The Role of Remuneration Structures in Hedge Fund Performance

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This version: 30th August 2012

Abstract

We rationalize the persistent performance of hedge funds with a simple model that takes into account the peculiarities of this industry. We show how incentive fees and the lack of benchmarking opportunities combine with the income-maximizing behavior of managers to effectively align the interests of investors and managers. Through management fee increases, hedge funds manipulate their attractiveness toward investors and control their size. Therefore, performance-diluting flows do not occur and performance persists. The predictions of our model are consistent with the literature and are confirmed by our analysis of a unique dataset of management fee changes. Our findings contribute to the regulatory debate by demonstrating that performance-based remunerations are beneficial to both investors and managers.

Keywords: Hedge Fund, Fees, Incentives, Remuneration, Persistence, Performance, Regulation

JEL classification: G23, G29

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1 Introduction

Despite a slowdown in growth and a relative cutback in performance in the recent years, hedge funds have been outperforming mutual funds for most of the past decades. Prior literature abounds of possible explanations for this lasting performance. Most of them are linked to the advanced risk exposures taken by hedge fund managers, while a smaller proportion finds an explanation in funds' characteristics and managerial skill. Interestingly though, the mutual funds industry is able to retain its most skilled managers; see Deuskar, Pollet, Wang and Zheng (2011a). Therefore, *a priori*, skill alone does not explain why hedge fund managers outperform their mutual fund peers. So, there must be some inherent differences between these two industries that play a role in the performance differential.

Berk and Green (2004) explain the lack of performance persistence in mutual funds. Mutual fund managers, because of their remuneration structure, have an incentive to let their fund grow as much as possible. Contrarily, in the hedge fund industry we observe a tendency to limit the size of the funds by refusing new investments and even forcing investors to redeem. Clearly, hedge fund managers' incentives must be different from the ones of mutual fund managers. Moreover, hedge fund performance persists for relatively long periods.

In this context, this paper proposes and tests a simple model that explains hedge fund outperformance. The model positions performance, fund size, and managers' remuneration in a global framework. We show how the income-maximizing behavior of hedge fund managers, their specific remuneration schemes,, along with the absence of costless investable benchmarks are sufficient to explain hedge fund managers' outperformance. We first illustrate that the model of Berk and Green (2004) is not consistent with the empirical evidence observed in the hedge fund industry. For this reason, we adapt it by assuming that hedge fund managers cannot invest in a costless passive benchmark. This hypothesis is consistent with several well known facts about hedge funds. Using this modified model, we show how the specific structure of hedge fund remuneration schemes gives incentives to the managers to limit the size of their fund to maximize their remuneration. The implications of our model are consistent with what is observed in hedge fund data, namely investment restrictions, important investor flows, performance persistence, and highly rewarded managers along with a limited abnormal performance. We further argue that managers can employ their discretion over remuneration schemes to set the fees at a level that allows them to maximize their income. Importantly, managers do not engage in rent-extracting practices, but they control the size of their fund by manipulating their management fees. As a consequence, the size of the fund converges toward the size that optimizes the performance and, indirectly, the remuneration of the manager.

We verify the validity of our model by testing its implication on a unique sample of hedge fund management fee increases. The empirical findings support our model. We find that managers who revise their management fees successfully affect the performance for new investors, and flows, in the optimal direction. Moreover, we show that fee revisions effectively protect the performance for the existing investors, leading to outperformance and persistent returns. Altogether, we illustrate that, within the hedge fund industry, the remuneration structure plays a central role in explaining the persistence of returns.

This paper contributes to two strands of research. First, by pinpointing the mechanisms behind the persistent outperformance of hedge funds, we add to the literature on the determinants of hedge fund performance. Contrarily to the majority of the existing studies, we do not focus on risk exposures or manager skills, but on fund characteristics. We provide support to the idea that hedge fund outperformance and persistence are possible because of the limited size of these funds.

Second, we complement the literature on remuneration in the money management industry. The peculiar remuneration schemes of hedge funds have been the subject of many studies and, consistently with financial theory, these papers generally conclude that performance-related remunerations are associated with higher returns; see Ackermann, McEnally and Ravenscraft (1999), Edwards and Caglayan (2001), Goetzmann, Ingersoll and Ross (2003) and Agarwal, Daniel and Naik (2009). Furthermore, several recent studies underline the formerly unnoticed dynamic nature of hedge fund remuneration contracts; see Agarwal and Ray (2011), Deuskar, Wang, Wu and Nguyen (2011b), and Ramadorai and Streatfield (2011). On the one hand, our paper helps understanding the mechanisms that transform incentive fee into persistence and outperformance. On the other hand, we provide a theoretical framework to rationalize the recent advances on fee dynamics. With respect to that, we show that the behavior of managers, even if self-interested, has positive consequences for investors.

Our paper also contributes to the current regulatory debate. After the 2008 turmoil the perception of the remuneration schemes of hedge funds changed drastically. Politicians and public opinion blamed the performance fees to be a source of excessive risk taking. As a consequence, regulators put a specific emphasis on remuneration schemes in the recent revisions of financial regulations. The Dodd Frank Act for instance states: "*Federal regulators shall jointly prescribe regulations or guidelines that prohibit any types of incentive-based payment arrangement, or any feature of any such arrangement, that the regulators determine encourages inappropriate risks (…).*"[1] We provide evidence that the remuneration structure commonly used by hedge funds effectively aligns the interests of investors and managers. The revised regulation thus threatens the outperformance of hedge funds and investors' returns.

Our work contrasts with the ones of Agarwal and Ray (2011) and Deuskar et al. (2011b) in that these authors focus on fund level determinants of fee changes. On the contrary, we propose a theoretical framework which explains management fee changes with the single assumption that managers try to maximize their remuneration. We show that investors have a rational reaction toward these changes in that they vote with their feet and allocate their money to the

[1] See the title IX, sec. 956 (b) of the Dodd-Frank Wall Street Reform and Consumer Protection Act, http://www.sec.gov/about/laws/wallstreetreform-cpa.pdf. Also see the chapter III of the Directive on Alternative Investment Fund Managers (AIFM), http://register.consilium.europa.eu/pdf/en/10/pe00/pe00060-re01.en10.pdf.

managers who fulfill their investment constraint. Similarly to these studies, our results are consistent with a self-interested behavior of both managers and investors. But, on the opposite, we show that this has a positive impact on the hedge fund industry. Moreover, we provide an alternative and more straightforward explanation to hedge fund performance persistence than the one proposed by Glode and Green (2011).

The remaining of the paper is organized as follows. In Section 2 we develop our theoretical framework. Section 3 introduces our testable propositions. Section 4 discusses the data. Section 5 details our computations and findings. Section 6 concludes.

2 Link between Performance, Size, Flows, and Remuneration

2.1 Evidence in the Mutual Fund and Hedge Fund Industry

Berk and Green (2004) propose a model of active management that explains why investors keep investing into mutual funds, allowing fund managers to pocket consequent fees, even if these funds deliver no abnormal performance; see e.g. Grinblatt and Titman (1989) or Malkiel (1995). Under a limited set of assumptions, the model predicts that managers will let their funds grow as much as possible. This results in a lack of performance persistence and, at equilibrium, zero net outperformance.

The model is widely accepted in the mutual funds literature, even if challenged by empirical evidence; see e.g. Fama and French (2010). Its predictions are, however, clearly inconsistent with empirical findings on hedge funds. While it has been documented that outperforming hedge funds attract flows and that these flows subsequently deteriorate performance, hedge funds keep outperforming persistently; see e.g. Fung, Hsieh, Naik and Ramadorai (2008). Indeed, in the hedge fund industry, there is evidence of performance persistence over relatively long periods; see e.g. Edwards and Caglayan (2001), Kosowski, Naik and Teo (2007), or Jagannathan, Malakhov and Novikov (2010). Moreover, contrarily to the mutual fund industry, hedge fund managers refuse to let their funds grow beyond given thresholds by closing them to new investments or by redeeming investors' money.[2] Thus, the model of Berk and Green (2004) does not fully capture the specificities of the hedge fund industry. An intuitive reason might be the difference in fee structures between hedge funds and mutual funds. The model can, however, be extended to accommodate incentive fees and its predictions remain unchanged. Thus, the difference in fee structures alone cannot explain the peculiarities of the hedge fund industry underlined above. Glode and Green (2011) propose an explanation of hedge funds' persistent outperformance based on information spillovers. They assume that insider investors become informed of the proprietary strategy of the hedge fund they invest in. Managers fear that investors could divulgate or replicate the strategy, thereby hurting the fund's profitability. For this reason, managers reward investors at a higher than minimal rate, so that investors have no incentive to disclose the proprietary strategy. While this proposition might be true for some funds in some investment strategies, we think it is a rather ambitious assumption in an industry where secrecy, or at least opacity, is the rule. Moreover, this theory does not explain why hedge fund managers restrain the size of their funds. In the present paper, we provide a straightforward explanation to persistent outperformance that directly derives from the combination of two specificities of hedge funds with respect to mutual funds: the performance-related remuneration scheme and the absence of a passive costless benchmark investment. While the first specificity is well known, the second deserves some rationalization.

Mutual funds are generally benchmarked against a market index. The managers' objective is to beat the benchmark, regardless of the sign or level of its return. Hedge fund managers face a different challenge: the typical objective of a hedge fund is to deliver an absolute return, regardless of the market conditions; see Fung and Hsieh (1997) and Harri and Brorsen (2004). This means being uncorrelated, and a passive investment in a benchmark is thus inconsistent

[2] See for instance The Financial Times, September 20th, 2011. Jones, S., Brevan Howard to return $2bn to investors. http://www.ft.com/intl/cms/s/0/c8f7f736-e373-11e0-8f47-00144feabdc0.html#axzz1Z8NyNDbM

with the objective of hedge funds; see Brown, Goetzmann and Ibbotson (1999), Agarwal and Naik (2004), or Lhabitant (2006, p. 25). This does not mean that hedge funds do not invest *at all* in market indices, but, when they do, they do it *actively*. Also, given the high fees they pay and the low limitations fund managers face in their investment strategy, investors have an incentive to continuously monitor the funds they are invested in. If managers use some kind of passive benchmark or if they deviate too importantly from their contractually agreed investment style, investors tend to terminate the contract; see Baquero and Verbeek (2009) or Lhabitant (2006, p. 576). The monitoring of the investors also prevents managers from keeping the assets of the fund in cash, which may be considered as a benchmark. Moreover, liquidity restrictions such as lockups, redemption frequency, and notice periods precisely exist because hedge funds are invested in illiquid strategies that cannot be unloaded instantaneously. Investments in a passive benchmark would make such restrictions superfluous; see Agarwal, Daniel and Naik (2004). Additionally, as underlined in Berk and Green (2004, p. 1276) *"if managers can expand the fund by investing a portion of it in the passive benchmark (…) efficient outcomes can be achieved with a proportional fee that does not change over time (…)."* Therefore, in the presence of a passive benchmark, changes of fees would be unnecessary, but they are actually numerous among hedge funds, thereby further consolidating our assumption; see Deuskar et al. (2011b). Finally, if hedge funds managers would be using a passive benchmark, they could simply invest any additional inflows into it to avoid hurting the return of their strategy.[3] Instead, we observe that managers close their funds to new investment or even force investors to redeem; see Goetzmann et al. (2003).

[3] These passive benchmarks do not only encompass traditional indices, but also the liquid hedge fund trackers offered by several investment banks.

2.2 Mutual Fund-Like Remuneration in the Absence of a Costless Investable Benchmark

The literature shows that hedge funds are facing decreasing return to scale, so that the performance-size relationship is concave; see e.g. Getmansky (2012). Managers exploit investment opportunities that are finite. The more assets they have under management, the more they have to spread their skills among these assets, and the higher the investment costs they face. Managers differ in their ability to generate returns and in the strategy they implement. As such, the funds are imperfect substitutes to each other and they compete monopolistically. In this context, we first consider a hedge fund manager who is solely remunerated with a percentage of the assets under management (mutual fund-like remuneration). Formally, the remuneration of this manager is:

(1) $Remun_t^{MF} = q_t mf$,

where q_t stands for the Assets Under Management (hereafter AUM) of the fund, mf the management fee, and the superscript "MF" indicates that the remuneration comes solely from the management fee. Figure 1 illustrates.

[Insert Figure 1 about here]

The dashed thin line represents the concave relation between performance and AUM as pinpointed by Getmansky (2012). The performance is represented by the monetary payoff for investors, i.e. the product of return and AUM. The shape of the curve is consistent with the fact that the entire portfolio is invested in the costly investment strategy. If a costless passive benchmark was at disposal, the curve would be skewed to the right. As illustrated by the negative returns on the left hand side of the graph, funds are facing fixed costs that prevent them from realizing positive returns before a break-even size is reached. The strategy exploited has increasing investment costs, but the performance at first increases because the fixed costs are spread among more assets. Eventually a maximum is reached and the performance starts decreasing until it reaches zero, after fees and costs. As illustrated by the dashed bold line, the remuneration of the managers is directly proportional to the level of AUM, so that they have an incentive to increase the size of their fund as much as possible regardless of the performance generated. Investors, who provide their money competitively among existing funds, invest into funds as long as their net performance is positive. If we express this condition in monetary, rather than relative terms, this means that investors provide funds to the managers as long as the net expected payoff is positive. Formally:

(2) $TP_{t+1}^{MF} = q_t R_{t+1} - C(q_t) - q_t mf > 0$,

where TP_{t+1}^{MF} is the total payoff, R_{t+1} the gross return of the strategy, and $C(q_t)$ the investment costs faced by the manager.

Thus, at equilibrium, managers maximize their remuneration and the funds do not provide investors with any outperformance. The equilibrium is reached when:[4]

(3) $\frac{C\left(q_t^{*MF}\right)}{q_t^{*MF}} = \phi_t - mf$,

where q_t^{*MF} is the optimal AUM of the fund, and ϕ_t is the expected gross return. At this equilibrium, the average cost of the strategy is equal to the gross return of the strategy netted of management fees.

2.3 Hedge Fund-Like Remuneration in the Absence of a Costless Investable Benchmark

Let us now consider the typical hedge fund which applies a management fee and a performance fee. In this case, the remuneration of the manager is:

(4) $Remun_t^{HF} = \left(q_t \phi_t - C(q_t) - q_t mf\right) pf + q_t mf$,

where pf is the performance fee and the superscript "HF" indicates that the remuneration has a fixed and a variable component (hedge fund-like). The situation is illustrated by the continuous lines in Figure 1.

[4] For a formal proof of the model, please refer to Appendix A.

The relationship between net performance and size is almost the same except that a slight kink appears when the line goes above zero because incentive fees kick in. What clearly changes though is the relation between remuneration and size. The relation is not anymore linear and remuneration now increases along a bell-shaped curve since it is both dependent on the AUM *and* on the performance. The remuneration reaches a maximum when:

$$(5) \quad C'\left(q_t^{*HF}\right) = \phi_t - mf + \frac{mf}{pf},$$

where q_t^{*HF} indicates the optimal AUM for a fund whose remuneration scheme includes a performance based fee. At this point, the payoff of the fund is still positive:

$$(6) \quad E\left(TP_{t+1}^{*HF}\right) = \left(q_t^{*HF}\phi_t - C\left(q_t^{*HF}\right) - q_t^{*HF} mf\right)\left(1 - pf\right) > 0.$$

This means that, at equilibrium, the demand for the fund is positive and that the manager has an incentive to limit the inflows to the fund. Importantly, the manager does not control the size of the fund to avoid hurting the performance, but to preserve her own remuneration. If the expected equilibrium payoff is positive, the equilibrium expected return is also positive and the outperformance is thus persistent. In fact, since managers limit the size of their fund, the flows that would drive away performance do not occur.

Furthermore, the manager's remuneration is not maximized at the same quantity that maximizes the total payoff to investors. The total payoff is maximized with an AUM, q_{pm}, that satisfies:

$$(7) \quad C'\left(q_{pm}\right) = \phi_t - mf.$$

The payoff to investors therefore reaches its maximum at an AUM that is *smaller* than the one that maximizes the manager's remuneration. The difference between the two quantities depends on the ratio between the incentive fee and the management fee (mf / pf). *Ceteris paribus*, the higher the incentive fee with respect to the management fee, the smaller the difference between the two quantities, the smaller the size of the fund, and the more aligned are the interest of the manager and of the existing investors. If the manager is remunerated only with a performance fee (management fee = 0%), the remuneration and the payoff are maximized simultaneously. This is consistent with the findings of Agarwal et al. (2004), who document that funds with greater incentives (as measured by delta, the sensitivity of remuneration to performance) perform better.

Altogether, in the absence of an investable costless passive benchmark, the incentive based fee is an efficient mean for aligning the interest of investors and managers. It makes the remuneration of the manager concave and it gives her an incentive to limit the size of the fund. Even if managers behave in a self-interested way, i.e. to preserve their own remuneration, this prevents inflows that would result in performance deterioration. Thus, the performance of hedge funds persists and the industry outperforms. This is consistent with what is observed in the industry, i.e. performance persistence over long horizons and restrictions of the funds' size.

3 Testable Hypotheses

The ideal test for the model introduced above would consist in verifying whether the AUMs of the funds converge toward their optimal levels. However, as the cost functions of the funds are unknown, we cannot conduct this test. Nevertheless, the model implies that rational hedge fund managers who want to maximize their remuneration undertake actions that push the AUM of the fund closer to the optimal size. For instance, funds below the optimal AUM level have to increase their size, while funds at, or above, their optimal AUM have to stabilize or decrease their size. To test the model we will thus analyze the actions of the managers and verify whether the consequences of those actions are consistent with the model.

As discussed in the previous section, investors enter the funds as long as the expected net performance is positive. If managers want to converge toward the optimal size, they have to adjust the net performance for the investors presented in Equation (6). As $0 < pf < 1$, the management fee is the only term which can modify the sign of the expected payoff; see Appendix A.[5] Indeed, the incentive fee consists in a fraction of the total payoff, and it is due only when the performance is positive. The model thus implies that managers modify the management fee to approach the optimal size.[6] Let us first consider a fund whose AUM is at q_t^{*HF}, i.e. a fund that reached its optimal size. The manager has the incentive to prevent additional investments, which would deteriorate her remuneration, by increasing the management fee. Importantly, these increases of fees only apply to the new investments in the fund; see Appendix B. As illustrated in Figure 2, the manager has to set the management fee applicable to new investments (denoted mf') at a level which neutralizes the marginal abnormal performance, i.e. the net performance remunerating the capital freshly invested in the fund.[7] In this way, the new investor, that would invest an amount q' in the fund, receives an amount:

$$(8) \quad E\left(TP'_{t+1}\right) = \left(q'_t\phi_t - q'_t\overline{C} - q'_t mf'\right)\left(1 - pf\right) \leq 0,$$

where $\overline{C} = C\left(q_t^{*HF} + q'_t\right) / \left(q_t^{*HF} + q'_t\right)$ is the average investment cost. As the expected net return for the new investments is not positive, investors do not enter the fund. The AUM of the fund thus stabilizes and the remuneration of the manager is protected.

[Insert Figure 2 about here]

The same behavior can be adopted by managers of funds that passed the optimal size to prevent further increases of size. On the contrary, funds that are below the optimal size may decrease their management fee, so that investors are incited to enter the fund. However, we do not expect any significant short term effect on the inflows. As a matter of facts, investors are in

[5] Alternatively, managers may also close the fund to new investments to control the size of the fund. As this process is exogenous to our model we focus on fee changes.
[6] As a matter of fact, in unreported results we find that variations of incentive fees are not an efficient mean to control size.
[7] In the rest of the paper, we distinguish marginal performance, i.e. the return received on additional investments, from the total performance, the return received by existing investors.

demand of funds that are due to raise their fees. For that reason they immediately perceive the change in marginal performance after the fee change and they stop allocating. On the contrary, investors are not willing to invest in the funds that are due to lower the fees. Indeed, before investing, investors need the time to notice the increase in marginal performance and conduct a throughout due diligence on the fund; see Baquero and Verbeek (2009). As such, there is an information gap between investors already interested in a fund and those who have yet to become interested. For these reasons, in the current study, we focus exclusively on *increases* of management fees.[8]

The model predicts that managers of funds with an AUM that reached or passed the optimal point raise their management fees to protect their remuneration. To reach their goal, managers have to stop inflows by increasing the management fee at a level which makes the marginal abnormal performance insignificant, at least. In fact, a decrease of performance that does not neutralize the abnormal marginal return, even if significant, does not effectively stop the inflows. This leads us to the first proposition:

Proposition 1: "Increases of management fees decrease the likelihood of realizing significantly positive marginal net performance and of experiencing significant flows"

Importantly, this proposition is not a mere mechanical consequence of the increase in fees. Undoubtedly, fee increases are likely to depress the performance, but they do not necessarily make the marginal abnormal performance *significantly negative*. We interpret this marginal performance control as a signal of the managers' willingness to control the size of the fund. The second part of the proposition related to flows, intends to verify that management fee increases are an efficient way to control flows.

According to our model managers control the size of the funds to protect their remuneration, which is equivalent to protect the performance for the existing investors. In fact, the

[8] Consistently with our model, unreported results confirm that decreases of management fees affect the marginal performance but not the flows to the fund.

remuneration of the manager is maximized when the returns for the existing investors are positive. We thus expect that the net total performance for the existing investors remains stable or even improves when managers raise their management fees. For this reason we test the following proposition on the total performance of the fund:

Proposition 2: "Increases of management fees increase the likelihood of realizing persistent net performance"

If the two propositions are simultaneously verified it means that the remuneration of the manager, which is unobservable,[9] remains stable. Indeed, since the remuneration is a function of the AUM and the total performance, if these two variables remain unchanged, remuneration does not change either.

4 Data

4.1 Construction of the Database

We obtain our dataset from the Hedge Fund Research (HFR) database. The database contains information on more than 6,800 living funds and, in a "graveyard" module, over 10,000 dead funds. Each month, HFR releases three updates of the database. At each update, the previous version of the database is overwritten. The subscribers, who only have access to the database from the HFR website, can only download the latest update. Each update of the database contains a snapshot of the characteristics of each fund (compensation terms, liquidity details, service providers, etc.) as well as other practical information (contact person, address, etc.). The database contains, among others, tables with the entire time series of returns, NAV, and AUM of the funds.

To obtain time-series of fund characteristics, we combine 83 different HFR updates released between January 2005 and November 2011. We follow a procedure that is similar to the one

[9] The remuneration of the manager can only be estimated by imposing very strong assumptions, see Feng, Getmansky and Kapadia (2011).

used by Aragon and Nanda (2011) and Patton, Ramadorai and Streatfield (2012). Contrary to these authors, who focus on the different versions of the returns time-series, we collect the snapshots of funds' characteristics.[10] Among the 14,240 funds contained in our raw sample, we select the ones reporting in USD, net of fees, and that report their terms at least once (management fee, incentive fee, high watermark, hurdle rate, redemption frequency and notice period). This results in a sample of 10,028 funds. For these funds, we compute gross returns, flows, amounts of fees collected, as well as all the variables required for our empirical analysis. The algorithm used to compute gross returns is similar to the one employed by Feng et al. (2011). The variables used in the study are defined in Appendix C. Because of missing AUMs, we cannot compute the flows and the total remuneration for 1,519 funds, which are dropped from the sample. We end up with a sample of 8,509 funds, out of which 3,842 are alive as of November 2011, while 4,667 stopped reporting during our sample period. These figures are in line with the attrition rates documented in previous literature; see Liang and Park (2010). For these 8,509 funds, we reconstruct the time-series of hurdle rates using data obtained from Morningstar. 37% of the funds are equity long/short funds. The second most frequent strategy is fund of funds (25%), followed by macro (16%), relative value (15%), and event-driven (9%).

Note that, even if we do not rely on any "graveyard" database, our approach is not subject to survivorship bias. Since we construct our dataset by merging several monthly updates of HFR, all the funds that reported at least once to HFR are retained in our sample, independently from their eventual disappearance from the database. Our results could however potentially be prone to backfilling bias. Nevertheless, since funds tend to change their fees when they reach a certain degree of seniority and since we focus on the performance around the fee change, the probability that we base our calculations on backfilled track records is low. In fact the inclusion of a dummy variable to control for backfilled data leaves our results unchanged. To further

[10] Since April 2008, hedge fund terms are available on daily basis from TASS as documented in Agarwal and Ray (2011). Nevertheless, as changes in terms do not occur at a daily frequency and returns are generally provided at a monthly frequency, more frequent observations would not improve the quality of our dataset.

confirm, we redo our tests on a sample where all information prior to the funds' entry into the database has been removed and our conclusions remain qualitatively unchanged. Considering the minimal impact of backfilling on our results, we prefer not to lose observations and we retain the original sample.

4.2 Fee Changes

Even though we are solely interested in management fee changes, we first collect some statistics about all possible modifications of the compensation terms. To identify these changes (management fee, incentive fee, high watermark, and hurdle rate) we analyze the time series of fund characteristics. For each change, we verify whether it is due to misreporting. We consider two types of reporting errors. The first consists in a change of terms that is immediately changed back to the original value. The second type of misreporting occurs when the fund changes its terms several times in a row. In this case, we only retain the latest change. Among the 8,509 funds retained, this analysis identifies 798 changes. Sometimes, the same fund modifies several terms at the same time. In these cases, we consider this as a single "change event". We identify 639 different change events[11] implemented by 573 funds.

Table 1 contains stylized facts on fee changes. From Panel A, we see that the management fee is the term changed the most often (more than 50% of the changes). In 20% of the changes, several terms are changed simultaneously. As illustrated in Panel B and C, we find more increases than decreases of fees. This has already been pointed out by Deuskar et al. (2011b) and Agarwal and Ray (2011), who use a different dataset. This is true especially for management fee revisions: increases of management fee revisions represent more than 70% of all the management fee revisions. Thus, by focusing on increases of management fees we

[11] In the rest of the present document we refer to "change events" as changes.

analyze the most recurrent type of fee revision, which account for more than 35% of all the changes.[12]

[Insert Table 1 about here]

4.3 Fund-level Variables

Table 2 contains descriptive statistics about the fund-level variables. For each fund, the last available observation is used. Thus, the observations have different dates, but each fund is considered only once.

[Insert Table 2 about here]

The median fund included in our sample has a monthly return of 0.5%, is 5.25 years old, has USD 30 million under management, and it takes about four months to redeem from it. It charges a management fee of 1.5% and an incentive fee of 20%. The vast majority of the funds (89%) have a high watermark provision. Hurdle rates are only applied by 12% of the funds. These figures are in line with the ones of the global HFR sample, indicating that our selection procedure does not bias the sample. The table also reveals some facts on the funds that raise their management fees. First, these funds have significantly higher and more volatile returns; see also Agarwal and Ray (2011). The difference with the funds that do not raise their management fee is significant at all conventional levels. Moreover, management fee-changing funds also have longer redemption periods and are better established (bigger and older) than the other funds. Finally, unsurprisingly, funds that raise their management fee have higher management fee levels, even if their incentive fee is not significantly different than the one of the other funds.

[12] The fact that fund managers mainly change the management fee is consistent with our model. However, we also observe changes of incentive fees, as well as of high watermarks and hurdle rates. This means that fund managers also modify fees for other reasons than size management. We leave the analysis of these changes for future research.

5 Estimations and Results

5.1 Management Fee Increases as a Means to Control Flows

We use a difference-in-differences analysis (DID) to verify our propositions. For any change date, the *treatment* group is composed of the funds that experienced a management fee increase at date *t*, while the *control* group consists of all the funds that are alive at that date, which never experienced any fee change, and which follow the same investment style as the treated fund. Since Cai and Liang (2011) and Gibson and Gyger (2007) find evidence of strategy misreporting and opportunism, instead of using self-reported strategies, we identify investment styles using a clustering algorithm. At any change date, the funds reporting their returns over the preceding 12 months are clustered into 5 categories using a PAM algorithm with a dissimilarity measure based on rank correlation. [13]

We first focus on the impact of management fee revisions on marginal performance by estimating the following logit model:

$$(9) \quad \begin{aligned} DMargAlpha_{t,j} &= a_0 + a_1 DTreat_j + a_2 DAfter_t + a_3\left(DTreat_j \times DAfter_t\right) \\ &\quad + a_4 Control_{j,t} + a_5 Year_t + \varepsilon_{t,j} \end{aligned},$$

where $DMargAlpha$ is a dummy variable that takes a value of one if the marginal abnormal performance is significantly positive and zero otherwise. $DTreat$ equals one if the fund is in the treatment group (fee revision) and zero otherwise. $DAfter$ is a dummy variable that takes a value of 1 if t is after the fee revision and zero otherwise. $Year$ controls for time effects. $Control$ is the set of control variables. These variables are defined in Appendix C. For their selection, we rely on Agarwal et al. (2009), Ding, Getmansky, Liang and Wermers (2009), and Getmansky (2012).

[13] The optimal number of categories has been selected by maximizing the silhouette width; see Kaufman and Rousseeuw (2008). Gibson and Gyger (2007) show that the PAM – Partitioning Around Medoids – algorithm, when dealing with hedge funds, has several advantages over the more common k-mean algorithm.

To test the impact of management fee increases on flows we replace $DMargAlpha$ with $DFlow$, a variable that equals one if the flows are not significantly different from zero, and zero otherwise. The set of control variables is also changed consequently. The model thus writes:

$$(10)\quad \begin{aligned} DFlow_{t,j} &= a_0 + a_1 DTreat_j + a_2 DAfter_t + a_3\left(DTreat_j \times DAfter_t\right) \\ &\quad + a_4 Control_{j,t} + a_5 Year_t + \varepsilon_{t,j} \end{aligned}.$$

As the composition of style clusters varies over time, it is not possible to control for strategy effects. The interaction between $DTreat$ and $DAfter$ is the parameter of interest and we expect its coefficient, a_3, to be significantly positive for both models.

[Insert Table 3 about here]

We estimate Equations (9) and (10) considering two semesters around the fee changes.[14] Table 3 displays the results. As expected, the coefficients of the interaction terms are significantly positive for both equations. As stated in our first proposition, when funds increase the management fee, they decrease the likelihood of generating positive alpha for the marginal investor. Thereby, management fee revisions decrease the funds' attractiveness toward incumbent investors. This relation is not only statistically significant, but also economically: the odds of generating insignificant abnormal marginal return almost triples when there is an increase in management fee.[15] Interestingly, when controlling for the effect of management fee changes, the size of the fund is not significantly related to performance. This fact is at odds with several studies that find a strong size-performance relationship; see Agarwal et al. (2004) among others. With respect to the other control variables, we obtain several coefficients that are consistent with the ones of existing studies. For instance, consistently with Agarwal et al.

[14] Results are robust to different lengths of the period around the fee change (6, 18 and 24 months). Moreover, the outcome is not affected by the interdependence that exists between performance and flows; see e.g. Agarwal et al. (2004) or Fung et al. (2008). The confidence level of the coefficients only changes marginally when the two regressions are estimated simultaneously using a three-stage least squares methodology.

[15] The change in odd ratio is calculated as *exp(0.96)-1*, where *0.96* is the coefficient of interest from Table 3.

(2004), the level of the incentive fees and the length of the redemption period are significantly negatively related to the likelihood of generating negative abnormal performance, even if the impact of the redemption period is not economically significant. Moreover, there is a momentum effect also in marginal performances: in fact the lagged marginal performance decreases the probability of posting negative future abnormal performances.

As a consequence of the change in attractiveness driven by the management fee increase, the flows of the funds evolve according to our model; see the right column of Table 3. The coefficient of the interaction term is indeed strongly and significantly positive. By raising their management fee, the managers increase the likelihood of having insignificant flows. This relationship is also economically significant. An increase in management fee more than doubles the odds of experiencing insignificant flows. Given the construction of the dependent variable, the coefficients of the control variables cannot be compared with the ones of the existing studies. However, since all of them are significant, we can conclude that investors are influenced by a number of variables beside the one we are interested in.

Altogether, with both regressions, we find empirical support for our first proposition. Fee changes have significant impacts on marginal abnormal performance and on flows. Management fee increases emerge as an effective means to control the size of fund, and managers exploit this property to manage the AUM of their funds in the direction predicted by our model.

5.2 Impact of Management Fee Increases on Total Performance

We now turn to the second proposition by analyzing the consequences of management fee increases on total performance, i.e. the performance for the existing investors. Our model assumes that the ultimate goal of fee changes is to protect, or even improve, the performance for these investors. To investigate this, we estimate whether the likelihood of improving the total performance is affected by management fee increases. Formally, we estimate the following equation:

(11) $DTotAlpha_{t,j} = a_0 + a_1 DTreat_j + a_2 Control_{j,t} + a_3 Year_t + \varepsilon_{t,j}$,

where $DTotAlpha$ takes a value of 1 if the total abnormal performance remains constant or improves after the fee change and zero otherwise (see Appendix C). This variable is defined according to the value of the *total* abnormal performance, not the *marginal* one. Table 4 reports the results.

[Insert Table 4 about here]

As predicted in our second proposition, the coefficient on the treatment variable is significantly positive. Hedge funds, by raising their management fee, protect the performance for the existing investors. The effect is, here also, economically significant. The odds of generating a persistent total performance increases by 60% when a fund raises its management fee, even after controlling for variables that proved to affect the performance of hedge funds. With respect to these control variables, we find several coefficients that are consistent with the findings of Agarwal et al. (2004). As a matter of fact, incentive fee and redemption periods are significantly positively related to abnormal performance, whereas the level of AUM and past flows are negatively related to performance. Though, even if these coefficients display a strong statistical significance, their economical relevance is weak. Their impact on the odd ratio is actually always lower than 10%.

Since both the size of the fund and the total performance for the existing investors remain constant, the remuneration of the manager, which is function of these two variables, should remain unchanged. This fact is consistent with our model which states that managers have a self-interested behavior intended at optimizing their performance. However, thanks to the incentive fee, this behavior results in a protection of the performance generated for the existing investors.

5.3 Do Funds Align their Fees with the Competitors?

One alternative explanation to our size management hypothesis could be that fund managers change their fees in order to align them with the competitors. For instance, Agarwal and Ray (2011) and Deuskar et al. (2011b) find that the fees before the change are lower than the average of the industry. They conclude that funds modify their fees to bring them in line with the industry average. This is inconsistent with our model, which predicts that fees are changed strategically. To further investigate the alignment hypothesis, each time that a management fee increase occurs, we record the old and the new fee, as well as the average fee for the funds in the same style-cluster. In addition, we record the level and the style-cluster average of the incentive fee. Then, we compare i) the old and the new management fee to the average management fee of the control funds, and ii) the incentive fee, which remains unchanged, to the average incentive fee of the control funds.

[Insert Table 5 about here]

Table 5 contains the results. Panel A shows the statistics about the management fee, as well as the statistic testing whether the average fee level is equal to the one of strategy. In Panel B we find the same figures for the incentive fee. We see that funds increasing their management fee have initial fees that are significantly *lower* than the strategy average. However, the revised fee is significantly *higher* than the one of the competitors. One could then think that these funds are “cheaper” in terms of incentive fee (i.e. they apply a lower incentive fee) and that they compensate it with the management fee. From Panel B, we see that it is not the case. The incentive fee of these funds is in fact not statistically different from the ones of their peers.

As it appears, management fee revisions are not a simple alignment with competitors. Funds that change their management fees, i.e. the majority of the fee revisions, go further and they set fees at a higher level than the competitors’ average. Moreover, these funds do not use the management fee to compensate for an unaligned incentive fee. Consistently with our model, these results show that funds do not change their fees to simply adapt them to industry level.

6 Conclusion

In this paper, we propose a simple explanation to the persistent outperformance of hedge funds. Managers control the size of their funds by changing their management fee. In this way the AUM of the fund remains close to the optimal size and the performance is not diluted by flows. With respect to the models already present in the literature, we take into account hedge fund peculiarities, namely the fact that the fees charged to investors depend on the timing of the investment, that managers' remuneration are not linearly related to fund size, and that the use of passive benchmarks is not possible. Our study gives a theoretical framework to appraise the recent developments made in the literature on compensation contracts in the hedge fund industry and the impact of those contracts on performance. In particular, it provides an important insight on the relationship between fees, performance, and flows. The predictions of our model reproduce empirical facts observed in the literature, i.e. outperformance, persistence, and inflows refusal.

The evidences from our model are relevant for the current regulatory debate. We show that incentive fees are crucial in the alignment of investors' and managers' interests when there is no investable benchmark. The performance fee introduces non-linearity in the size-remuneration relationship, which leads to size control and, consequently, outperformance.

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Appendix A: Flows, Size, Performance and Remuneration in the Absence of a Costless Investable Benchmark

In this appendix we modify the model of Berk and Green (2004) by assuming that the manager is not allowed to invest into a benchmark, but only into her proprietary strategy. We first analyze the case in which the manager only receives a management fee, then we include an incentive fee into the remuneration scheme.

As in the original model, we assume that the proprietary strategy is subject to diseconomies of scale. The return of the strategy, gross of all costs and fees is R_t and does not depend on the size of the fund. However, by implementing the strategy the manager incurs a variable cost denoted $C(q_t)$, where q_t is the amount invested into the strategy. The authors also assume that $C(0) = 0$, $C(q_t) < q_t, \forall q_t$, $C'(q_t) > 0, \forall q_t$, and $C''(q_t) > 0, \forall q_t$. In words, the strategy is subject to diseconomies of scale and the gross return after cost decreases with the quantity invested.

Mutual Fund-Like Remuneration

If there is no benchmark and no incentive fee, the manager receives a remuneration that only depends on the quantity of assets managed by the fund, formally:

(A.1) $$Remun_t^{MF} = q_t mf$$

where q_t stands for the AUM of the fund and mf the management fee. The manager runs the fund if her remuneration, at any point in time, is greater than the fixed cost she incurs (denoted $F > 0$), otherwise she shuts the fund down.

The total payoff of the fund, which is paid to investors at the end of each month, is:

(A.2) $$TP_{t+1}^{MF} = q_t R_{t+1} - C(q_t) - q_t mf$$

Investors chase the best performers: they infer managers' skill form past performance and they invest into the – supposedly – most skilled funds. At each period, investors use the new data at their disposal to update their inference. Money flows into funds with infinite elasticity as long as the expected value of the payoff is positive. Therefore, money flows into outperforming funds, and, because of decreasing returns to scale, the total payoff gradually decreases until becoming insignificant.

The objective of the manager is to maximize her remuneration, which solely comes from a percentage of the AUM. The manager has an incentive to let the fund grow *ad vitam æternam*. Thus, she solves the following problem:

$$\text{(A.3)} \qquad \begin{aligned} &\max_{q_t} \quad Remun_t^{MF} = q_t mf \\ &s.t. \quad E\left(TP_{t+1}^{MF}\right) = q_t\phi_t - C(q_t) - q_t mf \geq 0 \\ &\qquad\qquad F \leq q_t mf \\ &\qquad\qquad q_t \geq 0 \end{aligned},$$

where $\phi_t = E\left(R_{t+1} \middle| R_1,...,R_t\right)$ is the expected return gross of all costs and fees.

As the remuneration is strictly increasing with q_t and the payoff is strictly decreasing with q_t, the remuneration is maximized when the expected payoff (to the investors) is nil, i.e. when:

$$\text{(A.4)} \qquad \begin{aligned} &q_t^{*MF}\phi_t - C(q_t^{*MF}) - q_t^{*MF} mf = 0 \\ &\phi_t - mf = \frac{C(q_t^{*MF})}{q_t^{*MF}} \\ &C(q_t^{*MF}) = \left(\phi_t - mf\right) q_t^{*MF} \end{aligned},$$

where q_t^{*MF} indicates the optimal size of a fund invested only in the active strategy and which cannot invest into a benchmark. At equilibrium, the average cost of the strategy is equal to the excess return of the strategy netted by the management fee ($\phi_t - mf$). Thus, even in the absence of an investable benchmark, if the manager is remunerated with a management fee only, funds are not expected to outperform and there is no performance persistence.

Hedge Fund-Like Remuneration

We now consider the case in which there is also an incentive fee. We assume that the incentive fee is accrued monthly but paid when the investors leave the fund (this is equivalent to assume that the manager applies a high watermark provision and that the payment of the incentive fee is deferred to the moment at which the investor leaves the fund). In this case, the remuneration and the total payoff are respectively:

$$\text{(A.5)} \qquad Remun_t^{HF} = \begin{cases} \left(q_t\phi_t - C\left(q_t\right) - q_t mf\right) pf + q_t mf & \text{if } q_t\phi_t - C\left(q_t\right) - q_t mf > 0 \\ q_t mf & \text{otherwise} \end{cases},$$

$$\text{(A.6)} \qquad E\left(TP_{t+1}^{HF}\right) = \begin{cases} \left(q_t\phi_t - C\left(q_t\right) - q_t mf\right)\left(1 - pf\right) & \text{if } q_t\phi_t - C\left(q_t\right) - q_t mf > 0 \\ q_t\phi_t - C\left(q_t\right) - q_t mf & \text{otherwise} \end{cases},$$

where pf is the performance fee and the expression $q_t\phi_t - C\left(q_t\right) - q_t mf$ is the incremental NAV net of cost and management fees (without considering subscription and redemptions). In words, as soon as there is a positive return, the performance based remuneration kicks-in, decreasing the total payoff.

Investors participate in the fund only if $E\left(TP_{t+1}^{HF}\right) > 0$. This implies that the expected incremental NAV is positive. The expressions for remuneration and expected payoff can thus be rewritten as follow:

$$\text{(A.7)} \qquad Remun_t^{HF} = \left(q_t\phi_t - C\left(q_t\right) - q_t mf\right) pf + q_t mf$$

$$\text{(A.8)} \qquad E\left(TP_{t+1}^{HF}\right) = \left(q_t\phi_t - C\left(q_t\right) - q_t mf\right)\left(1 - pf\right)$$

To maximize her remuneration, the manager solves the following problem:

$$\text{(A.9)} \qquad \begin{aligned} &\max_{q_t} \quad Remun_t^{HF} = \left(q_t\phi_t - C\left(q_t\right) - q_t mf\right) pf + q_t mf \\ &s.t. \quad E\left(TP_{t+1}^{HF}\right) = \left(q_t\phi_t - C\left(q_t\right) - q_t mf\right)\left(1 - pf\right) \\ &\qquad\qquad F \leq \left(q_t\phi_t - C\left(q_t\right) - q_t mf\right) pf + q_t mf \\ &\qquad\qquad q_t \geq 0 \end{aligned}$$

The first order condition is:

(A.10) $$\left(\phi_t - C'\left(q_t^{*HF}\right) - mf\right) pf + mf = 0$$

And the solution of the problem:

(A.11) $$C'\left(q_t^{*HF}\right) = \phi_t - mf + \frac{mf}{pf}.$$

When the size of the fund is q_t^{*HF}, the expected total payoff is strictly positive. To see that, define $\left\{q_0 \middle| TP^{HF}(q_0) = 0\right\}$; and compute $Remun^{HF}(q_0) = q_0 mf$ and $C\left(q_0\right) = q_0\left(\phi_t - mf\right)$. As the cost function $C\left(q\right)$ is strictly convex, the remuneration of the manager defined in (A.5) is concave. We can write:

(A.12) $$\begin{aligned} Remun^{HF}\left(q_0\right) &\leq Remun^{HF}\left(q_t^{*HF}\right) + \frac{\partial Remun^{HF}\left(q_t^{*HF}\right)}{\partial q_t^{*HF}}\left(q_0 - q_t^{*HF}\right) \\ q_0 mf &\leq Remun^{HF}\left(q_t^{*HF}\right) \end{aligned}.$$

In words, the maximal remuneration is at least equal to the remuneration perceived when the payoff is nil. There are three possible cases:

i) $q_0 < q_t^{*HF}$, which implies that $\overline{C}\left(q_0\right) = C\left(q_0\right)/q_0 = \phi_t - mf < \overline{C}\left(q_t^{*HF}\right)$. The payoff defined in (A.6) can be rewritten as $TP_{t+1}^{HF}\left(q_t^{*HF}\right) = q_t^{*HF}\left(\phi_t - mf - \overline{C}\left(q_t^{*HF}\right)\right)\left(1 - pf\right)$, which is necessarily negative. As the total payoff is negative, investors leave the fund and thus $q_0 < q_t^{*HF}$ is not a possible equilibrium point.

ii) $q_0 = q_t^{*HF}$, which implies $Remun^{HF}\left(q_t^{*HF}\right) = Remun^{HF}\left(q_0\right) = q_0 mf$. However this is false because the first derivative of the remuneration valued at q_t^{*HF} is not equal to zero, which is the necessary condition for the quantity that maximizes the remuneration.

iii) $q_0 > q_t^{*HF}$. Equation (A.12) imply that $0 \leq Remun^{HF}\left(q_t^{*HF}\right) - q_0 mf$, or, $0 \leq \left(q_t^{*HF}\phi_t - C\left(q_t^{*HF}\right) - q_t^{*HF} mf\right) pf + \left(q_t^{*HF} - q_0\right) mf$. As the last term of the equation is negative, the first term has to be positive, and it is the case only when the total payoff is positive.

So, when the manager maximizes her remuneration, the total payoff for investors is positive. This means that investors would like to invest more in the fund and that the manager has to control the flows to her fund, and that the performance of the fund persists (because there are no flows that dilute the performance). Notice that $C\left(q_0\right)=C\left(q_t^{*MF}\right) \Rightarrow q_0=q_t^{*MF}$. This means that the incentive fee alone gives the manager an incentive to limit the AUM of the fund. Consequently, in the absence of a costless benchmark, an incentive fee makes the outperformance persistent.

In conclusion, the incentive fee, when there is no benchmark, has three main consequences: i) performance persistence, ii) the industry outperforms, and iii) manager has an incentive to refuse inflows.

Moreover, if the manager applies incentive fees, the total payoff is maximized when:

(A.13) $$\begin{aligned}&\left(\phi_t - C'(q_{pm}) - mf\right)\left(1-pf\right)=0\\&C'(q_{pm})=\phi_t - mf\end{aligned}$$

Thus, mf/pf plays a crucial role. If the remuneration only comes from the incentive fee, then $mf/pf=0$, and the manager limits the size of the fund at a level that maximizes the total payoff. In general, the lower mf/pf , i.e. the higher the variable remuneration with respect to the fixed one, the higher the total payoff of the fund.

Concerning the impact of the different fees on the value of q_0, first remember that we defined $\left\{q_0 \middle| TP^{HF}(q_0)=0\right\}$, second $C\left(q_0\right)=q_0\left(\phi_t - mf\right) \Rightarrow q_0=\dfrac{C\left(q_0\right)}{\phi_t - mf}$. It is thus clear that q_0 is not affected by pf and that it is inversely related to mf .

Appendix B: Description of Hedge Fund Fee Revisions

As documented by Agarwal and Ray (2011) and Deuskar et al. (2011b), fee revisions are numerous in the hedge fund industry. In this section, we detail the various tools available to hedge fund managers to change their remuneration terms.[16] One option is to revise the terms specified in the *prospectus*.[17] In this first case, the new fee conditions, whether they consist in an increase or a decrease of the fees perceived, apply to all existing and future investments so that all the investors are treated equally.

A second option managers often use is the creation of a new share class. Concretely, the fund manager can choose between opening a new feeder[18] or launching a new mirror fund.[19] The new investment vehicle is aimed at new investors and at new investments from existing investors. Regardless of the fund structure chosen, the manager usually also modifies the liquidity terms (lookup, redemption frequency, and advance notice), the minimum investment, or other covenants to justify the new fee structure. This variety of characteristics makes share classes significantly divergent from each other and they can arguably be considered as aimed at different clienteles. In addition, when a mirror fund is launched, it is common practice to slightly modify the fund (implementation of the strategy on additional markets, improvement of the risk management processes of the fund, etc.). This makes the mirror fund hardly comparable to the original fund.

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[16] The fee revision possibilities explained here have been put together after discussions with investment professionals of some multi-billion dollar hedge funds, funds of hedge funds, and family offices, as well as the analyses of several legal documents of hedge funds.

[17] The *prospectus*, also known as *offering memorandum*, is the charter of the hedge fund and it regulates all the aspects of the company. Generally, the prospectus discusses the strategy of the fund, the major risk factors, the external parties involved in the management, the administration of the fund, the fees charged by the fund, the liquidity restrictions, the valuation procedures, as well as all the rules governing the meetings of the boards of directors and of the investors.

[18] The master/feeder structure is frequently used in the hedge fund industry. Under such structure, the investors invest in the feeder fund, which in turn invests in the master fund (also known as fund for funds). The portfolio of the feeder fund is solely composed by shares of the master fund, while the portfolio of the master fund contains the assets underlying the fund. A master fund can have several feeder funds, and each feeder can have different terms, regulation, etc.

[19] In a mirror fund structure, two separate funds are created and managed with similar investment policies, common investment adviser, custodian, and administrator. The portfolios underlying the two funds are almost identical. Each fund of the structure, being a separate legal entity, can apply its own contractual terms.

In theory, these changes could be subject to investors' vote. In practice, hedge fund managers organize the fund in a way that prevents investors from exercising their voting rights; see Shadab (2009). Thus, existing investors, as well as prospective investors, do not have much bargaining power in the above-mentioned processes. Nevertheless, some investors have *side-letters* which make them subject to specific conditions.[20] A common term in *side-letters* is *grandfathering*, which means that if there is any change in the conditions that would adversely affect the investor (such as a fee increase), this change would not apply to the existing and future investments of the *grandfathered* investor. Side-letters can also contain *secured capacities* (i.e. guaranteed investment-lines), so that even if a new share class is created, the investor can continue to invest in the old class up to the guaranteed amount. Other conditions can give discounts on fees in the case of leveraged investments, different lockup periods, or any other specific term; see Lhabitant (2006, p. 120).

Considering the above, we take a conservative view and assume that increases of fees only apply to new investments from existing and new investors, whereas decreases of fees apply across all investments. Also, because of the substantial differences between share classes, we do not consider new share class creation as a fee change but as a creation of a new fund. Actually, hedge fund databases and academic studies follow the same logic and classify each share class as a fund on its own.[21]

[20] A side-letter is a contract that entitles the investor to specific conditions (reduced fees, improved liquidity, enhance transparency on the fund holdings) which differ from the ones contained in the prospectus of the fund.

[21] Recently, the academic literature started to consider "fund families". Fund families regroup all the funds managed by the same investment company. As such, a family does not only contain all the share classes of a fund, but it may also contain share classes of other funds pursuing different strategies.

Appendix C: Definition of the Control Variables

Table E.1: Definition of Control Variables

This tables details the variables used in the paper. X's indicate whether a variable is used or not in the correspoding set of control variables.

Variable Name	7 Control Marginal Alpha	8 Control Flow	9 Control Total Alpha	Variable Definition
Age_t	X	X	X	Number of years since inception
$Alpha_{t-1}$			X	Return in excess of the corresponding strategy index (funds belonging to the same style cluster) for the average investor.
$Flow_t$				Variation of assets under management that is not explained by performance.
$Flow_{t-1}$	X	X	X	
$Incentive\ Fee_t$	X	X	X	Incentive fee level at time *t*.
$MAlpha_t$				Return in excess of the corresponding strategy index (funds belonging to the same style cluster) for a marginal investor.
$MAlpha_{t-1}$	X	X		
$Management\ Fee_t$	X	X	X	Management fee level at time *t*.
$Redemption\ Period_t$	X	X	X	Sum of redemption frequency and notice period, expressed in years at time *t*.
$Remun_t$				The dollar remuneration of the manager at time *t*.
$Size_t$	X	X	X	Natural logarithm of AUM at time *t*.
$Volatility_{t-1}$		X		Volatility of excess returns.

Table E.2: Definition of Dummy Variables

This tables details the dummy variables used as dependent variables. The sign < denotes an inequality significant at a 5% level. Panel A gives the general definition. Panel B details de value of the dummies in each possible scenario.

Panel A: *D_Alpha*, *D_Flow*

$$DMargAlpha \quad \begin{cases} DMargAlpha = 1 & if\ Marginal\ Alpha_t < 0 \\ DMargAlpha = 0 & Otherwise \end{cases}$$

$$DFlow \quad \begin{cases} DFlow = 1 & if\ Flow_t = 0 \\ DFlow = 0 & Otherwise \end{cases}$$

Panel B: *DTotAlpha*

	Post-Treatment Alpha		
Pre-Treatment Alpha	Significantly positive	Insignificant	Significantly negative
Significantly positive	$DTotAlpha = 1$	$DTotAlpha = 0$	$DTotAlpha = 0$
Insignificant	$DTotAlpha = 1$	$DTotAlpha = 1$	$DTotAlpha = 0$
Significantly negative	$DTotAlpha = 1$	$DTotAlpha = 1$	$DTotAlpha = 0$

Figure 1: Optimal Size under Different Fee Structures

This plot displays the relationship between size, performance and remuneration when there is no costless investable benchmark. The plot shows both the case in which the remuneration solely comes from a management fee and the case in which the fund also charges an incentive fee. The three quantities represent the size that maximizes the payoff to investors q_{pm}, the size that maximizes the manager's remuneration q_t^{*HF}, and the size for which the total payoff is null q_t^{*MF}.

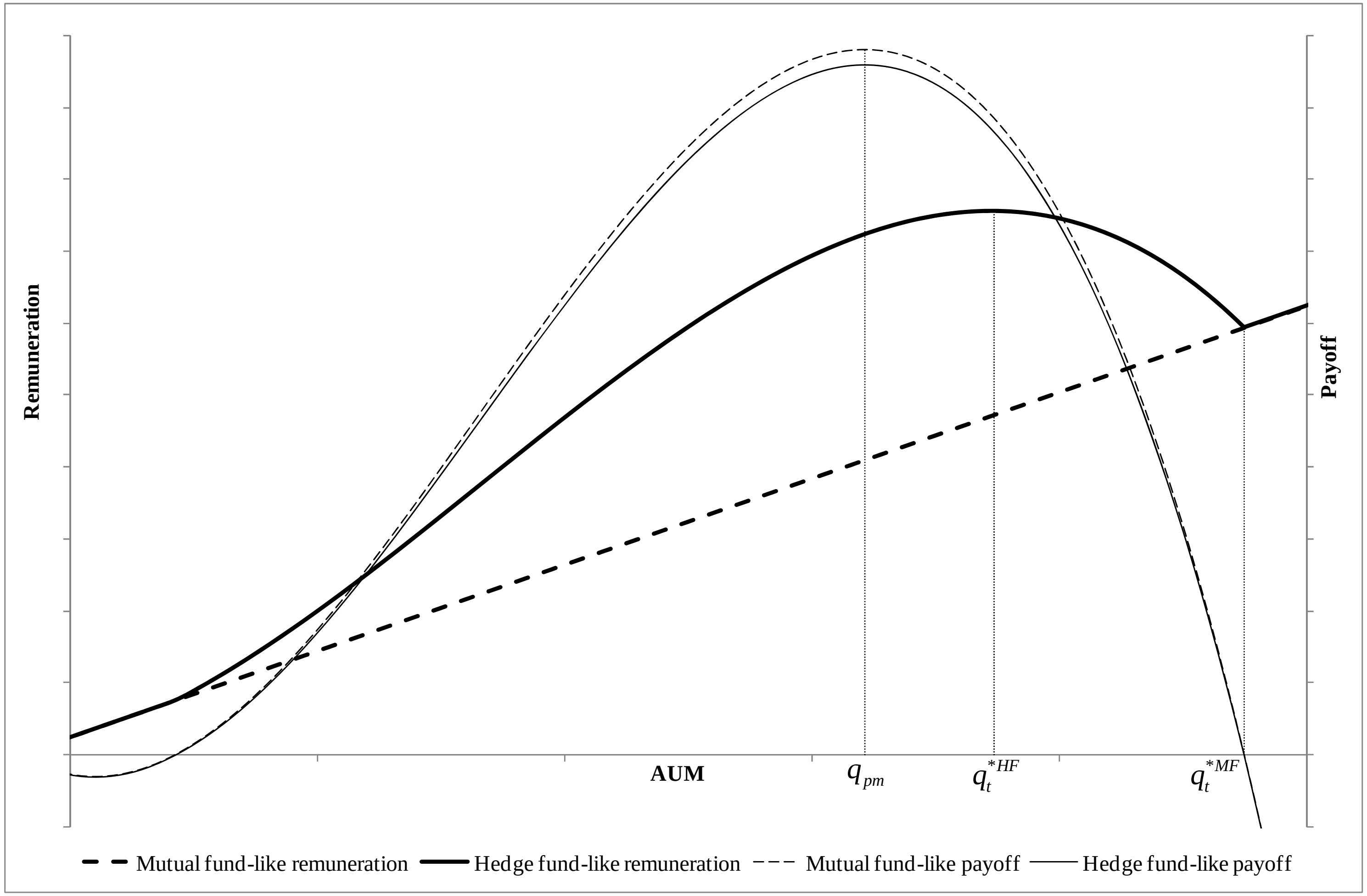

Figure 2: Impact of Management Fee Increases on Marginal Investors' Payoff

The plot displays the impact that an increase of management fee has on the payoff for the marginal investor. The total payoff is illustrated by the continuous line (equivalent to the standard situation in Figure 1) while the marginal payoff after the increase is illustrated by the dashed line. q_t^{*HF} is the size that maximizes the manager's remuneration from Figure 1.

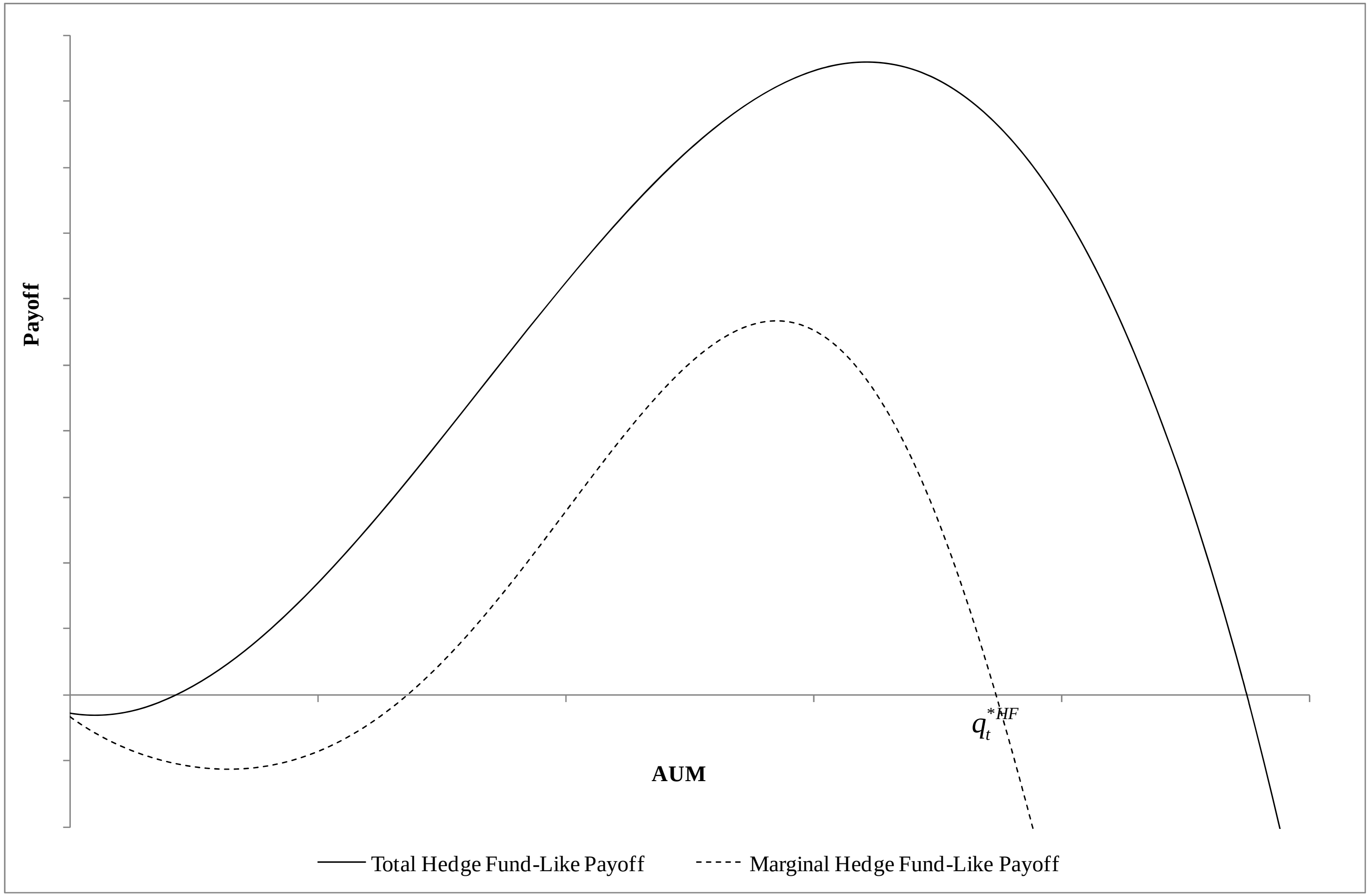

Table 1: Number of Changes by Fee Component and Direction of Revision

This table reports the number of changes and the number of funds that revised their fees. *Incentive fees* accounts the changes in performance fee, high watermark, and hurdle rate. In Panel A we only distinguish between the components of the compensation scheme. In Panel B and C, we also classify them according to the direction of the change.

	All Fees	Management Fee	Incentive Fees	Several Fees
Panel A: All Changes				
N Changes	639	334	174	131
N Funds	573	312	167	124
Panel B: Increases of Fees				
N Changes	399	235	97	67
N Funds	386	233	94	66
Panel C: Decreases of Fees				
N Changes	240	99	77	64
N Funds	235	98	77	64

Table 2: Descriptive Statistics of the Sample

This table shows summary statistics about the variables of the sample. For all the funds we use the latest observation. As such, the dates considered vary across funds, but each fund is considered only once. This also implies that, for funds that revised their management fee, the fee level considered are computed after the changes. The last column reports the differences between the means and t-statistics (within parenthesis) from t-tests comparing the means of the different variables. Statistical significance of 10%, 5%, and 1% are indicated by *, **, and *** respectively.

	Funds without Management Fee Increases N=8509			Funds with Management Fee Increases N=233			Difference of Means	
	Mean	StDev	Med	Mean	StDev	Med	Mean(change) – Mean(no change)	
Avg Monthly Net Return (%)	0.60	1.15	0.54	0.87	0.49	0.82	0.26***	(7.63)
StDev Net Return (%)	3.63	3.05	2.78	4.05	2.53	3.36	0.42***	(2.48)
Age (Years)	6.32	4.76	5.08	10.78	4.62	10.33	4.45***	(14.44)
Size (mio USD)	74.54	112.93	28.54	151.85	228.56	59.85	77.32***	(5.12)
Redemption Period (Days)	114.40	91.50	120.00	131.90	94.82	120.00	17.50***	(2.77)
Management Fee (%)	1.59	1.43	1.50	1.92	2.47	1.50	0.33***	(2.05)
Incentive Fee (%)	16.73	6.81	20.00	17.27	5.46	20.00	0.54	(1.48)
HWM (1/0)	0.89	-	-	0.94	-	-	0.05	
Hurdle Rate (1/0)	0.12	-	-	0.11	-	-	-0.01	

Table 3: Consequences of Management Fee Revisions on Marginal Alpha and Flows

This table reports the results of a DID regression describing the relation between fee revisions and marginal alpha, and fee revisions and flows in the two semesters around the fee change. Dependent variables are expressed as dummy variables; detailed definitions are given in Appendix C. Robust standard errors are provided between brackets. Statistical significance of 10%, 5%, and 1% are indicated by *, **, and *** respectively.

	DMargAlpha	*DFlow*
D_Treat_t	-0.88*	-0.56***
	[0.453]	[0.205]
D_After	-0.06***	0.24***
	[0.014]	[0.013]
D_Treat_t x *D_After*	0.96*	0.79**
	[0.537]	[0.373]
$Size_t$	0.00	-0.21***
	[0.004]	[0.004]
$Management\ Fee_t$	-0.16	-1.31***
	[0.356]	[0.286]
$Incentive\ Fee_t$	-3.30***	0.94***
	[0.087]	[0.091]
$Redemption\ Period_t$	-0.05***	0.10***
	[0.007]	[0.007]
$MAlpha_{t-1}$	-0.13***	-0.08***
	[0.004]	[0.005]
$Flow_{t-1}$	0.00	-0.04***
	[0.000]	[0.001]
Age_t	-0.01***	0.05***
	[0.002]	[0.002]
$Volatility_{t-1}$	-	12.54***
	-	[0.516]
Intercept	-2.31***	3.00***
	[0.029]	[0.029]
Year	YES	YES
Observations	377,086	377,086
R-squared	2.36%	4.29%

Table 4: Impact of Fee Revisions on Average Abnormal Return

This table reports the results of a logistic regression describing the relation between fee revisions and total alpha. The dependent variable is expressed as a dummy variable; detailed definitions are given in Appendix C. Robust standard errors are provided between brackets. Statistical significance of 10%, 5%, and 1% are indicated by *, **, and *** respectively.

	DTotAlpha
D_Treat_t	0.46**
	[0.227]
$Size_t$	-0.01***
	[0.004]
$Management\ Fee_t$	-0.06
	[0.345]
$Incentive\ Fee_t$	2.61***
	[0.081]
$Redemption\ Period_t$	0.02***
	[0.006]
$Alpha_{t-1}$	-0.09***
	[0.004]
$Flow_{t-1}$	-0.01**
	[0.001]
Age_t	0.01***
	[0.002]
Intercept	2.40***
	[0.027]
Year	YES
Observations	185,543
R-squared	1.99%

Table 5: Differences in Fee Levels before and after Fee Revisions

This table contrasts the levels of management and incentive fees of the funds that changed their management fee with the ones of the other funds of the same style cluster. Standard deviations are reported in brackets. Statistical significance of 10%, 5%, and 1% are indicated by *, **, and *** respectively.

	(i)	(ii)	(iii)	(i)-(iii)	(ii)-(iii)
	Old Fee Level	New Fee Level	Strategy Level	Old minus Strategy	New minus Strategy
			Panel A: Management Fee		
Mean	1.2	2.2	1.6	-0.4***	0.6***
	[1.0]	[3.2]	[0.1]	[0.98]	[3.17]
			Panel B: Incentive Fee		
Mean	18.7	-	18.2	0.6	-
	[4.5]	-	[3.2]	[2.52]	-