1976), Fama and Jensen (1983), and Holmstrom (1985); this literature has analyzed the consequences of firm capital structure on governance and agency conflicts. Related empirical work includes Demsetz and Lehn (1985), Randall, Shleifer and Vishny (1988), Himmelberg, Hubbard and Palia (1999), and Porta et al. (2002). Our work extends this literature by

emphasizing the conflict between managers and investors regarding the internal capital structure and fund formation decisions of hedge funds 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 2 outlines our data and empirical strategy, and also comments briefly on the nature of corporate governance in hedge funds. Section 3 presents our main results, while Section 4 concludes. The Appendix contains further details on our model and auxiliary results.

II Data and Empirical Strategy

II.A Data

Our dataset combines regulatory 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 U.S. 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 been generally exempt from registration. Hedge funds in this period frequently used complex fund structures to evade disclosure in this period 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; or 3) Have over $25 million in assets and are not subject to examination in their home states (states which 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, Barclays, Eureka Hedge, and CISDM. We begin the merge with HFR, eVestment and Barclays, 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 with 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 the ultimate ownership of investment stakes in the fund which can be attributed to "related persons," which we treat as internal investment for the remainder of the paper.

Summary Table I shows basic summary information about both our core Form ADV dataset, as well as the merged subset. Figure V demonstrates our merge rate across the range of 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.

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

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 in 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 II, 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 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 are typically closely related entities to the management company, share a supervised person almost 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 the 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 demonstrating 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.

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.

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

II.B Conflicts and Disclosure

Hedge fund operating agreements demand few fiduciary obligations to managers to prioritize one fund over another, or 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 typical limitations on investment to classes of accredited or well-informed investors.

II.C Empirical Strategy

II.C.1 Main Specification

Our model, (see Appendix A), yields sharp predictions on the relationship between inside investment and fund returns and size, which we examine the returns on portfolios invested in baskets of hedge funds. 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.

$$r_{it} - r_{ft} = \alpha_{iT} + \beta_{1,iT} RMRF_t + \beta_{2,iT} SMB_t + \beta_{3,iT} HML_t + \varepsilon_{it} \tag{1}$$

Where $i = 1, \ldots, 5$ different portfolios sorted along quartiles of internal investment, $t = 2012 - 2016$ monthly, and r_{it} represents returns net-fees of the different portfolios (with

the risk free return differenced out to produce the risky return). We also consider factor-correction using the set of seven factors as described in Fung and Hsieh (2004):[7]

$$r_{it} - r_{ft} = \alpha_{iT} + \beta_{1,iT} S\&P_t + \beta_{2,iT} SC - LC_t + \beta_{3,iT} 10Y_t + \beta_{4,iT} CredSpr_t + \beta_{5,iT} BdOpt_t + \beta_{6,t} FXOpt_t + \beta_{7,t} ComOpt + \varepsilon_{it} \tag{2}$$

Next, we turn to a fund-based approach and estimate the impact of ownership on returns on a fund-by-fund level, adjusting for factor exposure:

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

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. They 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.

$$r_{it} - r_{ft} = \alpha_{iT} + \gamma Ownership_{it} + \hat{\beta}_{1,iT} RMRF_t + \hat{\beta}_{2,iT} SMB_t + \hat{\beta}_{3,iT} HML_t + \delta FIRM_i + \eta Year_t + \varepsilon_{it} \tag{4}$$

This allows us to control for other year and firm factors driving excess return. 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 and year.

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

$$r_{it} - r_{ft} = \alpha_{iT} + \gamma Ownership_{it} + \hat{\beta}_{1,iT} S\&P_t + \hat{\beta}_{2,iT} SC - LC_t + \hat{\beta}_{3,iT} 10Y_t + \hat{\beta}_{4,iT} CredSpr_t + \hat{\beta}_{5,iT} BdOpt_t + \hat{\beta}_{6,t} FXOpt_t + \hat{\beta}_{7,t} ComOpt + \varepsilon_{it}$$

[7] This factor model has been widely used in previous empirical research on hedge fund returns and have been shown to have considerable explanatory power. The trend following factors can be found at: `http://faculty.fuqua.duke.edu/~dah7/DataLibrary/TF-FAC.xls`

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:

$$AUM_{it} = \psi Ownership_{it} + \delta FIRM_i + \eta Year_t + \varepsilon_{it} \tag{5}$$

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

II.C.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:

$$FLOW_{it} = \frac{AUM_{it} - (1 + r_{i,t}) \cdot AUM_{i,t-1}}{AUM_{i,t-1}} \tag{6}$$

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

$$FLOW_{i,t\to t+1} = \beta(1 + r^e_{i,t-1\to t}) + \varepsilon_{i,t} \tag{7}$$

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:

$$r^e_{i,t\to t+1} = \beta r^e_{i,t-1\to t} + \varepsilon_{i,t} \tag{8}$$

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

III Results

III.A Graphical Results

To illustrate our basic result, we first show the relationship between the non-parametric relationship between inside ownership and raw returns. Figure VII illustrates the outcome of an trading strategy implementable in real-time that sorts funds into quartiles each year based on inside investment. The high ownership quantile consists of an equal-weighted investment in all funds in the high-ownership bucket; with yearly balancing each year as new ADV data becomes publicly available. The figure illustrates that the high ownership category outperforms fund portfolios with less skin in the game over our sample period from 2012–2016.

III.B Regression Results

Next, we turn to regressions which 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 bring this model to the data, we examine the portfolio returns in the previous section and control for factor exposure at the level of the sorted portfolio. Table III illustrates this regression using the Fama and French (1992) 3-Factors as well as the Carhart (1997) momentum factor. In this specification, we examine the amount of monthly excess return of value-weighted portfolios sorted along the dimension of inside investment rebalanced yearly. We observe that the superior performance of the high-inside investment portfolio persists under factor correction. We find greater statistical significance in Table IV which uses the Fung and Hsieh (2004) series of seven hedge fund factors. In this table, we find that the fund portfolio in the highest quartile of inside investment has a statistically significant excess performance of 62 basis points a month, relative to an excess performance of 40 basis

points for the portfolio with least inside investment. Results follow a pattern of increasing alpha and sharpe ratios with the degree of inside investment in-between.

To further analyze the role of inside investment and risk-adjusted returns, we examine in Table V 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 this table regresses the percent of a fund's assets under management which 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. Our estimates in that column suggest that a fund at 100 percent skin in the game exhibits a 36 basis point higher excess monthly return relative to a fund with no internal investment, or 4.3% higher excess returns a year. 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 which 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. 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 larger in magnitude, and suggest that a fund with 100 percent skin in the game can expect 56 basis points higher in excess return, monthly, relative to a fund with zero percent inside investment.

Following prior literature, we present 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 V are value-weighted using the Gross Asset Value field in Form ADV, which is present for all funds. Table VI presents equally-weighted results, which yields very similar results.[8]

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 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.

III.C Main Mechanism: Capacity Constraints

Having established that investment by insiders predict fund outperformance, we next consider the possible drivers of this relationship. In order to investigate the source of relative out-performance 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 VIII 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 percent) amount of fraction of fund assets attributable to insiders.

The figure illustrates that outsider funds exhibit standard a fund flow-performance relationship as documented in prior research on hedge funds and mutual funds. However, insider funds demonstrate a very different profile: insider funds which experience positive

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

excess returns do not exhibit subsequent high inflows, consistent with the idea that funds with greater insider capital manage funds further away from their capacity constraint.

Complementing the results on flow performance, Figure IX plots a non-parametric relationship between excess returns over time. Outsider funds demonstrate low return return 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 period. Insider funds, however, exhibit high 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 7 and 8. The independent variable in these specifications is the same (lagged excess returns); the dependent variable is is either fund flows or subsequent excess returns.

The regression results confirm the graphical evidence that insider funds exhibit novel flow and performance behavior: high insider ownership funds do not experience additional inflows in response to high excess returns; and in parallel experience greater persistence in excess returns.

The joint relationship between inside investment, flow performance, and return predictability provides strong 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.

III.D Robustness

III.D.1 Heterogenous Treatment Effects

Figure XI illustrates the main effect (as in column (2) of Table V) 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 which 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 feature trend-following strategies with less role for managerial skill.

III.D.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 $14 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 size. Despite the limitations of this measure, using this field as a dependent variable enable 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 which 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 $19 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.

III.E 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 outside investors, and so deploy personal capital to the superior managers. To test this hypothesis, we estimate the following specification in Table IX:

$$r^{e}_{i,t-1\to t} = \beta InsiderInflow_{i,t-1} + \gamma OutsiderInflow_{i,t-1} + \varepsilon_{it} \tag{9}$$

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 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 operate funds further from their capacity constraint and gain excess returns.

III.F Event Study

The results from the previous section provide suggestive 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 (in our model, to the point that their participation constraint is binding, and they earn no additional returns beyond a passive benchmark).

We explore this possibility in Figure X, 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 instead 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 what happens 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 less performing funds. These results therefore provide additional context to our model and previous empirical results, in 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 whether that 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.

III.G 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 dispersion in firm-level equity dispersion 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 both at the levels of fund allocation, as well as firm-level equity contributions.

IV 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 been 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 which 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 which 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 and so compare funds within the same family. Our results are large in magnitude, suggesting that a fund with purely internal investment rather than purely outsider investment will outperform at a rate of around 36 basis points a month.

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 positive excess returns, they do not accept as much 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 document that firm performance improves when a newly created fund contains largely outsider capital but inside capital remains in the fund; relative to when insider investments shift to newly created funds. Overall, we find that funds which rely more on insider money outperform funds which 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 Raugh (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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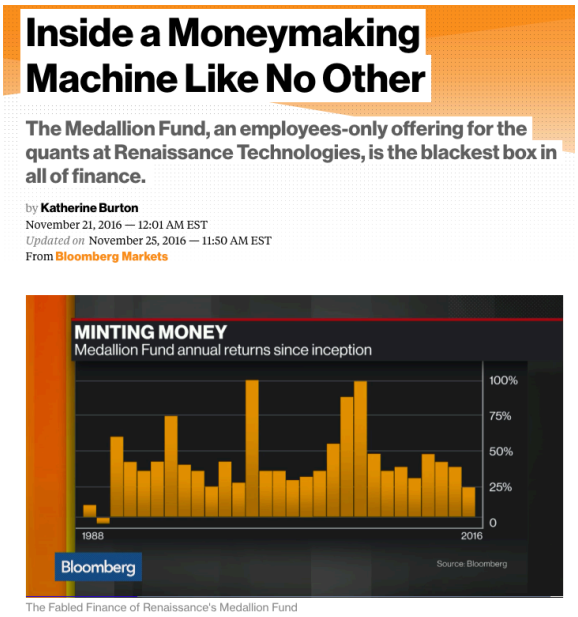
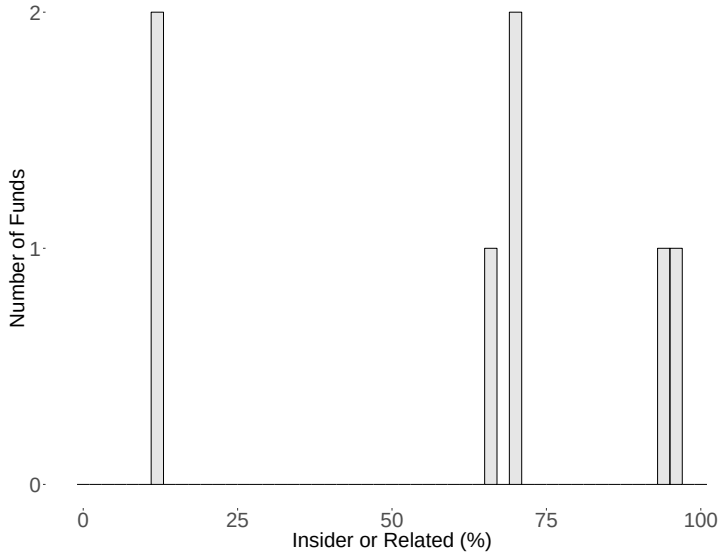


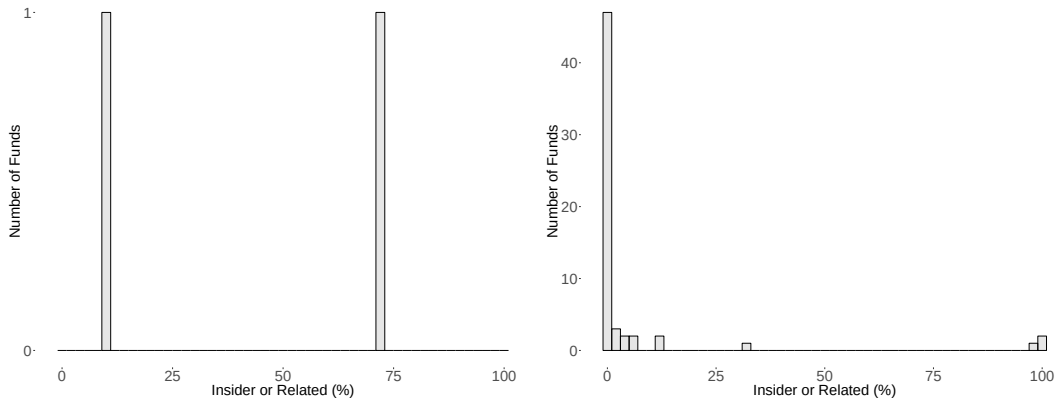
Panel A: Bloomberg Article Highlighting Rentech Returns



Panel B: Within-Fund Investment Distribution

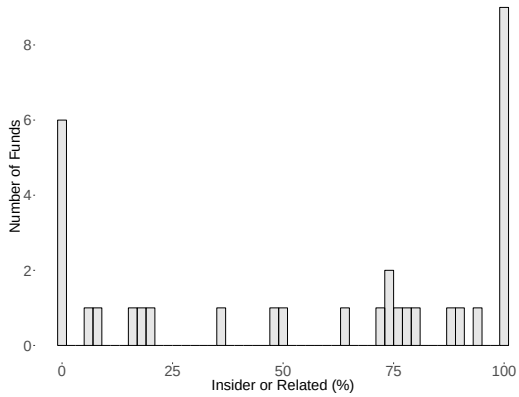
FIGURE I **Anecdotal Evidence, Relating Performance to Insider Investment**

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.

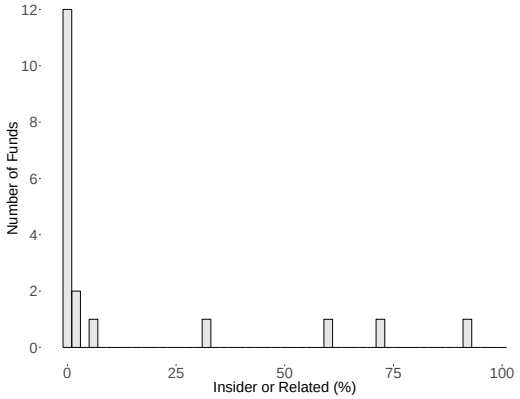


(a) Appaloosa LP

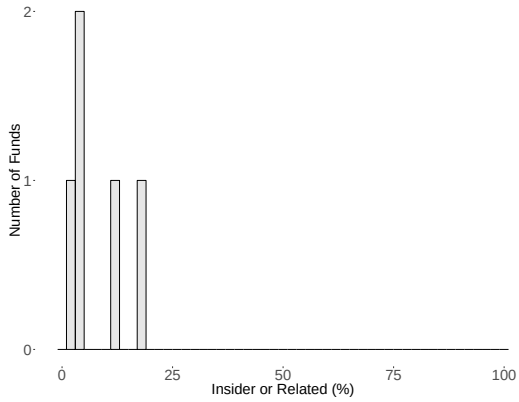
(b) AQR Capital Management



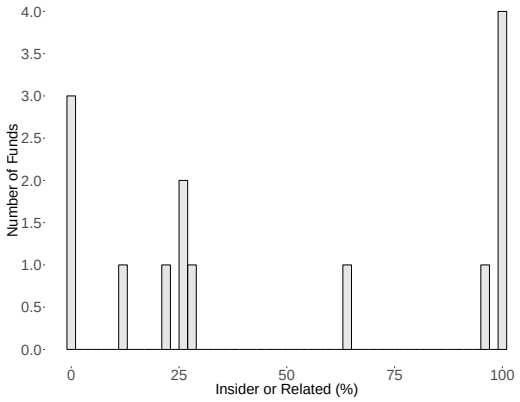
(c) BlueCrest Capital Management



(d) Citadel Advisors LLC



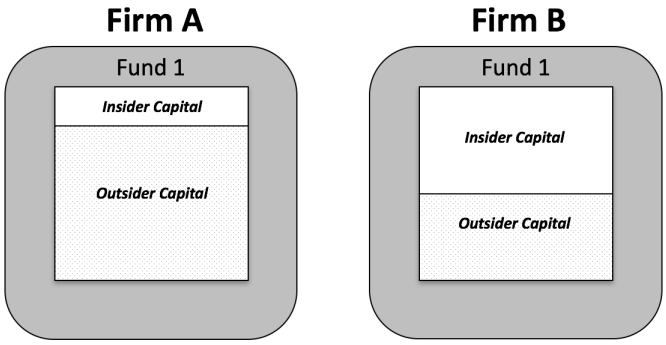
(e) Third Point LLC



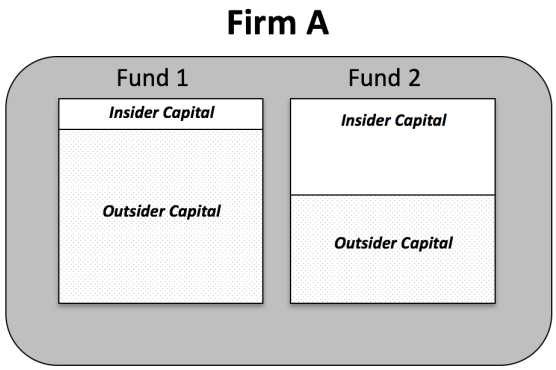
(f) Two Sigma Investments, LP

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

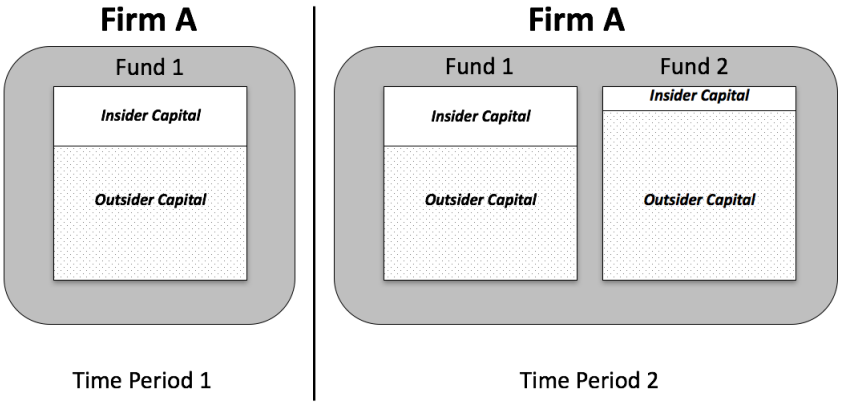
This figure shows the heterogeneity of insider investment for a set of sample firms. The horizontal axis corresponds to the percent of insider investment and the vertical axis corresponds to the count of funds. The histograms correspond to 2016 ADV filings, and excluded any funds less than $100 million.



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



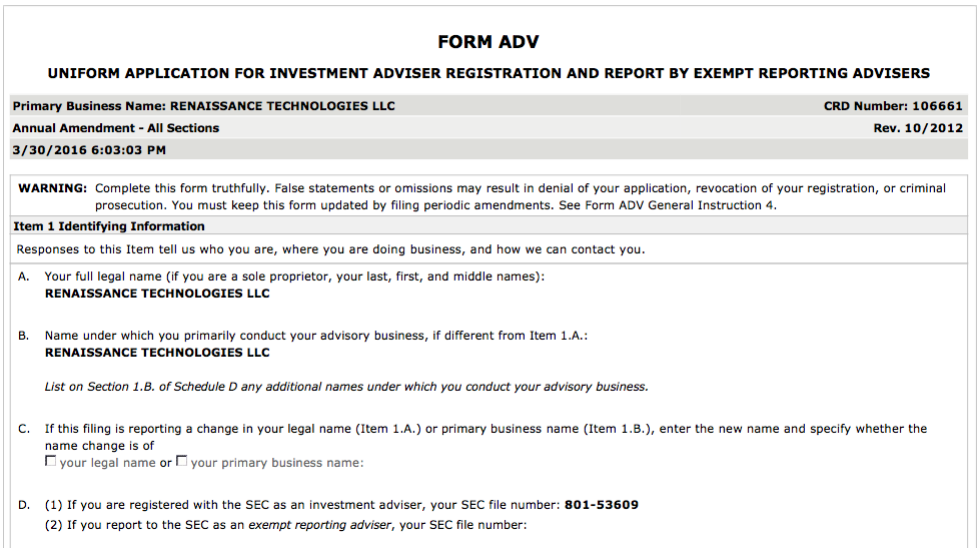
Panel B: Different Insider Investment, Within Firm



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

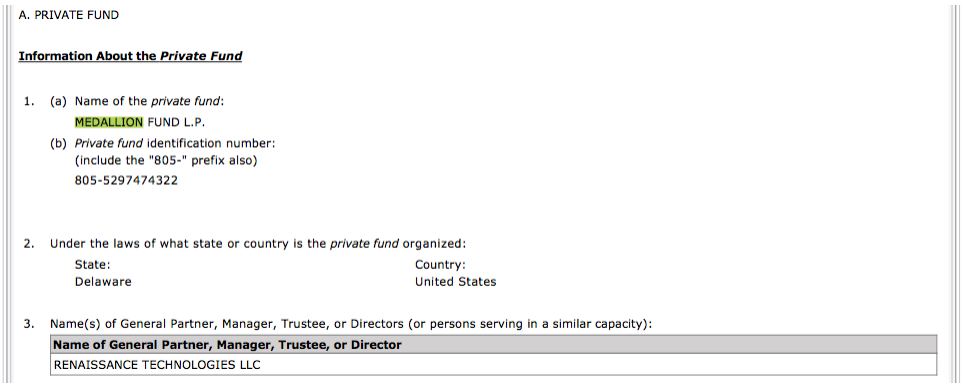
B. Name under which you primarily conduct your advisory business, if different from Item 1.A.:
RENAISSANCE TECHNOLOGIES LLC

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

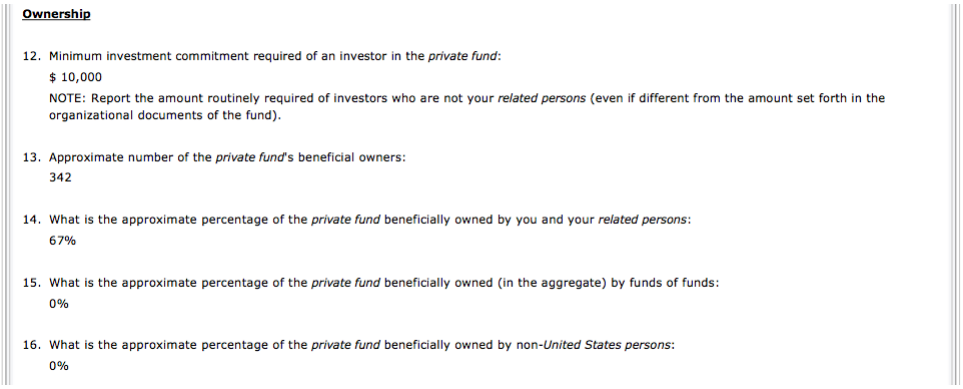
2. Under the laws of what state or country is the *private fund* organized:

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/`

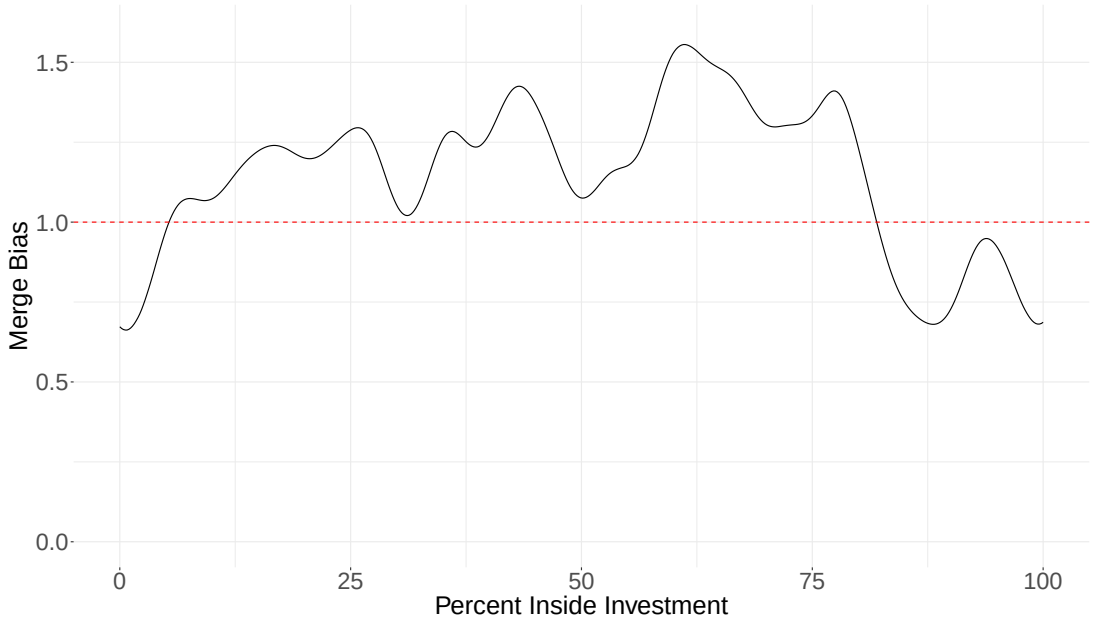
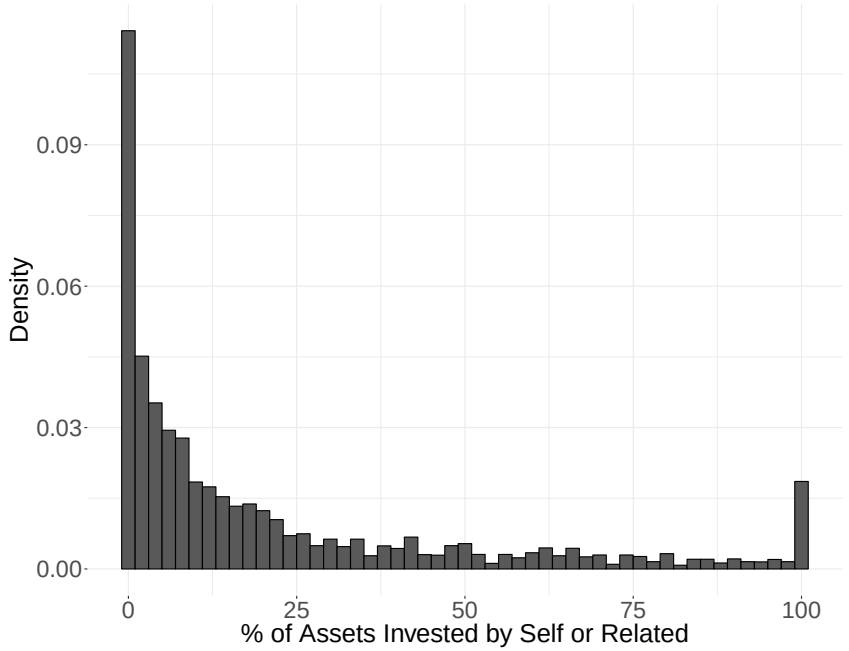
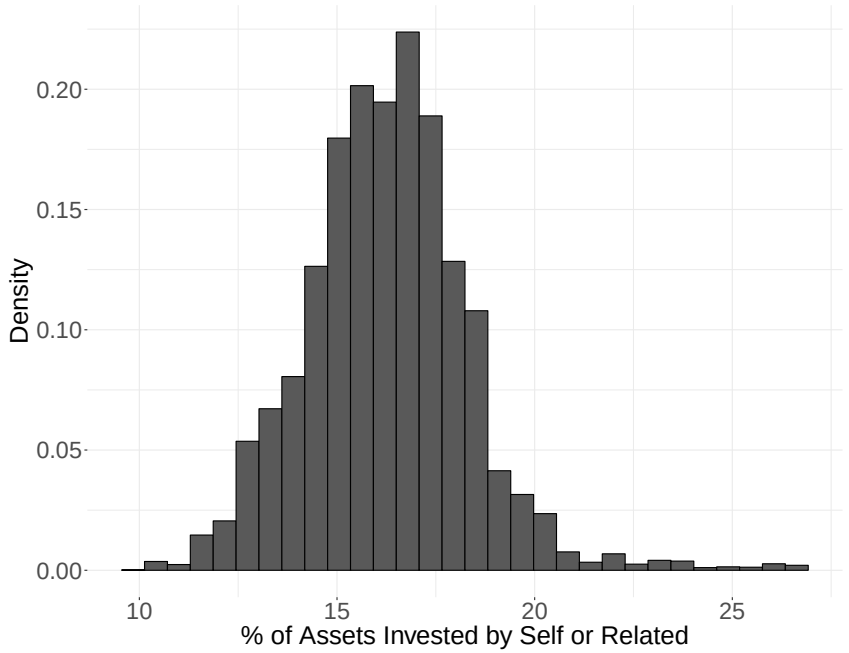


FIGURE V **Bias Analysis of Merged Sample**

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 Merge 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.

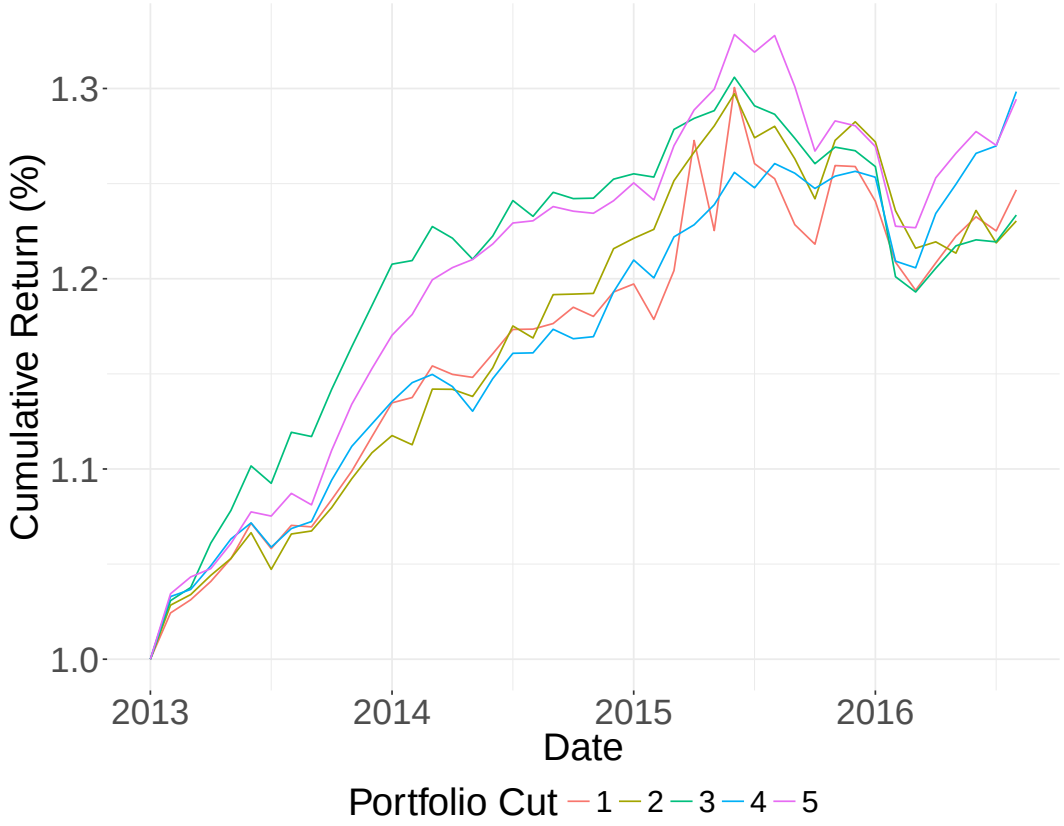


FIGURE VII **Return on Trading Strategy Buying Inside Investment Sorted Portfolios**

This figure plots the net cumulative returns to portfolios formed on a quartile sort of percent insider invested. Cut 1 corresponds to funds in the lowest quartile of inside investment; Cut 5 corresponds to funds in the highest quartile of investment. Returns reflect the value-weighted performance of baskets of funds within these ownership buckets, rebalanced annually.

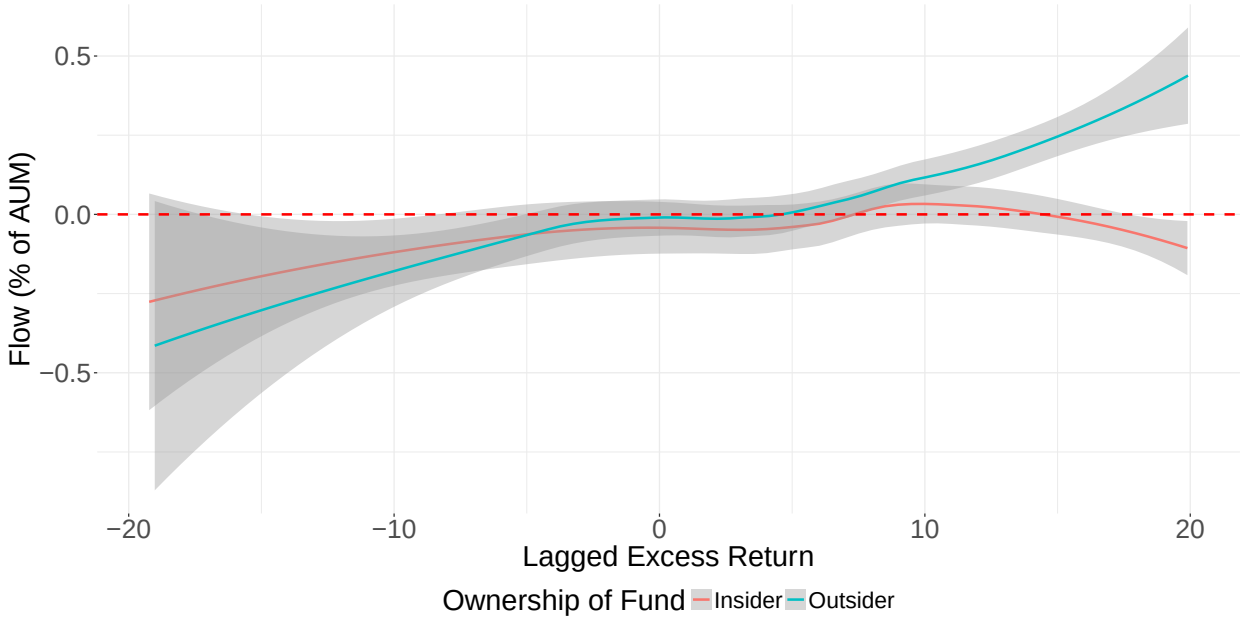


FIGURE VIII **Flow Performance of Funds by Insider Status**

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% Inside Investment) and outsider funds. Grey bars correspond to 95% confidence intervals.

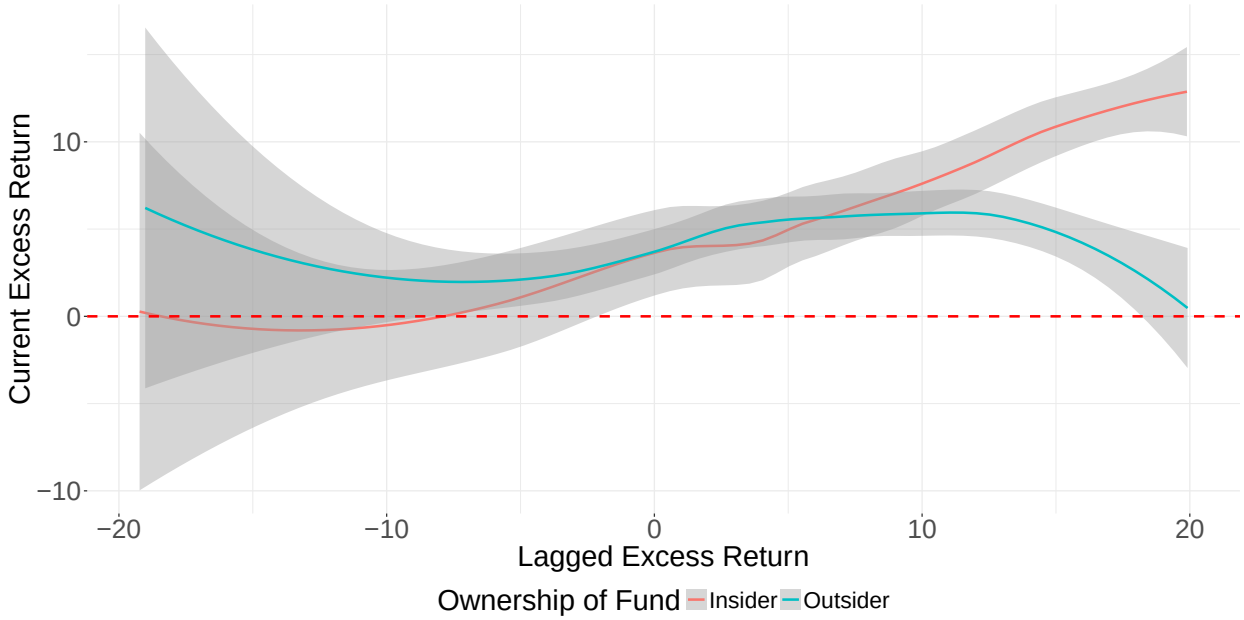


FIGURE IX **Return Predictability Funds by Insider Status**

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% Inside Investment) and outsider funds. Grey bars correspond to 95% confidence intervals.

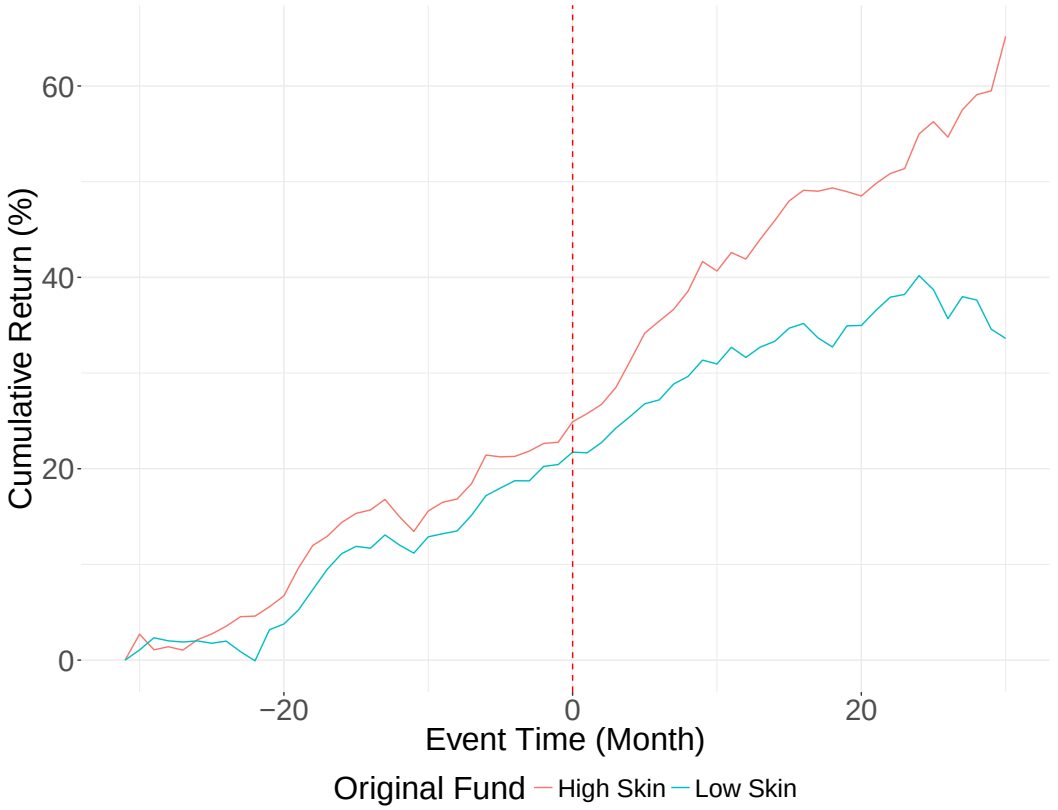
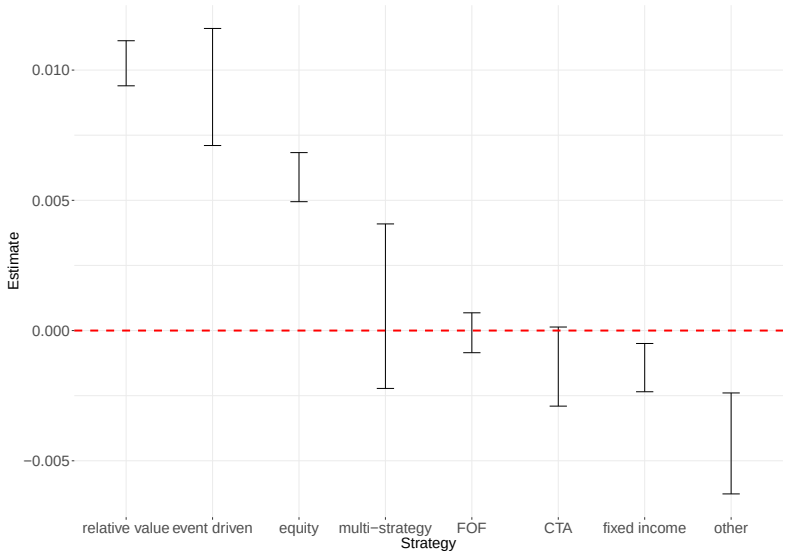
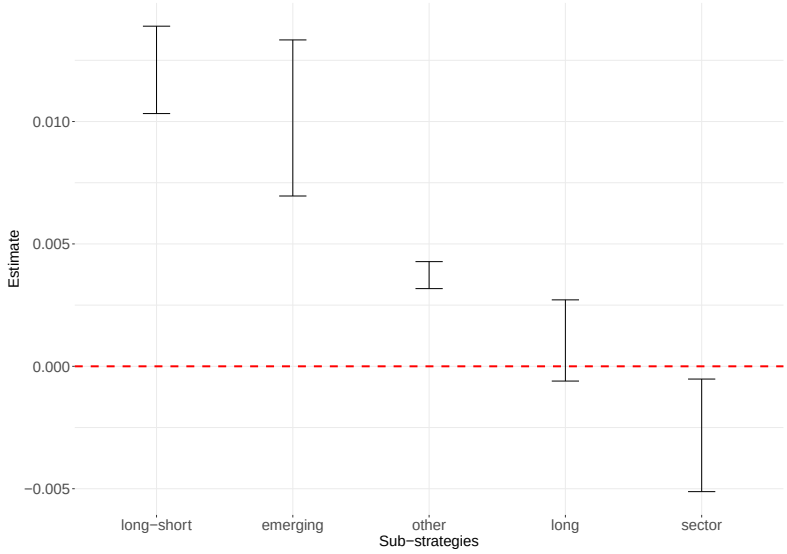


FIGURE X **Event Study, Transition From One Fund to Multiple Funds**

This figure plots the net cumulative returns of a firm transitioning from having one fund to multiple funds. The event time corresponds to the creation of the new fund, with time zero as the month a new fund is created. The lines corresponds to the cumulative performance of the original fund. After time zero, the high insider investment fund is flagged and tracked. The red solid line corresponds to the original fund that has the highest percent of insider investment. In contrast, the blue dotted line corresponds to the original fund that does not have the highest percent of insider investment.



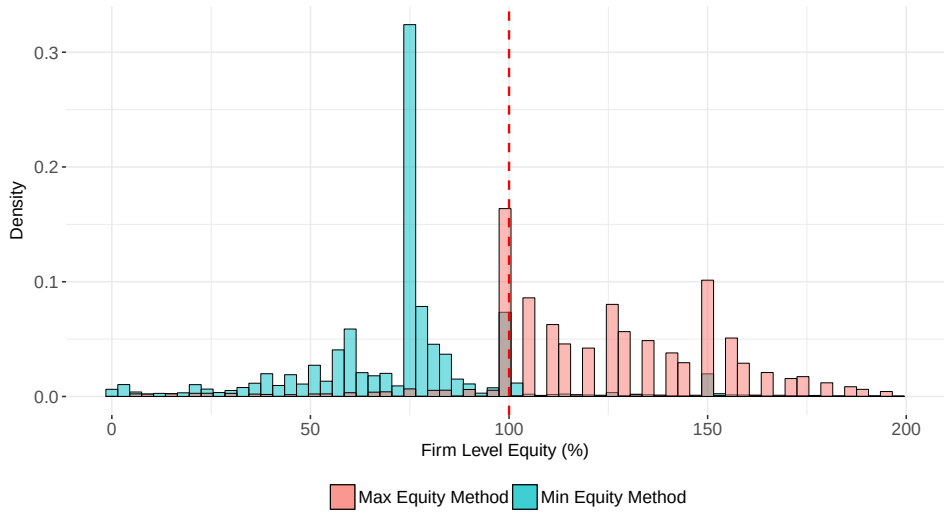
Panel A: Effects by Fund Type



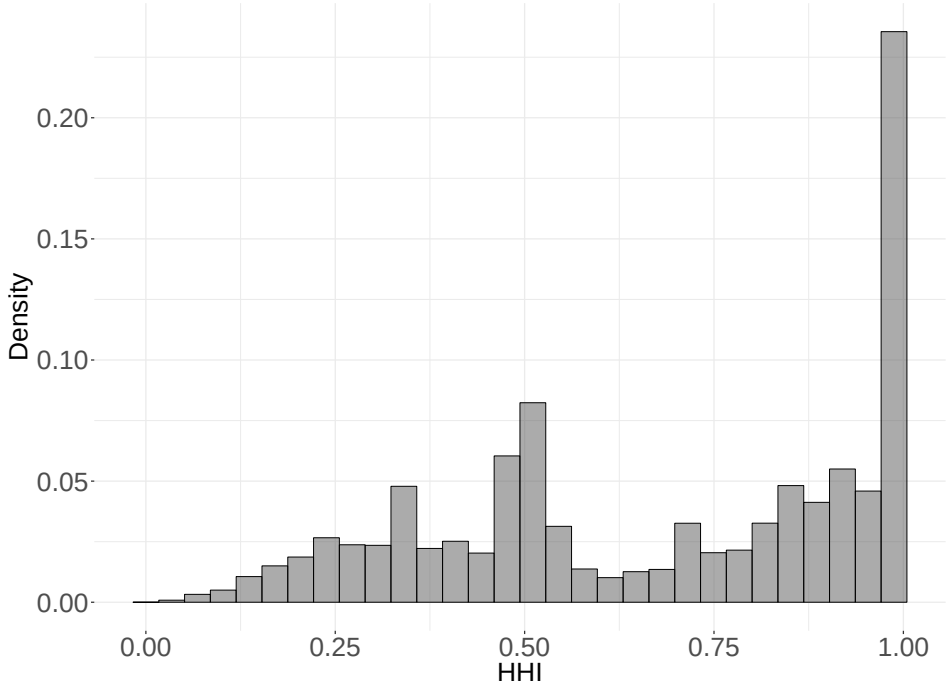
Panel B: Effects by Fund Type among Equity Funds

FIGURE XI **Main Effects by Fund Type**

This figure illustrates the main specification, as shown in Column (2) of Table V, broken out by fund category. Funds are categorized based on descriptions in commercial hedge fund datasets listed in the Data section.



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

TABLE I This table illustrates basic aggregate summary statistics for the entire ADV sample in 2015, as well as the subsample which matches with commercial hedge fund datasets (Eureka Hedge, Barclays, and CISDM).

	Total	Merged Sample
Total Gross Asset Value	6,013	236
Number of Employees	2,524,566	26,091
Non-Advisory Employees	1,699,510	15,669
Advisory Employees	825,056	10,422

TABLE II 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	**0.727**	0.446
Other Investment Advisor	0.486	0.500
Commodity Pool	0.424	0.494
Broker/Dealer	0.186	0.389
Insurance	0.065	0.247
Sponsor of LP	0.054	0.225
Trust	0.053	0.224
Bank or Thrift	0.045	0.208
Pension	0.036	0.187
Real Estate	0.027	0.163
Municipal Advisor	0.024	0.152
Accountant	0.023	0.150
Lawyer	0.015	0.123
Futures Merchant	0.014	0.119
Swap Dealer	0.011	0.103
Swap Participant	0.001	0.027
Share Supervised Persons	73%	
Share Office	56%	

TABLE III **Return Analysis of Trading Strategy, Four Factor Model**

This table reports the returns attribution of the trading strategy described in Figure VII. The risks of the net returns are modeled by the standard four-factor model. Cuts 1 through Cut 5 correspond to the portfolios of increasing insider investment, with Cut 1 having the smallest insider allocation and Cut 5 having the largest. The Sharpe Ratio and Residual SE columns capture the performance of each portfolio, while the Intercept term captures the alpha after controlling for the four factors.

Skin Level	R^2	Sharpe Ratio	Residual SE	(Intercept)	Mkt.RF	SMB	HML	MOM
1	0.34	0.06	1.63	0.11	0.33	0.1	0.08	0.14
				(0.39)	(3.91)	(0.86)	(0.48)	(1.42)
2	0.61	0.08	0.88	0.08	0.33	-0.02	-0.08	0.02
				(0.53)	(7.21)	(-0.31)	(-0.87)	(0.38)
3	0.64	0.12	0.86	0.11	0.32	0.1	0.01	0.03
				(0.78)	(7.17)	(1.67)	(0.08)	(0.53)
4	0.54	0.34	0.84	0.32	0.24	0.07	-0.1	-0.02
				(2.24)	(5.6)	(1.15)	(-1.18)	(-0.42)
5	0.62	0.27	0.86	0.25	0.31	0.06	-0.03	-0.03
				(1.77)	(6.91)	(0.94)	(-0.31)	(-0.54)

TABLE IV **Return Analysis of Trading Strategy, Fung-Hsieh Model**

This table reports the returns attribution of the trading strategy described in Figure VII. The risks of the net returns are modeled by Fung and Hsieh (2004) seven-factor model. Cuts 1 through Cut 5 correspond to the portfolios of increasing insider investment, with Cut 1 having the smallest insider allocation and Cut 5 having the largest. The Sharpe Ratio and Residual SE columns capture the performance of each portfolio, while the Intercept term captures the alpha after controlling for the seven factors.

Skin Level	R^2	Sharpe Ratio	Residual SE	(Intercept)	PTFSBD	PTFSFX	PTFSCOM	SNPMRF	SCMLC	BD10RET	BAAMTSY
1	0.3	0.21	1.74	0.4	-0.02	0.01	-0.04	0.2	-0.06	0.01	-0.04
				(1.39)	(-0.62)	(0.68)	(-2.23)	(2.06)	(-1.75)	(0.49)	(-1.51)
2	0.26	0.38	1.27	0.52	-0.02	0.01	-0.03	0.01	-0.01	0.01	-0.03
				(2.49)	(-1.16)	(1)	(-2.34)	(0.08)	(-0.32)	(0.74)	(-1.63)
3	0.3	0.42	1.25	0.57	-0.01	0.02	-0.02	-0.03	0	0.01	-0.04
				(2.73)	(-0.66)	(1.18)	(-1.76)	(-0.37)	(-0.15)	(1.26)	(-2.56)
4	0.25	0.51	1.12	0.63	-0.01	0	-0.02	-0.01	0	0	-0.04
				(3.37)	(-0.63)	(0.33)	(-1.66)	(-0.1)	(0.14)	(0.07)	(-2.36)
5	0.36	0.49	1.17	0.62	-0.01	0.01	-0.02	0.02	0	0.01	-0.05
				(3.19)	(-0.35)	(0.49)	(-2.12)	(0.28)	(-0.02)	(0.96)	(-2.88)

TABLE V **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. 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 Gross Asset Value from Form ADV.

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

	Risk Adjusted Excess Returns (FF)			
	All	Controls	All	Controls
	(1)	(2)	(3)	(4)
Skin (percent)	0.0050***	0.0036***		
	(0.0005)	(0.0009)		
Skin (log of gross)			0.0754***	0.0416***
			(0.0070)	(0.0123)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Log AUM	No	No	Yes	Yes
Observations	59,588	59,588	59,588	59,588
R^2	0.0016	0.0728	0.0025	0.0728

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

	Risk Adjusted Excess Returns (FH)			
	All	Controls	All	Controls
	(1)	(2)	(3)	(4)
Skin (percent)	0.0057***	0.0056***		
	(0.0005)	(0.0009)		
Skin (log of gross)			0.0890***	0.0812***
			(0.0069)	(0.0121)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Log AUM	No	No	Yes	Yes
Observations	59,588	59,588	59,588	59,588
R^2	0.0021	0.0805	0.0034	0.0805
Note:				*p<0.1; **p<0.05; ***p<0.01

TABLE VI **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. 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.

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

	Risk Adjusted Excess Returns (FF)			
	All	Controls	All	Controls
	(1)	(2)	(3)	(4)
Skin (percent)	0.0014***	0.0019**		
	(0.0004)	(0.0007)		
Skin (log of gross)			0.0321***	0.0413***
			(0.0080)	(0.0143)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Log AUM	No	No	Yes	Yes
Observations	59,588	59,588	59,588	59,588
R^2	0.0002	0.0713	0.0007	0.0713

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

	Risk Adjusted Excess Returns (FH)			
	All	Controls	All	Controls
	(1)	(2)	(3)	(4)
Skin (percent)	0.0015***	0.0019***		
	(0.0004)	(0.0007)		
Skin (log of gross)			0.0341***	0.0422***
			(0.0075)	(0.0133)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Log AUM	No	No	Yes	Yes
Observations	59,588	59,588	59,588	59,588
R^2	0.0002	0.0888	0.0008	0.0888
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% Inside Investment) and outsider funds. All results are value-weighted using the Gross Asset Value from Form ADV.

Dep. Var:	Flow		Current Return	
	(1)	(2)	(3)	(4)
Lag Excess Return	-0.007^{***}	0.005^{**}	0.336^{***}	0.159^{***}
	(0.002)	(0.002)	(0.059)	(0.046)
Sample:	Insider	Outsider	Insider	Outsider
Size	Yes	Yes	Yes	Yes
Observations	217	450	217	450
R^2	0.059	0.068	0.287	0.028

*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)
Pct Skin	-37.50^{***}	-13.70^{***}	-0.03^{***}	-0.02^{***}
	(2.23)	(1.00)	(0.001)	(0.001)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Dataset	Matched	Matched	Matched	Matched
Observations	3,700	3,223	3,700	3,223
R^2	0.07	0.96	0.11	0.88

Panel B: **Results on ADV Dataset**

	Dependent variable:			
	Gross Asset Value (in $m)		Log(Gross Asset Value)	
	(1)	(2)	(3)	(4)
Pct Skin	-49.17^{***}	-19.13^{***}	-0.001^{***}	-0.003^{***}
	(5.99)	(2.29)	(0.0003)	(0.0002)
Year FE	No	Yes	No	Yes
Firm FE	No	Yes	No	Yes
Dataset	ADV	ADV	ADV	ADV
Observations	51,006	51,006	51,006	51,006
R^2	0.001	0.93	0.0002	0.76
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 are in parenthesis.

	Excess Return		
	(1)	(2)	(3)
Lagged Insider Flow (%)	0.0003	−0.0000	0.0001
	(0.0003)	(0.0003)	(0.0003)
Lagged Outsider Flow (%)	0.0002**	0.0002**	−0.0001
	(0.0001)	(0.0001)	(0.0001)
Year FE	No	Yes	Yes
Firm FE	No	No	Yes
Observations	936	936	936
R^2	0.0035	0.2465	0.6035
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 in parenthesis.

	Monthly Excess Return (FF)		
	(1)	(2)	(3)
Skin (Percent)	0.0025^{***}	0.0021^{***}	0.0025^{***}
	(0.0004)	(0.0004)	(0.0004)
# of Equity Holders	-0.0165^{***}		-0.0170^{***}
	(0.0028)		(0.0032)
HHI of Firm Equity		0.0840^{**}	-0.0142
		(0.0355)	(0.0399)
Year	Yes	Yes	Yes
Log(Size)	Yes	Yes	Yes
Observations	63,978	63,978	63,978
R^2	0.0142	0.0132	0.0143
Note:			*p<0.1; **p<0.05; ***p<0.01

A 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.[9] 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.

[9]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:

$$q^T \equiv q^I + q^O \tag{10}$$

We exclude the possibility of leverage and define total capital as. Further, we exclude the possibility of short-selling, so $q^I, q^O \geq 0$.[10]

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:

$$R_{n,t+1} = \alpha_n - C_n\left(q^T_{n,t}\right) \tag{11}$$

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, $\lim_{q^T_t \to \infty} C'(q^T_{n,t}) = \infty$.[11] 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.[12] A smaller scale cost indicates that a strategy

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

[11] 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.

[12] 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:[13]

$$V^I = q^I \left(R\left(q^T\right)\right) + q^O f \tag{12}$$

$$V^O = q^O \left(R\left(q^T\right)\right) - q^O f \tag{13}$$

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:

$$\bar{q}^{I*}_t = \sqrt{\frac{2\alpha}{3a}} \tag{14}$$

Notice that, $\bar{q}^{I*} = q^T$, insider are sufficiently capitalized and refuse outside capital. Substituting back into 12, the value add to insider, we get $\frac{2\alpha q^I}{3}$, and corresponds to the maximum achievable benefit from the strategy.

[13] 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:

$$\bar{q}_t^{O*} = \sqrt{\frac{2\left(\alpha - f\right)}{a}} \tag{15}$$

Notice that the value add to ousiders 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:

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

$$V^O = q^O\left(\alpha - C(q^T)\right) - fq^O \geq 0 \tag{17}$$

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:

$$\arg\max_{q^O, f} \quad q^I \left(\alpha - C\left(q^T\right)\right) + f q^O \tag{18}$$

$$s.t.\ V^O \quad = \quad q^O \left(\alpha - C(q^T)\right) - f q^O \geq 0 \tag{19}$$

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 managmeent 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 insdier 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 deriviative 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 managmeent fee and positive level of outside investment, gross fees are weakly increasing as a portion of insider capital.*

Proof This is immediate when subsitiuting 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:

$$\frac{dV_1^I}{dq_1^I} \geq \frac{dV_2^I}{dq_2^I} \tag{20}$$

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.[14]

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

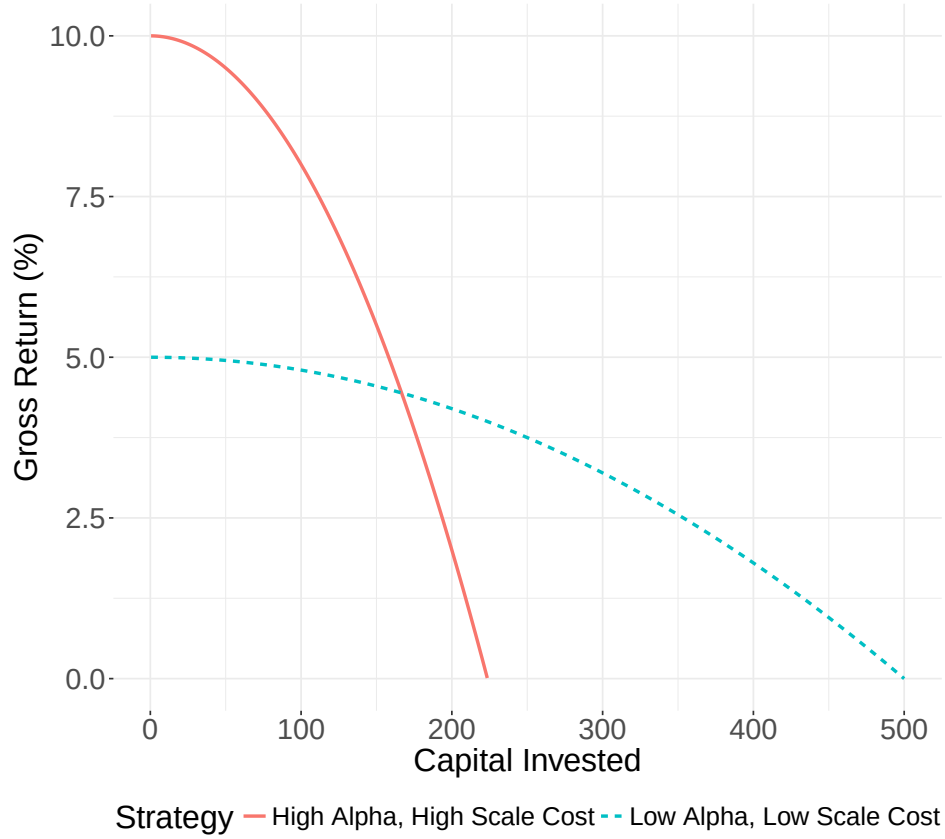
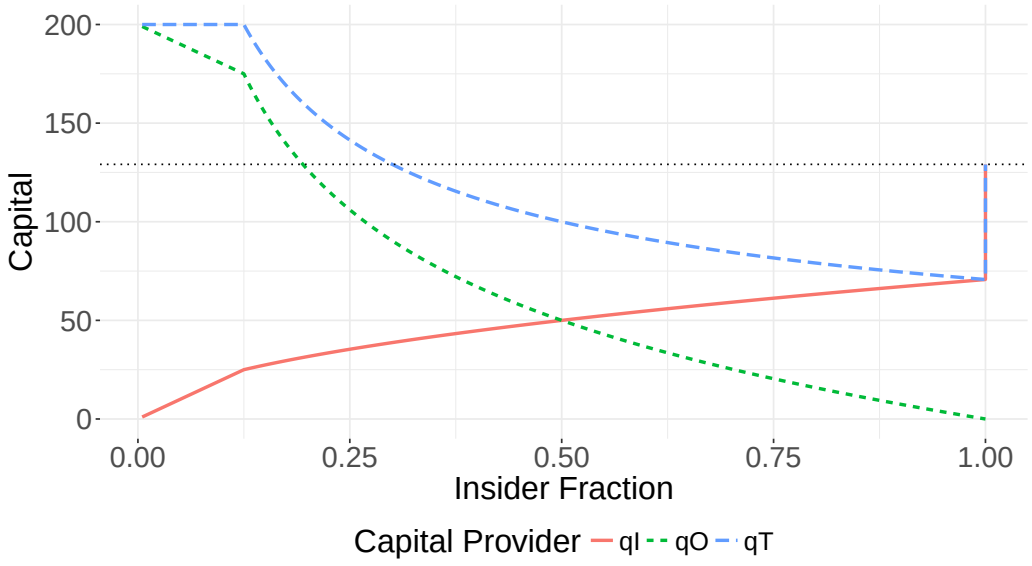
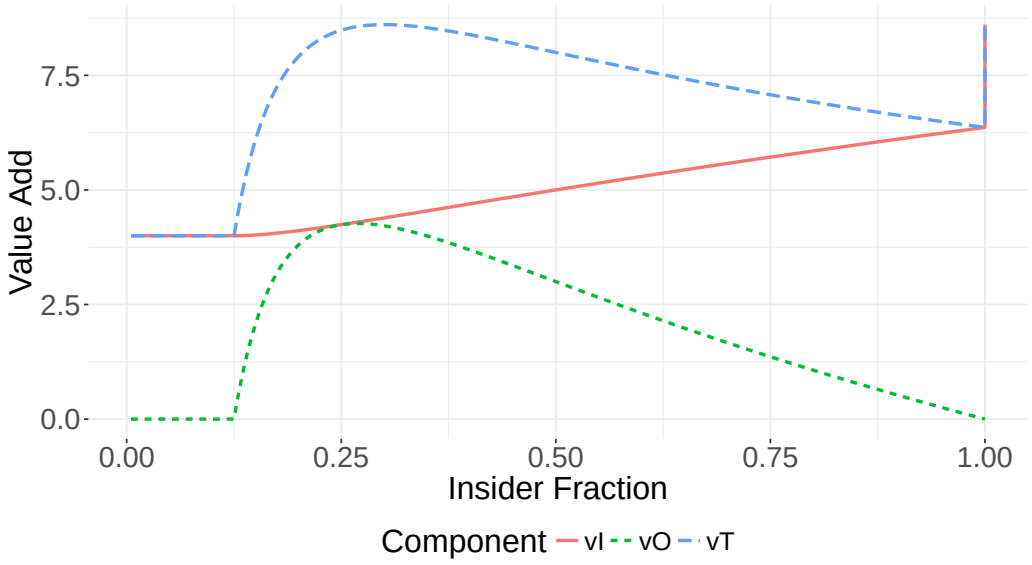


FIGURE A.1 **Gross Return Profiles of Different Strategies**

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 $a = 4 \times 10^6$.

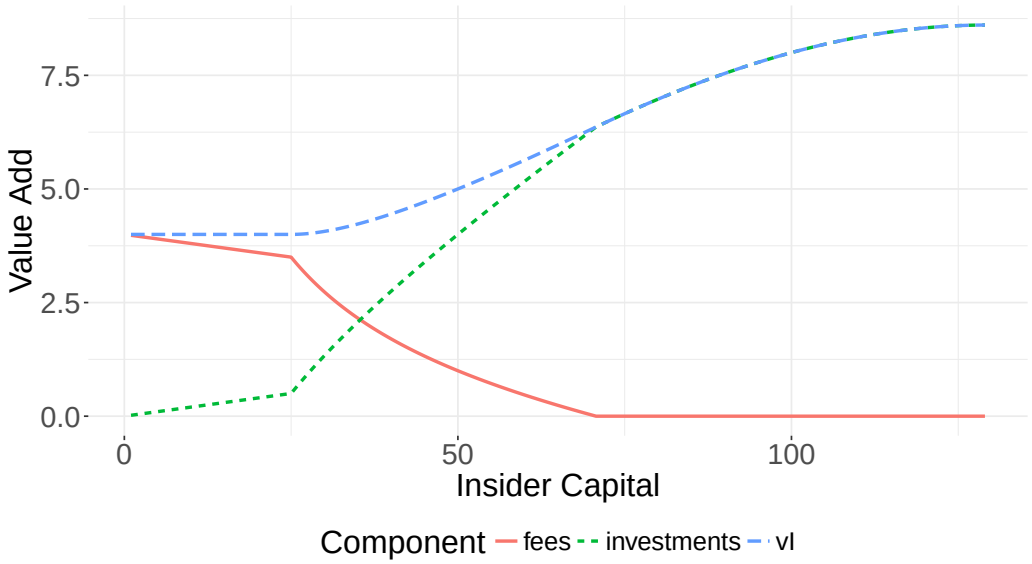
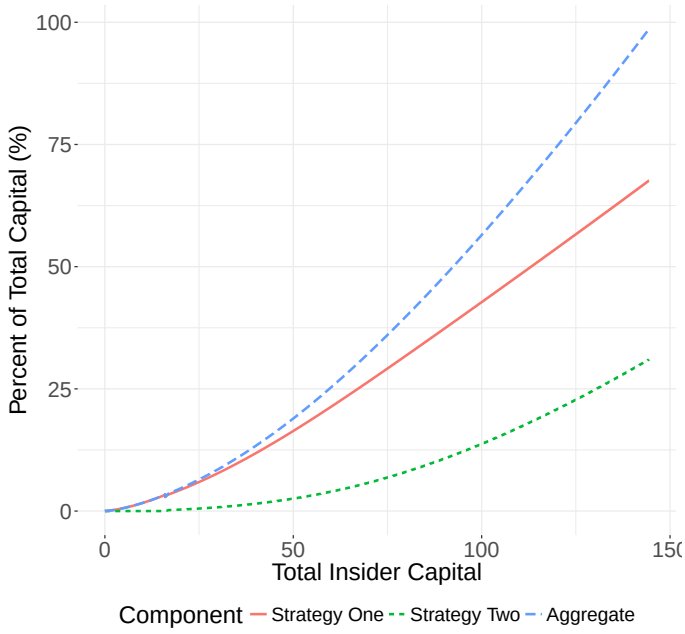
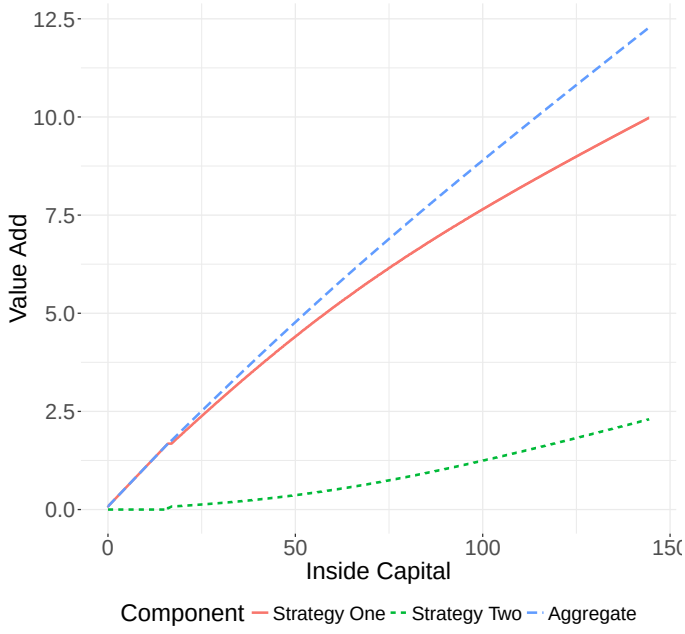


FIGURE A.3 **Value Add to Insider and Components**

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 $a = 4 \times 10^7$

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_n	Management fee that is a fraction of the assets delegated by the outsider to the insider. This is set by the insider at time t.
N	Total number of strategies available to an investor.
n	Referes to an individual strategy n. A strategy has a unique α_n, a_n, and thus $C_n\left(q_n^T\right)$.