The Optimal Size of Hedge Funds:

Conflict between Investors and Fund Managers

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ABSTRACT

This study examines whether the standard compensation contract in the hedge fund industry aligns managers' incentives with investors' interests. I show empirically that managers' compensation increases when fund assets grow, even when diseconomies of scale in fund performance exist. Thus, managers' compensation is maximized at a much larger fund size than is optimal for fund performance. However, to avoid capital outflows, managers are also motivated to restrict fund growth to maintain style-average performance. Similarly, fund management firms have incentives to collect more capital for all funds under management, even at the expense of fund performance, including their flagship funds.

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One of the important ways in which hedge funds differ from traditional investment vehicles is in the design of managers' compensation contracts. One key difference is that, in contrast to their peers in the mutual fund industry, hedge fund managers charge an additional performance-based incentive fee. The incentive fee contract allows hedge fund managers to charge part of the profits as their compensation, which is intended to motivate them to maximize fund performance.

The evidence on whether the standard compensation contract of hedge funds truly aligns managers' incentives with investors' best interests, however, is mixed. Like other investment vehicles, such as mutual funds, hedge funds are likely to suffer from diseconomies of scale. Limited investment opportunities, potential negative price impacts from large block trading, and high transaction and administrative costs may erode fund performance when funds grow large. This decline in performance generates a conflict of interest between investors and fund managers. If the design of managers' compensation contracts is effective, it should mitigate the conflict of interest, and fund assets should match the optimal size for fund performance. Indeed, some hedge fund managers claim that they protect their investors by closing their funds to new investment.[1] However, many hedge funds also become too big to show profits.[2] In addition, previous research, such as Getmansky (2012) and Teo (2009), documents that diseconomies of scale still exist in the

[1] For example, see "RBC Closes Hedge Fund to New Investors" (http://dealbook.nytimes.com/2011/01/14/rbc-closes-off-hedge-fund-to-new-investors/), and "Some Hedge Funds, to Stay Nimble, Reject New Investors" (http://dealbook.nytimes.com/2011/09/07/some-hedge-funds-to-stay-nimble-reject-new-investors/), among others.

[2] For example, see "Billionaire John Paulson's Hedge Fund: Too Big To Manage" (http://www.forbes.com/sites/nathanvardi/2012/12/21/billionaire-john-paulsons-hedge-fund-too-big-to-manage/), "John Paulson's Very Bad Year" (http://www.businessweek.com/printer/articles/59946-john-paulsons-very-bad-year), "Too Big to Profit, a Hedge Fund Plans to Get Smaller" (http://dealbook.nytimes.com/2012/08/01/hedge-fund-titan-plans-to-return-2-billion-to-investors/), and "Hedge Funds Are for Suckers" (http://www.bloomberg.com/bw/articles/2013-07-11/why-hedge-funds-glory-days-may-be-gone-for-good), among others.

hedge fund industry.[3] In other words, it appears that the incentive fee contract does not provide fund managers with sufficient motive to restrict fund growth to protect fund performance.

This study seeks to reconcile these apparently contradictory facts. The literature commonly overlooks the fact that hedge fund managers' compensation depends on fund size as well and that hedge fund managers care about their compensation in absolute dollar amounts. This study overcomes this shortcoming by examining how hedge fund managers' compensation is related to both fund performance and fund size. With a more accurate measure, I then examine whether the standard compensation contract in the hedge fund industry aligns managers' incentives with investors' best interests and, if not, how fund managers' incentives influence fund growth and performance. These issues are important for hedge fund investors and the future design of managers' compensation contracts. For example, understanding managers' incentives can help investors to choose among different funds and to better monitor fund performance.

I first examine individual hedge funds and test whether there are diseconomies of scale in fund performance. Consistent with the literature, I find that fund growth erodes fund performance. The existence of diseconomies of scale suggests that there is an optimal fund size for fund performance. Ideally, if the design of managers' compensation contracts is effective, the optimal fund size for managers' compensation should match the optimal size for fund performance. In other words, an effective compensation contract design would align managers' incentives with investors' best interests.

[3] See Perold and Salomon (1991), Indro et al. (1999), and Chen et al. (2004), among others, for a discussion of diseconomies of scale in the mutual fund industry.

However, the two optimal sizes are different under the standard compensation contract. In the Appendix, I provide a simple model to compare the two optimal sizes. In the model, fund managers with limited abilities set the fund size to maximize their compensation in absolute dollar amounts. The solution indicates that the difference between the two optimal sizes is related not only to the compensation contract design, but also to the performance-size relationship.[4] For example, when fund assets increase faster than performance declines, the deviation from the optimal size for fund performance becomes larger.

My empirical analysis provides some supporting evidence for the implications of the model. By measuring compensation in absolute dollar amounts, I find that hedge fund managers' compensation increases as fund assets grow, even when diseconomies of scale exist. There are two possible explanations for this finding. First, the performance-based incentive fee in absolute dollar amounts increases with fund size. Because diseconomies of scale exist, this result implies that the increase in fund assets is faster than the decrease in fund performance.[5] Second, when fund assets grow, the management fee increases, regardless of the changes in the incentive fee. Ultimately, the management fee may become the more important part of managers' total compensation. Therefore, fund managers likely have strong incentives to increase their assets under management. As discussed earlier, when diseconomies of scale exist, this is not in the best interests of hedge fund investors.

[4] Agarwal, Daniel, and Naik (2009) argue that the incentive fee and the high-water mark provision are normally set at the time when the funds are established and do not change over time. Agarwal and Ray (2011) document that about 8% of all hedge funds have changed their fee structure and that 7% of all hedge funds changed only once. Therefore, managers' compensation contracts are relatively exogenous in the hedge fund industry.

[5] Liang and Schwarz (2011) show that this is possible, but they do not investigate this issue thoroughly.

To increase fund assets, fund managers need to attract capital inflows and avoid capital outflows. For this reason, I examine the association between capital flows and fund performance. Consistent with the literature, I find that investors chase performance with different sensitivities.[6] Investors are most sensitive when funds are in the poorest and the best performance groups, and they are least sensitive when funds have average performance. Because hedge fund investors likely evaluate and compare fund performance within the same style category, I expect that fund managers need to maintain style-average performance to avoid outflows. Therefore, managers would want to restrict fund size when fund growth erodes performance to style-average level. This notion is supported by fund closure decisions. I find that most funds close to new investment around the fund size at which they can provide style-average performance.[7]

Another way for fund managers to increase their assets under management is to launch new funds. Thus, I also analyze performance and compensation at the fund-family level. If fund management firms keep each fund at its optimal size for performance and collect more capital by having more funds under management, it is possible for fund families to boost their compensation without hurting performance. However, the empirical results show that larger fund families underperform, while they generate much higher compensation than do their smaller peers.

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[6] See Naik, Ramadorai, and Stromqvist (2007), Fung et al. (2008), and Ding et al. (2009), among others, for a discussion of the flow-performance relationship and capacity constraints in the hedge fund industry. See also Chevalier and Ellison (1997), Sirri and Tufano (1998), and Berk and Green (2004), among others, for a discussion of the flow-performance relationship in the mutual fund industry. See Spiegel and Zhang (2013), among others, for a discussion of a linear flow-performance relationship using market share-adjusted fund flows in the mutual fund industry.

[7] Liang and Schwarz (2011) find no evidence that hedge fund closure can protect fund performance. When funds reopen, they do not demonstrate superior performance. The authors argue that the performance-based compensation is not strong enough to prevent overinvestment and that the primary goal of fund managers is to increase fund size. See Zhao (2004) and Bris et al. (2007), among others, for a discussion of fund closure in the mutual fund industry.

Therefore, fund management firms have strong incentives to increase their total assets under management, even when family growth erodes family performance.

Although it appears that fund management firms do not restrict asset growth to protect family performance, they may protect the performance of certain funds, namely their flagship funds. My analysis does not support this hypothesis. First, I document that flagship funds suffer from diseconomies of scale. This implies that fund managers do not restrict fund growth and collect capital more than optimal for flagship funds' performance. Second, I observe that flagship funds' performance rankings decrease following the launch of non-flagship funds, and flagship funds do not outperform their peers in the same style after they are closed to new investment. Thus, it seems that management firms keep collecting capital for all funds under management to maximize their compensation. This is consistent with the results at the individual-fund level.

The key contributions of this paper are as follows. First, I show empirically that, under the standard compensation contract, hedge fund managers have strong incentives to increase fund assets to boost their compensation even when diseconomies of scale exist. The compensation contract in the hedge fund industry, especially the incentive fee contract and the high-water mark provision, has been studied analytically and empirically. However, limited research examines how managers' compensation is related to fund size.[8] One paper that is closely related to this one is

[8] The literature commonly focuses on how the compensation contract can motivate hedge fund managers to improve fund performance, how the compensation contract can influence fund managers' risk-taking behavior, or how fund managers choose the fee structure strategically to signal their abilities. For fund performance, see Ackermann, McEnally, and Ravenscraft (1999), Liang (1999), and Liang (2001), among others. For fund managers' risk-taking behavior, see Hodder and Jackwerth (2007), Kouwenberg and Ziemba (2007), and Panageas and Westerfield (2009), among others. See Aragon and Qian (2010) and Pan et al. (2012), among others, for fee structure and managers' quality. See also Carpenter (2000), Elton, Gruber and Black (2003), Golec and Starks (2004), among others, for the incentive fee in the mutual fund industry.

Agarwal, Daniel, and Naik (2009). They propose to use delta, which is the total expected dollar increase in the manager's compensation for a 1% increase in the fund's net asset value (NAV), to measure managerial incentives. Although they realize that fund managers care about dollar incentives, they do not analyze the relationship between dollar incentives and fund assets. Goetzmann, Ingersoll, and Ross (2003) argue that, due to diminishing returns to scale, hedge funds may not be able to take or even want new funds. However, the authors neglect the possibility that the incentive fee in absolute dollar amounts may increase if fund assets grow faster than performance declines. My empirical results indicate that the optimal size for managers' compensation differs substantially from the optimal size for fund performance. In other words, the standard compensation contract does not solve the conflict of interest between fund investors and fund managers in the hedge fund industry.

Second, I find some evidence that hedge fund managers are also motivated to maintain style-average performance to avoid capital outflows and thus retain fund assets. It is widely documented in the literature that investors chase performance. In Berk and Green's (2004) model, investors chase performance, and, in equilibrium, managers' abilities will be fully extracted. Sirri and Tufano (1998) find a nonlinear relationship between capital flows and mutual fund performance. While funds in the top performance quintile attract significant capital inflows, there is no relationship between fund performance and capital flows in the lowest quintile. Consistent with the literature, I also find that investors chase performance with different sensitivities. Investors are most sensitive when hedge funds are in the poorest and the best performance groups, and they are least sensitive when funds have average performance. Therefore, fund managers face the following tradeoff: On the one hand, they have strong incentives to increase assets under management to maximize their compensation; on the other hand, they are also motivated to restrict fund growth to maintain style-average performance, given that diseconomies of scale exist. Indeed, when I examine fund closure decisions, I find that most funds close when they can only provide style-average performance.

Furthermore, this study is related to the fund-family literature. Fung et al. (2014) show that hedge fund management firms have strong incentives to have multiple funds to increase their fee income. To do so, fund management firms rely on the good performance records of their flagship funds to attract capital inflows and launch new funds.[9] I complement this strand of literature by focusing on the conflict of interest between investors and managers. I document that diseconomies of scale exist in both fund families and flagship funds, while managers' compensation increases with family size. These results suggest that fund managers have incentives to collect more capital for both flagship funds and non-flagship funds, even at the expense of family performance.

The rest of the paper proceeds as follows: Section I summarizes the data; Section II examines performance and compensation of individual hedge funds; Section III is the analysis at the fund-family level; Section IV presents the robustness tests; and Section V concludes upon the results.

I. Data

[9] See Nanda, Wang, and Zheng (2004) and Gaspar, Massa, and Matos (2006), among others, for a discussion of star funds and spillover effect in the mutual fund industry.

The data used in this study are from the Lipper TASS database. Following the literature, I keep only those funds that report monthly net-of-fee returns in US dollars (USD). Observations with missing information about fund performance, fund assets, or investment styles are deleted. Funds in the Dedicated Short Bias, Options Strategy, and Funds-of-Funds styles are excluded.[10]

To mitigate survivorship bias, I include defunct funds in the sample.[11] Because TASS began to include the data of defunct funds since 1994, the time span of my sample is from January 1994 to December 2009. To mitigate backfill bias, I exclude the data before the date when funds were added to the TASS database.[12] If the add-date information is not available, I exclude the first 18 months of data.

Because fund size is one of the key variables in this study, I carefully examine the data in the TASS database. First, it appears that the monthly time series of fund assets are very noisy. For example, some funds report the same assets under management for two or more consecutive months. This potentially biases the performance-size relationship and makes it difficult to measure capital flows accurately. To mitigate this problem, I use quarterly frequency in this study. I aggregate monthly returns into quarterly returns and measure fund size by assets reported at the end of each quarter. Second, there are some obvious outliers in the sample. For example, some funds report fund assets as low as $1. To mitigate the influence of these outliers, I delete

[10] There are only a few funds in Dedicated Short Bias and Options Strategy styles (either style has fewer than 1% of all funds in the sample).
[11] Defunct funds consist of funds that have been liquidated, have been merged into other funds, and have stopped reporting.
[12] This step also can mitigate a potential survivorship bias. As discussed in Aggarwal and Jorion (2010a), around the Year 2000, another database was merged into the TASS database, and only funds that were alive at that time were added to TASS. Therefore, data from the other database may suffer from a potential survivorship bias.

observations with assets smaller than a predetermined cutoff point. At the same time, to avoid any possible impact on the results, I use a simulation to investigate various cutoff points.[13] In this simulation, I generate fund performance randomly, that is, fund performance does not depend on fund size. However, when I use high cutoff points, the regression results suggest that there is a convex relationship between fund performance and fund size. Therefore, to avoid generating an artificial relationship, a low cutoff point is preferred. Finally, another concern is that smaller funds have relatively higher attrition rates, that is, smaller funds are more likely to drop out of the sample. This problem is not fixed by including the data of defunct funds. After examining attrition rates of different size groups, I choose $10 million as the lower bound for fund assets.[14] Furthermore, I require each fund to have at least one year of data, and I winsorize both the highest and lowest 0.5% of raw returns and capital flows to mitigate the influence of outliers.

Table I shows the summary statistics of my sample. Panel A provides a description of fund characteristics. Hedge funds commonly charge a management fee between 1% and 2% and an incentive fee of 20%. High-water mark provisions and leverage are widely used in the hedge fund industry. The redemption frequency is normally one month (30 days) or one quarter (90 days), with a 30-day notice period.[15] Most funds do not have lockup periods and are not open to the public. Following the literature, I assume that capital flows happen at the end of each quarter, and

[13] Please refer to Internet Appendix Section I.A.
[14] Please refer to Internet Appendix Section I.B.
[15] In my sample, 46.47% of the funds have a redemption frequency of 30 days, and 39.25% have a redemption frequency of 90 days. The most common redemption notice periods in the sample are 30 days (36.09% of all funds), 45 days (11.24%), 60 days (13.46%), and 90 days (9.68%).

capital flows of fund *i* in quarter *t* are defined using Equation (1), where AUM is assets under management:

$$Flow_{it} = \frac{AUM_{it} - AUM_{i,t-1} \times (1 + Return_{it})}{AUM_{i,t-1}}. \tag{1}$$

Panel B shows the number of distinct funds in my sample. About 40% of the funds belong to the Long/Short Equity Hedge style. The table also shows that there are more defunct funds than live ones. I believe that this is due to the subprime crisis.[16]

[Insert Table I about here]

II. Individual Hedge Funds

A. Performance Measure and Diseconomies of Scale

A.1. Performance Measure

In this study, I use style-adjusted returns to measure fund performance. Style-adjusted returns are defined as the difference between fund quarterly returns and the average return of all funds in the same investment style. Thus, for fund *i* in quarter *t*, its performance is defined as:

$$Style\text{–}\ adjusted\ Return_{it} = Return_{it} - \frac{1}{N} \sum_{j=1}^{N} Return_{jt} \tag{2}$$

I choose this measure for the following reasons. First, style-adjusted returns can be easily calculated from fund raw returns, which are directly observable by all investors. Therefore, style-adjusted returns are less noisy than are measures such as risk-adjusted returns estimated from

[16] There were 260 funds (18.01% of all defunct funds) that became defunct in 2007 and 321 funds (22.23%) in 2008 in my sample.

factor models.[17] Second, hedge funds in different style categories may face very different markets and use significantly different investment strategies. Thus, hedge fund investors likely evaluate and compare hedge funds and fund managers within the same style, and style-adjusted returns are a good measure of relative performance in this sense.

A.2. Performance-Size Relationship and Diseconomies of Scale

Using style-adjusted returns, I first test whether diseconomies of scale exist in fund performance. As discussed in Berk and Green (2004), different managers have different but limited abilities. When managers are given too much capital, they may need to invest more than is optimal in each investment opportunity, or they may need to look outside their area of expertise and invest in less profitable ideas. In addition, there are another two possible negative effects on performance when funds grow large. One is the negative price impact from large block trading. When funds grow large, their trading volumes may become so large that they have a significant price impact on the market. The other effect is the hierarchy cost, discussed by Stein (2002). Large funds may hire more than one manager to handle multiple investment ideas. To get their investment ideas carried out, fund managers may give up profitable opportunities supported by soft information because this kind of information is difficult to justify. At the same time, managers need to spend more resources on analyzing hard information. This may increase expenses and erode fund performance. Therefore, I expect that hedge funds would suffer from diseconomies of scale when they grow large.

[17] Risk-adjusted returns could be different due to using different factor models and different methods to estimate factor loadings. As a robustness test, I report results using risk-adjusted returns in Section IV.

To examine the relationship between fund performance and fund size, I rank funds into five groups every quarter based on their lagged fund assets. Then I calculate average style-adjusted return for each group over time. The results are presented in Figure 1.[18] The graph shows a convex relationship between fund performance and fund size when funds are relatively small and a concave relationship when funds grow large. Because average fund age increases almost monotonically in Figure 1, the nonlinear relationship could be related to the life cycle of hedge funds.[19] For young funds, the convex performance-size relationship may be explained by fixed costs. For example, funds need to hire professionals to manage risk, invest in the latest trading software, and spend on research. Young funds, however, may not be large enough to generate sufficient fees to cover these costs, and thus fixed costs erode their performance.[20] Larger and more mature funds not only can generate sufficient fees to cover those fixed costs but also can enjoy economies of scale by sharing these fixed costs across different investment ideas. However, when funds grow larger than their optimal size for performance, they will suffer from diseconomies of scale, as discussed earlier, and the performance-size relationship becomes concave.

[Insert Figure 1 about here]

[18] Additional summary statistics for Figure 1 are available in Internet Appendix Table IAIII Panel A.
[19] See Getmansky (2012), among others, for a discussion about the life cycle of hedge funds. See Aggarwal and Jorion (2010b), among others, for a discussion about emerging hedge funds.
[20] For example, Wilson (2012) interviewed many family office executives (available at http://richard-wilson.blogspot.com/2012/09/hedge-fund-assets-under-management-aum.html). These investors mentioned some concerns about small funds: "For a fund with a low level of AUM… These funds also may not be able to afford the latest trading software or talented traders and risk management professionals and other expenses that become more feasible with a steady stream of revenue coming in from the management fees on a high-AUM fund."

To further examine the relationship, I use the polynomial regressions below. The dependent variable is style-adjusted returns. Following the literature, I use the natural log of lagged fund assets as the independent variable.

$$Performance_t = \beta_0 + \beta_1 \times ln(assets_{t-1}) + Control\ Variables \tag{3}$$

$$Performance_t = \beta_0 + \beta_1 \times ln(assets_{t-1}) + \beta_2 \times [ln(assets_{t-1})]^2 + Control\ Variables \tag{4}$$

$$Performance_t = \beta_0 + \beta_1 \times ln(assets_{t-1}) + \beta_2 \times [ln(assets_{t-1})]^2 + \beta_3 \times [ln(assets_{t-1})]^3 + Control\ Variables \tag{5}$$

Equation (4) tests whether the relationship between fund performance and fund size is quadratic, and Equation (5) examines whether the relationship is cubic, as shown in Figure 1. Following Petersen (2009), I use clustering methods to adjust the standard errors of coefficients. I include the following control variables. Fund family size is the total assets of all other funds in the same fund family. The management fee percentage, the incentive fee percentage, and the high-water mark provision dummy represent the fee structure. Redemption frequency, subscription frequency, redemption notice periods, and lockup periods represent the capital flow restrictions. I include dummy variables to indicate whether funds are open to the public and whether funds use leverage. I also control for fund age, fund capital flows, and style and year fixed effects.[21]

The regression results in Table II show that the coefficients of lagged fund assets are all significant in the cubic equation. The negative coefficient before the cubic term indicates that the

[21] Fund age is defined as the number of months between fund inception date and the current date.

relationship between fund performance and fund assets is convex when funds are relatively small, and the relationship becomes concave when funds grow large. The nonlinear performance-size relationship in Table II is consistent with the results in Figure 1. The concave part of the relationship indicates that hedge funds suffer from diseconomies of scale when they grow large.

[Insert Table II about Here]

Table III presents the regression results for each investment style. Consistent with the literature, I find significant performance-size relationships only for certain styles. Funds in the Emerging Markets, Global Macro, and Long/Short Equity Hedge styles show a significant cubic relationship, while a negative linear relationship can be found among funds in the Managed Futures and Multi-Strategy styles. Although the shape of the performance-size relationship is somewhat different, one commonality is that there are diseconomies of scale in performance when funds grow large. In addition, these five styles cover about 71% of all the funds in my sample. In other words, more than two-thirds of the funds in my sample suffer from diseconomies of scale.

[Insert Table III about here]

B. Hedge Fund Managers' Compensation

B.1. Compensation Contracts

It appears that, because diseconomies of scale exist, the standard compensation contract does not give hedge fund managers enough motive to restrict fund growth to protect fund performance. Thus, it is important to examine managers' incentives under the standard compensation contract. As rational agents, hedge fund managers care about their compensation in absolute dollar amounts, not just as a percentage of fund performance or fund assets. Therefore, I measure fund managers' incentives by calculating the total compensation that they receive. Hedge fund managers' compensation has two parts. One is the performance-based incentive fee, which is calculated using the following equation:

$$incentive\ fee = fund\ assets \times return \times incentive\ fee\ percentage. \quad (6)$$

Clearly, even the incentive fee depends on both fund performance and fund assets. When diseconomies of scale exist, fund growth will erode fund performance. However, if the increase in fund assets is faster than the decrease in fund performance, it is possible for the incentive fee in absolute dollar amounts to increase with fund size. This possibility is consistent with the model in the Appendix. In the model solution, when β decreases (i.e., when funds suffer less from diseconomies of scale), the deviation from the optimal size for fund performance becomes larger. This is because, when β is small, the incentive fee in absolute dollar amounts grows with fund size, and thus fund managers have incentives to collect more capital.

The other part of hedge fund managers' compensation is the management fee. The management fee increases with fund assets, regardless of the changes in the incentive fee, and may become the more important part of managers' total compensation when funds grow large. Thus, even when the incentive fee decreases due to the diseconomies of scale, the total compensation may still increase if the management fee grows faster.[22]

[22] The model in the Appendix shows that deleting the management fee from the compensation contract does not necessarily eliminate the deviation from the optimal size for fund performance. When β is small, the incentive fee in absolute dollar amounts increases with fund size. Thus, fund managers are still motivated to increase their assets under management.

As a result, fund managers have strong incentives to increase fund assets to maximize their compensation in absolute dollar amounts. In other words, the optimal size in terms of managers' compensation may be different from (i.e., larger than) the optimal size in terms of fund performance. Therefore, the conflict of interest between investors and fund managers may still exist under the standard compensation contract.

B.2. Compensation-Size Relationship

To study the relationship between managers' compensation and fund size, one first needs to calculate the fees charged by fund managers in absolute dollar amounts. The TASS database provides information about how often and how much hedge fund managers charge the management fee. Using these data, one can easily calculate the management fee.

To calculate the incentive fee, I assume that fund managers charge the incentive fee at the end of each year. For funds without a high-water mark provision, I assume that the incentive fee is charged if the annual return is positive. For funds with a high-water mark provision, I compare the year-end NAV to the highest historical NAV (i.e., the high-water mark). If the current NAV is higher than the high-water mark, the incentive fee is charged, and the current NAV becomes the new high-water mark. Hedge fund managers' total compensation is the sum of the management fee and the incentive fee.

To examine the compensation-size relationship, I rank funds into five groups based on lagged fund assets every year. Then I calculate the average compensation for each group over time. Figure

2 shows both the compensation-size relationship and the performance-size relationship.[23] The graph indicates that managers' total compensation increases monotonically as fund assets grow, even when diseconomies of scale exist. This relationship explains why hedge fund managers are not motivated to restrict fund growth to protect fund performance.

[Insert Figure 2 about here]

Table IV Panel A presents the compensation-size relationship for each investment style. Funds in all style categories show a significant positive linear relationship, while funds in five styles also exhibit a significant concave relationship. The results in Tables III and IV allow the estimation of the optimal size for fund performance and the optimal size for managers' compensation, respectively. The comparison results are summarized in Internet Appendix Table IAXI.[24] If the compensation contract is effective, fund managers would set fund assets to match the optimal size for fund performance. However, under the standard compensation contract, it is clear that the optimal size for managers' compensation is much larger than the optimal size for fund performance. Thus, fund managers have strong incentives to increase their assets under management, even when fund growth erodes fund performance.

[Insert Table IV about here]

B.3. Discussion

[23] Additional summary statistics for Figure 2 are available in Internet Appendix Table IAIII Panel B.

[24] Please note that the estimations in the Internet Appendix Table IAXI are based on the regression results for each investment style. Fund managers with different abilities may have different optimal sizes, and the optimal sizes may change over time. Nevertheless, Table IAXI provides some evidence that the optimal size for managers' compensation is much larger than the optimal size for fund performance.

The results above show that, under the standard compensation contract, hedge fund managers' compensation increases as fund assets grow. Earlier, I discussed two possibilities that may lead to this relationship. First, if fund assets grow faster than fund performance declines, the incentive fee may increase even when diseconomies of scale exist. Second, even when the incentive fee decreases due to diseconomies of scale, managers' total compensation may still increase if the management fee grows more rapidly. This section seeks to examine these potential explanations. The results should provide more insight into the standard compensation contract in the hedge fund industry and shed light on future compensation contract design.

To test the first possibility, I regress the incentive fee on lagged fund assets. Panel B of Table IV shows that there is a significant positive linear relationship between the incentive fee and fund size; that is, the incentive fee in absolute dollar amounts increases as fund assets grow. Because I document that diseconomies of scale exist, this result implies that the increase in fund assets is faster than the decline in fund performance, which is consistent with the first possibility.

To test the second possibility, I calculate the ratio of the management fee to managers' total compensation. This measure reflects the importance of the management fee to hedge fund managers. I rank funds based on their lagged fund assets every year and then calculate the average ratio for each quintile over time. Internet Appendix Table IAIII Panel B shows that the ratio decreases from 0.63 to 0.49 for the first four size groups but increases to 0.57 for the largest size group. The increase supports my second hypothesis. Because the management fee depends only on fund assets, it provides a more stable source of compensation for hedge fund managers. Therefore, when the management fee becomes the more important part of managers' total compensation, fund managers have stronger incentives to increase their assets under management and less incentives to improve fund performance.[25]

While the empirical results above suggest that the design of future compensation contracts needs to consider both fund performance and fund size, it is worth noting that certain frictions might preclude corrections to the standard compensation contract. First, certain corrections may be difficult to implement. For instance, with a fixed fee percentage, the incentive fee in absolute dollar amounts may increase with fund assets. One possible solution is to make the incentive fee percentage change with both fund performance and fund size. However, detailed designs, such as when to change the percentage and how much to change, would be difficult to specify and justify.

Second, corrections to the standard compensation contract could be costly. For example, modifications to the compensation contract may change fund managers' risk-taking behavior, and these changes are not necessarily in the best interests of investors. Golec and Starks (2004) examine the impact of an exogenous, government-required performance fee contract change in the mutual fund industry.[26] The purpose of this change was to mitigate the agency problem and reduce the risk-taking of managers with an asymmetric performance fee contract. However, the authors document that mutual funds that were required to change their compensation contracts actually increased their risk levels.

[25] In Wilson's (2012) interview (available at http://richard-wilson.blogspot.com/2012/09/hedge-fund-assets-under-management-aum.html), some family office executives also expressed the following concern: "For funds with several billions of dollars under management, another fear grows among investors, that the management team is not motivated to achieve high returns and is content risking little and 'getting fat' off the management fees."

[26] Since the early 1970s, the use of asymmetric performance fee has been prohibited in the mutual fund industry. If investment companies use performance-based compensation contracts, the contracts must be symmetric.

The problems discussed above suggest that corrections to the contract design could be challenging. Such complications may explain why there are few changes in the compensation contract over time. Therefore, future designs should carefully examine the marginal benefits and marginal costs of further corrections.

C. Capital Flows and Optimal Fund Size

C.1. Flow-Performance Relationship

In the compensation-size regressions above, I do not explicitly consider capital flows. To increase fund assets, fund managers need to attract capital inflows and avoid capital outflows. Previous research documents that investors chase performance. Berk and Green (2004) argue that investors use past performance as a measure of managers' abilities. Investors will invest more money in funds with good performance until managers' abilities are fully extracted.[27] Therefore, I expect that, to avoid capital outflows and thus retain fund assets, hedge fund managers are also motivated to maintain a certain level of performance. To test the flow-performance relationship, I run the following two regressions.

$$Flow_t = \beta_0 + \beta_1 \times Performance_{t-1} + Control\ Variables \tag{7}$$

$$\begin{aligned} Flow_t = \beta_0 &+ \beta_1 \times Performance\ Rank\ 1 + \beta_2 \times Performance\ Rank\ 2 + \cdots \\ &+ \beta_5 \times Performance\ Rank\ 5 + Control\ Variables \end{aligned} \tag{8}$$

In Equation (7), I regress capital flows on lagged fund performance. The control variables are similar to those in the previous regressions. I include the standard deviation of past performance

[27] Lim, Sensoy, and Weisbach (2015) show that good performance increases future capital inflows, which leads to higher future fees.

to measure the risk. Lagged capital flows are used to capture factors that are not related to fund characteristics. However, the literature shows that investors chase performance with different sensitivities. To capture this possible nonlinear relationship, I use a piecewise regression as in Equation (8). Following Sirri and Tufano (1998), I rank funds within the same style category from 0 to 1 based on their lagged performance and divide them into five groups. The bottom quintile is defined as Performance Rank 1 = min (0.2, performance rank), and the second quintile is defined as Performance Rank 2 = min (0.2, performance rank – Performance Rank 1), and so on. Another thing to consider in an analysis of capital flows in the hedge fund industry is the share restrictions. In my sample, most hedge funds have a redemption frequency of 30 days or 90 days, with an additional notice period commonly varying from 30 to 90 days.[28] To take the delayed capital flows into consideration, I include fund performance in time periods t-2 and t-3 in the regressions as well.

Table V shows the pooled regression results for the flow-performance relationship. The results in Panel A indicate that investors chase performance: The coefficient of lagged fund performance is positive and significant. The significant negative coefficient of the standard deviation of lagged fund performance suggests that investors care about risk. In addition, funds with a high-water mark provision and funds with longer redemption notice periods enjoy higher capital flows. I find similar results when I include fund performance over the past three quarters. All three coefficients of lagged performance are positive and significant. This is consistent with my conjecture that certain capital flows are delayed by the share restrictions.

[28] The most common combinations of the redemption frequency and notice periods in my sample are a redemption frequency of 30 days with notice periods of 30 days (19.70% of all funds), 90 days with 30 days (13.81%), 90 days with 45 days (7.53%), 90 days with 60 days (7.37%), and 90 days with 90 days (5.35%).

[Insert Table V about here]

Panel B presents the results of the piecewise regressions. When I include only the fund performance over the last quarter, the coefficients of the performance quintiles are all positive and significant, confirming that investors chase performance. However, investors' sensitivities to past performance are different. Investors are most sensitive when funds are in the worst performance group (Performance Rank 1) and the best performance group (Performance Rank 5), and they are least sensitive when funds have average performance (Performance Rank 3).

When I include fund performance over the past three quarters, all the coefficients of the performance groups continue to be positive. However, there are some interesting changes in investors' sensitivities. First, the insignificant coefficient of Performance Rank 3 in time t-1 suggests that investors are insensitive to average performance. Second, investors are more sensitive to bad performance in time t-2. This is consistent with the fact that redemption restrictions are longer than the subscription frequency; that is, it is easier to invest in hedge funds than to withdraw money. Third, investors are not very sensitive to fund performance in time t-3. One possible explanation is that hedge fund investors are sophisticated and react to fund performance very fast. Thus, the results in time t-3 are driven by few funds with long share restrictions.[29]

Because investors chase performance, fund managers need to improve fund performance to attract capital inflows. But fund growth will erode fund performance when diseconomies of scale

[29] Based on the combination of most common subscription frequency, redemption frequency, and notice periods, most investors are able to invest in a hedge fund within a quarter and withdraw their money within two quarters. In my sample, fewer than 10% of the funds have a share restriction (i.e., sum of the redemption frequency and notice periods) that is longer than two quarters (180 days).

exist. So fund managers face a tradeoff: On the one hand, fund managers have strong incentives to increase fund assets to boost their compensation; on the other hand, they are also motivated to maintain a certain level of performance to retain fund assets. This also can be viewed from a supply-and-demand perspective. Fund managers want to raise capital, and they attract inflows by delivering superior performance. Investors look for investment opportunities and provide their capital to managers with skills. In other words, fund size is determined by the supply and demand of both fund performance and capital flows.

C.2. The Optimal Size and Fund Closure/Reopen Decision

Based on the flow-performance relationship and the discussion above, I expect that fund managers may want to maintain style-average performance. To examine this conjecture, I rank funds within the same style into quintiles every quarter based on their lagged performance. The average capital flow of each group is reported in Table V Panel C. When funds underperform their peers, they suffer significant outflows. When funds provide average performance, they still attract capital inflows, but at lower levels than funds with above-average performance. These results provide some evidence that fund managers have incentives to maintain style-average performance to avoid capital outflows.

To further examine this question, I look at fund closure and reopening decisions. Closing a fund to new investment is a direct way to restrict fund growth, and fund closure/reopening decisions reflect fund managers' opinions about the optimal size of their funds. If fund managers genuinely care about investors' best interests, they should close their funds to new investment when further growth would erode fund performance, and they should reopen closed funds only when fund growth can improve fund performance.

In the first approach, I rank funds within the same style category into percentiles based on their performance and assets under management every quarter. Panel A of Table VI shows the summary statistics of funds' performance rankings and size rankings in the quarter when funds choose to close/reopen. On average, only funds in the Global Macro style provide above-average performance when they close. When they reopen, only funds in the Long/Short Equity Hedge style outperform. Panel A also shows that funds in Global Macro and Long/Short Equity Hedge styles have assets above average when they close and that funds in the Global Macro and Managed Futures styles are larger than average when they reopen. This suggests that closed funds may still accept capital from their existing investors after closure.

[Insert Table VI about here]

However, fund managers may choose the timing of closure/reopening strategically. Liang and Schwarz (2011) argue that fund managers choose to close their funds after a period of good performance. Therefore, in the second approach, I examine the average performance ranking and average size ranking in the one-year time period right after the closure/reopening decision. The summary statistics for each style category are reported in Panel B of Table VI. Funds in all five styles do not have performance rankings significantly above average. The results are consistent with my hypothesis that fund managers close funds to new investment when they can only provide style-average performance. After funds reopen, their performance does not significantly improve.

III. Analysis of Hedge Fund Families

Previous section presents some evidence that hedge fund managers' compensation increases as fund assets grow, even when funds suffer from diseconomies of scale. Thus, fund managers have strong incentives to increase their assets under management. However, fund managers do not necessarily need to collect more capital for an individual fund. One alternative is to launch new funds, and this approach could allow fund managers to protect fund performance and boost their compensation simultaneously. For example, fund managers could restrict the growth of each fund and increase their assets under management by having more funds in the same fund family. Or, fund managers could strategically protect the performance of certain funds and use their good performance records to attract capital flows into other funds in the same fund family.

Therefore, I examine performance and managers' compensation at the fund-family level in this section. Funds belong to the same fund family if they share the same management firm. In my sample, I am able to match 2,510 funds to 1,416 management firms. Among these firms, about 40% have at least two funds under management, and these multi-fund firms manage 1,619 funds in total, about 65% of the sample.

A. Performance of Fund Families

To measure family performance, I use the average after-fee raw return of funds under management, both equal-weighted and asset-weighted.[30] Family size is the total assets of each fund under management. In the first approach, I rank fund families into size quintiles every quarter,

[30] I do not use style-adjusted returns here because funds in the same fund family may use different investment styles. Results based on risk-adjusted returns are available in the Internet Appendix Section III.A.

and Panel A of Table VII summarizes the average performance for each group over time. When one looks at all fund families, the family performance-size relationship is nonlinear and similar to the one in Figure 1. The concave part of the relationship suggests that fund families suffer from diseconomies of scale when they grow large. However, these results could be driven by single-fund families. To explore this possibility, I apply the same approach to fund families with multiple funds. The last two columns of Panel A show that family performance decreases monotonically as family size increases. The performance difference between the smallest size group and the largest size group is positive and significant.

[Insert Table VII about here]

In the second approach, I regress family performance on lagged family size. If a fund family expands its operation by launching new funds and keeps each fund at its optimal capacity, then managing more funds would not erode family performance. However, if funds in the same family implement the same investment strategy, then the capacity constraints of the strategy could lead to a decreasing return to scale. Therefore, in the regression, I control for the number of funds and the number of investment styles in the same fund family. The results in Table VII Panel B show that there is a nonlinear relationship between family performance and family size. The negative coefficient of the cubic term indicates that the relationship becomes concave when fund families grow large. Panel C examines multi-fund families, and the results show a significant negative linear relationship. Both panels suggest that fund families suffer from diseconomies of scale. The coefficients of the number of funds in the same family are not significant. The negative sign, however, implies that launching new funds may hurt family performance.

The results of both approaches show that large fund families underperform. One possible explanation is that management firms do not restrict growth of individual hedge funds. This is consistent with evidence in earlier sections that fund managers have incentives to increase fund size to boost their compensation. However, it is also possible that management firms only protect the performance of certain funds but do not restrict growth of other funds in the same family. I will examine the latter case in Section C. Another possible explanation is that funds in the same family use similar strategies, and the capacity constraints of these strategies lead to diseconomies of scale in family performance. The coefficients of the number of investment styles in Panels B and C of Table VII are positive and marginally significant. This suggests that fund families using different investment strategies are more likely to have better performance.[31]

B. Family Compensation

Family total compensation is the sum of compensation of each fund under management. To make single-fund families and multi-fund families more comparable, I also calculate family average compensation, which is the family total compensation divided by the number of funds under management.

To examine the compensation-size relationship, I rank fund families based on their lagged size and then calculate average compensation for each quintile over time. Table VII Panel D shows that both family total compensation and family average compensation increase with family assets.

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[31] In the Internet Appendix Section III.B, I decompose fund family size in Equations (3) through (5) into two parts: assets of all other funds in the same family using the same strategy and assets of all other funds using different strategies. The coefficient of family assets using the same investment style is negative and significant, indicating that funds in the same family may suffer from capacity constraints of similar strategies.

Family compensation of the largest group is much larger than in the other four groups. I also observe that the management fee becomes increasingly important when family size grows. When I apply the same approach to multi-fund families, I find similar results.

The family compensation-size relationship is consistent with my earlier findings for individual hedge funds and provides more evidence that hedge fund managers have strong incentives to increase their assets under management to maximize their compensation. However, this is apparently not in the best interests of investors, as large fund families underperform, based on the results presented in the previous section.

C. Flagship Funds

As discussed earlier, management firms may strategically protect performance of certain funds and use their performance records to attract capital flows into other funds of the same family. Fung et al. (2014) show that management firms leverage on the performance of their first funds or flagship funds, and firms with successful flagship funds are able to launch new funds with higher fees. Thus, I examine performance and growth of flagship funds in this section.

Following Fung et al. (2014), I define a flagship fund as the first fund established by a fund family. If there are multiple flagship funds, I combine them as one: For fund performance, I use both the equal-weighted and asset-weighted average of after-fee raw returns; for fund size, I use the combined fund assets; for fund characteristics, I use the equal-weighted average as the flagship funds' characteristics; and, for capital flows, I use the asset-weighted average flow.

I first regress flagship fund performance on lagged fund size, as in Equations (3) through (5). Table VIII Panel A shows that there is a nonlinear relationship between fund performance and fund size. The relationship becomes concave when flagship funds grow large, indicating that flagship funds suffer from diseconomies of scale. This result, however, may be driven by flagship funds of single-fund families. Thus, I examine flagship funds of multi-fund families in Panel B. The results show a significant negative linear relationship, suggesting that larger flagship funds underperform. Thus, it seems that fund management firms do not restrict fund growth to protect flagship funds' performance.

[Insert Table VIII about here]

Although I find some evidence that there are diseconomies of scale in flagship funds' performance, they may still outperform their peers in the same style. To determine whether this is the case, I next examine flagship funds' performance rankings and size rankings after two events. The first event is the establishment of non-flagship funds. Hedge fund management firms may have incentives to generate good performance for flagship funds so that they can attract capital inflows and launch new funds. However, whether management firms continue to protect the performance of flagship funds afterwards remains to be determined. Table VIII Panel C presents the average performance ranking of flagship funds for each style during the one-year time period before and after the establishment of the first non-flagship funds. The *t*-test results show that, before the establishment, flagship funds in three styles outperform their peers. However, after new funds were launched, flagship funds' performance is not significantly different from style average. The second event is the closure to new investment. Fund families may strategically close their flagship funds to new investment to protect their performance. Panel E of Table VIII shows the average performance ranking over the one-year time period after the closure. Flagship funds in all five styles do not outperform their peers. However, funds in three styles have assets significantly higher than the 50th percentile. These results are similar to my earlier findings and suggest that, even for flagship funds, fund managers have incentives to collect more assets until funds can only provide style-average performance.

D. Discussion

In Section A, I document that fund families suffer from diseconomies of scale and that larger families underperform. While it is possible that management firms strategically protect the performance of their flagship funds, I find evidence inconsistent with this conjecture in Section C. In Section B, I find that family compensation increases with family size and that larger fund families enjoy both higher management fees and higher incentive fees. Thus, fund management firms have strong incentives to increase their assets under management, even when family growth erodes family performance. In addition, I show in prior sections that, when fund size increases faster than fund performance declines, the incentive fee increases with fund assets. As a result, management firms have incentives not only to launch more funds, but also to collect more capital for each fund under management.

The analysis of family performance and family compensation is consistent with Fung et al. (2014) and suggests that there is a conflict of interest between investors and fund managers at the fund-family level as well. Management firms have strong incentives to grow family size to maximize their total compensation. However, investors do not benefit from this because larger fund families tend to underperform.[32]

IV. Robustness Test[33]

A. Different Performance Measures

Thus far, I have documented that diseconomies of scale exist in the hedge fund industry using style-adjusted returns. However, whether this effect still exists when one uses different performance measures needs to be determined. To address this issue, I employ several alternative measures. The first one is net-of-fee raw returns, which are directly observable by all hedge fund investors. The second measure is risk-adjusted returns, measured as the alpha calculated from Fung and Hsieh's (2004) seven-factor model.[34] To take hedge funds' dynamic trading strategies into account, I use a three-year rolling window to estimate the factor loadings (at least 24 observations for each fund during the three-year time period are required). Then I define the alpha of fund *i* in month *t* as follows, where the excess return is fund return in excess of the risk-free rate:

$$alpha_{it} = excess\ return_{it} - (\beta_1 S\&P + \beta_2 SML + \beta_3 BD10Y + \beta_4 CredSpr \\ + \beta_5 PTFSFX + \beta_6 PTFSCOM + \beta_7 PTFSBD). \tag{9}$$

[32] In the Internet Appendix Section III.C, I analyze performance and compensation at the portfolio-manager level. The results are similar to my findings for fund families. Fund managers with more assets under management underperform but generate higher fee income. At the same time, I do not find supporting evidence that fund managers would restrict fund growth to protect the performance of their first funds.

[33] In the Internet Appendix Section II, I provide more robustness tests, including additional performance measures (e.g., unsmoothed fund performance and performance adjusted for volatility), additional cutoff points for fund size, and different sub-periods, among others.

[34] Thanks to William Fung and David A. Hsieh for providing the data. http://faculty.fuqua.duke.edu/~dah7/DataLibrary/TF-FAC.xls

The set of factors comprises the equity market factor (S&P), measured as Standard & Poor's 500 index monthly total return; the size spread factor (SML), constructed as the difference between the Russell 2000 index monthly total return and S&P's 500 monthly total return; the bond market factor (BD10Y), which is the monthly change in the 10-year Treasury constant maturity yield; the credit spread factor (CredSpr), calculated as the monthly change in the Moody's Baa yield less the 10-year Treasury constant maturity yield; and three trend-following risk factors, which are the excess returns on portfolios of look-back straddle options on currencies (PTFSFX), commodities (PTFSCOM), and bonds (PTFSBD). Quarterly alpha is the sum of monthly alphas within the same quarter.

The last measure is style-adjusted returns using the asset-weighted average return as the benchmark. This measure can test whether my results are driven by performance of smaller funds. The Internet Appendix Table IAV Panel A shows that there is a nonlinear relationship between fund performance and fund size when I use raw returns and style-adjusted returns, and the relationship is concave when I use risk-adjusted returns. Although the shape of the performance-size relationship is somewhat different, one thing in common is that fund growth erodes fund performance. In other words, diseconomies of scale exist in the hedge fund industry.

B. Different Fund Assets' Cutoff Points

To preclude the possibility that my results are driven by the choice of using $10 million as the lower bound for fund size, I utilize several alternative cutoff points: $5 million, $20 million, and $50 million. The results are reported in the Internet Appendix Table IAV Panel B. I document a significant nonlinear relationship between fund performance and fund size using cutoff points below $50 million. The relationship becomes negative linear when I use $50 million as the lower bound for fund size.

Panel C provides a summary of the performance-size relationship for different investment styles using different performance measures and different cutoff points for fund size. The results are consistent in most cases that use raw returns and style-adjusted returns. This is not surprising, as the two measures are highly correlated. Although the performance-size relationship using risk-adjusted returns is slightly different, one commonality is that funds suffer from diseconomies of scale when they grow large.

V. Conclusion

Traditional investment vehicles, such as mutual funds, normally charge an asset-based management fee. The design of the management fee motivates fund managers to increase their assets under management and thus maximize their compensation. Because mutual funds suffer from diseconomies of scale, increasing fund assets will erode fund performance. This erosion, or decline in performance, generates a conflict of interest between fund managers and investors. In contrast to their peers in the mutual fund industry, hedge fund managers charge an additional performance-based incentive fee. This incentive fee is intended to motivate fund managers to enhance fund performance, including restricting fund growth to protect fund performance when diseconomies of scale exist. In other words, if the design of the compensation contract is effective, it should mitigate the conflict of interest between investors and fund managers.

In this study, however, I find that hedge fund managers actually have strong incentives to increase their assets under management, even if asset growth hurts performance. Thus, the conflict of interest between investors and fund managers still exists in the hedge fund industry under the standard compensation contract.

I document this conflict of interest in several ways. First, I find that individual hedge funds suffer from diseconomies of scale, while managers' compensation increases as funds grow large. As a result, fund managers have strong incentives to increase fund assets, even when fund growth erodes fund performance. At the same time, to avoid capital outflows and thus retain fund assets, fund managers need to maintain style-average performance. This prediction is confirmed by managers' fund closure decisions. Most funds close to new investment around the size at which they can provide style-average performance. Thus, although fund managers would prefer more assets, fund sizes also are limited by investors' behavior of chasing performance. Second, I document that larger fund families generate lower performance but collect more fee income than do their smaller peers. At the same time, I show that flagship funds suffer from diseconomies of scale and that they do not outperform their peers in the same style after the establishment of non-flagship funds or after their closure to new investment. These results suggest that fund managers have incentives to collect more assets for all funds under management, both flagship funds and non-flagship funds, even at the expense of performance.

This study has several implications for hedge fund investors and for the future design of managers' compensation contracts. For example, hedge fund investors should realize that, under the standard compensation contract, fund managers have incentives to increase fund assets and sacrifice fund performance to boost their compensation. Therefore, investors need to monitor fund performance more closely and to avoid long lockup periods. At the fund-family level, although hedge fund management firms have incentives to deliver superior performance for their flagship funds so that they can attract capital inflows and launch new funds, they may not protect flagship funds' performance afterwards. In terms of the design of compensation contracts, future designs need to consider both fund performance and fund size. The current compensation contract is not effective because it ignores the fact that managers' compensation also depends on fund assets, even in the case of performance-based fees.

References

Ackermann, Carl, Richard McEnally, and David Ravenscraft, 1999, The Performance of Hedge Funds: Risk, Return, and Incentives, *Journal of Finance* 54, 833–874.

Agarwal, Vikas, Naveen D. Daniel, and Narayan Y. Naik, 2009, Role of Managerial Incentives and Discretion in Hedge Fund Performance, *Journal of Finance* 64, 2221–2256.

Agarwal, Vikas, and Sugata Ray, 2011, Determinants and Implications of Fee Changes in the Hedge Fund Industry, *Working Paper*, Georgia State University and University of Florida.

Aggarwal, Rajesh K., and Philippe Jorion, 2010a, Hidden Survivorship in Hedge Fund Returns, *Financial Analysts Journal* 66, 1–6.

Aggarwal, Rajesh K., and Philippe Jorion, 2010b, The Performance of Emerging Hedge Funds and Managers, *Journal of Financial Economics* 96, 238–256.

Aragon, George O., and Jun Qian, 2010, High-Water Marks and Hedge Fund Compensation, *Working Paper,* Arizona State University and Boston College.

Berk, Jonathan B., and Richard C. Green, 2004, Mutual Fund Flows and Performance in Rational Markets, *Journal of Political Economy* 112, 1269–1295.

Bris, Arturo, Huseyin Gulen, Padma Kadiyala, and P. Raghavendra Rau, 2007, Good Stewards, Cheap Talkers, or Family Men? The Impact of Mutual Fund Closures on Fund Managers, *Review of Financial Studies* 20, 953–982.

Carpenter, Jennifer, 2000, Does Option Compensation Increase Managerial Risk Appetite?, *Journal of Finance* 55, 2311–2331.

Chen, Joseph, Harrison Hong, Ming Huang, and Jeffrey D. Kubik, 2004, Does Fund Size Erode Mutual Fund Performance? The Role of Liquidity and Organization, *American Economic Review* 94, 1276–1302.

Chevalier, Judith A. and Glenn D. Ellison, 1997, Risk Taking by Mutual Funds as a Response to Incentives, *Journal of Political Economy* 105, 1167–1200.

Ding, Bill, Mila Getmansky, Bing Liang, and Russ Wermers, 2009, Share Restrictions and Investor Flows in the Hedge Fund Industry, *Working Paper*, State University of New York at Albany, University of Massachusetts at Amherst, and University of Maryland.

Elton, Edwin J., Martin J. Gruber, and Christopher R. Blake, 2003, Incentive Fees and Mutual Funds, *Journal of Finance* 58, 779–804.

Fung, William, and David A. Hsieh, 2004, Hedge Fund Benchmarks: A Risk Based Approach, *Financial Analysts Journal* 60, 65–80.

Fung, William, David A. Hsieh, Narayan Y. Naik, and Tarun Ramadorai, 2008, Hedge Funds: Performance, Risk and Capital Formation, *Journal of Finance* 63, 1777–1803.

Fung, William, David A. Hsieh, Narayan Naik, and Melvyn Teo, 2014, Growing the Asset Management Franchise: Evidence from Hedge Fund Firms, *Working Paper*.

Gaspar, José-Miguel, Massimo Massa, and Pedro Matos, 2006, Favoritism in Mutual Fund Families? Evidence on Strategic Cross-Fund Subsidization, *Journal of Finance* 61, 73–104.

Getmansky, Mila, 2012, The Life Cycle of Hedge Funds: Fund Flows, Size and Performance, *Quarterly Journal of Financial Economics* 2.

Goetzmann, William N., Jonathan E. Ingersoll, and Stephen A. Ross, 2003, High-Water Marks and Hedge Fund Management Contracts, *Journal of Finance* 58, 1685–1717.

Golec, Joseph, and Laura Starks, 2004, Performance fee contract change and mutual fund risk, *Journal of Financial Economics* 73, 93–118.

Hodder, James E., and Jens Carsten Jackwerth, 2007, Incentive Contracts and Hedge Fund Management, *Journal of Financial and Quantitative Analysis* 42, 811–826.

Indro, Daniel C., Christine X. Jiang, Michael Y. Hu, and Wayne Y. Lee, 1999, Mutual Fund Performance: Does Fund Size Matter? *Financial Analysts Journal* 55, 74–87.

Kouwenberg, Roy, and William T. Ziemba, 2007, Incentives and Risk Taking in Hedge Funds, *Journal of Banking & Finance* 31, 3291–3310.

Liang, Bing, 1999, On the Performance of Hedge Funds, *Financial Analysts Journal* 55, 72–85.

Liang, Bing, 2001, Hedge Fund Performance: 1990–1999, *Financial Analysts Journal* 57, 11–18.

Liang, Bing, and Christopher Schwarz, 2011, Is Pay for Performance Effective? Evidence from the Hedge Fund Industry, *Working Paper*, University of Massachusetts at Amherst and University of California at Irvine.

Lim, Jongha, Berk Sensoy, and Michael Weisbach, 2015, Indirect Incentives of Hedge Fund Managers, *Journal of Finance*, forthcoming.

Naik, Narayan Y., Tarun Ramadorai, and Maria Stromqvist, 2007, Capacity Constraints and Hedge Fund Strategy Returns, *European Financial Management* 13, 239–256.

Nanda, Vikram, Jay Wang, and Lu Zheng, 2004, Family Values and the Star Phenomenon: Strategies of Mutual Fund Families, *Review of Financial Studies*, 17(3), 667–698.

Pan, Fei, Kwei Tang, Xiaoyan Zhang, and Hui Zhao, 2012, Hedge Fund Manager Compensation Contracts During Financial Crisis, *Working Paper*, Purdue University and Pennsylvania State University.

Panageas, Stavros, and Mark M. Westerfield, 2009, High-Water Marks: High Risk Appetites? Convex Compensation, Long Horizons, and Portfolio Choice, *Journal of Finance* 64, 1–36.

Perold, André F., and Robert S. Salomon, Jr., 1991, The Right Amount of Assets under Management, *Financial Analysts Journal* 47, 31–39.

Petersen, Mitchell A., 2009, Estimating Standard Errors in Finance Panel Data Sets: Comparing Approaches, *Review of Financial Studies* 22, 435–480.

Sirri, Erik R., and Peter Tufano, 1998, Costly Search and Mutual Fund Flows, *Journal of Finance* 53, 1589–1622.

Spiegel, Matthew, and Hong Zhang, 2013, Mutual Fund Risk and Market Share-Adjusted Fund Flows, *Journal of Financial Economics* 108, 506-528.

Stein, Jeremy C., 2002, Information Production and Capital Allocation: Decentralized versus Hierarchical Firms, *Journal of Finance* 57, 1891–1921.

Teo, Melvyn, 2009, Does Size Matter in the Hedge Fund Industry?, *Working Paper*, Singapore Management University.

Zhao, Xinge, 2004, Why are some mutual funds closed to new investors?, *Journal of Banking and Finance* 28, 1867–1887.

Appendix

In this appendix, I provide a simple model to motivate this study. First, I assume that managers' compensation in absolute dollar amounts of fund i, c_i, has the following form[36]:

$$c_i = \alpha x_i + \gamma r_i x_i, \tag{A1}$$

where x_i is the assets under management of fund i and r_i is the fund return. α and γ are the management fee percentage and the incentive fee percentage, respectively. Second, I assume that hedge fund managers have limited abilities. Thus, there is an optimal size for fund performance. For fund i in style j, fund performance, r_i, can be written as follows, where $\hat{x}_i^j$ is the optimal size for performance:

$$r_i = \bar{r}_i - \beta(x_i - \hat{x}_i^j)^2. \tag{A2}$$

The objective of hedge fund managers is to maximize their compensations in absolute dollar amounts. In other words, they choose x_i to maximize the following function:

$$\max_{x_i} \alpha x_i + \gamma\left[\bar{r}_i - \beta(x_i - \hat{x}_i^j)^2\right]x_i\,, s.t.\, x_i - \hat{x}_i^j \in \left(-\sqrt{\frac{\bar{r}_i}{\beta}}, \sqrt{\frac{\bar{r}_i}{\beta}}\right). \tag{A3}$$

The solution would generate two roots for $x_i - \hat{x}_i^j$ as in Equation (A4). Ideally, one would like fund managers to set fund assets at the optimal size for fund performance, that is, $x_i - \hat{x}_i^j = 0$.[37]

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[36] Managers without a high-water mark provision can charge the incentive fee when $r_i > 0$. Managers with a high-water mark provision can charge the incentive fee when fund net asset value is higher than the high-water mark. In this simple model, I assume that fund managers will keep $x_i - \hat{x}_i^j \in \left(-\sqrt{\frac{\bar{r}_i}{\beta}}, \sqrt{\frac{\bar{r}_i}{\beta}}\right)$, that is, $r_i > 0$. Then Equation (A1) could apply to funds with and without a high-water mark provision.

[37] In other words, one wants to avoid the other solution, which is near $-\frac{2}{3}\hat{x}_i^j$

$$x_i - \hat{x}_i^j = \frac{1}{3}\left[-\hat{x}_i^j \pm \sqrt{\left(\hat{x}_i^j\right)^2 + 3\left(\frac{\alpha}{\beta\gamma} + \frac{\bar{r}_i}{\beta}\right)}\right] \tag{A4}$$

However, the solution above indicates that the optimal size for managers' compensation is larger than the optimal size for fund performance, and the difference between the two optimal sizes is related to both the performance-size relationship and the compensation contract design.[38] First, the smaller β is, the larger the deviation is. When β is small, funds suffer less from diseconomies of scale. In other words, fund size increases faster than performance declines. As a result, the incentive fee (and managers' total compensation) in absolute dollar amounts increases with fund size. Second, the lower the incentive fee percentage (i.e., the smaller γ is) and/or the higher the management fee percentage (i.e., the bigger α is), the larger the deviation. This result is intuitive. When γ is small, managers have less stake in the profits; when α is large, the management fee becomes the more important part of managers' total compensation. In both cases, fund managers have more incentives to increase their assets under management to boost their fees. Third, deleting

[38] The implications of the model actually do not depend on the shape of the performance-size relationship.
When the relationship between fund performance and fund size is linear, the solution to the optimal size for fund managers would be: $x_i = \frac{1}{2}\left(\frac{\alpha}{\gamma\beta} + \frac{\bar{r}_i}{\beta}\right)$.
When the performance-size relationship is cubic, it can be written as $\bar{r}_i - \beta(x_i - \hat{x}_i^j)f(x_i^2)$, where $f(x_i^2)$ is a quadratic function of x_i. The solution would be a cubic equation of $x_i - \hat{x}_i^j$, and can be expressed in a general form as $a\left(x_i - \hat{x}_i^j\right)^3 + b\left(x_i - \hat{x}_i^j\right)^2 + c\left(x_i - \hat{x}_i^j\right) + d = 0$, and $\left(-\frac{\alpha}{\gamma\beta} - \frac{\bar{r}_i}{\beta}\right)$ is part of d. The solution can be written as

$$\sqrt[3]{\left(\frac{-b^3}{27a^3} + \frac{bc}{6a^2} - \frac{d}{2a}\right) + \sqrt[2]{\left(\frac{-b^3}{27a^3} + \frac{bc}{6a^2} - \frac{d}{2a}\right)^2 + \left(\frac{c}{3a} - \frac{b^2}{9a^2}\right)^3}} +$$
$$\sqrt[3]{\left(\frac{-b^3}{27a^3} + \frac{bc}{6a^2} - \frac{d}{2a}\right) - \sqrt[2]{\left(\frac{-b^3}{27a^3} + \frac{bc}{6a^2} - \frac{d}{2a}\right)^2 + \left(\frac{c}{3a} - \frac{b^2}{9a^2}\right)^3}} - \frac{b}{3a}$$

The solution increases when d decreases. Thus, in both cases above, when α increase, γ decreases, or β decreases, fund size would deviate more from the optimal size for fund performance.

the management fee (i.e., $\alpha = 0$) does not necessarily mitigate the deviation. When $\alpha = 0$, the solution above indicates that fund assets may still deviate from the optimal size for fund performance if β is small.

Figure 1. Relationship between Fund Performance and Fund Size

Every quarter, I rank funds into five groups based on their lagged fund assets. Then I calculate the average of style-adjusted returns, fund ages, and lagged fund assets for each group over time. The combinations of average lagged fund assets (in $millions) and average fund performance (in %) for each size group are shown in the callouts. The graph shows that there is a convex relationship between fund performance and fund size when funds are relatively small and a concave relationship when funds grow large.

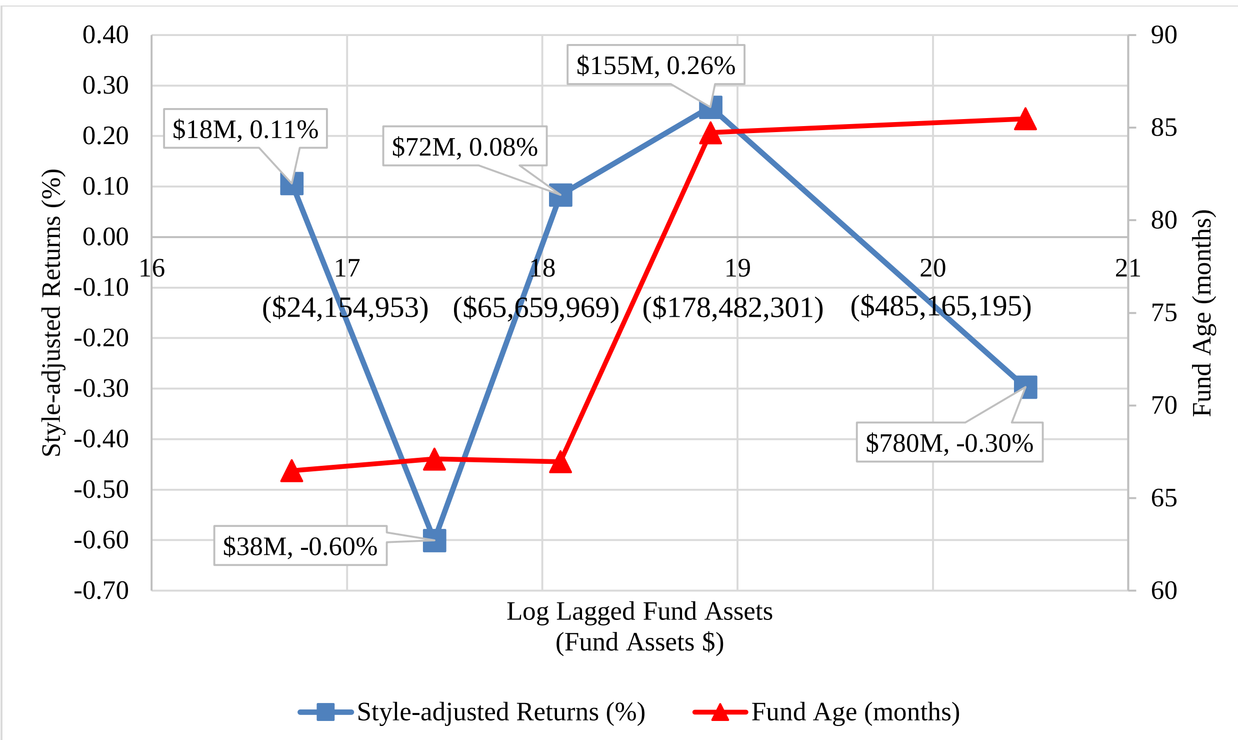

Figure 2. Managers' Compensation

Every year, I rank funds into five groups based on their lagged fund assets. Then I calculate the average of managers' compensation for each group over time. The combinations of average lagged fund assets (in $millions) and average compensation (in $millions) for each size group are shown in the callouts. This figure provides a comparison of the compensation-size relationship with the performance-size relationship, as in Figure 1. The graph shows that managers' total compensation increases monotonically as fund assets grow, even when diseconomies of scale exist.

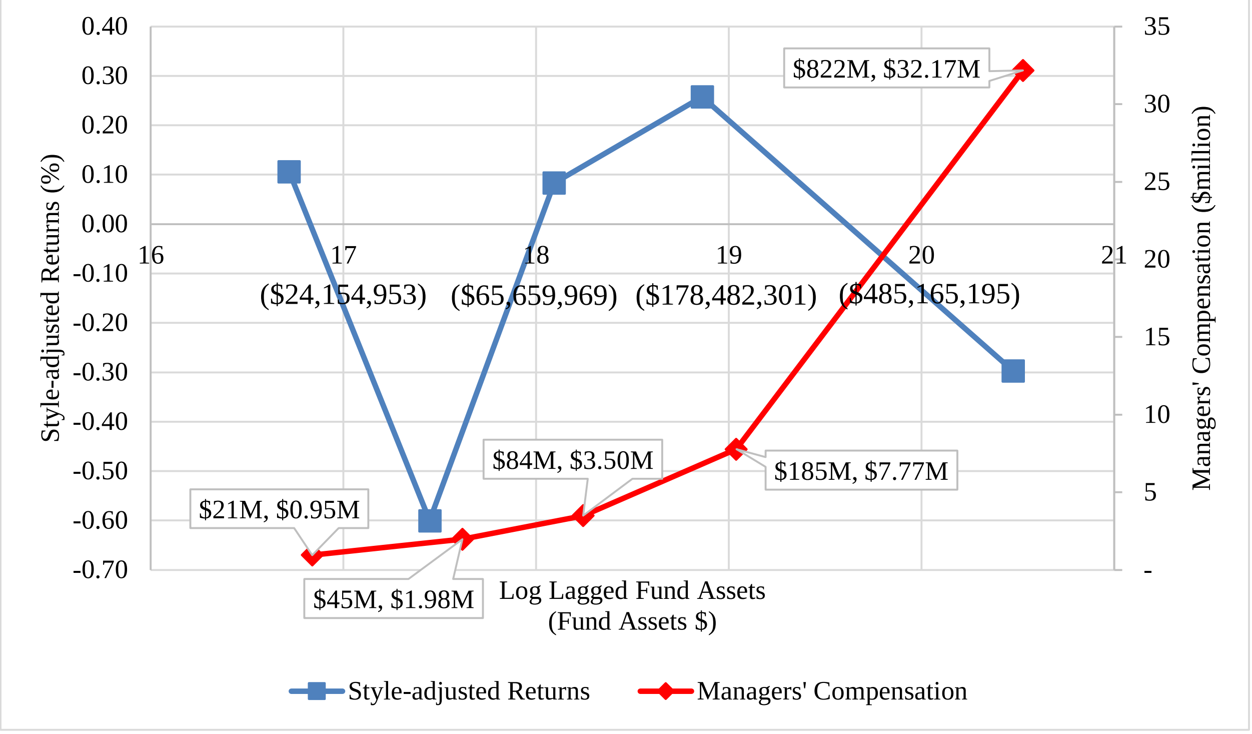

Table I Summary Statistics

Panel A shows the summary statistics of the entire sample. The rate of return is the after-fee raw return. Incentive fee is the percentage of fund profits that investors pay to the fund managers. Management fee is the percentage of fund assets that investors pay to the fund managers. High-water mark equals 1 if the high-water mark provision is used by a fund, and 0 otherwise. Open to public equals 1 if a fund is open to the public, and 0 otherwise. Leverage equals 1 when leverage is used by a fund, and 0 otherwise. Panel B shows the number of funds in total and for each style. The percentage is the number of funds in each style divided by the total number of funds.

Panel A. Summary Statistics

	Mean	Median	Min	Max	Std	Mode
Rate of Return (%)	1.9758	1.8776	-33.1698	42.1142	8.6620	
Fund Assets	242,992,048	79,395,000	10,000,000	13,000,000,000	564,492,483	
Capital Flows (%)	0.8684	-0.0272	-61.6394	125.5980	20.2653	
Minimum Investment	1,037,903	500,000	-	50,000,000	2,266,440	1,000,000
Incentive Fee (%)	18.9836	20	0	50	4.7485	20
Management Fee (%)	1.4542	1.5	0	7	0.5833	1
High-Water Mark	0.7335	1	0	1	0.4422	1
Redemption Frequency (days)	77.9824	30	1	1080	90.6838	30
Subscription Frequency (days)	36.0432	30	1	360	26.6252	30
Redemption Notice Period (days)	38.3324	30	0	365	28.6542	30
Lock-Up Period (months)	4.1217	0	0	90	7.0608	0
Open To Public	0.1588	0	0	1	0.3656	0
Leverage	0.6492	1	0	1	0.4773	1

Panel B. Number of Funds

	Defunct	Live	Total	Percentage
Convertible Arbitrage	89	34	123	4.80%
Emerging Markets	108	169	277	10.81%
Equity Market Neutral	119	53	172	6.71%
Event Driven	208	116	324	12.64%
Fixed Income Arbitrage	86	28	114	4.45%
Global Macro	89	60	149	5.81%
Long/Short Equity Hedge	588	437	1025	39.99%
Managed Futures	76	136	212	8.27%
Multi-Strategy	81	86	167	6.52%
	1444	1119	2563	100.00%

Table II Performance-Size Relationship

This table shows the pooled regression results of the performance-size relationship. The dependent variable is style-adjusted returns, which are the differences between fund quarterly returns and the average return of all funds in the same style category. The independent variable is the natural log of lagged fund assets. Following Petersen (2009), I use the clustering method to adjust standard errors of the coefficients. The standard errors are clustered by fund. The fund family assets are the total assets under management of all other funds in the same fund family. Model I tests for cubic relationship, Model II tests for quadratic relationship, and Model III tests for linear relationship. In all the regressions, style dummies and year dummies are included but not reported for simplicity. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

	I		II		III	
	Estimate	Std Err	Estimate	Std Err	Estimate	Std Err
Intercept	329.0242***	83.6415	5.6319	7.1870	0.1910	0.7743
Log Lagged Assets	-52.3735***	13.3506	-0.6851	0.7639	-0.1011***	0.0347
Square of Log Lagged Assets	2.7572***	0.7081	0.0157	0.0203		
Cubic of Log Lagged Assets	-0.0483***	0.0125				
Log Lagged Family Assets	-0.0088*	0.0046	-0.0084*	0.0046	-0.0085*	0.0046
Lagged Capital Flows	0.0015	0.0019	0.0013	0.0019	0.0012	0.0019
Incentive Fee (%)	0.0066	0.0102	0.0065	0.0103	0.0061	0.0102
Management Fee (%)	0.3076***	0.1048	0.2980***	0.1070	0.2995***	0.1063
High-water Mark	0.0047	0.1118	0.0057	0.1123	0.0031	0.1121
Log Minimum Investment	0.0654	0.0410	0.0602	0.0411	0.0624	0.0410
Redemption Frequency	0.0010**	0.0005	0.0010**	0.0005	0.0010**	0.0005
Subscription Frequency	-0.0013	0.0013	-0.0015	0.0013	-0.0015	0.0013
Lockup Periods	0.0110	0.0071	0.0103	0.0070	0.0103	0.0070
Redemption Notice Periods	0.0044**	0.0018	0.0045**	0.0018	0.0045**	0.0018
Lagged Fund Age	0.0012	0.0009	0.0011	0.0009	0.0012	0.0009
Open to Public	-0.1328	0.1267	-0.1427	0.1263	-0.1392	0.1264
Leverage	0.1576	0.0966	0.1627*	0.0966	0.1636*	0.0965
# of Obs	33084		33084		33084	
Adj. R^2	0.0016		0.0010		0.0010	

Table III Performance-Size Relationship for each Style

This table shows the regression results of the performance-size relationship for each style category. The dependent variable is style-adjusted returns. Control variables are the same as in Table II. Control variables, style dummies, and year dummies are included but not reported for simplicity. The standard errors of the coefficients are clustered by fund and are reported in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

	Intercept	Log Lagged Assets	Square of Log Lagged Assets	Cubic of Log Lagged Assets
Convertible Arbitrage	-199.8935	31.7587	-1.6765	0.0293
	(234.6573)	(36.6477)	(1.9001)	(.0327)
	-1.1891	0.0746	-0.0036	
	(31.5811)	(3.2245)	(.0851)	
	0.0753	-0.0601		
	(3.5801)	(.1298)		
Emerging Markets	1274.7143***	-200.1144***	10.4572***	-0.1819***
	(445.4898)	(71.4293)	(3.8055)	(.0674)
	89.8555**	-9.1212**	0.2312**	
	(38.7765)	(4.1536)	(.1109)	
	10.2921***	-0.5379***		
	(3.4824)	(.1775)		
Equity Market Neutral	-10.7919	1.3199	-0.0774	0.0015
	(218.6961)	(35.2584)	(1.8949)	(.0338)
	-0.9730	-0.2726	0.0084	
	(20.9225)	(2.2555)	(.0608)	
	-3.7828	0.0360		
	(2.9411)	(.105)		
Event Driven	206.3394	-32.7565	1.6931	-0.0290
	(164.6054)	(25.917)	(1.3562)	(.0236)
	7.4761	-1.2021	0.0324	
	(14.3383)	(1.4854)	(.0388)	
	-4.1030	0.0183		
	(1.3014)	(.0648)		

(continued)	Intercept	Log Lagged Assets	Square of Log Lagged Assets	Cubic of Log Lagged Assets
Fixed Income Arbitrage	273.3396	-43.7808	2.3060	-0.0405
	(525.0651)	(84.6083)	(4.5225)	(.0804)
	5.0443	-0.7682	0.0164	
	(33.1428)	(3.5147)	(.0932)	
	-0.7170	-0.1535		
	(3.4692)	(.1301)		
Global Macro	804.1910*	-129.5518*	6.8976*	-0.1221*
	(436.8914)	(69.7906)	(3.7025)	(.0653)
	-24.8698	2.4033	-0.0692	
	(36.8693)	(3.9019)	(.1037)	
	-0.3438	-0.2098		
	(3.2434)	(.1468)		
Long/Short Equity Hedge	331.0199**	-53.2975**	2.8506**	-0.0507**
	(142.0163)	(22.676)	(1.2024)	(.0212)
	0.8601	-0.0556	-0.0002	
	(11.7363)	(1.2605)	(.0339)	
	0.9195	-0.0621		
	(1.3594)	(.0571)		
Managed Futures	285.4944	-45.4425	2.3684	-0.0413
	(256.2848)	(40.5836)	(2.1337)	(.0372)
	3.1230	-0.5866	0.0045	
	(21.5513)	(2.3057)	(.0618)	
	1.5421	-0.4184***		
	(2.3478)	(.1144)		
Multi-Strategy	110.0423	-18.8571	1.0445	-0.0194
	(212.4727)	(33.0089)	(1.7028)	(.0292)
	-24.6802	2.4176	-0.0708	
	(22.631)	(2.3858)	(.0624)	
	0.2866	-0.2536*		
	(2.411)	(.1381)		

Table IV Compensation-Size Relationship

Panel A shows the regression results of the compensation-size relationship for each style. The dependent variable is managers' total compensation. The total compensation and fund assets are in millions of dollars. I include fund characteristics as control variables (not reported for simplicity). In Panel B, I regress the incentive fee on fund assets. The incentive fee and fund assets are in millions of dollars. In all regressions, style dummies and year dummies are included but not reported. The standard errors of the coefficients are clustered by fund and are reported in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

Panel A.

	Intercept	Lagged Fund Assets	Square of Lagged Fund Assets
Convertible Arbitrage	2.9351	0.0573***	5.90E-07
	(9.9996)	(.0133)	(.0000)
	1.8583	0.0599***	
	(9.3064)	(.0048)	
Emerging Markets	-2.4384	0.0586***	-7.29E-06
	(4.3165)	(.0138)	(.0000)
	-2.9089	0.0449***	
	(4.236)	(.0074)	
Equity Market Neutral	-4.3735***	0.0253***	-4.17E-06***
	(1.4455)	(.0025)	(.0000)
	-3.6657***	0.0177***	
	(1.3761)	(.0009)	
Event Driven	-14.1812**	0.0328***	2.11E-06***
	(6.5578)	(.0041)	(.0000)
	-11.1468	0.0484***	
	(7.7798)	(.0045)	
Fixed Income Arbitrage	-4.4694	0.0494***	-1.58E-05**
	(8.2558)	(.0064)	(.0000)
	-1.5928	0.0270***	
	(8.0817)	(.0048)	
Global Macro	-10.6258	0.0172	1.09E-05**
	(8.7964)	(.0113)	(.0000)
	-21.5685*	0.0476***	
	(11.0481)	(.0109)	
Long/Short Equity Hedge	-7.4347***	0.0502***	-6.62E-06***
	(2.2325)	(.0049)	(.0000)
	-8.7750***	0.0260***	
	(2.8367)	(.0034)	
Managed Futures	-23.0949***	0.0716***	-6.02E-06***
	(8.1905)	(.0124)	(.0000)
	-23.0326***	0.0420***	
	(8.6064)	(.0100)	
Multi-Strategy	-2.3060	0.0349***	-1.27E-06
	(5.3353)	(.0126)	(.0000)
	-3.5547	0.0250***	
	(5.6516)	(.0011)	

Panel B.

	I		II	
	Estimate	Std Err	Estimate	Std Err
Intercept	-6.1522**	2.6381	-6.1764**	2.5841
Lagged Fund Assets ($ million)	0.0196***	0.0054	0.0204***	0.0036
Square of Lagged Fund Assets	0.0000	0.0000		
Incentive Fee (%)	0.4849***	0.0779	0.4872***	0.0789
Management Fee (%)	-0.4425	0.8838	-0.4608	0.9125
High-water Mark	-3.2738***	0.9897	-3.2890***	0.9697
Minimum Investment	0.5910	0.4248	0.5793	0.4240
Fund Family Assets	0.0007	0.0006	0.0007	0.0006
Redemption Frequency	0.0061*	0.0031	0.0061*	0.0033
Subscription Frequency	-0.0157	0.0099	-0.0158	0.0100
Lock-up Period	0.0631	0.0448	0.0638	0.0467
Redemption Notice Period	0.0271	0.0240	0.0268	0.0239
Fund Age	-0.0035	0.0063	-0.0039	0.0063
Open to Public	0.3583	0.7444	0.3563	0.7394
Leverage	0.4548	0.5686	0.4352	0.6188
# of Obs	6075		6075	
Adj. R^2	0.3222		0.3221	

Table V Flow-Performance Relationship

This table shows the regression results of the flow-performance relationship. The dependent variable is quarterly capital flows. In Panel A, I regress capital flows on lagged fund performance. Panel B presents the results of the piecewise regressions for the flow-performance relationship. Following Sirri and Tufano (1998), I rank fund quarterly performance from 0 to 1 and divide funds into five groups. The bottom quintile is defined as Performance Rank 1 = min (0.2, performance rank), and the second quintile is defined as Performance Rank 2 = min (0.2, performance rank – Performance Rank 1), and so on. The standard errors of the coefficients are clustered by fund. Style dummies and year dummies are included but not reported for simplicity. In Panel C, I rank funds within the same style into quintiles every quarter based on their lagged performance. Performance rank 1 is the worst performance group and performance rank 5 is the best performance group. I then calculate the average capital flow for each group and examine whether the average flow is significant using a *t*-test. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

Panel A.

	Estimate	Std Err	Estimate	Std Err
Intercept	12.6531***	1.8863	7.5209***	1.9707
Fund Performance, t-1	0.3383***	0.0183	0.3004***	0.0187
Fund Performance, t-2			0.2048***	0.0162
Fund Performance, t-3			0.1364***	0.0154
Std Dev of Lagged Fund Performance	-0.2872***	0.0376	-0.1667***	0.0275
Lagged flow	0.3019***	0.0091	0.2637***	0.0096
Log of Lagged Fund Assets	-1.2478***	0.0879	-0.9209***	0.0897
Incentive Fee (%)	0.0270	0.0249	0.0122	0.0264
Management Fee (%)	0.6648***	0.2050	0.3434	0.2178
High-water Mark	1.0073***	0.2634	0.8466***	0.2709
Log of Minimum Investment	0.4710***	0.1011	0.4766***	0.1069
Redemption Frequency	0.0009	0.0011	0.0016	0.0011
Subscription Frequency	-0.0059	0.0037	-0.0014	0.0034
Lockup Periods	0.0078	0.0140	0.0070	0.0149
Redemption Notice Periods	0.0103**	0.0048	0.0086*	0.0051
Open to Public	0.5800*	0.3205	0.5179	0.3343
Leverage	0.3631	0.2407	0.4895*	0.2521
# of Obs	33084		28211	
Adj. R^2	0.1421		0.1235	

Panel B. Piecewise Regression

	Estimate	Std Err	Estimate	Std Err
Intercept	7.3470***	1.8594	-1.4106	2.0516
Fund Performance, t-1				
Performance Rank 1	16.1474***	3.2433	11.9367***	3.4221
Performance Rank 2	12.0311***	2.4435	12.8922***	2.5477
Performance Rank 3	6.4311***	2.3680	3.0960	2.4357
Performance Rank 4	12.2689***	2.5132	10.7991***	2.5554
Performance Rank 5	13.5327***	3.4049	12.5908***	3.6857
Fund Performance, t-2				
Performance Rank 1			8.3471**	3.5026
Performance Rank 2			8.4007***	2.6187
Performance Rank 3			6.3388***	2.3835
Performance Rank 4			5.2120**	2.4909
Performance Rank 5			4.7829	3.3245
Fund Performance, t-3				
Performance Rank 1			1.7972	3.5218
Performance Rank 2			5.8755**	2.5402
Performance Rank 3			2.7097	2.4031
Performance Rank 4			3.4483	2.4378
Performance Rank 5			8.3779***	3.0462
Std Dev of Lagged Fund Performance	-0.2574***	0.0379	-0.1163***	0.0374
Lagged flow	0.2972***	0.0091	0.2484***	0.0095
Log of Lagged Fund Assets	-1.2948***	0.0862	-1.0247***	0.0892
Incentive Fee (%)	0.0372	0.0248	0.0324	0.0272
Management Fee (%)	0.5948***	0.2036	0.2159	0.2195
High-water Mark	0.9877***	0.2568	0.8344***	0.2673
Log of Minimum Investment	0.4553***	0.0997	0.4478***	0.1065
Redemption Frequency	0.0003	0.0011	0.0006	0.0010
Subscription Frequency	-0.0059	0.0037	-0.0015	0.0035
Lockup Periods	0.0046	0.0138	0.0025	0.0152
Redemption Notice Periods	0.0083*	0.0048	0.0044	0.0052
Open to Public	0.5965*	0.3165	0.5441	0.3373
Leverage	0.3702	0.2341	0.5063**	0.2478
# of Obs	33084		28211	
Adj. R^2	0.1529		0.1401	

Panel C.

Performance Rank	1	2	3	4	5
Capital Flow	-4.3602***	-1.2063***	1.0220***	2.9810***	5.8111***
t	-19.4831	-5.1818	4.2884	12.2911	21.2636

Table VI Funds Closure/Reopen Decisions

I rank funds within the same style category into percentiles based on their performance and their assets under management every quarter. Panel A shows the average percentile ranking of fund performance/fund assets in the quarter of closure/reopening. In Panel B, I first calculate the average percentile ranking over the one-year time period after the closure/reopening for each individual fund. Then I calculate the summary statistics of the average ranking for each style category. In both panels, I compare the average percentile ranking of fund performance and fund size to the 50th percentile using a *t*-test. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

Panel A. Percentile Ranking in the Quarter of Closure/Reopening

	Closure Quarter					
	Performance Rank			Size Rank		
	Mean	Median	Std Dev	Mean	Median	Std Dev
Emerging Markets	56.39	53.66	31.68	61.39	70.84	33.32
Global Macro	75.01***	77.36	18.24	78.13***	76.6	16.05
Long/Short Equity Hedge	52.05	62.53	32.21	72.20***	78.04	22.89
Managed Futures	59.08	63.1	19.38	63.96	75.95	30.62
Multi-Strategy	29.47	29.47	7.28	65.7	65.7	5.00

	Reopening Quarter					
	Performance Rank			Size Rank		
	Mean	Median	Std Dev	Mean	Median	Std Dev
Emerging Markets	27.33*	18.53	28.08	44.85	46.61	29.33
Global Macro	58.29	63.04	31.7	72.80*	90.38	33.84
Long/Short Equity Hedge	60.48*	61.63	23.21	55.83	60.66	29.57
Managed Futures	68.67	63.22	13.38	85.05***	85.05	5.75
Multi-Strategy	54.57	54.57	49.62	83.77	83.77	22.96

Panel B. Average Percentile Ranking One Year after Closure/Reopening

	One Year after Closure					
	Performance Rank			Size Rank		
	Mean	Median	Std Dev	Mean	Median	Std Dev
Emerging Markets	49.91	46.16	20.08	60.93	65.71	32.45
Global Macro	57.17	62.12	17	79.20****	76.78	13.85
Long/Short Equity Hedge	46.43	45.03	13.98	74.80***	78.99	20.92
Managed Futures	48.31	50.23	11.78	63.67	77.7	30.15
Multi-Strategy	46.93	46.93	23.2	69.91	69.91	7.76

	One Year after Reopening					
	Performance Rank			Size Rank		
	Mean	Median	Std Dev	Mean	Median	Std Dev
Emerging Markets	46.85	41.87	15.05	46.75	56.55	29.13
Global Macro	59.86*	55.9	14.3	82.37***	91.34	21.32
Long/Short Equity Hedge	62.47**	60.29	16.98	60.23	54.66	26.09
Managed Futures	53.82	58.39	10.76	70.13	84.7	34.25
Multi-Strategy	49.53	49.53	3.58	80.15	80.15	28.08

Table VII Fund Families

This table presents the results of the analysis at the fund-family level. Funds belong to the same family if they share the same management firm. In Panel A, I rank fund families into five groups based on their lagged size every quarter. Family size is the sum of assets of funds under management. Then I calculate average family performance over time. Family performance is the average of after-fee raw returns of funds under management, both equal-weighted and asset-weighted. In Panel B, I regress family performance on family size. Control variables include number of funds under management and number of styles used by the family. Panel C shows the performance-size regression results for families with at least two funds under management. In Panels B and C, year dummies are included but, for simplicity, are not reported. The standard errors of the coefficients are clustered by fund family and are reported in parentheses. Panel D provides a summary of the compensation-size relationship. Family total compensation is the sum of fees of funds under management. Family management fee and family incentive fee are defined similarly. Family average compensation is family total compensation divided by the number of funds under management. Family average management fee and family average incentive fee are calculated in a similar way. I rank fund families into five groups based on their lagged size every year. Then I calculate average compensation over time for each group. All numbers in Panel D are in millions of dollars. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

Panel A.

	All Fund Families		Fund Families with Multiple Funds	
Family Size Group	Equal-weighted Family Performance	Asset-weighted Family Performance	Equal-weighted Family Performance	Asset-weighted Family Performance
1 (smallest)	2.4008	2.4026	2.5705	2.5670
2	1.7771	1.7771	2.5115	2.5545
3	2.2256	2.2536	2.2272	2.2781
4	2.1743	2.1926	1.7536	1.7805
5 (largest)	1.7075	1.7340	1.7117	1.7395
Diff (1-5)	0.6933	0.6686	0.8588	0.8275
t	3.78	3.63	3.57	3.42
p-value	0.0002	0.0003	0.0004	0.0006

Panel B. Family Performance-Size Regression: All Fund Families

	Equal-weighted			Asset-weighted		
	I	II	III	IV	V	VI
Intercept	266.6501***	19.6029**	7.3444***	265.5689***	19.0183**	7.3057***
	(86.5811)	(7.8799)	(.8405)	(87.8485)	(8.0315)	(.8457)
Log Lagged Family Assets	-40.4836***	-1.4338*	-0.1283***	-40.3507***	-1.3794	-0.1321***
	(13.5726)	(.8267)	(.0453)	(13.7813)	(.8438)	(.0451)
Square of Log Lagged Family Assets	2.0824***	0.0346		2.0767***	0.0331	
	(.7064)	(.0216)		(.7179)	(.0221)	
Cubic of Log Lagged Family Assets	-0.0356***			-0.0356***		
	(.0122)			(.0124)		
Number of Funds	-0.0739	-0.0667	-0.0584	-0.0591	-0.0519	-0.044
	(.0602)	(.0595)	(.0599)	(.0632)	(.0625)	(.0628)
Number of Styles	0.1671	0.1706	0.1794	0.2318*	0.2353*	0.2438*
	(.1255)	(.1255)	(.1266)	(.1371)	(.1373)	(.1386)
# of Obs	21470	21470	21470	21470	21470	21470
Adj. R^2	0.0905	0.0902	0.0902	0.0886	0.0883	0.0882

Panel C. Family Performance-Size Regression: Fund Families with Multiple Funds

	Equal-weighted			Asset-weighted		
	I	II	III	IV	V	VI
Intercept	123.4258	24.1143**	9.4889***	118.8848	23.2990**	9.5030***
	(104.2077)	(10.1078)	(1.1395)	(107.3019)	(10.4005)	(1.1535)
Log Lagged Family Assets	-17.2756	-1.7850*	-0.2563***	-16.6157	-1.7062	-0.2642***
	(16.1583)	(1.0407)	(.0589)	(16.6485)	(1.0732)	(.0587)
Square of Log Lagged Family Assets	0.8415	0.0397		0.8092	0.0375	
	(.8322)	(.0267)		(.858)	(.0276)	
Cubic of Log Lagged Family Assets	-0.0138			-0.0133		
	(.0142)			(.0147)		
Number of Funds	-0.0863	-0.0861	-0.087	-0.0724	-0.0722	-0.0731
	(.0647)	(.0645)	(.0656)	(.0676)	(.0673)	(.0684)
Number of Styles	0.1887	0.1911	0.1969	0.2532*	0.2555*	0.2610*
	(.1289)	(.1292)	(.1308)	(.1409)	(.1413)	(.1428)
# of Obs	10971	10971	10971	10971	10971	10971
Adj. R^2	0.0923	0.0924	0.0923	0.088	0.088	0.088

Panel D. Family Compensation

All Fund Families

Family Size Group	Total Fee	Management Fee	Incentive Fee	Average Total Fee	Average Management Fee	Average Incentive Fee
1 (smallest)	1.2123	0.3984	0.8138	1.1959	0.3938	0.8022
2	2.6857	0.9096	1.7761	2.4246	0.8344	1.5902
3	5.5883	1.8177	3.7706	4.6675	1.5391	3.1284
4	13.3009	4.5450	8.7559	9.7611	3.3318	6.4292
5 (largest)	57.1539	23.6937	33.4602	31.3011	12.5422	18.7589

Fund Families with Multiple Funds

Family Size Group	Total Fee	Management Fee	Incentive Fee	Average Total Fee	Average Management Fee	Average Incentive Fee
1 (smallest)	2.0651	0.6240	1.4411	1.7337	0.5449	1.1888
2	5.2156	1.5818	3.6339	3.7087	1.1495	2.5592
3	10.1101	3.5393	6.5708	6.4986	2.2788	4.2198
4	18.8916	7.0561	11.8355	10.4701	3.8901	6.5800
5 (largest)	77.6213	33.4228	44.1985	34.9281	14.8292	20.0989

Table VIII Flagship Funds

This table shows the results of the analysis of flagship funds. A flagship fund is the first fund established by a fund family. Panel A presents the regression results of the performance-size relationship for all flagship funds. If a fund family established multiple flagship funds at the same time, I combine them: For fund performance, I use both equal-weighted and asset-weighted average of after-fee raw returns; for fund size, I use the combined fund assets; for fund characteristics, I use the equal-weighted average as the flagship funds' characteristics; and, for capital flows, I use the asset-weighted average flow. Panel B exhibits the regression results for flagship funds of fund families with multiple funds under management. In Panels A and B, control variables and year dummies are included but, for simplicity, are not reported. Standard errors are clustered by fund and reported in parentheses. Panel C shows the average performance ranking of flagship funds for each style during the one-year time period before and after the first non-flagship funds were established. Panel D shows the average size ranking of flagship funds for each style during the one-year time period before and after the first non-flagship funds were established. Panel E presents the average performance ranking and size ranking for each style over the one-year time period after flagship funds were closed to new investment. In Panels C, D, and E, I compare the average ranking to the 50th percentile using a *t*-test. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

Panel A. Performance-Size: All Flagship Funds

	Equal-weighted Performance			Asset-weighted Performance		
	I	II	III	IV	V	VI
Intercept	398.0858***	31.6778***	5.4895***	399.1429***	31.3035***	5.4884***
	(127.4842)	(10.4021)	(1.1094)	(127.5648)	(10.4126)	(1.1111)
Log Lagged Flagship Fund Assets	-61.7924***	-2.9802***	-0.1582***	-61.9785***	-2.9366***	-0.1548***
	(20.3903)	(1.1028)	(.0498)	(20.4037)	(1.1042)	(.0502)
Square of Log Lagged Flagship Fund Assets	3.2086***	0.0757**		3.2198***	0.0747**	
	(1.0827)	(.0294)		(1.0835)	(.0294)	
Cubic of Log Lagged Flagship Fund Assets	-0.0554***			-0.0556***		
	(.0191)			(.0191)		
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs	19151	19151	19151	19151	19151	19151
Adj. R^2	0.0963	0.0959	0.0957	0.0960	0.0957	0.0955

Panel B. Flagship Funds of Fund Families with Multiple Funds

	Equal-weighted Performance			Asset-weighted Performance		
	I	II	III	IV	V	VI
Intercept	71.8807	21.9839	7.3943***	73.7920	21.7878	7.4507***
	(175.2933)	(14.5813)	(1.5944)	(175.3529)	(14.5533)	(1.5992)
Log Lagged Flagship Fund Assets	-9.7596	-1.8068	-0.2470***	-10.0665	-1.7779	-0.2451***
	(27.8674)	(1.5519)	(.0686)	(27.8777)	(1.5499)	(.0688)
Square of Log Lagged Flagship Fund Assets	0.4623	0.0415		0.4793	0.0408	
	(1.4715)	(.0412)		(1.4721)	(.0411)	
Cubic of Log Lagged Flagship Fund Assets	-0.0074			-0.0077		
	(.0258)			(.0258)		
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes
# of Obs	8226	8226	8226	8226	8226	8226
Adj. R^2	0.0926	0.0927	0.0927	0.0921	0.0923	0.0923

Panel C. Performance Rankings

	Before 2nd Fund			After 2nd Fund		
	Mean	Median	Std	Mean	Median	Std
Emerging Markets	60.28**	61.81	15.85	49.75	44.45	19.18
Global Macro	61.59*	66.84	15.71	50.14	49.31	18.43
Long/Short Equity Hedge	54.71	56.31	21.99	51.46	54.12	21.33
Managed Futures	80.14***	76.98	10.17	54.60	58.86	13.68
Multi-Strategy	52.17	55.96	25.54	52.16	51.59	24.68

Panel D. Size Rankings

	Before 2nd Fund			After 2nd Fund		
	Mean	Median	Std	Mean	Median	Std
Emerging Markets	59.79	64.15	23.96	62.00**	65.45	23.85
Global Macro	66.72	73.37	23.47	51.43	54.55	26.04
Long/Short Equity Hedge	57.47	61.17	29.65	53.23	53.50	29.50
Managed Futures	57.20	60.22	29.10	63.98	65.43	25.19
Multi-Strategy	53.73	50.49	29.99	51.98	50.00	25.64

Panel E. After Closure to New Investment

	Performance Ranking			Size Ranking		
	Mean	Median	Std	Mean	Median	Std
Emerging Markets	45.44	42.30	13.73	57.70	58.95	31.54
Global Macro	61.21	70.67	16.75	82.65***	80.69	13.51
Long/Short Equity Hedge	44.91	45.01	14.48	72.37***	77.60	23.54
Managed Futures	52.43	49.35	12.18	70.15**	77.56	25.97
Multi-Strategy	41.77	41.77	13.30	69.81	69.81	6.66