High-water Marks and Hedge Fund Compensation*

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Abstract

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We examine the role of high-water mark provisions in hedge fund compensation contracts. In our model of competitive markets and asymmetric information on manager ability, a fee contract with a high-water mark can improve the quality of the manager pool entering the market. In addition, a high-water mark contract can reduce inefficient liquidation by raising after-fee returns following poor performance. Consistent with our model’s predictions, we find that high-water marks are more commonly used by less reputable managers, funds that restrict investor redemptions, and funds with greater underlying asset illiquidity. High-water marks are also associated with greater sensitivity of investor flows to past performance, but less so following poor performance. Overall, our results suggest that compensation contracts in hedge funds help alleviate inefficiencies created by asymmetric information.

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1 Introduction

Hedge funds are open-ended private investment vehicles that are exempt from the Investment Company Act of 1940. The absence of significant regulatory oversight allows managers to profit from flexible trading strategies based on private information about investment opportunities. However, the secretive nature of hedge funds makes it difficult for investors to discern manager ability, especially among managers with little or no track record. Moreover, investors’ capital flows can be highly sensitive to funds’ past performance, leading to higher non-discretionary trading costs as managers meet redemptions. Another distinguishing feature of this industry is the pervasive use of asymmetric, performance-based bonuses/fees in the manager’s compensation contract. Additionally, though far less often, the contract also contains a high-water mark provision (HWM hereafter) that makes the manager’s performance fee contingent upon the fund recovering all previous losses.

In this paper we demonstrate that compensation contracts with HWMs can arise endogenously in competitive markets for hedge funds. We argue that HWM-contracts play two distinct roles to reduce costs of asymmetric information on manager ability. First, including a HWM in the compensation contract is costly for all managers, but more so for managers who are less likely to generate positive returns. Hence, the HWM can improve the average quality of the pool of managers raising a fund. This certification role is likely to be more important for funds with share restrictions, like lockups, that make it difficult for investors to withdraw capital following poor performance. Second, the HWM reduces future manager fees following bad performance, thereby making the fund more attractive precisely when investors have less favorable beliefs about manager ability. Keeping investors within the fund can be efficient when the fund is attractive on a before-fee basis and managers cannot renegotiate the compensation contract.

We show these ideas using a simple, dynamic model in which wealth-constrained managers raise capital from outside investors in exchange for a performance fee. Each manager invests the fund’s capital into a risky asset that exhibits independent and identically distributed (i.i.d.) returns over each performance period. However, managers differ in their ability as reflected in the expected returns of the risky asset. Two starting premises of the model are, first, manager ability is ex ante private information

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\[1\] In a recent letter to the SEC, hedge fund manager Phillip Goldstein argues that the mandatory quarterly 13F public disclosures to the SEC force hedge funds to publicly disclose valuable trade secrets. “The entire value of a trade secret lies in its secrecy,” his letter said. “Once a trade secret is publicly disclosed, its owner loses its entire economic value...”

\[2\] Goetzmann, Ingersoll, and Ross (2003) find that explicit performance fees represent a significant fraction of a hedge fund manager’s total expected compensation. Elton, Gruber, and Blake (2003) find that the number of mutual funds offering performance fees is less than 2% of the total number of stock and bond funds.
and investors learn and update their beliefs about manager ability in response to performance; and second, managers decide and commit to a compensation structure at the fund’s inception. We derive competitive equilibrium for the fund industry, in the sense that managers who enter the industry and raise capital will set fee contracts to extract all the (expected) surplus from investors due to the limited supply of qualified managers relative to the size of investors (e.g., Berk and Green, 2004). We take as exogenous the general form of the compensation contract as follows: A performance fee that is paid out as a percentage of positive profits earned in a given period, and potentially also a HWM provision that restricts the manager from earning additional fees until previous losses are recovered. The contract parameters, investors’ beliefs and capital flows are determined endogenously in the model.

We first examine the benchmark case in which manager ability is known to both managers and investors. In this case, the equilibrium performance contract without a HWM is optimal and efficient in that it maximizes total surplus between investors and managers. Since manager ability is known and the performance fee is a claim to a constant fraction of fund profits, investors’ after-fee expected returns (and their participation constraint) are constant over time and across states given the i.i.d. return structure of the risky asset. In equilibrium, therefore, each manager that enters the market will choose a unique performance fee that makes investors just indifferent between staying with and leaving the fund. On the other hand, the presence of a HWM in the performance contract leads to state-dependent expected returns on an after-fee basis. Specifically, the fund is more attractive for investors following poor performance because the HWM increases after-fee returns. This implies that the manager will set a higher performance fee ex ante in order to extract all the surplus. In the absence of contract renegotiation, a higher fee will violate the investor rationality constraint and lead to outflows following good performance (where the HWM does not change performance fees earned). Investor flows reduce surplus when the fund is attractive on a before-fee basis, and thus the HWM contract is inefficient.

We next examine whether the HWM can lead to greater surplus in the presence of asymmetric information on manager ability. We consider two cases. First, we assume that investors are unable to withdraw their capital after learning about manager ability. This case corresponds to funds that have explicit restrictions on share redemptions, like lockups and notice periods. In this case, a contract without a HWM necessarily leads to a worse pool (i.e., lower average quality) of managers as compared

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3Chordia (1996), Nanda et al. (2000), and Lerner and Schoar (2004) show that share restrictions help investment funds screen for longer-horizon investors. Aragon (2007) documents that lockups are more common among hedge funds that manage illiquid assets.
to first-best, and therefore lower surplus. Since including a HWM in the fee structure is more costly for lower-quality managers, the HWM can credibly certify manager quality ex ante and improves the quality of the pool of managers entering the market, thereby leading to more surplus and higher efficiency. A key prediction of our model is therefore a negative association between the HWM usage and manager reputation.

Next we consider the case where investors do not face redemption restrictions and can freely withdraw capital from the fund. In this case we find that the certification role of the HWM is diminished because the entrance of low-quality managers can be deterred by the threat of investor outflows following poor performance. However, when investors can freely remove capital, the inability to renegotiate the compensation contract can lead to a deadweight cost when the fund is attractive on a before-fee basis. This inefficient (ex post) liquidation occurs following poor performance because the (ex ante) performance fee is too high given updated beliefs. The situation here is similar to debt financing in the framework of incomplete contracts (e.g., Aghion and Bolton 1992). The control of assets shifts to the debtholders and asset liquidation occurs when the firm defaults on the loan, even though liquidation is sometimes (ex post) inefficient, but cannot be avoided due to the ex ante commitment not to renegotiate the debt contract. In this regard, we show that a HWM has a second, “lock-in” role that reduces inefficient fund liquidation. By waiving the performance fee following poor performance, the HWM raises investors’ expected after-fee returns without altering the performance fee contract. Hence, the HWM-fund can avoid investor withdrawals and fund liquidation after poor performance and increase total surplus. Further, in the context of hedge fund contracts, we show that this lock-in effect of HWMs, first discussed by Goetzmann et al. (2003, pp. 1700-02), can arise endogenously in a competitive market setting.4

We find empirical support for our model’s predictions using a sample of 8,526 hedge funds and their affiliated management companies (i.e., fund families) from the TASS database, over the period 1994-2007. Among these funds, 4,947 are ‘live’ as of March 19, 2008, and the remaining funds have ceased reporting to TASS and are considered ‘defunct.’ While 91% of all funds (excluding funds of funds) have a performance fee only 68% of all funds use a HWM.

Our empirical analysis yields several new findings. First, the HWM provisions are more commonly used by smaller funds or funds that are operated by management companies with shorter track records.  

4The lock-in effect that we document is similar to the practice of fee-waiving by mutual funds documented in Christoffersen (2001). She argues that fee waivers are an indirect method of setting flexible performance-based fees to circumvent a suboptimal fee structure.
For example, the likelihood of using a HWM increases by 4.92% per one standard deviation decrease in the fund family’s track record length. We also find that HWM funds are subject to greater sensitivity of flows to past performance as compared to no-HWM funds, even after controlling for variation in our manager reputation proxies. These results are consistent with our model’s prediction that HWMs are used by fund managers facing asymmetric information regarding their ability.

Second, we find that a (one-year) lockup provision and a one standard deviation increase in the redemption notice period are associated with a 13.4% and 11.2% increase in the likelihood of using a HWM, respectively. Further, we find that the negative relation between the HWM usage and fund families’ size and length of track record is concentrated among funds that restrict investor redemptions. These results support our model’s prediction that the certification role of HWMs in environments with asymmetric information on manager ability becomes more useful when investors cannot remove capital from poorly performing funds, leading to possibly worsened adverse selection. In addition, we exploit plausibly exogenous changes in hedge fund lockup periods attributable to changes in hedge fund registration requirements, and find that increases in lockup periods are associated with an increased usage of HWMs. This evidence suggests that the relationship between lockups and HWMs is unlikely to be driven by an endogeneity bias resulting from the fact that funds’ use of these two features are jointly determined.

Third, we find a negative relation between HWMs and underlying asset liquidity, as proxied by the autocorrelation of monthly returns, after controlling for the presence of share restrictions. The positive relation is more pronounced for managers whose fund family has a shorter track record. Edelen (1999) and Chordia (1996) show that investor redemptions can lead to significant non-discretionary trading costs, and we expect these costs to be greater for funds investing in more illiquid assets. Therefore, we interpret our results to be consistent with the lock-in mechanism of a HWM, and this mechanism is more useful for fund managers facing more severe degrees of asymmetric information. In addition, we find that the greater flow-performance sensitivity associated with HWMs is driven by investors’ response to superior past performance. HWM-funds with poor performance actually have lower flow-performance sensitivity than funds without a HWM, consistent with the lock-in mechanism of the HWM.

Our paper contributes to the literature on the forms of investment manager compensation. Prior research examines how contract parameters are related to portfolio choice, taking the contract as given. Other studies have focused on how performance-based compensation (versus a fixed wage) can reduce costs associate with moral hazard and/or asymmetric information. Complementing these studies, our
model studies the joint use of performance fees and HWMs, and empirically examines model predictions on hedge fund contracts. Goetzmann et al. (2003) evaluate the cost of a HWM-adjusted fees structure to investors, taking as given the fund’s fee structure and investment decisions. Hodder and Jackwerth (2007) and Panageas and Westerfield (2009) demonstrate that the use of HWMs can reduce the risk-taking behavior of risk-averse fund managers. By contrast, in our risk-neutral model we illustrate how HWMs can arise endogenously in a competitive market setting with asymmetric information on manager ability, and identifies two distinctive roles of HWMs that can enhance the efficiency of the fee contracts. In addition, our paper bridges a gap between the form of manager compensation and restrictions on investor flows, and also the underlying asset liquidity of the fund’s portfolio.

The rest of the paper is organized as follows. In Section 2, we develop a multi-period model of the hedge fund industry with fund flows, and demonstrate how the addition of a HWM to a performance fee contract can solve problems of asymmetric information and improve efficiency. Section 3 describes the data and presents empirical tests on our model predictions. Section 4 concludes. All the proofs are in the Appendix.

2 The Model

In this section we describe our model of investment and compensation in the hedge fund industry. The model yields partial equilibria in that funds’ investment and fee structures do not affect interest rates and the aggregate economy.

2.1 Elements of the Model and First-Best

There is a continuum of managers and investors. All agents are risk neutral and do not discount payoffs. Each manager has zero initial wealth and must raise $1 from a continuum of identical, outside investors in order to set up a fund and invest in a risky asset. We assume that all managers have the same reservation wage ($W$), available only at the fund inception date (Date 0). Investors are assumed Bayesian rational, and may invest in an outside opportunity that yields a constant gross return of $R_0$ per period or with a fund manager. The measure of fund managers is assumed to be smaller than that of aggregate funds.

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available from the small investors. Hence, funds that enter the industry and raise capital can always achieve their desired capital level without having to offer investors an expected return (per period) greater than $R_0$.

The risky asset generates a gross return of either $u$ or $d = 1/u$ in each of the two periods, where $0 < d < 1 < u$. Manager types are distinguished by the probability of a positive net return. Specifically, manager $i$’s expected return of managing the risky asset is defined as $R_i \equiv p_i u + (1 - p_i) d$, where $p_i$ denotes the manager’s ability or type. Manager types are private information. However, it is common knowledge that the population of manager types is uniformly distributed with upper and lower bound $\bar{p}$ and $\underline{p}$, respectively $(0 \leq \underline{p} < \bar{p} \leq 1)$.

Figure 1 describes the timeline and payoffs of the risky asset and a representative fund. At Date 0, the manager raises capital and announces the fee (compensation) structure. At Date 1, investors observe the first period returns, revise their beliefs about manager ability, and decide whether to liquidate the fund. If the fund is liquidated, then investors re-invest the proceeds at $R_0$. If the fund is not liquidated, it operates for another period, and, at Date 2, fund returns and fees are realized and the fund is shut down.

An important element of our model is investor flows. Investors decide whether to withdraw their capital from the fund at Date 1 given their updated beliefs on manager ability after observing the fund’s first period return. We assume that it is impossible for a fund to attract new investors after Date 0. At Date 1, therefore, risk-neutral investors will either leave 100% of the remaining capital in the fund or force the fund to shut down.

The fee structure is announced at Date 0 and is publicly observable and verifiable. We take as exogenous the following compensation contract: 1) A performance fee that is paid out of the fund’s assets, as a fixed percentage ($f$) of any positive profits earned in the first and second periods; and 2) a HWM provision that makes performance fees contingent on the recovery of all fund losses at any prior date. We also assume that performance fees earned at Date 1 are reinvested in the risky asset. Finally, as commonly observed in practice, funds cannot revise fee structure at Date 1.

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7This assumption rules out the possibility that investors can wait until Date 1 to invest in a fund. In practice, many funds use a “share equalization method,” where funds will reset the HWMs for investors arriving after the inception of the funds.

8We assume that the cost (e.g., reputation loss) for managers to walk away from a fund at Date 1 is high. For more discussions on the managers’ walk-away option, see, e.g., Chakraborty and Ray (2010).

9This assumption simplifies analytical derivations, but is not necessary for the main results. Instead, we could assume the manager’s Date 1 fees are taken out of the fund and invested in a risk-free asset.
we present empirical evidence, in Section 3.4 below, on the rarity of contract renegotiation even following a significant change in the regulatory environment.

To summarize, given that there will be no fund inflow or renegotiation of a fund’s fee structure at Date 1, a fund manager chooses the fee structure \((f\) and the use of HWM) at Date 0 to maximize expected fees, while investors first decide at Date 0 whether to invest in a fund, followed by their withdrawal decision at Date 1. The compensation contract—both \(f\) and the decision to include a HWM to calculate performance fees, investor beliefs and liquidation decision are determined endogenously in equilibrium.

The criteria for the First Best outcome is to maximize (Date 0) expected total surplus between fund managers and investors, with information on manager types publicly available at Date 0. In our multi-period model, total surplus depends on both the type of manager raising a fund and also whether the fund is liquidated at Date 1.

**Definition 1** Let \(I(p_i)\) denote an indicator that equals 1 if a type \(p_i\) fund is liquidated at Date 1. The surplus generated by manager of type \(p_i\) from raising a fund is defined as

\[
s(p_i) \equiv (1 - I(p_i)) \times [R_i^2 - R_0^2 - W] + I(p_i) \times [R_i - R_0 - W].
\]

Furthermore, the aggregate surplus is defined as the cumulative surplus across all managers that raise a fund at Date 0.

The first bracketed term equals the surplus from managing the risky asset over two periods—namely, the difference between the expected return on the risky asset and the sum of the investor’s outside opportunity and the manager’s reservation wage. The second bracketed term is the surplus from managing a fund for one period. As stated above, in equilibrium manager \(i\)’s decision to raise a fund and the fund’s duration are determined endogenously.

**Lemma 1** Aggregate surplus is maximized iff every manager of type \(p_i \geq p^{FB}\) raises a fund and there is no liquidation at Date 1, where \(p^{FB} = \frac{\sqrt{W + R_0^2} - d}{u - d}\).

Lemma 1 states that the necessary and sufficient conditions for an efficient equilibrium – that is, one that maximize aggregate surplus, include a critical value of manager skill \((p^{FB})\) above which all managers enter the industry and raise capital. Moreover, for all such managers who enter and set up a fund, the fund should not be liquidated at Date 1. Thus, for each manager \(i\), (individual) surplus equals the expected returns from managing a fund for two periods less the manager’s reservation wage and the investor’s
outside opportunity, i.e., $R_i^2 - R_0^2 - W$. The critical lower bound on manager quality $p^{FB}$ results from the assumption that the reservation wage is the same across managers, and therefore the surplus is increasing in manager type $p_i$.

2.2 Competitive Equilibrium When Manager Ability is Known

In this section we solve the equilibrium contracts in competitive markets for hedge funds (Second Best) in the benchmark case where manager types are publicly observable. In this case, the equilibrium contract without a HWM achieves First Best. The following proposition establishes that, when manager ability is known, a competitive equilibrium without a HWM in the compensation contract can yield the First Best outcome.

**Proposition 1** If manager ability is known and the compensation contract does not contain a HWM, then the competitive equilibrium specified below yields the First Best total surplus:

- a) The performance fee for manager $i$ is $\bar{f}_i = \frac{R_i - R_0}{p_i(u-1)}$;
- b) A fund is raised and managed for two periods iff $p_i \geq p^{FB}$ and there is no outflow at Date 1.

In the case of known manager ability and no HWM and given the i.i.d. return structure of the asset, investors’ opportunity set is constant across periods and states: At each node, the investor rationality constraint satisfies $p_i(u-(u-1)f)+(1-p_i)d \geq R_0$. Hence, the manager can choose a constant performance fee $\bar{f}_i$ that makes investors indifferent between staying with or leaving the fund at all dates and states, i.e., their rationality constraint is binding at every date/state, and extract all the surplus. Moreover, since investor rationality is binding at each date, there is no fund outflow in equilibrium.

While the no-HWM fee contract described in Proposition 1 is efficient, we show in the following lemma that the same cannot be said for a fee contract with a HWM.

**Lemma 2** If manager ability is known and a HWM is used to calculate performance fees, then in the competitive equilibrium the optimal performance fee is given by:

$$\hat{f}_i = \frac{p_i u R_0 + (1-p_i)d \cdot R_i - R_0^2}{p_i(u-1)R_0} > \bar{f}_i.$$  

Furthermore, there is fund outflow at Date 1 following good performance.
Lemma 2 shows that there exists an equilibrium in which the performance contract includes a HWM. However, in this equilibrium there is fund outflow at Node 1u and is therefore inefficient according to Lemma 1. With the HWM, the investor rationality constraint for investing/staying with the fund is path-dependent even when manager ability is known and outside opportunities are constant. Specifically, the after-fee returns are higher following poor performance (Node 1d) because the HWM waives fees after a loss, but the HWM has no impact on after-fee returns following good performance (Node 1u). This asymmetric impact of the HWM on after-fee returns implies that, unlike the case with a fee contract without a HWM, the investor rationality constraint cannot bind at all three dates/nodes: Date 0, Node 1u and Node 1d. For example, if a manager can raise a fund at Date 0 by making investors just indifferent between investing in the fund for two periods and receiving \( R^2 \), investors’ rationality constraint will not bind at Node 1d since the HWM waives the fees and investors extract surpluses in the second period; but, for the manager to maximize their expected fees, he would set a higher performance fee (as shown in Lemma 2), but this means the investor rationality constraint will be violated at Node 1u, leading to investor outflows and lower total surpluses than the case without a no-HWM fee contract.

2.3 Competitive Equilibrium With Asymmetric Information

In the previous section we show that, when manager ability is known, the First Best outcome is achievable without a HWM in the compensation contract, and the contract with a HWM is associated with lower total surplus. In this section, we examine whether a HWM can lead to more efficient equilibrium outcomes in an environment with asymmetric information on manager ability. Before studying the roles of a HWM in compensation contracts, we first derive preliminary results that characterize the fund industry for the case of asymmetric information.

Lemma 3 Let \( f_i \) denote the performance fee of manager \( i \) and let \( h_i \) denote an indicator variable that equals one if manager \( i \) uses a HWM to calculate performance fees. Then there is no competitive equilibrium in which \( i \neq j \) implies \((f_i, h_i) \neq (f_j, h_j)\).

Lemma 3 shows that no competitive equilibrium can be fully separating. If manager types are observable, competitive equilibrium fee contracts are given by either Proposition 1 or Lemma 2 depending on whether a HWM is used to compute fees. Since both \( \tilde{f}_i \) and \( \hat{f}_i \) increase with manager quality, lower-quality managers have an incentive to mimic higher-quality managers. Thus, in a separating equilibrium, high-quality managers need to set lower performance fees in order to deter low-quality managers from
mimicking. However, any fee lower than \( \hat{f}_i \) and \( \widehat{f}_i \) creates investor surplus and therefore violates the condition for a competitive equilibrium. Lemma 3 motivates our focus on pooling equilibria, in which all the managers entering the market at Date 0 set the same fee contract.

We can now characterize pooling equilibria with different contracts and the use of HWMs in the asymmetric information case. We show that the HWM serves two distinct roles that can lead to higher total surplus as compared to equilibrium contracts without a HWM. We next consider two cases depending on whether investors can freely withdraw capital from the fund at Date 1.

### 2.3.1 Restricted Investor Flows and the Certification Role

In this subsection we assume that investors cannot remove their capital at Date 1. This situation corresponds to the use of share redemption restrictions, such as a lockup. As prior research has shown, the purpose of using lockups is to reduce the costs associated with (informationless) investor flows, especially when the fund invests in illiquid assets (e.g., Chordia 1996; Edelen 1999; Nanda et al. 2000; Aragon 2007), or to screen for long-term investors (e.g., Lerner and Schoar 2004). However, in our model we show that these restrictions worsen the adverse selection problem and that HWMs can improve surplus by certifying manager quality ex ante.

**Proposition 2** Suppose there is asymmetric information about manager ability and investors cannot leave the fund at Date 1, and let \( p^*_l (f^*_l) \) and \( p^*_{lh} (f^*_{lh}) \) denote the equilibrium pool of managers that raise a fund (fee) in the absence and presence of a HWM, respectively. Then a) \( p^*_l < p^{FB} ; \) and b) there exists a set of parameters such that \( p^*_l < p^*_{lh} \leq p^{FB} . \)

The first part of Proposition 2 shows that, when investor fund flows are restricted, an asymmetric information pooling equilibrium without a HWM necessarily implies a lower average quality of managers as compared to First Best. Without investor flows or a HWM, the only possible mechanism to deter the entrance of lower quality managers at Date 0 would be for higher quality managers to set lower fees (than \( f^{FB} \)); but, this is costly as all managers face the same reservation wage. As a result, the average quality of managers raising a fund is lower than that of First Best \( (p^*_l < p^{FB}) \), leading to lower total surplus. More importantly, Proposition 2b) shows that, in the absence of investor flows, a HWM can certify manager types at Date 0 and deter the entrance of lower quality managers. By definition, all managers of ability \( p < p^{FB} \) generate negative surplus. Therefore, in contrast to the case where manager ability is known, a HWM-equilibrium can strictly increase the lower bound on manager quality towards
the First Best, leading to higher aggregate surplus.

Figure 2 uses a numerical example to illustrate the intuition behind Proposition 2. For possible equilibria in the case of asymmetric information with no flow at Date 1, we use the following set of parameters: $u = 1.2$, $R_0 = 1$, $W = 0.05$; we also assume that manager type $p$ is uniformly distributed over the interval $[0, 1]$, i.e., $p = 0$ and $p = 1$. The figure plots the lower bound on manager quality (top panel), investor surplus (middle panel), and the expected (Date 0) aggregate surplus (bottom panel) as a function of the performance fee ($f$) and depending on whether a HWM is used to calculate performance fees.

According to Lemma 1, the First Best outcome in this example involves all managers of type $p \geq p_{FB} = 0.52$ raising a fund. This implies a maximum total surplus of 0.091. The top panel of Figure 2 is consistent with the intuition that a higher performance fee attracts lower quality managers, thereby decreasing the lower bound on managers that raise a fund. However, for each performance fee, the lower bound on manager quality in the presence of a HWM is never less than that in the absence of the HWM. This reflects the fact that a HWM lowers expected fees for a given performance fee.

Investor surplus reflects the expected (Date 0) after-fee returns from investing with the fund less the (constant) outside opportunity. As shown in the middle panel of Figure 2, a higher performance fee lower investor surplus for two reasons: first, it reduces the after-fee returns to investors for a given manager pool; and second, it reduces the quality of the manager pool, thereby reducing the attractiveness of investing with the fund. The competitive equilibrium point is reached where investor surplus equals zero (crosses the horizontal axis). For the HWM contract, the equilibrium performance fee ($f_{lh}$) and lower bound on manager quality ($p_{lh}$) are 58% and 0.33, respectively, as compared to 52% ($f_l$) and 0.26 ($p_l$) for the equilibrium without a HWM.

The bottom panel of Figure 2 plots the (Date 0) aggregate surplus for the two cases as a function of the performance fee. For performance fees close to zero, the aggregate surplus is zero because low performance fees fail to attract managers to forego their reservation wage and raise a fund. As the performance fee rises, some managers are attracted to the industry and surplus rises. After some point, however, the quality of the marginal manager deciding to raise a fund decreases, and, as a result, the aggregate surplus also falls. The equilibrium with a HWM generates higher aggregate surplus as compared to without a HWM (0.077 for a fee of 58% versus 0.066 for a fee of 52%) because it improves the equilibrium pool of managers that raise a fund towards the First Best level.
2.3.2 **Unrestricted Investor Flows and the Lock-In Role**

In this subsection we allow investors to withdraw capital after observing fund performance at Date 1. Investors’ decision to leave the fund at Date 1 will depend on how the continuation value compares with the outside opportunity. The following lemma shows that investors will leave the fund after poor performance.

**Lemma 4** *The equilibrium fee contract in the absence of a HWM implies that investors leave the fund at Date 1 if and only if the fund performs poorly.*

In the absence of a HWM, changes in investors’ continuation value depend entirely on their beliefs about manager quality. Bayesian investors revise downward the quality of the manager following poor performance and vice versa. Therefore, if investors do not leave the fund at Node 1\(d\), then they must stay with the fund at Node 1\(u\), where the continuation value is higher. Moreover, since investors’ beliefs at Date 0 about manager quality are also higher than that at Node 1\(d\), this implies that investors strictly prefer to stay with the fund at Date 0, thereby violating the competitive equilibrium condition that managers extract all the surplus from investors through the fee structure. Similarly, investors cannot leave the fund at Node 1\(u\) because this would imply a violation of investor rationality at Date 0, where investors’ beliefs about manager quality are even less favorable as compared to beliefs at 1\(u\).

Lemma 1 and Lemma 4 together imply that any asymmetric information equilibrium without a HWM leads to lower total surplus than First Best. Even if the equilibrium pool of managers matches First Best, the inability of investors to discriminate among managers forces managers to set the same fee. At Date 1, an outflow is generated, leading to fund liquidation, because poor-performing funds will be overvalued relative to the pooling fee. However, liquidation following poor performance is inefficient if the manager can generate a higher, before-fee return than the investor’s outside opportunity.

A second implication is that the certification role of a HWM in improving the quality of the pool of managers is diminished because investor flows have the same effect on manager fees as the HWM. In our two-period model, outflows also eliminate the manager’s ability to earn fees following poor performance. However, the flow-based mechanism is different from the HWM in that unrestricted flows necessarily lead to fund liquidation at Node 1\(d\). This suggests that a HWM might still play a role in reducing investors’ incentive to leave the fund following poor performance and thus avoiding inefficient fund liquidation.

Inefficient liquidations in our model are analogous to what happens to firms when they default on debt. In the framework of incomplete contracts (e.g., Aghion and Bolton 1992), the control of assets shifts
from shareholders to debtholders and asset liquidation occurs upon default, even though liquidation is sometimes (ex post) inefficient. Liquidation cannot be avoided because shareholders and debtholder commit, ex ante, not to renegotiate the debt contract, as renegotiation may lead to other problems. In this regard, a HWM can play an additional role under asymmetric information to increase total surplus. By waiving fees following a loss— at Node 1, the HWM raises investors' after-fee return without altering the Date 0 fee contract, thus avoiding inefficient fund liquidation. The next proposition shows that, this feature of the HWM can increase total expected surplus toward First Best, even though the quality of the pool of managers raising a fund worsens relative to the equilibrium without a HWM in the fee contract.

**Proposition 3** With investor flows and asymmetric information on manager ability, a HWM-contract is associated with higher surplus than the contract without a HWM if, in the HWM-equilibrium, there are no fund flows at Date 1. In addition, such an equilibrium exists, and, as compared to the pooling equilibrium without a HWM, involves a higher performance fee and a worse pool of managers.

Proposition 3 states that there exists a pooling equilibrium in which the use of a HWM in the Date 0 compensation contract can increase total surplus as compared to the situation without a HWM. A sufficient condition for this to occur is that investors find it incentive compatible to remain with the fund following both good and bad performance at Date 1. The intuition stems from two observations. First, investors remain with the fund at Node 1 because their beliefs about manager ability are more favorable as compared to Date 0, where their rationality constraint is binding. Second, in order to assure that no outflow occurs at Node 1, it is necessary that, on a before-fee basis, the fund is more attractive than the investor's outside opportunity ($R_{1d} \geq R_0$). In contrast, Lemma 4 predicts that investors will always leave the fund at Node 1 in the absence of a HWM. In particular, investors will leave the fund because the fee contract cannot be renegotiated and the updated manager quality ($p_{1d}$) implies that the after-fee return is lower than $R_0$. In this regard, the HWM contract, announced at Date 0, effectively allows the managers to commit to waiving their fees following poor performance without revising the fee contract, thereby avoiding investor withdrawals and creating more (Date 0) surplus.

\footnote{In our context, renegotiation may be costly because while information on fund’s past and future (expected) returns as well as that of investor’s outside opportunity may be observable to both parties, this information is not verifiable by a third party (e.g., a court). This implies that opportunistic behaviors (holdup problem) may occur during renegotiation. For example, investors have an incentive to demand a lower fee whenever the realization of their outside opportunity is high. See, e.g., Hart and Moore (1988) for a model on how renegotiation can lead to holdup problems that reduce (ex ante) total surplus.}
The mechanism through which the HWM contract enables managers to capture all the Date 0 surplus from investors is by charging a higher performance fee, thereby earning more fees after a positive return at both Dates 1 and 2. The higher performance fee (at Date 0) is acceptable for investors because the HWM allows them to earn higher expected returns following Node 1. Interestingly, Proposition 3 also shows that the HWM-equilibrium does not improve the quality of the equilibrium manager pool. This is the case because higher fees attract lower quality managers to enter the market, while investor flows (or the HWM) will not affect fees earned in the first period if these managers get ‘lucky.’ In this sense, the beneficial role of a HWM in retaining investors after a loss is distinct from its role in reducing adverse selection described in Proposition 2 above. To summarize, Proposition 3 demonstrates that the lock-in effect of a HWM discussed by Goetzmann et al. (2003, pp. 1700-02) can arise endogenously in a competitive market setting with asymmetric information on manager ability.

Figure 3 uses a numerical example to illustrate the basic intuition behind Proposition 3. We use the same set of baseline parameters as in Figure 2 above: \( u = 1.2, R_0 = 1, W = 0.05, \) and \( p = 0. \) The figure plots and compares how \( \bar{p}, \) the upper bound of the distribution of manager types, affects the equilibrium performance fee (top panel), cutoff manager type to enter the market (middle panel), and aggregate surplus (bottom panel), for the two pooling equilibria (with and without a HWM). Depending on parameters, one or both equilibrium might not exist. For example, the HWM equilibrium with no investor flow exists only for high values of \( \bar{p}. \)

The top panel of Figure 3 shows that the equilibrium performance fee is increasing in \( \bar{p} \) for both the HWM and no-HWM equilibria, as a higher \( \bar{p} \) indicates higher quality of the population of managers. But the fee is higher in the HWM equilibrium. Similarly, as the middle panel illustrates, the equilibrium cutoff manager type is decreasing in \( \bar{p} \) for both the HWM and no-HWM equilibria, but the pool of managers has lower average quality in the HWM equilibrium. However, the absence of inefficient liquidation at Date 1 (Node 1d) in the HWM case leads to greater overall (Date 0) expected surplus despite a worse pool of managers, and this is reflected in the bottom panel.

2.4 Summary of Model Predictions

Here we review the results from our model and develop the empirical predictions tested in the following section. First, Proposition 1 shows that, when manager ability is observable, a performance fee contract without a HWM always leads to an efficient equilibrium, in the sense that the aggregate surplus equals First Best. On the other hand, Lemma 2 implies that the HWM contract is generally inefficient under
symmetric information. However, in the case of asymmetric information on manager ability, Propositions 2 and 3 show that HWMs can lead to a more efficient equilibrium as compared to fee contracts without a HWM. Taken together, a key prediction of our model is that asymmetric information is necessary for the use of HWMs. Thus, we expect HWMs to be more frequently used among managers who face more severe degrees of asymmetric information of their ability.

Second, Proposition 2 shows that HWMs can provide a certification role for manager ability when investor flows are restricted. In particular, a HWM can improve the equilibrium pool of managers, thereby increasing aggregate surplus. Thus, after controlling for variables that measure managerial reputation (and asymmetric information), we expect HWMs to be more frequent among funds with longer lockup provisions and redemption notice periods. We also test the interaction between our asymmetric information variables and share restrictions. That is, managers with less reputation and use lockups should be most likely to use HWMs.

Third, when investors are unrestricted from leaving the fund, Proposition 3 shows that the (ex ante) use of a HWM can raise aggregate surplus by reducing (ex post) inefficient liquidation. Inefficient liquidation arises when, in the absence of a HWM, investors force fund liquidation even if on a before-fee basis the fund is more attractive than the investor’s outside opportunity. Therefore, we expect to find greater HWM usage among funds for which liquidation is likely to be most costly. Specifically, we expect that HWM’s are more frequently used by funds with greater underlying asset illiquidity, and that this relation is especially strong for funds with shorter track records.

Finally, our model has implications for the sensitivity of investor flows to past performance. Specifically, the presence of HWM’s corresponds to a pooling equilibrium in which investors update their beliefs about managers’ quality based on past performance. Therefore, we hypothesize an overall positive association between HWM usage and the sensitivity of fund flows to past performance. In addition, the greater sensitivity should be especially strong following good performance, because in this case the lock-in effect is unlikely to play a role.

3 Empirical Analysis

In this section we present the results from testing the model’s main empirical predictions. We first examine how the HWM usage varies with fund characteristics that are measurable at the date of fund inception. We then examine how the sensitivity of fund flows to past performance is related to the use of
HWMs. We also report on the robustness of our findings to excluding Funds of Funds, data biases, and a potential endogeneity problem between the use of HWMs and restrictions on share redemptions.

3.1 Data

The main database used in our empirical analysis is supplied by Lipper/TASS, a major hedge fund data vendor. Our sample period covers January 1994 through December 2007. The raw sample includes 8,526 individual hedge funds, of which 4,947 are ‘live’ as of March 19, 2008. The remaining funds have ceased reporting to TASS and are considered ‘defunct.’ For each fund we observe net-of-fees returns and also organizational characteristics. The form of manager compensation is reported by TASS in three separate fields: First, the fixed management fee equals the percentage of total net assets awarded to the manager during each fee payable period. Second, the performance fee equals the percentage of total profits awarded during each period. Third, an indicator variable that equals one if the fund uses a HWM to calculate performance fees.

Our model predicts that the HWM usage is associated with asymmetric information about manager ability. Following Gompers and Lerner (1999), we define two measures of manager reputation that are based on the fund’s management company (i.e., fund family). First, we consider the length of the family’s track record when the (new) fund was opened. This is defined as the number of months between the fund’s inception date and the earliest inception date across all funds belonging to the same management company. Second, we consider the sum of total net assets across all other funds managed by the corresponding fund family. Both the age and size variables are measured at the year-end preceding the date the fund was organized. It is common for a fund family to list multiple individual funds. In our sample, the average and maximum number of funds per family are 6.59 and 86, respectively.

Our model also predicts a positive relation between the HWM usage and the fund’s restrictions that limit the ability of investors to remove their capital. Redemption policy characteristics are directly observable from the database and include the initial lockup and redemption notice period. In our sample, lockup periods are clustered around one year and exhibit little variability across funds. Following Aragon (2007), we focus on an indicator variable that equals one if the fund has a lockup period and zero otherwise. The redemption notice period is the number of days of advanced notice that investors must provide to the fund before redeeming their shares. Unlike the lockup period, the notice period is a rolling restriction and applies throughout the investor’s tenure with the fund.

Finally, we test the relation between the HWM usage and the illiquidity of the fund’s underlying
assets. Ideally, a measure of asset illiquidity would be calculated by looking directly at the illiquidity of the fund’s portfolio. However, holdings data are generally unavailable for hedge funds. Instead, we follow Getmansky, Lo, and Makarov (2004) and use the estimated first-order autocorrelation coefficient of monthly fund returns as a proxy for asset illiquidity. From the original set of 8,526 funds, 1,165 were dropped because they did not have at least 18 return observations with which to estimate the first-order autocorrelation coefficient.

3.2 Fund Characteristics and the Use of HWMs

Table 1 summarizes various characteristics for the sample of hedge funds, depending on the HWM usage. The first two rows of Panel A (all funds) reveal that the median performance and management fees (20% and 1.50%, respectively) are identical for the two fund subgroups. However, HWM-funds are associated with higher mean performance fees than funds without a HWM. From Panel A, the difference in means is 4.92% and statistically significant. The next two rows correspond to our proxies for manager reputation. HWMs are observed more frequently among funds established by less reputable families, as proxied by family age at fund inception. Specifically, the difference in family track record length between HWM and no-HWM groups is −4.56 months and significant at 1%. A similar pattern is observed for the other reputation proxy – the natural logarithm of family size; however, the difference is not significant. Lockups and notice periods are also higher among funds that use HWMs. For example, 32% of HWM funds have lockups as compared to just 11% for funds that do not use HWMs. Finally, the average monthly return autocorrelation is higher (0.14 vs. 0.13) among funds with HWMs; however, the difference is not statistically significant.

Panel B reports the same statistics for the subsample of funds that excludes Fund of Funds (FoFs). Liang (2004) and Brown, Goetzmann, and Liang (2004) advocate treating FoFs separately from other hedge funds. They note that the fee structure of these funds typically involves a much lower performance fee as compared to funds in other style categories. Panel B shows that the main comparisons are unchanged. The use of HWMs is associated with shorter family track records, longer lockups and notice periods, and greater return autocorrelations. One change from Panel A is that the difference in average logarithm of family assets between funds with and without HWMs is positive (0.39); but once again, this difference is not significant. Overall, we interpret the univariate results as consistent with the predictions that HWMs are associated with asymmetric information about manager ability, restrictions on investor fund flow, and costs of liquidating the fund’s assets.
Table 2 shows the results from a multivariate probit analysis. The dependent variable is an indicator variable that equals one if a HWM is used. Panel A uses the natural logarithm of family age (FamAge) while Panel B uses the natural logarithm of family assets (FamSize) as the proxy for fund reputation and the degree of asymmetric information on manager quality. Both variables are measured at the end of the year prior to the year of fund inception. We consider three different variables for share restrictions. $D_{Lock}$ is an indicator variable that equals one if the fund has a lockup provision; $\text{Notice}$ is the natural logarithm of the fund’s redemption notice period; and $D_{ Restrict}$ is another indicator variable that equals one if the fund has a lockup provision or an above-the-median redemption notice period. Therefore, $D_{Restrict}$ distinguishes between funds that place strict or moderate restrictions on investor redemptions. We include fixed effects for a fund’s style category and year of inception into the estimation. The table reports estimated marginal effects and $t$-statistics for different models. All variables (except indicator variables) are standardized to have zero mean and variance of one across funds in the sample. Standard errors are clustered at the level of the fund family.

We find a negative relation between the HWM usage and family track record length. Specifically, a one standard deviation increase in the family age variable is associated with a 4.92% decrease in the probability of using a HWM (Model 1). The presence of restrictions on investor flow is positively related to HWM use. In fact, funds with strict restrictions ($D_{Restrict} = 1$) are 15% more likely to use a HWM. Model 2 reveals that the presence of a lockup and a one standard deviation increase in the redemption notice period variable are associated with a 13.4% and 11.2% increase in the probability of using a HWM. We also include interaction terms between share restrictions and family age in Models 3 and 4. The interaction terms are negative and significant. In fact, Model 3 shows that the negative relation between HWM and FamAge is almost entirely driven by funds that restrict investor redemptions ($D_{Restrict} = 1$). We interpret this evidence as support for our model’s prediction that the certification role of HWMs in environments with asymmetric information on manager ability is particularly useful when investors cannot remove capital from poorly performing funds, leading to possibly worsened adverse selection.

Models 5 − 8 include our proxy for asset illiquidity in the probit model. Overall, we find a positive relation between HWM usage and monthly return autocorrelation. For example, Model 5 shows that a one standard deviation increase in the asset illiquidity variable is associated with a 1.91% increase in the HWM usage. The estimate is significant, although about 60% smaller than the coefficient on FamAge. Therefore, while we find empirical support for both the certification and lock-in roles of HWMs, the former role appears to have a greater influence on a fund’s decision to use a HWM. Finally, Models 7 − 8 report
a negative interaction between the monthly return autocorrelation and family age. Specifically, Model 7 reveals that the positive relation between HMW usage and the asset illiquidity variable disappears among funds with a family age of one standard deviation increase above the mean. We interpret this evidence as support for our model’s prediction that HWMs are used to reduce (ex post) inefficient fund liquidation, and this lock-in mechanism is more useful for fund managers facing more severe degrees of asymmetric information about their ability.

Panel B shows that the main results are unchanged when FamSize is used to proxy for asymmetric information about manager ability. For example, a one standard deviation increase in family size is associated with a 5.33% decrease in HWM use (Model 1). Also consistent with the findings of Panel A, Model 3 reveals that the negative association between HWM and manager reputation is concentrated among funds that impose restrictions on investor redemption. We partly attribute the drop in statistical significance among the interaction variables to a smaller sample size (2,440 funds do not report information about family assets under management). Overall, we interpret the results as support for our predictions that HWMs arise in the presence of asymmetric information to help certify manager quality, especially when managers impose restrictions on share redemptions, and to reduce inefficient fund liquidation. We further conclude that our findings are insensitive to the choice of manager reputation variable.

3.3 Sensitivity of Flows to Past Performance and HWMs

The above results point to a negative relation between HWM usage and uncertainty about manager ability. In this section we provide further support for this relation by studying how net investor flows are related to past fund performance. In the pooling equilibrium described in Proposition 3, investors update manager quality based on past performance. To the extent that HWMs are associated with asymmetric information about manager quality, we expect greater flow-performance sensitivity for funds with HWMs. We estimate the pooled regression of annual net investor flows on past relative performance over the sample period 1994-2007. Specifically,

\[
\text{Net flow}_{i,y} = \beta_0 + \beta_1 \text{Rank}_{i,y-1} + \beta_2 \text{Age}_{i,y-1} + \beta_3 \text{HWM}_i + \gamma_1 \text{Rank}_{i,y-1} \times \text{Age}_{i,y-1} + \gamma_2 \text{Rank}_{i,y-1} \times \text{HWM}_i + \text{Controls}_{i,y-1} + \epsilon_{i,y},
\]

where \(\text{Net flow}_{i,y} = [A_{iy} - A_{i,y-1} \times (1 + R_{i,y})] / A_{iy}\), \(A_{iy}\) denotes the net asset value of fund \(i\) at the end of year \(y\), and \(R_{i,y}\) denote the net raw return of fund \(i\) during year \(y\). \(\text{Rank}_{i,y}\) denotes the percentage rank of fund \(i\)’s raw return across all funds in year \(y\); \(\text{Age}_{i,y}\) denotes the natural logarithm of the number
of available monthly return observations for fund $i$ at the end of year $y$; $HWM_i$ is an indicator variable that equals one if the fund has a HWM; and the control variables include the fund’s lockup, redemption notice period, assets under management, and year and style category fixed effects.

Table 3 reports the results from estimating Eq. (1) using a pooled estimation with standard errors clustered by year. We estimate the model on three subsets of the data. Models 1 and 2 correspond to the full sample of funds and the subsample that excludes FoFs, respectively. We exclude FoFs for robustness since, as described earlier, previous studies distinguish between FoFs and other style categories in the hedge fund industry. We also control for the presence of backfilled observations – namely, observations that precede the date a fund was added to the TASS database. Panel B excludes backfilled observations while Panel A does not.

We find a positive relation between annual net flows and the fractional rank of the fund’s past performance over the previous year. For example, the difference in net flow between the best and worst performing fund is about 110% of fund assets for the full sample (Model 1). The coefficient on the interaction term $\text{Rank} \times HWM$ is positive and significant, implying that the flow/performance sensitivity is approximately 18% greater among funds with a HWM. This result holds even after controlling for several other fund variables, including an interaction between performance and fund age. Similar results are obtained across the various subsamples. Taken together, we interpret this evidence as further support for the model’s prediction that HWMs are associated with a pooling equilibrium about manager ability.

Our model also predicts that HWMs provide a lock-in mechanism that serves to reduce fund outflows following poor performance. We address this issue using a difference-in-difference approach in which we allow the interaction between lagged performance and HWMs to depend on the level of past performance. We expect the differential flow/performance sensitivity of funds with HWMs to be greater (lower) in the top (bottom) quintiles of past performance. Table 4 presents the results from estimating a pooled regression model of investor flows (Eq. (1)), but now allowing for different coefficients on the $\text{Rank}$ variables depending on the rank quintiles. Specifically, we estimate the regression

$$\text{Net flow}_{i,y} = \sum_{q=1}^{5} \beta_q \text{Rank}_{i,y-1} D_{q,i,y-1} + \sum_{q=1}^{5} \theta_q \text{Rank}_{i,y-1} \text{Age}_{i,y-1} D_{q,i,y-1} + \sum_{q=1}^{5} \gamma_q \text{Rank}_{i,y-1} HWM_i D_{q,i,y-1} + \text{Controls}_{i,y-1} + \epsilon_{i,y},$$

(2)

where $D_{q,i,y-1}$ is an indicator variable that equals 1 if the raw return of fund $i$ in year $y - 1$ is in quintile $q$. The control variables include Age, Size, HWM, year and style fixed effects, and a constant. For example,
Rank\textsubscript{i,y}D_{3,i,y} denotes the percentage rank of fund \textit{i}'s raw return across all funds in year \textit{y} if the rank is between 40\% and 60\% (third best quintile); otherwise, it equals 0. From coefficients \textit{β}_{1} through \textit{β}_{5} we can infer the relation between net flow and past performance for the youngest funds (i.e., Age = 0) without a HWM (i.e., HWM\textsubscript{i} = 0). From coefficients \textit{θ}_{1} through \textit{θ}_{5} we can infer the relation between flow performance sensitivity and fund age; and from \textit{γ}_{1} through \textit{γ}_{5} we can compare the flow/performance sensitivity between funds with and without HWMs.

The results are striking. For the full sample of observations (Panel A, Model 1), the coefficients on \textit{Rank} * \textit{HWM} for the top two quintiles (\textit{D}4 and \textit{D}5) are positive and statistically significant, but insignificant for the bottom two performance quintiles (\textit{D}1 and \textit{D}2). Therefore, the overall greater flow/performance sensitivity associated with HWMs is driven by investors’ response to superior past performance. Similar results are obtained for the subsample that excludes FoFs (Model 2). The coefficient estimates on the \textit{Rank} * \textit{HWM} variables for the subsamples that exclude backfilled observations are generally not significant. However, the overall pattern of the coefficient estimates are the same: lower differences in the flow/performance sensitivity conditional on lower quintile performance.

Overall, we interpret the difference in flow/performance sensitivity across performance quintiles as evidence consistent with distinctive roles of HWMs in environments with asymmetric information on manager ability. Following good performance, investors increase their capital inflow to HWM-funds more than they do to non-HWM funds, because the HWM usage is associated with asymmetric information on manager quality and the increased inflow reflects more favorable posterior belief on manager quality. Following poor performance, however, the lock-in mechanism deters investors’ withdrawal of capital from HWM-funds.

Finally, one alternative explanation for the findings in Table 4 is that the reduced sensitivity among the lower performance quintiles reflects explicit restrictions on withdrawal, as opposed to investors’ voluntarily choosing to remain with the fund. Table 5 reports results from repeating the analysis after excluding the subsample of funds that either have a lockup or an above-the-median redemption notice period. We find similar results. In fact, according to Model 1 of Panel A, the decrease in investor capital from HWM funds is 23.124\% (115.66\%/5) less following a drop from the 20th to the 0 percentile (significant at the 5\% level). This evidence indicates that, compared to funds without a HWM, investors are less likely to remove capital from HWM-funds following poor performance, as they perceive this as a better opportunity going forward. The results reported for the subsamples that exclude backfilled observations (Panel B) have similar patterns: the differential flow/performance sensitivity of HWM funds is greater in
the top quintiles as compared to the lower quintiles. Overall, our findings cannot be explained by a greater use of share redemption restrictions by HWM funds, and are consistent with the lock-in mechanism that retains investors after poor performance in HWM-funds.

### 3.4 Contract Changes During Hedge Fund Registration

One of our key results indicates a positive association between HWM usage and share restrictions. In practice, however, the compensation contract and share restrictions can be simultaneously determined, and therefore the lockup choice might not be exogenous to the HWM usage. In this subsection, we use the 2006 SEC registration requirement (since overturned) as an instrument to identify changes in hedge fund lockups that are *exogenous* to the fund’s compensation contract. We argue that this rule change led to changes in the use of lockups of some hedge funds that were unrelated to the compensation contract, and find that these changes are associated with an increases in the use of HWMs by the same funds.

In December 2004, the SEC issued a new rule that required most hedge fund advisers to register with the SEC by February 1, 2006 as investment advisers under the Investment Advisers Act. This requirement, with minor exceptions, applied to firms managing in excess of US$25,000,000 and over 15 investors. The rule change was challenged in court and, in June 2006, overturned by the U.S. Court of Appeals for the District of Columbia.\(^\text{[11]}\) A special feature of the rule change is that the SEC’s rule only applies to advisors that permit investors to redeem their interests in a hedge fund within *two* years of purchasing their stakes. Therefore, between 2004 and February 2006, it is suspected that some hedge funds adopted longer lockups intentionally to fall under the SEC registration exemption that had been intended to exempt private equity funds.\(^\text{[12]}\)

Panel A of Table 6 compares the lockup periods (in months) reported by hedge funds to the TASS database at different data snapshots. For example, Row 1 reports that 1,839 funds appear in both the 01/2002 and 01/2003 databases. Apparently, only 1.58% of these funds changed their lockup period between the two snapshots. The small number of funds revising a significant aspect of their contracts with investors supports our model’s implicit assumption that renegotiation of the limited partnership

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\(^{11}\)Brown, Goetzmann, Liang, and Schwartz (2008) use the registration rule to construct a measure of operational risk in the hedge fund industry.


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agreement is costly. Furthermore, 1.14% of the matched funds increased their lockup period, and 0.05% of the funds increased their lockup to at least 24 months. These data snapshots precede the SEC rule change and will be used to benchmark the observed lockup changes around the event date. Row 2 compares the snapshots at 01/2003 and 04/2006. This later sample period covers the announcement date (12/2004) and effective date (02/2006) of the SEC rule change. The proportions of funds that increase their lockup (3.01%) and increase their lockup to at least two years (0.70%) are both larger than that between the earlier snapshots. Row 6 shows that we can reject the null hypothesis that the sample proportions are equal across the two sets of comparisons. This is consistent with the anecdotal evidence that some funds increased their lockup period to avoid the registration rule.

Rows 7 and 9 show that we can also reject the hypothesis that the sample proportion of funds that increase their lockup over the 01/2003 − 04/2006 period is equal to the sample proportion of funds that increase their lockup over either the 04/2006 − 03/2007 or 04/2006 − 07/2008 period. We also reject the hypothesis of equal proportions of funds that increase their lockup to at least two years. Finally, Row 8 presents results from comparing the 04/2006, 03/2007, and 07/2008 data snapshots that occur after the SEC rule change. We cannot reject the null hypothesis of equal sample proportion of funds that increase the lockup is the same between the 04/2006 − 03/2007 and 03/2007 − 07/2008 snapshots. Overall, we conclude that the proportion of funds that increased their lockup around the SEC rule change is high compared to other sample periods, and that these lockup changes are at least partly attributed to a desire to avoid the registration requirement, and unrelated to the fund’s other characteristics including the compensation contract.

Next we compare the reported HWM’s of the 3,420 matched funds in the 01/2003 and 04/2006 data snapshots. The last column of Panel B in Table 6 reports the change in the frequency of HWM usage (AVG(ΔHWM)) across the two snapshots. For example, Row 1 reports that, among the 3,263 funds that do not report any change in lockup period over this period, HWM usage increases by 3.19%. In contrast, Row 4 reports that, among the 103 funds that increased their lockup over this period, the frequency of HWM usage increases by 32.04%. Row 7 reports that the difference in the sample proportions, 28.85%, is significant at the 1% level.

Panel B also shows that the change in HWM usage is positive (11.11% in Row 3, significant at the 10% level) among funds that decrease their lockup. However, the results in Row 8 indicates that this change is statistically lower than that obtained for the subsample of funds that increase the lockup (32.04%). The AVG(ΔHWM) (20.83% in Row 5, significant at 10%) of the subsample of 24 funds that increase their
lockup to at least two years is also significantly larger than that for the subsample of funds that do not change their lockup over this period. This estimate is also larger than that for the subsample of funds that decreases their lockup; however, the difference is not statistically significant.

Overall, the average change in HWMs among funds that increased their lockup, apparently to avoid the SEC registration requirement, is greater than the change in HWMs among funds that did not change their lockup provision. We interpret the evidence as supportive of our argument that the use of a HWM in the compensation contract is an outcome of a fund’s decision to impose redemption restrictions on fund investors. This evidence also suggests that our earlier results are unlikely to be driven by an endogeneity bias resulting from the fact that funds’ use of HWMs and share restrictions are jointly determined.

4 Conclusion

The hedge fund industry, which saw rapid growth during the past twenty years, has two defining characteristics. First, as open-ended private investment vehicles, hedge funds are exempt from the Investment Company Act of 1940 and face limited regulatory oversight and disclosure requirements. Second, investors, who offer lucrative compensation contracts for managers, search for and invest in managerial skills. These characteristics imply that asymmetric information is an important aspect for the industry. The terms of the compensation contracts, specified in the fund’s prospectus and rarely revised, represent perhaps the only visible and well-defined aspects of the fund.

We develop a multi-period model of the hedge fund industry in a framework of competitive markets, where the risky asset exhibits independent and identically distributed returns over each performance period. We derive equilibrium compensation contracts consisting of performance fees and possibly a high-water mark. We first show that high-water mark contracts are not optimal under symmetric information of manager ability. With asymmetric information on managerial quality, a high-water mark provides a certification role at fund inception, and this role is especially valuable when investors face restrictions on capital redemptions. When redemptions are unrestricted, the high-water mark provision can also reduce fund flows that lead to inefficient liquidation in the absence of renegotiation. We argue that this “lock-in” role is especially important for funds managing illiquid assets.

Empirically, we find that high-water marks are more commonly used by less-reputable managers, funds that restrict investor redemptions, and funds with greater underlying asset illiquidity. The sensitivity of flows to past performance is also positively related to high-water marks, but less so following poor
performance. Overall, the results suggest that compensation contracts in hedge funds help alleviate inefficiencies created by asymmetric information.
Appendix: Proofs

Lemma 1 (Maximizing total surplus in First Best)
Given the distribution of manager types and definition of individual surplus $s_i(p_i)$, a sufficient condition for maximizing the aggregate surplus is if $s_i$ is maximized for all $i$. For any manager $i$, raising a fund for only one period is inconsistent with maximizing surplus $s_i^0$. A one-period fund generates $R_i - R_0 - W$, while a two-period fund generates $R_i^2 - R_0^2 - W$; the difference between the two expressions is $(R_i - R_0)(1 - R_i - R_0)$, and is non-negative if and only if $R_i \leq R_0$. However, this condition implies negative surplus from raising a fund and therefore inconsistent with maximizing $s_i$. A manager generates positive surplus from managing a two-period fund if and only if $R_i^2 - R_0^2 - W \geq 0$. Rearranging we obtain the condition $p_i \geq p^{FB} \equiv \sqrt{\frac{R_0^2 + W - d}{u - d}}$.

Proposition 1 (Competitive Equilibrium with symmetric information)
In the equilibrium, the performance fee $(f_i)$ for manager type $i$ is set such that investor’s rationality constraint is binding at Date 0. Investor rationality at Date 0 is binding iff

$$p_i(u - (u - 1)f_i) \max\{p_i(u - (u - 1)f_i) + (1 - p_i)d, R_0\} + (1 - p_i)d \max\{p_i(u - (u - 1)f_i) + (1 - p_i)d, R_0\} = R_0^2$$

The above condition is satisfied iff $f_i = \frac{R_i - R_0}{p_i(u - 1)} \equiv \tilde{f}_i$. In particular, the value of the max operators in the above equation is never less than $R_0$; since the max operators correspond to investor rationality constraints at Date 1, this also implies no fund flow at either node at Date 1. Given the equilibrium performance fee, the manager’s participation constraint is satisfied at Date 0 iff the expected fees from managing the fund are equal to the outside opportunity:

$$p_i(u - 1)\tilde{f}_i R_i + p_i^2(u - (u - 1)\tilde{f}_i)(u - 1)\tilde{f}_i + (1 - p_i)p_i d(u - 1)\tilde{f}_i \geq W.$$ 

Note that in the first term, $p_i(u - 1)\tilde{f}_i$ indicates the amount of expected fees earned in the first period (after positive return). Since we assume the manager reinvests fees in the risky asset using his own account, expected fees multiplied by $R_i$, the expected return on the risky asset, yields the total payoff for the manager in the period. Substituting $\tilde{f}_i$ and rearranging the last inequality implies that manager rationality is satisfied iff

$$p_i \geq p^{FB} \equiv \sqrt{\frac{W + R_0^2 - d}{u - d}}.$$ 

Finally, since $W > 0$, the right hand side of the above inequality is no less than the minimum $p_i$, which is necessary to ensure a non-negative performance fee.

Lemma 2 (Competitive Equilibrium with symmetric information and HWM)
We first show that an equilibrium contract with a HWM implies that there is fund flow if and only if the fund reaches Node 1u. Suppose not. For each of the three possible alternative cases below, we will derive a contradiction. We will repeatedly use the definitions of two critical performance fees, $\hat{f}$, defined in Proposition 1 and indicating highest fee to attract investors at Date 0 without a HWM, and $\tilde{f}$, defined in Lemma 2 and denoting the highest Date 0 fee with a HWM.

Case 1: Flows at both Nodes 1u and 1d imply $\hat{f} > \tilde{f}$ (at Node 1u) and $R_i < R_0$ (at Node 1d, fees waived due to the HWM). But this implies that investor rationality at Date 0 is not satisfied because

$$p_i (u - (u - 1)\hat{f}) \max\{p_i(u - (u - 1)\hat{f}) + (1 - p_i)d, R_0\} + (1 - p_i)d \max\{R_i, R_0\} = p(u - (u - 1)\hat{f}) R_0 + (1 - p)d R_0 < R_0^2.$$ 

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Case 2: Flow at Node 1\textsuperscript{d} only implies that $R_i < R_0$, but no flow at Node 1\textsuperscript{u} implies that $p(u - (u - 1)\hat{f}) + (1 - p)d \geq R_0$. In other words, $R_i \geq R_0$, a contradiction.

Case 3: No flow at Date 1 is inconsistent with the competitive equilibrium assumption that fund managers extract all Date 0 expected surplus. Specifically, investor rationality at Date 0 is

$$p_i(u - (u - 1)\hat{f}) \max\{p_i(u - (u - 1)\hat{f}) + (1 - p_i)d, R_0\} + (1 - p_i)d \max\{R_i, R_0\}$$

which the last inequality follows from the assumption of no flow at Node 1\textsuperscript{d}.

With flow at Node 1\textsuperscript{u} but not at Node 1\textsuperscript{d} the competitive equilibrium performance fee with a HWM for manager of type $i$ satisfies

$$p_i(u - (u - 1)\hat{f})R_0 + (1 - p_i)dR_i = R_0^2.$$  

Rearranging gives

$$\hat{f}_i = \bar{f}_i + \frac{(1 - p_i)(R_i/R_0 - 1)d}{p_i(u - 1)}.$$  \hspace{1cm} (3)

In order to verify $\hat{f}_i$ given in (3) is indeed the equilibrium performance fee, we need to check the manager participation/rationality constraint at Date 0. It is satisfied iff:

$$F_i(p_i, \hat{f}_i) = p_i(u - 1)\hat{f}_i \geq W,$$

where $F_i$ indicating expected fees for manager of type $i$. Notice the fees in the above expression is not multiplied by $R_i$, the expected return on the risky asset, because we assume that the risky asset is only available when the fund is in operation. Substituting for $\hat{f}_i$ and rearranging the last inequality, and we can show that the inequality holds with ‘$=$’ iff

$$p_i \geq \frac{-(1 + uR_0 - 2d) \pm \sqrt{(uR_0 + 1 - 2d^2)^2 - 4(1 - d^2)(R_0^2 + WR_0 - d^2)}}{-2(1 - d^2)}.$$  

Since $uR_0 \geq 1$, the value of $p_i$ is less than 1 only for the positive root. Finally, the minimum $p_i$ to ensure a non-negative performance fee in (3) equals to

$$\frac{-(1 + uR_0 - 2d) \pm \sqrt{(uR_0 + 1 - 2d^2)^2 - 4(1 - d^2)(R_0^2 - d^2)}}{-2(1 - d^2)}.$$  

Again, since $uR_0 \geq 1$ the right hand side is less than 1 only for the positive root; given that $W > 0$ we also know this positive root is no larger than the $p$ given in the previous inequality. \hspace{1cm} ■

Our proofs of the remaining results make use of the following two additional lemmas:

**Lemma 5** With asymmetric information on manager ability and a given fee contract (with or without a HWM) and a set of investor beliefs about the pool of managers, if there exists a manager of type $p'$ who enters the market, then all managers of type $p \geq p'$ will also enter.
Since $W$ is the same for all managers, it suffices to show that the expected fees are increasing with $p$. We examine four cases.

Case 1: No HWM and flow at Node 1d but no flow at Node 1u: these flow patterns are exactly the same when a HWM is used (waives fees after reaching Node 1d and no flow at 1u). Given a performance fee $f$, the expected fees equal

$$F_i(p_i, f) = p_i(u - 1)fR_i + p_i^2(u - (u - 1)f)(u - 1)f.$$ 

The derivative of the above expression with respect to $f$ equals

$$\partial F_i/\partial f = 2p_i(u - 1)f[2u - d - (u - 1)f] + p_i(u - 1)fd \geq 0, \ \forall f, \ p_i \in [0, 1].$$

Case 2: No HWM and no flow at either node at Date 1. For a given $f$ the expected fees equal

$$F_i(p_i, f) = p_i(u - 1)fR_i + p_i^2(u - (u - 1)f)(u - 1)f + (1 - p_i)p_i(d(u - 1)f), \ \text{and}$$

$$\partial F_i/\partial f = 2p_i(u - 1)f[2u - d - (u - 1)f] + (1 - d)f \geq 0, \ \forall f, \ p_i \in [0, 1].$$

Case 3: No HWM and flow at Node 1u only. For a given $f$, the expected fees equal

$$F_i(p_i, f) = p_i(u - 1)f + (1 - p_i)p_i(d(u - 1)f), \ \text{and}$$

$$\partial F_i/\partial f = (u - 1)f[-2p_id + 1 + d] \geq (u - 1)f[1 - d] \geq 0, \ \forall f, \ p_i \in [0, 1].$$

Case 4: No HWM and flows at both Nodes 1u and 1d: this is equivalent to the case of using a HWM and flow at Node 1u. Given a performance fee $f$, the expected fees equal $p_i(u - 1)f$, which is clearly increasing in $p$, $\forall f, p_i \in [0, 1].$}

The intuition for Lemma 5 can be described as follows. Since managers’ compensation is tied to performance, higher-quality managers are expected to garner more fees upon entering and raising a fund. With all managers having the same reservation wage, this implies better managers are more likely to enter the industry. The above lemma also implies that, in the presence of asymmetric information, investor beliefs can be characterized in terms of a lower bound ($\bar{p}'$) on the pool of managers entering the market. The next lemma discusses the properties of investors’ beliefs at Date 0 upon observing the same contract and posterior beliefs at Date 1 upon observing funds’ first period performance.

**Lemma 6** Given investor beliefs $\bar{p}'$, let $p_0$ denote the Date 0 probability that a randomly selected fund earns $u$ during Period 1; let $p_{1u}$ and $p_{1d}$ denote the Date 1 probability that the fund earns $u$ during Period 2 conditional on reaching Node 1u and 1d, respectively. Then

a) $p_{1d}(\bar{p}') \leq p_0(\bar{p}') \leq p_{1u}(\bar{p}')$;

b) $\frac{\partial p_{1d}}{\partial \bar{p}'} \geq 0, \ \frac{\partial p_{1u}}{\partial \bar{p}'} \geq 0, \ \frac{\partial p_0}{\partial \bar{p}'} \geq 0.$

Given the uniform distribution (over the interval $[\bar{p}, \bar{p}']$) of manager types and a cutoff $\bar{p}'$, we have

$$p_0 = \frac{\bar{p} + \bar{p}'}{2}, \ p_{1u} = \frac{\frac{2}{3}(\bar{p}^3 - \bar{p}'^3)}{\bar{p}^2 - \bar{p}'^2}, \ p_{1d} = \frac{(\bar{p}^2 - \bar{p}'^2) - \frac{2}{3}(\bar{p}^3 - \bar{p}'^3)}{(\bar{p} - \bar{p}')(2 - \bar{p} - \bar{p}')}.$$ 

Therefore, $p_0 \leq p_{1u}$ if and only if

$$3\bar{p}'\bar{p}(\bar{p} - \bar{p}') - (\bar{p}^3 - \bar{p}'^3) \leq 0.$$
The left-hand side of the expression equals 0 when \( p' = \bar{p} \), and it equals \(-\bar{p}^3 < 0\) when \( p' = 0 \). The derivative of the left-hand side w.r.t. \( p \) is \( 3(\bar{p} - p')^2 \), which is nonnegative for all \( p' \in [0, \hat{p}] \). Similarly, \( p_0 \geq p_{1d} \) iff
\[
\bar{p}^3 - p^3 + 3p'^2 \bar{p} - 3p'^2 p' \geq 0.
\]
The left-hand side of the above expression equals 0 when \( p' = \bar{p} \), and it equals \( p^3 > 0 \) when \( p' = 0 \). The derivative of the left-hand side w.r.t. \( p \) is \( 3(\bar{p} - p')(p' - \bar{p}) \), again nonpositive for all \( p' \in [0, \hat{p}] \).

To prove the second part of the lemma observe \( \frac{\partial p_0}{\partial p} = \frac{1}{2} > 0 \). Moreover,
\[
\text{sign} \left[ \frac{\partial p_{1u}}{\partial p'} \right] = \text{sign} \left[ p'^3 - 3p'^2 p' + 2\bar{p}^3 \right].
\]
The bracketed term on the right-hand side of the above expression equals 0 if \( p' = \bar{p} \). By the mean-value theorem, it suffices to show that the derivative of the bracketed term w.r.t. \( p' \), evaluated at some \( \bar{p} \), is nonpositive for any \((\bar{p}, \hat{p})\) combination such that \( 0 \leq p' \leq \bar{p} \leq \hat{p} \leq 1 \). The derivative equals
\[3(\hat{p}^2 - \bar{p}^2) \leq 0.\] Similarly,
\[
\text{sign} \left[ \frac{\partial p_{1d}}{\partial p'} \right] = \text{sign} \left[ p'^2 + \bar{p}^2 - 2p' \bar{p} - p'^3/3 - 2\bar{p}^3/3 + \bar{p}^2 p' \right].
\]
Again, the bracketed term on the right-hand side equals 0 if \( p' = \bar{p} \). By the mean-value theorem, it suffices to show that the derivative of the bracketed term w.r.t. \( p' \), evaluated at \( \bar{p} \), is nonpositive for any \((\bar{p}, \hat{p})\) combination such that \( 0 \leq p' \leq \bar{p} \leq \hat{p} \leq 1 \). The derivative equals \((\hat{p} - \bar{p})(2 - (\bar{p} + \hat{p})) \leq 0. \]

The first part of Lemma 6 shows that Bayesian investors adjust upward their beliefs about manager quality following a positive return at Date 1 \((p_{1u} \geq p_0)\), and adjust their beliefs downward \((p_{1d} \leq p_0)\) following a negative return. In the absence of a HWM, investor learning will determine whether to exit the fund at Date 1. The second part of the lemma shows that an increase in the lower bound on manager quality \( p' \) raises investors’ beliefs about the fund’s ability to generate positive returns at all dates and states. This is not surprising as a higher \( p' \) implies a higher average quality of the pool of managers entering the market at Date 0 and no manager voluntarily drops out at Date 1.

**Lemma 3 (No fully revealing separating equilibrium)**

In a separating equilibrium, manager types are distinguished by the Date 0 fee contract. A competitive equilibrium requires that managers extract all the expected surpluses at Date 0. Thus, the only possible equilibrium fees in a separating equilibrium are \( \hat{f}_i \), specified in Proposition 1 when a HWM is not used in the contract, or \( \hat{f}_i \) specified in Lemma 2 with the presence of a HWM in the fee contract.

Lemma 5 shows that the pool of managers raising a fund is a continuum that is characterized by a lower bound on manager types. Therefore, we can assume, without loss of generality, that there are three managers who raise a fund such that \( p_i < p_j < p_k \). We show below that there always exist a \( p_i \) such that the manager of that type has an incentive to mimic the fee structure set by manager of type \( k \), or at least one manager has an incentive to deviate from the equilibrium fee contract, either of which contradicts the definition of a fully revealing separating equilibrium.

**Case 1:** \( h_i = h_j = 0 \) (no HWM for managers \( i \) and \( j \)). Then there is no flow at Date 1 according to Proposition 1 (manager types are revealed by \( f_i \) and \( f_j \)) and \( f_i = \hat{f}_i < \hat{f}_j = f_j \). Manager \( i \) will choose to...
mimic manager \( j \) if and only if:

\[
p_i(u - 1)\tilde{f}_j R_i + p_i^2 (u - (u - 1)\tilde{f}_j)(u - 1)\tilde{f}_j + (1 - p_i)p_i(1 - d)\tilde{f}_j
\]

\[
- p_i(u - 1)\tilde{f}_j R_i + p_i^2 (u - (u - 1)\tilde{f}_j)(u - 1)\tilde{f}_i + (1 - p_i)p_i(1 - d)\tilde{f}_i
\]

\[
= p_i(1 - d)(\tilde{f}_j - \tilde{f}_i) + p_i^2 (u - 1)(\tilde{f}_j - \tilde{f}_i)[2u - d - (u - 1)(\tilde{f}_j + \tilde{f}_i)] + (1 - p_i)p_i(1 - d)(\tilde{f}_j - \tilde{f}_i)
\]

\[
\geq 0, \forall p_i \in [0, 1].
\]

The first and third terms in the last equality are positive because \( \tilde{f}_j \geq \tilde{f}_i \); the second term is also positive because a viable equilibrium requires \( \tilde{f}_j, \tilde{f}_i \leq 1 \).

Case 2: \( h_i = h_j = 1 \) (HWM for both managers \( i \) and \( j \)). Then \( f_i = \hat{f}_i < \tilde{f}_j = f_j \) and there is flow at Node 1u according to Lemma 2. Manager \( i \) will choose to mimic manager \( j \) if and only if:

\[
p_i(u - 1)\tilde{f}_j \geq p_i(u - 1)\hat{f}_i,
\]

which is true for all \( p \) given that \( \hat{f}_i < \tilde{f}_j \).

Case 3: \( h_i = 1, h_j = 0 \). Then \( f_i = \hat{f}_i \) and \( f_j = \tilde{f}_j \) and there is flow at Node 1u for manager \( i \). Manager \( i \) will choose to mimic manager \( j \) if and only if:

\[
p_i(u - 1)\tilde{f}_j R_i + p_i^2 (u - (u - 1)\tilde{f}_j)(u - 1)\tilde{f}_j + (1 - p_i)p_i(1 - d)\tilde{f}_j \geq p_i(u - 1)\hat{f}_i.
\]

But Proposition 1 predicts that the performance fee without a HWM will give manager \( i \) at least as much surplus (contracts with a HWM under symmetric information are suboptimal). Therefore,

\[
p_i(u - 1)\hat{f}_i \leq p_i(u - 1)\tilde{f}_i R_i + p_i^2 (u - (u - 1)\tilde{f}_i)(u - 1)\tilde{f}_i + (1 - p_i)p_i(1 - d)\tilde{f}_i
\]

\[
\leq p_i(u - 1)\tilde{f}_j R_i + p_i^2 (u - (u - 1)\tilde{f}_j)(u - 1)\tilde{f}_j + (1 - p_i)p_i(1 - d)\tilde{f}_j,
\]

where the last inequality follows from the fact that \( \tilde{f}_i \leq \tilde{f}_j \).

Case 4: \( h_i = 0, h_j = 1, h_k = 0 \). Identical arguments to Case 3 show that manager \( j \) will mimic \( k \).

Case 5: \( h_i = 0, h_j = 1, h_k = 1 \). Identical arguments to Case 2 shows that manager \( j \) will mimic \( k \). 

\( \blacksquare \)

**Proposition 2 (Restrictions on fund flows)**

To prove statement a) suppose instead \( p_i^* \geq p_i^{FB} \); that is, the pool of managers is no worse than the First Best case. Then the equilibrium fee \( \hat{f}_i^* \) must be strictly higher than the performance fee \( f_i^{FB} \) for type \( p_i^{FB} \) manager when manager ability is known. Otherwise, (i.e., \( f_i^* \leq f_i^{FB} \)) the investor’s rationality constraint will not bind at Date 0. To see this observe that:

\[
p_0 p_{1u}(u - (u - 1)\hat{f}_i^*)^2 + [p_0(1 - p_{1u}) + (1 - p_0)p_{1d}]d(u - (u - 1)\hat{f}_i^*) + (1 - p_0)(1 - p_{1d})d^2
\]

\[
> (p_i^{FB})^2(u - (u - 1)\hat{f}_i^*)^2 + 2p_i^{FB}(1 - p_i^{FB})d(u - (u - 1)\hat{f}_i^*) + (1 - p_i^{FB})^2d^2
\]

\[
> (p_i^{FB})^2(u - (u - 1)\hat{f}_i^{FB})^2 + 2p_i^{FB}(1 - p_i^{FB})d(u - (u - 1)\hat{f}_i^{FB}) + (1 - p_i^{FB})^2d^2
\]

\[
= R_0^2
\]

where \( p_0 = p_0(p_i^*), p_{1u} = p_{1u}(p_i^*), \) and \( p_{1d} = p_{1d}(p_i^*) \). The first inequality in \( [1] \) follows from the fact, holding the performance fee constant, investors strictly prefer a better pool of managers. Formally
speaking, let $\Delta_0 \equiv p_0 - p_{FB}$, $\Delta_{1u} \equiv p_{1u} - p_{FB}$, and $\Delta_{1d} \equiv p_{1d} - p_{FB}$. Then $p^*_l > p_{FB}$ implies that $0 < \Delta_{1d} < \Delta_0 < \Delta_{1u} < 1 - p_{FB}$. The first line in (4) can be rewritten as

$$
(p_{FB})^2(u - (u - 1)f^*_l)^2 + 2p_{FB}(1 - p_{FB})d(u - (u - 1)f^*_l) + (1 - p_{FB})^2d^2
$$

$$
+ \left[p_{FB}(\Delta_{1u} + \Delta_0) + \Delta_0\Delta_{1u}\right](A - B) + (1 - p_{FB})\Delta_0(B - C) + \Delta_{1d}\left[(1 - p_{FB}) - \Delta_0\right](B - C),
$$

where $A \equiv (u - (u - 1)f^*_l)^2$, $B \equiv d(u - (u - 1)f^*_l)$, and $C \equiv d^2$. The second term in the last expression is strictly positive.

The second inequality in (4) follows from the fact that the left-hand side is decreasing in the performance fee. The final equality follows from the definition of $f_{FB} \equiv \frac{d + p_{FB}(u - d) - R_0}{p_{FB}(u - 1)}$. Therefore, $p^*_l > p_{FB}$ implies that $f^*_l > f_{FB}$, and therefore manager $p_{FB}$ earns strictly more than his reservation wage $W$. To see this observe that the manager’s expected fees equal

$$
F(p, f) \equiv p(u - 1)f(d + p(u - d)) + p^2(u - (u - 1)f)(u - 1)f + (1 - p)p(d(u - 1)f).
$$

The last expression is a polynomial functions of $p$ and therefore continuous. By continuity and the fact that a manager’s expected fees are increasing in his type, there exists an $\epsilon > 0$ such that a manager of type $p^* - \epsilon$ also earns at least as much as his reservation wage.

Figure 2 shows that, in the case of restricted investor flows at Date 1, there exists a pooling equilibrium such that $p^*_l < p_{lh} < p_{FB}$ for these parameters: $u = 1.2$, $R_0 = 1$, $W = 0.05$, $p = 0$, and $\bar{p} = 1$. By continuity (both functions determining $f$ and $p$ are quadratic polynomials) the equilibrium also exists for a set of parameters surrounding the baseline equilibrium. In the HWM equilibrium, the performance fee is higher than that in the no-HWM equilibrium so that managers can extract all the surplus from investors. This higher fee will attract some low quality managers to enter the market ($p^*_h < p_{FB}$). However, since the use of HWM is more costly for lower quality managers, the equilibrium cutoff quality is higher with a HWM ($p^*_l < p^*_h$).

**Lemma 4 (Unrestricted flows; No HWM)**

It suffices to show that any other flow scenario is inconsistent with the equilibrium condition that investor rationality must be binding at Date 0. Let $p^*$ denote the cutoff manager ability in the competitive equilibrium without a HWM and unrestricted flows, and $p_{1d}$, $p_{1u}$, and $p_0$ denote investor beliefs given $p^*$. First, no flow at Node $1d$ implies $f \leq (R_{1d} - R_0)/(p_{1d}(u - d))$, and by Lemma 6 also implies $f < (R_{1u} - R_0)/(p_{1u}(u - d))$ and, therefore, no flow at Node $1u$. Investor rationality at Date 0 is no longer binding since,

$$
p_0(u - (u - 1)f)\max\{p_{1u}(u - (u - 1)f) + (1 - p_{1u})d, R_0\} +
$$

$$
(1 - p_0)d\max\{p_{1d}(u - (u - 1)f) + (1 - p_{1d})d, R_0\}
$$

$$
> [p_0(u - (u - 1)f) + (1 - p_0)d] R_0 > R_0^2,
$$

where the last inequality also follows from Lemma 6. The above logic also shows that equilibrium condition cannot be satisfied if there are no fund flows at Date 1. However, if there are flows at both Nodes $1u$ and $1d$, then by assumption investor rationality is violated at Date 1. But in this case Lemma 6 implies that investor rationality is also violated at Date 0 because

$$
p_0(u - (u - 1)f_i)\max\{p_i(u - (u - 1)f_i) + (1 - p_i)d, R_0\} +
$$

$$
(1 - p_i)d\max\{p_i(u - (u - 1)f_i) + (1 - p_i)d, R_0\}
$$

$$
< [p_0(u - (u - 1)f_i) + (1 - p_0)d] R_0 < R_0^2.
$$
The proof of Proposition 3 makes use of the following two additional lemmas:

**Lemma 7** In the absence of a HWM, the competitive pooling equilibrium is a set of beliefs $p^*$ and performance fee $f^*$ such that:

\[
\begin{align*}
p^* &= -\frac{(u-1)f^*+\sqrt{(u-1)f^*+4W(u-(u-1)f^*)(u-1)f^*}}{2(u-(u-1)f^*)(u-1)f^*}, \\
f^* &= \frac{2p_0p_{1u}u(u-1)+p_0(1-p_{1u})(1-d)}{2p_0p_{1u}(u-1)^2} - \sqrt{p_0^2(1-p_{1u})^2(1-d)^2 + 4p_0p_{1u}(u-1)^2R_0[R_0-d(1-p_0)]}.
\end{align*}
\]

The equilibrium fee ($f^*$) and lower bound on manager quality ($p^*$) are determined simultaneously as follows. Given $p^*$, the performance fee is set such that investor rationality is binding at Date 0. In the absence of a HWM, Lemma 4 implies that investor rationality constraint is binding iff:

\[p_0(u-(u-1)f^*)[p_{1u}(u-(u-1)f^*) + (1-p_{1u})d, R_0] + (1-p_0)dR_0 = R_0^2.\]

The above expression implies

\[f^* = \frac{[2p_0p_{1u}u(u-1) + p_0(1-p_{1u})(1-d)] + \sqrt{p_0^2(1-p_{1u})^2(1-d)^2 + 4p_0p_{1u}(u-1)^2R_0[R_0-d(1-p_0)]}}{2p_0p_{1u}(u-1)^2}.\]

A viable equilibrium ($f^* \in [0, 1]$) requires that the equilibrium fee equals the negative root of the above expression. Given $f^*$, the lower bound on manager pool is determined by type $p_i$ such that the manager rationality constraint is binding. In the absence of a HWM, Lemma 4 implies that manager rationality constraint is binding iff:

\[p^*(u-1)f^*[d + p^*(u-d)] + p^2(u-(u-1)f^*)(u-1)f^* = W.\]

The above expression gives

\[p^* = -\frac{(1-d)f^* + \sqrt{(1-d)^2f_{\star}^2 + 4W(u-1)f[2u-d-(u-1)f]}}{2(u-1)f[2u-d-(u-1)f]}.\]

A viable equilibrium ($p^* \in [0, 1]$) requires that the equilibrium cutoff type equals the positive root of the above expression. ■

**Lemma 8** The lower bound ($p^*$) on the manager pool in an equilibrium with no HWM and unrestricted investor flows is decreasing in the performance fee ($f^*$).

The expression for $p^*$ in the absence of a HWM is given by Lemma 7. The derivative of this expression with respect to $f^*$ is nonpositive if and only if

\[-2(u-1)(1-d)(2u-d)f^* + 2(u-1)(1-d)(2u-d)f^* + 2(u-1)^2(1-d)f^* + 4(u-1)^2(1-d)f^* - 4(u-1)^2(1-d)f^* + .5A^{-1/2}[2(1-d)^2f^* + 4W(u-1)(2u-d) - 8W(u-1)^2f^*] - A^{1/2}[2(u-1)(2u-d) - 4(u-1)^2f^*] \leq 0,
\]

where $A \equiv (1-d)^2f^* + 4W(u-1)f^*[2u-d -(u-1)f^*]$. By the nonnegativity of $A$, the left hand side of the last expression is nonpositive iff

\[-2(u-1)(1-d)^2f^* + (u-1)A^{1/2}[2u-d -(u-1)f^*]f^*[d-2u + 2(u-1)f^*] \leq 0.\]
But the left hand side of the above inequality is less than or equal to \(4W(u-1)^2[2u-d-(u-1)f^*](d-2)\). The last expression is thus negative for all \(f^* \in [0,1] \). ■

**Proposition 3** (No restrictions on fund flows)

Let \((p^*, f^*)\) and \((p^*_h, f^*_h)\) denote the cutoff manager type and performance fee combinations in the competitive equilibria without and with a HWM, respectively. By the definition of a competitive equilibrium, investors earn no surplus in either case. Therefore, it suffices to show that expected fees are higher in the HWM equilibrium. If there are no fund flows at Node 1d or 1u, then expected fees in the HWM equilibrium equal to:

\[
F_h(p^*_h, f^*_h) = p(u-1) f^*_h R + p^2(u-(u-1)f^*_h)(u-1)f^*_h, \forall p \geq p^*_h.
\]

Lemma 1 implies that expected fees in the no-HWM equilibrium equal to:

\[
F(p^*, f^*) = p(u-1) f^* R + p^2(u-(u-1)f^*)(u-1)f^*, \forall p \geq p^*.
\]

Both expressions are increasing in the performance fee \((f^*)\) and are analogous. Therefore, to show \(F_h(p^*_h, f^*_h) > F(p^*, f^*)\) it suffices to show \(p^*_h \leq p^*\) and \(f^*_h \geq f^*\), as this would imply more managers raising a fund and they earn more (expected) fees due to the higher \(f\). Suppose not. Then either \(p^*_h > p^*\) and \(f^*_h \geq f^*\) (Case 1), \(p^*_h > p^*\) and \(f^*_h < f^*\) (Case 2), or \(p^*_h \leq p^*\) and \(f^*_h < f^*\) (Case 3). By the assumption of no flow in the HWM equilibrium, for the same performance fee \(f\) we must have \(p^*_h(f) = p^*(f)\). This is due to the fact that in our two-period model, an outflow at Node 1d in the no-HWM case waives performance fees in Period 2, just like what a HWM does. Therefore, Lemma 5 implies that Cases 1 and 3 are impossible.

We next show Case 2 is inconsistent with the competitive equilibrium assumption that managers extract all the expected surplus from investors. We examine investors’ Date 0 expected payoff from investing with a manager of type \(p^*_h\) and setting \(f^*_h\) along with a HWM. In the absence of a HWM, investor’s Date 0 expected payoff (with manager \(p\)) is equal to:

\[
U(p, f) = p_0(p)[u-(u-1)f][p_{1u}(p)(u-(u-1)f) + (1-p_{1u}(p))d] + (1-p_0(p))dR_{1d}(p),
\]

where the second term in the above expression denotes expected payoff after reaching Node 1d. Investors’s Date 0 expected payoff with a HWM, \(U_h(p_h, f_h)\), takes on the same form after replacing the \((p, f)\) pair with \((p_h, f_h)\) and the subscript \(h\) for \(U()\) indicating the use of a HWM. It is easy to show that both \(U(p, f)\) and \(U_h(p_h, f_h)\) are increasing in \(p\) and decreasing in \(f\). We then have

\[
U_h(p^*_h, f^*_h) > U(p^*_h, f^*_h) > U(p^*_h, f^*) > U(p^*, f^*) = R^2_0.
\]

The last equality follows from the assumption that \((p^*, f^*)\) is the equilibrium contract without a HWM.

Figure 3 shows that, in the case of unrestricted investor flows at Date 1, there exists a pooling equilibrium depicted in Proposition 3 for these parameters: \(u = 1.2, R_0 = 1, W = 0.05, p = 0,\) and \(\bar{p} \in [0.88,1]\). By continuity the equilibrium also exists for a set of parameters surrounding the baseline equilibrium. In the HWM equilibrium, the performance fee is higher than that in the no-HWM equilibrium. This higher fee will attract more low quality managers to enter the market \(p^*_h < p^*\). However, since the use of HWM avoids inefficient fund liquidation at Node 1d (in the no-HWM pooling equilibrium funds are liquidated at 1d), the Date 0 aggregate surplus is higher in the HWM equilibrium. ■
References


Table 1: Summary statistics of hedge fund characteristics. The table presents summary statistics for the hedge funds in the sample. Panels A and B correspond to the full sample of 8,526 funds and the sub-sample of 6,356 funds that excludes FoFs, respectively. Performance fee is the percentage of profits the manager receives as compensation on any profits above the high-water mark. Management fee is the percentage of total assets the manager receives as compensation. Family Age is the number of months between the fund’s inception date, and the earliest inception date across all funds under the same fund family. Family Size is the natural logarithm of the total net assets (in millions of dollars) under management, across all funds under the same management firm. Family Age and Family Size are measured at the year-end preceding the fund’s inception date. The lockup variable is an indicator variable that equals one if the fund’s lockup period exceeds zero. Notice is the number of days required notice before investors may redeem their shares. $\rho(1)$ is the estimated first-order autocorrelation of monthly net returns. *, and ** denote significance at 5% and 1% levels for two-tailed test that the mean difference equals zero.

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Table 2: Probit Analysis of High-water mark Usage: Pooled Estimation with Clustered Standard Errors. The table reports the results from a pooled probit analysis of a hedge fund’s decision to use a high-water mark to calculate performance fees. Panels A and B use FamAge and FamSize, respectively, to measure the degree of asymmetric information between managers and investors at the date of fund inception. FamAge is the natural logarithm of the number of months between the fund’s inception date, and the earliest inception date across all funds under the same fund family. FamSize is the natural logarithm of the total net assets (in millions of dollars) under management, across all funds under the same management firm. FamAge and FamSize are measured at the year-end preceding the fund’s inception date. DRestrict is an indicator variable that equals one if the fund has either a lockup provision and/or an above-the-median redemption notice period. DLock is an indicator that equals one if the fund has a lockup provision. Notice is the fund’s redemption notice period in days. $\rho(1)$ is the estimated first-order autocorrelation in reported monthly fund returns. Fixed effects for fund inception year and style categories are included in the estimation. The independent variables are standardized to have a zero mean and variance of one across funds. Standard errors allow for clustering at the level of the fund family. +, *, and ** denote significance at 10%, 5% and 1% levels for two-tailed test that the coefficient equals zero.

Panel A: Using FamAge as the asymmetric information variable

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+ significant at 10% level; * significant at 5% level; ** significant at 1% level
Table 2: cont.

Panel B: Using FamSize as the asymmetric information variable

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+ significant at 10% level; * significant at 5% level; ** significant at 1% level
Table 3: High-water Mark Usage and the Sensitivity of Fund Flows to Past Performance: Pooled Regressions with Clustered Standard Errors. This table reports the output from pooled regression analysis of annual hedge fund investor flows. The dependent variable is the annual percentage change in total assets that is not attributed to annual net returns. Rank is the rank of the fund’s lagged annual return relative to all other funds. HWM is an indicator variable that equals one if the fund has a high-water mark. Age and Size are the natural logarithms of the fund’s track record length and total assets under management, respectively, at the end of the previous year. Lockup is an indicator that equals one if the fund has a lockup provision. Notice is the fund’s redemption notice period in days. Fund style and year fixed-effects are included in the estimation. Standard errors allow for within-year clustering of the regression residuals. Models 1 and 2 correspond to the full sample of funds and the subample that excludes FoFs, respectively. Panel A uses all monthly return observations and Panel B excludes backfilled observations. t-statistics are reported beneath coefficient estimates. +, *, and ** denote significance at 10%, 5% and 1% levels for two-tailed test that the coefficient equals zero.

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<th>Panel B: Excluding Backfilled Observations</th>
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Table 4: Fund Flows and High-water Marks by Past Performance Quintile. This table reports the output from a pooled regression analysis of annual hedge fund investor flows. The dependent variable is the annual percentage change in total assets that is not attributed to annual net returns. Rank is the rank of the fund’s lagged annual return relative to all other funds. D1-D5 are indicator variables that take the value of one depending on the quintile of fund rank. For example, D2 equals one if Rank is greater than 0.20 but less than 0.40. HWM is an indicator variable that equals one if the fund has a high-water mark. Age and Size are the natural logarithms of the fund’s track record length and total assets under management, respectively, at the end of the previous year. Lockup is an indicator that equals one if the fund has a lockup provision. Notice is the fund’s redemption notice period in days. Fund style and year fixed-effects are included in the estimation. The coefficient estimates for Size, Age, Lockup, Notice, HWM, and style and year fixed effects are not reported in the table. Standard errors allow for within-year clustering of the regression residuals. Models 1 and 2 correspond to the full sample of funds and the subample that excludes FoFs, respectively. Panel A uses all monthly return observations and Panel B excludes backfilled observations. t-statistics are reported beneath coefficient estimates. +, *, and ** denote significance at 10%, 5% and 1% levels for two-tailed test that the coefficient equals zero.

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<tr>
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<td>-1.7</td>
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<tr>
<td>Rank<em>D2</em>age</td>
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</tr>
<tr>
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<td>-5.07**</td>
</tr>
<tr>
<td>Rank<em>D3</em>age</td>
<td>-0.2695</td>
</tr>
<tr>
<td></td>
<td>-4.62**</td>
</tr>
<tr>
<td>Rank<em>D4</em>age</td>
<td>-0.2281</td>
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<tr>
<td></td>
<td>-5.26**</td>
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<tr>
<td></td>
<td>-4.48**</td>
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</tr>
<tr>
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<td>0.39</td>
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<tr>
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<td>Rank<em>D3</em>HWM</td>
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<td>Rank<em>D4</em>HWM</td>
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<td>2.57*</td>
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<td></td>
<td>3.49**</td>
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<tr>
<td>R-squared</td>
<td>0.1794</td>
</tr>
<tr>
<td>Other control variables?</td>
<td>yes</td>
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</table>
Table 5: Fund Flows and High-water Marks by Past Performance Quintile: Excluding Funds with Lockups and Above-the-Median Notice Periods. This table reports the output from a pooled regression analysis of annual hedge fund investor flows, for the subsample of funds that do not have a lockup or an above-the-median redemption notice period. The dependent variable is the annual percentage change in total assets that is not attributed to annual net returns. Rank is the rank of the fund’s lagged annual return relative to all other funds. D1-D5 are indicator variables that take the value of one depending on the quintile of fund rank. For example, D2 equals one if Rank is greater than 0.20 but less than 0.40. HWM is an indicator variable that equals one if the fund has a high-water mark. Age and Size are the natural logarithms of the fund’s track record length and total assets under management, respectively, at the end of the previous year. Lockup is an indicator that equals one if the fund has a lockup provision. Notice is the fund’s redemption notice period in days. Fund style and year fixed-effects are included in the estimation. The coefficient estimates for Size, Age, Lockup, Notice, HWM, and style and year fixed effects are not reported in the table. Standard errors allow for within-year clustering of the regression residuals. Models 1 and 2 correspond to the full sample of funds and the subample that excludes FoFs, respectively. Panel A uses all monthly return observations and Panel B excludes backfilled observations. t-statistics are reported beneath coefficient estimates. +, *, and ** denote significance at 10%, 5% and 1% levels for two-tailed test that the coefficient equals zero.

<table>
<thead>
<tr>
<th></th>
<th>Panel A: All Observations</th>
<th>Panel B: Excluding Backfilled Observations</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1</td>
<td>2</td>
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<tr>
<td>Rank*D1</td>
<td>5.7093</td>
<td>6.1896</td>
</tr>
<tr>
<td></td>
<td>3.81**</td>
<td>3.74**</td>
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<tr>
<td>Rank*D2</td>
<td>4.7654</td>
<td>5.1898</td>
</tr>
<tr>
<td></td>
<td>6.07**</td>
<td>6.06**</td>
</tr>
<tr>
<td>Rank*D3</td>
<td>2.7804</td>
<td>3.1236</td>
</tr>
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<td>5.44**</td>
<td>5.76**</td>
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<tr>
<td>Rank*D4</td>
<td>2.1417</td>
<td>2.5424</td>
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<td>6.18**</td>
<td>9.09**</td>
</tr>
<tr>
<td>Rank*D5</td>
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<td>2.0578</td>
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<td>9.89**</td>
<td>7.67**</td>
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<td>-1.1907</td>
<td>-1.3974</td>
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<tr>
<td></td>
<td>-3.19**</td>
<td>-3.49**</td>
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<tr>
<td>Rank<em>D2</em>age</td>
<td>-1.0314</td>
<td>-1.1846</td>
</tr>
<tr>
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<td>-5.09**</td>
<td>-5.56**</td>
</tr>
<tr>
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<td>-0.5363</td>
<td>-0.6343</td>
</tr>
<tr>
<td></td>
<td>-4.15**</td>
<td>-4.79**</td>
</tr>
<tr>
<td>Rank<em>D4</em>age</td>
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<td>-0.4663</td>
</tr>
<tr>
<td></td>
<td>-4.26**</td>
<td>-7.71**</td>
</tr>
<tr>
<td>Rank<em>D5</em>age</td>
<td>-0.3301</td>
<td>-0.3566</td>
</tr>
<tr>
<td></td>
<td>-6.85**</td>
<td>-5.93**</td>
</tr>
<tr>
<td>Rank<em>D1</em>HWM</td>
<td>-1.1566</td>
<td>-0.3647</td>
</tr>
<tr>
<td></td>
<td>-2.51*</td>
<td>-0.97</td>
</tr>
<tr>
<td>Rank<em>D2</em>HWM</td>
<td>-0.1302</td>
<td>0.1994</td>
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<td></td>
<td>-0.44</td>
<td>0.64</td>
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<td>Rank<em>D3</em>HWM</td>
<td>-0.0641</td>
<td>0.2154</td>
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<td></td>
<td>-0.46</td>
<td>1.37</td>
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<td>0.3181</td>
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<td>0.93</td>
<td>2.12+</td>
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<td>Rank<em>D5</em>HWM</td>
<td>0.1274</td>
<td>0.218</td>
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<td>2.64*</td>
<td>3.29**</td>
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<td>Observations</td>
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<td>10023</td>
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<td>R-squared</td>
<td>0.1691</td>
<td>0.1732</td>
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<tr>
<td>Other control variables?</td>
<td>yes</td>
<td>yes</td>
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</table>
Table 6: Changes in Hedge Fund Lockups and HWMs Around Changes in SEC Registration Requirements.

Panel A compares the lockup provisions reported by individual hedge funds to the TASS database at different data snapshots over the 01/2002-07/2008 period. The five different data snapshots are taken at 01/2002, 01/2003, 04/2006, 03/2007, and 07/2008. Each of the first five rows of the table summarizes the changes in a fund’s lockup provision across two snapshots. The third column reports the number of funds that appear in both of the snapshots reported in the second column. The fourth column reports the proportion of funds for which the lockup period in the later snapshot does not match the lockup provision reported in the earlier snapshot. The fifth and sixth column reports the proportion of funds that report a smaller (greater) lockup period in the later snapshot. The seventh column reports the proportion of funds for which the reported lockup period is at least two years in the later snapshot but less than two years in the earlier snapshot. Rows 6-9 compares the proportions in Rows 1-5. Panel B compares the high-water mark provisions reported by individual hedge funds to the TASS database in the 01/2003 and 04/2006 snapshots of the TASS database. AVG(ΔHWM) denotes the average change in the HWM indicator variable across funds within subgroups of the two data snapshots. HWM equals one if the fund uses a high-water mark provision to calculate performance fees; and zero otherwise. Rows 1-5 correspond to different subgroups of funds that are found in both snapshots, depending on differences in the reported lockup provision across the two snapshots. Rows 6-9 compares the proportions in Rows 1-5. * and ** denote significance at 5% and 1% levels for two-tailed test that the proportions are the same.

Panel A: Changes in Hedge Fund Lockups Across Data Snapshots

<table>
<thead>
<tr>
<th>Row</th>
<th>Snapshot Comparisons</th>
<th>Matching Funds</th>
<th>Lockup Change</th>
<th>Lockup Decrease</th>
<th>Lockup Increase</th>
<th>Lockup Increase to at least 2yrs</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>01/2002-01/2003</td>
<td>1839</td>
<td>1.58%</td>
<td>0.44%</td>
<td>1.14%</td>
<td>0.05%</td>
</tr>
<tr>
<td>2</td>
<td>01/2003-04/2006</td>
<td>3420</td>
<td>4.59%</td>
<td>1.58%</td>
<td>3.01%</td>
<td>0.70%</td>
</tr>
<tr>
<td>3</td>
<td>04/2006-03/2007</td>
<td>6514</td>
<td>0.81%</td>
<td>0.23%</td>
<td>0.58%</td>
<td>0.20%</td>
</tr>
<tr>
<td>4</td>
<td>03/2007-07/2008</td>
<td>7357</td>
<td>0.98%</td>
<td>0.56%</td>
<td>0.42%</td>
<td>0.10%</td>
</tr>
<tr>
<td>5</td>
<td>04/2006-07/2008</td>
<td>6436</td>
<td>1.62%</td>
<td>0.65%</td>
<td>0.96%</td>
<td>0.31%</td>
</tr>
<tr>
<td>6</td>
<td>Row 2-1</td>
<td></td>
<td>3.01%**</td>
<td>1.14%*</td>
<td>1.87%**</td>
<td>0.65%**</td>
</tr>
<tr>
<td>7</td>
<td>Row 3-2</td>
<td></td>
<td>-3.78%**</td>
<td>-1.35%**</td>
<td>-2.43%**</td>
<td>-0.5%**</td>
</tr>
<tr>
<td>8</td>
<td>Row 4-3</td>
<td></td>
<td>0.17%**</td>
<td>0.33%**</td>
<td>-0.16%</td>
<td>-0.10%</td>
</tr>
<tr>
<td>9</td>
<td>Row 5-2</td>
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<td>-2.97%**</td>
<td>-0.93%**</td>
<td>-2.05%**</td>
<td>-0.39%**</td>
</tr>
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</table>

Panel B: Changes in Hedge Fund High-Water Marks After SEC Registration Requirements

<table>
<thead>
<tr>
<th>Row</th>
<th>Fund Subsample</th>
<th>N</th>
<th>AVG(ΔHWM)</th>
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<tbody>
<tr>
<td>1</td>
<td>No lockup Change</td>
<td>3263</td>
<td>3.19%**</td>
</tr>
<tr>
<td>2</td>
<td>Lockup Change</td>
<td>157</td>
<td>24.84%**</td>
</tr>
<tr>
<td>3</td>
<td>Lockup Decrease</td>
<td>54</td>
<td>11.11%*</td>
</tr>
<tr>
<td>4</td>
<td>Lockup Increase</td>
<td>103</td>
<td>32.04%**</td>
</tr>
<tr>
<td>5</td>
<td>Lockup Increase to at least 2 years</td>
<td>24</td>
<td>20.83%*</td>
</tr>
<tr>
<td>6</td>
<td>Row 3-Row1</td>
<td>.</td>
<td>7.92%**</td>
</tr>
<tr>
<td>7</td>
<td>Row 4-Row1</td>
<td>.</td>
<td>28.85%**</td>
</tr>
<tr>
<td>8</td>
<td>Row 4 - Row 3</td>
<td>.</td>
<td>20.93%**</td>
</tr>
<tr>
<td>9</td>
<td>Row 5-Row1</td>
<td>.</td>
<td>17.65%**</td>
</tr>
<tr>
<td>10</td>
<td>Row 5-Row3</td>
<td>.</td>
<td>9.72%</td>
</tr>
</tbody>
</table>
Fee structure announced

First period return observed; fees; fund flow

Second period return observed; fees; end

Figure 1 Timeline and Payoffs of Risky Asset  The risky asset generates a gross return of either \( u \) or \( d \equiv 1/u \) at Dates 1 and 2, where \( 0 < d < 1 < u \). Manager types are distinguished by the probability of a positive return \( (p) \). At Date 0, the manager raises capital and announces the fee structure. At Date 1, investors observe Date 1 returns, revise their beliefs about manager ability, and decide whether to liquidate the fund. If the fund is liquidated, then investors reinvest the proceeds at \( R_0 \). If the fund is not liquidated, then the manager reinvests his Date 1 fees (if any) into the fund. At Date 2, fund returns and fees are realized and the fund is shut down.
Figure 2 Outcomes with Asymmetric Information and Restricted Fund Flow: The figure plots the lower bound on manager quality (top panel), investor surplus (middle panel), and aggregate surplus (bottom panel) as a function of the performance fee ($f$), depending on whether the manager uses a high-water mark for the case of restricted investor flows. We choose the following set of parameters: $u = 1.2; R_0 = 1; W = 0.05$. We assume that manager type is a uniformly distributed variable between 0 and 1.
Figure 3 Comparing Equilibrium Outcomes with Unrestricted Fund Flow: The figures compare the equilibrium performance fee (top panel), cutoff manager quality (middle panel), and aggregate surplus (bottom panel), for the equilibrium without a HWM (and flow at Node 1d) and the equilibrium with HWM (and no flow). We choose the following set of parameters: $u = 1.2; R_0 = 1; W = 0.05; \text{ and } \bar{p} = 0$. We assume that manager type is a uniformly distributed variable between 0 and $\bar{p}$ (allowed to vary in the figures).