The Role of High-water Marks in Hedge Fund Compensation*

George O. Aragon†
Arizona State University
George.Aragon@asu.edu

Jun "QJ" Qian‡
Boston College
qianju@mail.bc.edu

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†Department of Finance, W.P. Carey School of Business, Arizona State University, Tempe, AZ 85287. Phone: 480-965-5810, fax: 480-965-8539.

‡Finance Department, Carroll School of Management, Boston College, Chestnut Hill, MA 02467, Phone, 617-552-3145, fax, 617-552-0431; and Wharton Financial Institutions Center.

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Abstract

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We examine the role of loss-recovery provisions ("high-water marks") in hedge fund compensation contracts in an environment with asymmetric information on manager quality. In our dynamic model, high-water marks raise the entry costs for low-quality managers and therefore complement investor flows in reducing adverse selection. When investors face costs in withdrawing from poorly performing funds, managers have a greater incentive to certify their quality ex-ante by adopting a high-water mark. We find empirical support for our model using a data set on $5,699$ hedge funds over the period 1994-2005. High-water mark are more commonly used by funds that are operated by management firms with shorter track records and by funds that impose lockups provisions and lengthy redemption notice periods. We also find that measures of average fund performance are negatively related to the use of high-water marks. This evidence is consistent with an equilibrium in which the average ability of well-established managers is greater than that for managers with short track records.

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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 makes this industry an interesting environment to examine contractual relations between portfolio managers and their investors. Typically, hedge fund managers receive a fixed (annual) management fee equal to a percentage of total net assets, in addition to an explicit performance fee that equals a fixed percentage of the fund's profits. In addition, the manager may be subject to a loss-recovery ("high-water mark," HWM hereafter) provision that makes performance fees contingent upon the fund recovering previous losses.[1]

Economists do not yet have a theory for how a HWM can arise endogenously as a solution to the optimal contracting problem between managers and investors. In this paper, we argue that these provisions allow high-quality managers to reduce the costs of adverse selection. Since hedge funds are purported to be a pure bet on manager skills yet do not face strict disclosure requirements applied to most open-ended investment vehicles, information asymmetry between managers and investors is both a logical and important premise for the industry. The terms of the compensation contract, outlined in the fund's initial offering documents to investors and rarely revised during the history of the fund, represent one of the most visible and well-defined aspects of the fund, and therefore provide a natural means through which managers can certify their quality.

We develop a risk-neutral, multi-period model where capital-constrained managers raise a fixed level of capital from outside investors in exchange for a management fee. All managers invest the fund's capital into a risky asset that exhibits independent and identically distributed returns over each performance period. When a manager of higher-quality manages the asset, the likelihood of a *positive* return in each period increases as compared to the asset being managed by a lower-quality manager. Three starting premises of the model are, first, manager types are ex ante private information; second, investors have the option to leave the fund after each period; and third, managers decide and commit to a compensation structure at the fund's inception that maximizes their cumulative expected fees. We take as exogenous the following compensation contract: (1) A performance fee that is paid out as a *fixed* percentage of positive profits earned in a given period; and (2) a HWM provision stipulating that

[1] Goetzmann, Ingersoll and Ross (2003) find that explicit performance fees represent a significant fraction of a hedge fund manager's total expected compensation. By contrast, 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.

the manager is not entitled to receive a performance fee until all previous losses have been recovered.

We first show that HWM's are never optimal when investors have complete information about manager ability. In this case, investors' participation constraint is the same in every state of the world because the expected fund return (on a before-fee basis) is a constant. In the absence of a HWM, each manager type can find a performance fee that makes investors just indifferent from leaving the fund and this maximizes total expected fees. On the other hand, a HWM increases the expected, after-fee returns following poor performance, and therefore makes the investor participation constraint *state-dependent*. In this case, it is generally impossible for managers to make investors just indifferent from leaving the fund in different states, and this leads to a dominated contract.

In the case of asymmetric information, the entrance of low-quality managers is deterred by a market-based mechanism – fund flows based on investors' updating of manager types. However, because adding a HWM is more costly for low-quality managers, we find that HWMs can complement investor flows to reduce adverse selection costs at the fund's inception, and therefore be a part of the optimal contract that maximizes expected fees. Specifically, we solve for a pooling equilibrium in which all managers above a critical quality level enter the industry and set the same percentage fee that is adjusted by a HWM. Going forward, investors update their beliefs about manager quality based on fund performance, and withdraw capital from the fund as expected return from staying with the fund falls below that of the investor's outside opportunities. Hence, the dual mechanisms of informed investor flows and the HWM raise the entry costs for low-quality managers, and ensure that investors' expected return from investing in any fund is no lower than their best alternative.

We also study the case where investors face explicit restrictions on share redemptions.[2] The use of share restrictions increases adverse selection costs because high-quality managers can no longer signal their type by risking fund outflows following poor performance. In this case, the incentive to deter the entrance of low-quality managers at fund inception, through the inclusion of a HWM in the compensation contract, is higher.[3]

[2]Chordia 1996 and Nanda et al. 2000 argue that share restrictions provide a means through which investment funds can screen for longer-horizon investors. Aragon (2006) documents that lockups are more common among hedge funds that manage illiquid assets.

[3]Similar to some hedge funds, private equity funds face liquidation risk due to their holdings of illiquid assets (e.g., shares of private, start-up firms). These funds typically do not charge performance-based fees until they "exit" the private firms. This infrequent payment of fees serves a similar purpose as how HWMs modify performance fees in hedge funds (which are paid every six months to one year): Short-term gains and losses of the funds are less important relative

We find empirical support for our model using a sample of $5,699$ hedge funds (live and defunct) and $2,448$ affiliated management firms over the period 1994-2005. Our analysis yields several new empirical findings: First, although the majority (68%) of all funds have HWMs, these provisions are more commonly used by smaller funds or funds that are operated by management firms with shorter track records. A five year decrease in the length of the management firm's track record is associated with a 6.52% greater likelihood of using a HWM. Second, we find that funds requiring a one-year lockup are 15% to 22% more likely to use a HWM provision.

Third, we find that measures of average fund performance and the sensitivity of investor flows to past performance are both higher for HWM funds as compared to no-HWM funds. This evidence is consistent with an equilibrium in which HWM's are only used by managers with short track records, and the average ability of well-established managers is greater than that for managers with short track records. Finally, we document a secular trend over the 1994-2005 period in the adoption rate of the HWM provision by new funds. The proportion of new funds with HWMs increases from 49% in 1994, to 71% in 1999 and 94% in 2005. We conjecture that this could reflect diminishing returns for the industry due to a growth in total hedge fund capital from \$200 billion in 1994 to over $\$1,200$ billion at the end of 2005.

Our results contribute to the literature on the form of investment manager compensation. Heinkel and Stoughton (1994), Gompers and Lerner (1999), and Das and Sundaram (2002) show that performance-based compensation can arise endogenously in the presence of both moral hazard and adverse selection. By contrast, our model analyzes how a HWM provision can complement the use of a standard performance contract in resolving adverse selection. Goetzmann et al. (2003) evaluate the cost of a HWM-adjusted fee structure to investors, taking as given the fund's fee structure and investment decisions. Hodder and Jackwerth (2005) and Panageas and Westerfield (2004) 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 the presence of adverse selection. Our model establishes a link between the form of manager compensation and restrictions on investor flows. This suggests that provisions in the compensation contract are related to a fund's ability to manage illiquid assets.[4]

to cumulative, long-term returns of the funds.

[4]Shleifer and Vishny (1997) study the impact of liquidation risk on the demand curves of capital-constrained arbitrageurs. Pontiff (1996) shows that transaction and holdings costs can lead to persistence in the discount on closed-end

Empirically, Gompers and Lerner (1999) find lower management fees and higher performance fees among older and larger venture capital funds, and conclude that the pay of new venture capitalists is *less* sensitive to performance because career concerns induce them to exert effort. By contrast, we find that the use of HWM is associated with younger and smaller hedge funds, and interpret this as support for the signaling hypothesis. Aragon (2006) documents a positive relation between hedge fund returns and the use of share restrictions. He argues that share restrictions allow funds to efficiently manage illiquid assets, and these benefits are captured by investors as a share illiquidity premium. We extend this analysis and find that the use of share restrictions is also related to the use of HWMs. Finally, our empirical analysis also reveals a new form of survivorship bias in hedge fund data that affects inferences about the relation between hedge fund performance and fund characteristics. We show how to control for this bias, and that ignoring this bias might to qualitatively different inferences.

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 can solve problems of asymmetric information and investor outflows. Section 3 describes the data and presents empirical tests on our model predictions. Section 4 concludes. All the proofs are left to the Appendix.

2 Model of Hedge Fund Industry

Our multi-period model is a *partial* equilibrium in that funds' investment and fee structures do not affect interest rates and the aggregate economy. We begin with the benchmark case where information on manager ability or types is symmetric. We then demonstrate that with asymmetric information on manager types, a HWM can serve as a credible signaling device for manager types. We also examine the effectiveness of HWM relative to another potential signaling device, namely, the 'market' mechanism of investor flows. This comparison will facilitate our subsequent analysis on the role of HWMs in situations where high-quality managers must impose restrictions on fund outflows in order to manage *illiquid* assets.

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funds shares (relative to net asset value). Brunnermeier and Nagel (2004) provide evidence that liquidation risk led many large hedge funds to avoid short positions in technology stocks during the late 1990s.

2.1 Elements of the Model

There are a continuum of fund managers and investors. Each manager has no initial wealth, and needs to raise \$1 from a continuum of identical, outside investors in order to set up a fund and invests a risky asset. Investors may invest in a risk-free asset that yields a constant, net (of investment) return of $r_0 > 0$ per period or with a fund manager. All agents are risk neutral and do not discount payoffs. The risky asset generates an i.i.d. (gross) return of $\tilde{R} \in \{u, d\}$ each period (per \$1 investment), with $u > 1$ (up factor) and $d \equiv 1/u$, and

$$\Pr\left(\tilde{R} = u\right) = p_i, \qquad \Pr\left(\tilde{R} = d\right) = 1 - p_i,$$

where p_i depends on the manager's ability or type. The managers are distinguishable only by their per-period return distribution (p_i). For simplicity, we assume there are two types of managers. The following list of conditions, maintained throughout the model, along with Figure 1, describes the assets and payoffs.

A) When a *Good* manager (type G) manages the asset, the likelihood for a positive return in each period $\left(\tilde{R} = u\right)$ is p_G; the manager's reservation payoff is W_G; there is mass $\alpha \in (0, 1)$ of type G managers;

B) With a *Bad* manager (type B), the likelihood for a positive return $\left(\tilde{R} = u\right)$ is p_B each period, with $.5 < p_B < p_G < 1$; the manager's reservation payoff is $W_B = W_G = w_0 > 0$; there is mass $1 - \alpha$ of type B managers.

Insert Figure 1 here.

Figure 1 describes the timeline and payoffs of a representative fund. At date 0,the manager raises capital and announces the fee (compensation) structure. We take as exogenous the following compensation contract: 1) A performance fee that is paid out as a fixed percentage (f) of positive profits earned in a given period; these fees are paid at the end of periods 1 and 2 out of the fund's assets; and 2) a HWM, set initially at \$1,the level of assets under management at Time 0, stipulating that the manager is prohibited to receive a performance fee until all previous losses have been recovered. The fund first period return is observed at Time 1, at which point fund flows may occur, while the second period return and final payoffs are realized at Time 2.

Assumption 1 a) Fee structure announced at Time 0 is publicly observable and verifiable, but manager types are private information; b) the costs of attracting new investors at Time 1 is prohibitively high; and c) funds cannot renegotiate fee structure at Time 1.

Assumption 1a) conforms with industry practice of outlining the management contract in the limited partnership agreement. The information asymmetry on manager types implies that there is an adverse selection problem in the industry, which leads to type G managers using fee structure, the only publicly observable and verifiable information at Time 0, to signal their types.

In our model, investors withdraw their capital from a fund by, for example, redeeming shares at Time 1, and pursue outside investment opportunities whenever r_0 is higher than the expected return from staying in the fund, unless the fund impose restrictions on fund outflows (as we will discuss below). Risk-neutral investors will either leave 100% of the remaining capital in the fund or withdraw all of the capital. Assumption 1b) indicates it is impossible a fund to attract new investors after Period 1.[5] Hence, an outflow of capital at Time 1 is extremely costly for the fund, as it forces the fund to shut down. More generally, we can allow for fund inflows, for example, by assuming that funds can find *new* investors (who are not around at Time 0), and thus there will be partial liquidation of the fund's assets.

Assumption 1c) implies that there will be no renegotiation of fee structure announced at Time 0, as commonly observed in practice. Renegotiation is 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 but not *verifiable* by a third party (e.g., a court); this problem is more severe if the fund invests in illiquid assets (e.g., private equity or foreign securities).[6] Finally, we assume that if there is negotiation between the manager and investors about how to split the profits (i.e., fee structure) at Time 0, the manager has all the bargaining power and makes the take-it-or-leave-it offers to investors.

To summarize, given that there will be no fund inflow or renegotiation of a fund's fee structure at Time 1, a fund manager chooses the fee structure (the percentage incentive fee and the use of HWM) at Time 0 to maximize expected fees, while investors first decide at $t = 0$ whether to invest in a fund,

[5] This assumption also rules out the possibility that investors can wait till Time 1 to invest in a fund. In practice, most funds use a "share equalization method," where funds will reset the HWMs for investors arriving *after* the inception of the funds.

[6] This implies that opportunistic behaviors 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, for example, Hart and Moore (1988, 1990) for models of renegotiation with holdup problems.

followed by their withdrawal decision at $t = 1$.

2.2 Benchmark Case with Symmetric Information

In this case as in all subsequent cases, we derive optimal management contracts with and without the HWM. With symmetric information on manager types and i.i.d. returns of the assets, we show that it is never optimal to use the HWM. We also examine the loss in expected fees when using a HWM for different types of managers.

We first derive a representative investor's decision on whether to stay with the fund. We begin at $t = 1$, at which point first period performance has become publicly available.[7] First consider the case where the manager has chosen a percentage fee f without a HWM. If the fund's first period performance is good (Node $1u$ in Figure 1), a fee in the amount of $(u-1)f$ is paid out at Time 1, and the fund begins Period 2 with total assets value $\$\left(u-(u-1)f\right)$.[8] Investors' expected, after-fee payoff (net of $\$\left(u-(u-1)f\right)$ investment) in Period 2 is (for $i \in \{G, B\}$):

$$\begin{aligned}\pi_{i2}\left(f|\,1u\right) &= p_i\left(u-1\right)\left(u-\left(u-1\right)f\right)\left(1-f\right)+\left(1-p_i\right)\left(d-1\right)\left(u-\left(u-1\right)f\right) \\ &= \left(u-\left(u-1\right)f\right)\left[p_i\left(u-1\right)\left(1-f\right)-\left(1-p_i\right)\left(1-d\right)\right].\end{aligned} \tag{1}$$

As discussed above, investors' decision at this node is to compare expected return from staying with the fund, $\pi_{i2}\left(f|\,1u\right)/\left[u-\left(u-1\right)f\right]$, with that of r_0, and will stay if the former is higher.

$$\text{Investors decision at Node } 1d \begin{cases} \text{stay} & \text{if } p_i\left(u-1\right)\left(1-f\right)-\left(1-p_i\right)\left(1-d\right)\geq r_0; \\ \text{leave} & \text{otherwise.}\end{cases} \tag{2}$$

If the fund had poor performance in Period 1 (at Node $1d$ in Figure 1), no fees are paid leading to Node $1d$, and the fund begins Period 2 with total value of assets $\$d$. Investors' expected, after-fee payoff (net of $\$d$ investment) of remaining in the fund for Period 2 (without a HWM) is (for $i \in \{G, B\}$):

$$\pi_{i2}\left(f|\,1d\right) = p_i d\left(u-1\right)\left(1-f\right)-\left(1-p_i\right)d\left(1-d\right), \tag{3}$$

where *second* period fees are paid along the path $\$d \rightarrow \$1$. Investors' decision here is to compare expected return from staying with the fund, $\pi_{i2}\left(f|\,1d\right)/d$, with that of r_0, and will stay if the former

[7] In terms of notations, expressions for fees and other payoffs associated with Good (Bad) manager are indicated by subscript "G" ("B"); fees and payoffs associated with a HWM are indicated by a superscript "H," while expressions without a superscript denote fees and payoffs with only the percentage fees.

[8] Following common practice of fee payments, we assume that fees earned a period are NOT reinvested but rather paid out of the fund, which reduces the size of fund's assets under management. Assuming reinvestment of fees (so that at Node $1u$ fund will have $\$u$) can be regarded as a special case of the model.

is higher. But this condition is exactly the same as that specified in (2) due to the i.i.d. structure of asset returns.

Working backwards, investors' expected, after-fee payoff (net of \$1 investment) investing in a fund in Period 1 is:

$$\pi_{i1}(f) = p_i (u-1)(1-f) - (1-p_i)(1-d). \tag{4}$$

There are two issues regarding investors' decision at Time 0. First, since funds do not allow investors to invest at Time 1 (i.e., funds are closed after $t = 0$), by not investing in the fund at $t = 0$ investors forego the option to invest in any fund in the second period and receiving potentially higher return than r_0. Second, given that investors can withdraw capital from the fund and pursue alternative opportunities (and earn r_0) at Time 1, they are willing to invest in the fund at Time 0 if $\pi_{i1}(f)$,defined in (4), is no lower than r_0, but once again, this condition is the same as (2).

In our two-period model, the HWM (set at \$1) has no impact on fees or after-fee returns unless the fund has incurred a loss in Period 1. This implies that, with the HWM the investors' net after-fee payoff is the same at Node $1u$ as compared to the no HWM case, i.e., $\pi_{i2}^{H}(f|\,1u) = \pi_{i2}(f|\,1u)$, $i \in \{G, B\}$. However, compared to (3), investors' net after-fee payoff is higher at Node $1d$ with the HWM:

$$\pi_{i2}^{H}(f|\,1d) = p_i d(u-1) - (1-p_i) d(1-d), \tag{5}$$

where fees are now waived along the path $\$d \rightarrow \$1$. Clearly, $\pi_{i2}^{H}(f|\,1d) > \pi_{i2}(f|\,1d)$ for all $f > 0$,and investors are better-off.

With the knowledge on the investor's decisions at various points, we now examine the manager's problem. The manager's expected fees at Time 0, $E(F_i|\,f, r_0)$, $i \in \{G, B\}$, conditional on the choice of fee percentage f and no HWM, are:

$$\begin{aligned} E(F_i|\,f, r_0) &= p_i \left[(u-1) f + p_i (u-1)(u-(u-1) f) f \cdot E\left[I_{1u,i}(f, r_0)\right]\right] && (6)\\ &\quad + (1-p_i)\left[p_i d(u-1) f\right] \cdot E\left[I_{1d,i}(f, r_0)\right], && (7)\end{aligned}$$

where $I_{1u,i}$ and $I_{1d,i}$ are *indicator* functions on fund flows at nodes $1u$ and $1d$, satisfying:

$$I_{1u,i}(f, r_0) \equiv \begin{cases} 1 \text{ (no outflow)}, & \pi_{i2}(f|\,1u) / [u-(u-1) f] \geq r_0; \\ 0 \text{ (outflow)}, & \pi_{i2}(f|\,1u) / [u-(u-1) f] < r_0; \end{cases} \tag{8}$$

and

$$I_{1d,i}\left(f,r_0\right) \equiv \begin{cases} 1 \text{ (no outflow)}, & \pi_{i2}\left(f\right|1d)/d \geq r_0; \\ 0 \text{ (outflow)}, & \pi_{i2}\left(f\right|1d)/d < r_0. \end{cases} \tag{9}$$

When a HWM is used to modify the performance fee, the manager's expected fees, $E\left(F_i^H \middle| f, r_0\right)$, $i \in \{G, B\}$, are:

$$E\left(F_i^H \middle| f, r_0\right) = p_i\left[(u-1)f + p_i(u-1)(u-(u-1)f)f \cdot E\left[I_{1u,i}^H(f,r_0)\right]\right], \tag{10}$$

where $I_{1u,i}^H$ is another indicator function on fund flows at Node $1u$, but since the HWM has no impact at Node $1u$, $I_{1u,i}^H$ is the same as $I_{1u,i}$ (indicator without the HWM) defined in (8). A comparison of (7) and (10) confirms the fact that the HWM lowers the expected fees of the fund in Period 2, as no fees will be earned once the fund reaches Node $1d$.[9]

To summarize, a manager's problem at time 0, $(P0)$, for $i \in \{G, B\}$, is as follows:

$$\underset{\{f,H\}}{Max} E\left[F_i^{(H)} \middle| f, r_0\right]$$

$$\text{s.t. } E\left(F_i\middle| f, r_0\right) \text{ and } E\left(F_i^H \middle| f, r_0\right) \text{ are defined in (7) and (10);} \tag{Fees}$$

$$\text{Investors' decisions to stay with fund at Time 0 and 1 are defined in (2);} \tag{Flows}$$

$$E\left(F_i^{(H)}\middle| f, r_0\right) \geq w_0. \tag{IR}$$

The manager's optimal choice of the fee structure (percentage fee, f, and the use of HWM) depends on payoffs of the fund's assets and those of investors' outside opportunities. There are two sets of constraints in $(P0)$. First, given a fee structure (f and the HWM), expected fees earned by the fund depends on whether there is fund flow in either of the two states (nodes 1u and 1d) at $t = 1$; the conditions are given in (Fees) and (Flows) in $(P0)$. Second, (IR) is the participation constraint for the fund manager, in that expected fees earned must cover his reservation payoff w_0.

We need the definitions of two critical percentage fees to derive the optimal fee structure.

Definition 1 a) $\overline{f}_i$ *is the* maximum *percentage fee consistent with investors staying with a fund* $(i \in \{G, B\})$*:*

$$\overline{f}_i = \frac{p_i u + (1-p_i)d - (1+r_0)}{p_i(u-1)}; \tag{11}$$

[9]This result is an artifact of the two-period model (while it simplifies algebra). We can extend the model to three- or more periods, so that funds can still 'rebound' from first period losses and earn a positive fees in latter periods. In this model, the HWM provides an additional 'lock-in' mechanism to retain investors after losses.

b) $\underline{f}_i$ *is the* minimum *percentage fee consistent with a fund* $(i \in \{G, B\})$ *entering the industry:*

$$\underline{f}_i = \frac{w_0}{p_i (u-1) [1 + p_i u + (1 - p_i) d]}; \qquad \underline{f}_i^H = \frac{w_0}{p_i (u-1)(1 + p_i u)}. \tag{12}$$

Clearly, $\underline{f}_i^H > \underline{f}_i$ for either type of manager due to the fact that HWM waives fees along the path $\$d \to \$1$ at Node $1d$, so that the use of a HWM requires a higher minimum performance fee for a fund manager to enter the industry.

Proposition 1 *With symmetric information, it is never optimal to include HWM in the fee structure. There exists a* $\underline{p}_0 (w_0, r_0; u) \in (.5, 1)$ *such that all funds with* $p \geq \underline{p}_0$ *enter the industry and set percentage fee at* $\overline{f}$ *specified in Definition* 1a.

Proof. See Appendix A.1. ■

The optimal percentage fee $(\overline{f})$ that maximizes expected fees defined in (11) is derived from (2). Under this percentage fee there is no outflow of capital at either node at Time 1 (in particular, their decision to stay with fund is given in 2). Since investors' payoff at Node $1d$ is strictly higher with a HWM, the same percentage fee $(\overline{f})$ would also retain investors at Node $1d$ when a HWM is used. But this implies that the fund is overpaying the investors to stay at this node if a HWM is included in the fee structure, and hence a fee structure with a HWM is suboptimal with symmetric information on manager types.

Corollary 1 a) *The optimal percentage fee,* $\overline{f}$ *increases with* p, *so that* $\overline{f}_G \equiv \overline{f}(p_G) > \overline{f}_B \equiv \overline{f}(p_B)$;b) *the loss in fees due to the use of HWM for a given* f *is given by:*

$$L^H (p; f) = p (1-p)(1-d) f; \tag{13}$$

it increases with f *and decreases with* p, *in particular,* $L_G^H \equiv L^H (p_G; f) > L_B^H \equiv L^H (p_B; f)$.

Corollary 1a) implies that a higher-quality manager can charge a higher f (and earn higher fees) and retain investors. While it is costly to include a HWM to adjust performance fees in our model with i.i.d. returns, the loss is greater for type B managers as the likelihood of them having a poor performance in the first period is higher (Corollary 1b). Hence, with asymmetric information a HWM can be used as a credible signal.

2.3 Optimal Fee Structure under Asymmetric Information

In order to understand how a contract feature such as the HWM allows a type G manager to signal his quality, we need to first understand whether and how other mechanisms can solve the adverse selection problem. Perhaps the most natural mechanism is investor flows, as argued by prior research (e.g., Fama 1980; Fama and Jensen 1981). In our model, investors can update their beliefs about manager types based on their performance in the first period. This Bayesian updating then becomes the basis for the decision to stay with the fund or withdraw capital at Time 1.

2.3.1 Investor Updating and Fund Flows without the HWM

Suppose at Time 0 all funds entering the industry set the same percentage fee (with no HWM), which implies investors cannot differentiate their types. However, investors can and will update their beliefs on fund types after first period performance is realized and observed. After observing a good performance, investors' posterior beliefs on manager types, using the Bayes' Rule, are:

$$\Pr(G|\,1u) = \frac{\Pr(G\ \&\ 1u)}{\Pr(1u)} = \frac{\alpha p_G}{\alpha p_G + (1-\alpha)\,p_B}, \quad \text{and} \quad \Pr(B|\,1u) = \frac{(1-\alpha)\,p_B}{\alpha p_G + (1-\alpha)\,p_B}, \tag{14}$$

and their posterior beliefs after observing a bad performance are:

$$\Pr(G|\,1d) = \frac{\alpha(1-p_G)}{\alpha(1-p_G) + (1-\alpha)(1-p_B)}, \quad \Pr(B|\,1d) = \frac{(1-\alpha)(1-p_B)}{\alpha(1-p_G) + (1-\alpha)(1-p_B)}. \tag{15}$$

Notice that, $\Pr(G|\,1u) > \alpha$, and $\Pr(B|\,1d) > 1-\alpha$, so that following a good (bad) performance in Period 1, investors are more certain that the fund they invest in is a good (bad) fund and more likely to keep (withdraw) their capital from the fund. Since funds cannot alter their fee structure and there is no investor inflow at Time 1, investors will not leave the fund at Node $1u$ as long as they invest at Time 0. Hence, the only meaningful updating for fund flows is whether updated beliefs trigger an investor outflow at Node $1d$.

Lemma 1 *The precision in the investors' updating at Node* $1d$ *approaches perfection, i.e.,* $\Pr(B|\,1d) \to 1$ *when* $p_G \gg p_B > 0.5$ *(*$p_G \to 1$ *and* $p_B \to .5$*) or as* $\alpha \to 0$.

Proof. See Appendix A.2. ■

When p_G approaches 1 and is much higher than p_B, investors know that the chances of a type G manager having a poor performance in any period (and in Period 1) is close to 0; when there are very few type G managers in the population, investors can rule out the association of a bad performance with a type G manager; thus in both cases upon observing a bad performance investors are almost certain the fund they had invested in is of type B.

Lemma 1 also implies that investors' updating and fund flows will not be informative in general. We next show that there exists a pooling equilibrium at Time 0 in which both types of managers enter at Time 0 and set the same percentage fee, while investors' updating at Time 1 leads to fund outflows.

Definition 2 $p_0 \equiv \alpha p_G + (1-\alpha) p_B; \quad p_{1d} \equiv p_G \Pr(G|\, 1d) + (1-\alpha) \Pr(B|\, 1d)\,.$

In a pooling equilibrium, investors' belief of the average quality of the managers (p_0 in Definition 2) must be sufficiently high (as compared to r_0) to induce investment at Time 0. On the other hand, at Node $1d$ investors update the average quality of the manager downward, since from (15) it can be easily shown that $\Pr(G|\, 1d) < \alpha$ and $\Pr(B|\, 1d) > 1-\alpha$ and thus $p_{1d} < p_0$. If the expected return from staying with the fund of (updated) lower (average) quality is less than r_0, then investors will withdraw their capital at Node $1d$.

Assumption 2 a) $\underline{p}_B^P \leq p_B < \underline{p}_0(w_0, r_0; u)$; and b) $p_{1d}(p_G, p_B; \alpha) < \underline{p}_0(w_0, r_0; u) < p_0(p_G, p_B; \alpha)\,.$

The second part of Assumption 2a) implies that type B managers should not enter the industry and manage a fund under symmetric information ($\underline{p}_0$, defined in Proposition 1, is the minimum required *average* level of managerial quality to induce investor capital at Time 0); the first part of Assumption 2a) implies that the quality of these managers is high enough that they will enter the industry in a pooling equilibrium ($\underline{p}_B^P$ is the minimum required probability such that given the pooling equilibrium percentage fee type B managers can just cover their reservation payoff, w_0). Assumption 2b) implies that, given the mixture of types G and B managers (in a pooling equilibrium) the *average* quality of the managers is above the minimum required quality level ($\underline{p}_0$) to attract investors; however, the second part of the inequality implies that the updated average quality upon seeing poor performance is below the minimum level.

Proposition 2 *Given Assumption 2, there is a* pooling *equilibrium at Time* 0 *where all funds set percentage fee* $f_P = \overline{f}(p_0)$*; at Time* 1 *there will be fund outflow at Node* $1d$.

Proof. See Appendix A.3. ■

In the pooling equilibrium, all managers enter the industry and set the same percentage fee f_P such that investors are indifferent between investing in a randomly matched fund (average quality indicated by p_0) and receiving r_0. Combining Lemma 1 and Proposition 2, we know that when $p_G \ll 1$ and/or $\alpha \gg 0$, investors' Bayesian updating based on first period performance is not very informative, and hence type G managers' payoffs are significantly lower than what they can garner under symmetric information, because they are essentially subsidizing type B managers in the pooling equilibrium.

2.3.2 Equilibria with the HWM

We have shown above that without a HWM, there are two potential problems associated with adverse selection. First, there is no signaling device at Time 0 that helps investors differentiate the quality of managers (recall fund flow occurs only at Time 1 so that type B managers, upon their entrance, can earn a performance fee with probability p_B). Second, the effectiveness of investors' updating (and hence decision on capital withdrawal) is generally not high (Lemma 1). Therefore, type G managers can benefit from an additional, *ex ante* signaling device of their quality, and this is the role of the HWM.

While using a HWM is costly for all managers under symmetric information (Proposition 1), as Corollary 1b) indicates, given the same percentage fee type B managers incur a greater loss. In addition, Corollary 1a) indicates that type G managers can set a higher percentage fee than B managers to retain investors. Given that the fee structure is publicly observable at Time 0 and before investors' investment decisions are made, a HWM can thus serve as a signaling device for manager quality.

Depending on parameters, there are *four* possible equilibria in the industry. In the first two cases, type B managers enter the industry; there can be either a pooling equilibrium at Time 0, in which all managers set the same fee structure with a HWM, or a separating equilibrium, where only type G managers set the HWM at Time 0. In the third and fourth cases, type B managers do not enter the industry; if type G managers enter the industry then there is no adverse selection at Time 0,but if type G managers do not enter the industry, then adverse selection problems are so severe such that the industry collapses. In what follows, we focus the more interesting cases of type B managers entering the industry.

We first derive the pooling equilibrium with the use of HWMs. This pooling equilibrium is similar to Proposition 2, in that both types of managers enter the industry at Time 0 and set the same fee structure but here all funds use a HWM. In addition, investors' updating following the realization of first period performance is exactly the same as in (14) and (15), so that investors decision to withdraw capital at Node $1d$ is an (partially) informed decision. The main difference between these two pooling equilibria is that a HWM increases the entry cost for type B managers, so that in equilibrium the average quality of a fund manager is better under the HWM case than without it, which tend to benefit the investors and type G managers, as they can charge a higher performance fee and still retain investors.

Assumption 3 a) $\underline{p}_B^{H-P} \leq p_B < \underline{p}_0^H (w_0, r_0; u)$; and b) $p_{1d}(p_G, p_B; \alpha) < \underline{p}_0^H (w_0, r_0; u) < p_0^H (p_G, p_B; \alpha)$.

Assumption 3 is similar to Assumption 2 above without the HWM, with the only difference being the use of HWM increases the minimum required quality for a type B manager to enter the industry, which improves the average managerial quality in the industry and, in turn, benefits the type G managers, who can now charge a higher equilibrium fee than they can in Proposition 2. The proposition below summarizes the results and the comparisons between the two pooling equilibrium.

Proposition 3 *Given Assumption 3, there is a* pooling *equilibrium at Time* 0 *where all funds set percentage fee* $f_P^H = \overline{f}\left(p_0^H\right)$*; at Time* 1 *there will be fund outflow at Node* $1d$*. Moreover,* $p_0^H \geq p_0$ *and* $f_P^H \geq f_P$*, where* p_0 *and* f_P *are average quality of manager and equilibrium fee in the pooling equilibrium in Proposition 2.*

Proof. See Appendix A.4. ■

We next derive the separating equilibrium with HWM. There are two possibilities regarding the decision to enter the industry for type B managers in a separating equilibrium. If their quality (p_B) is high enough to earn fees to cover their reservation payoff (w_0) then they will enter the industry and set a fee structure *without* a HWM; otherwise they will not enter the industry so that only type G managers enter the industry.

Definition 3 f_{BG}^H *is such that* $E\left(F_B | f_{BG}^H, r_0; B\right) = E\left(F_B | \overline{f}_B, r_0; B\right)$.

$\overline{f}_B$, defined in Corollary 1, is the highest fee charged by a type B manager to retain investors in the fund under symmetric information; $E\left(F_B | \overline{f}_B, r_0; B\right)$ gives the expected fees under this fee structure. f_{BG}^H is a fee charged by type G managers along with the use of a HWM. Definition 3 indicates that this fee is chosen such that type B managers gain no extra profits by mimicking type G managers.

Assumption 4 a) $p_B > \underline{p}_B^{H-S}$; and b) $f_{BG}^H \leq \overline{f}_G$.

Assumption 4a) indicates that type B managers' quality is good enough to earn sufficient fees to cover reservation payoff in the separating equilibrium. Assumption 4b) requires that the fee charged by type G managers to make type B managers indifferent from mimicking must be below the highest percentage fee charged by type G managers under symmetric information, or else investors will not invest in any fund at Time 0.

Proposition 4 *Given Assumption 4, there is a* separating *equilibrium in which type G managers set the percentage fees,* $f_G^* = Min\left(f_{BG}^H, \overline{f}_G\right)$ *along with a HWM; type B managers set the percentage fee* $f_B^* = \overline{f}_B$ *without a HWM;* $f_G^* > f_B^*$. *Investors earn the same after-fee payoffs from investing with either type of funds, and there is no fund flow at Time* 1.

Proof. See Appendix A.5. ■

Notice that even though investors earn the same (expected) after-fee payoff (since the managers have all the bargaining power) regardless of the funds they invest, type G managers are strictly better off in the separating equilibrium than in either of the pooling equilibrium described above.

The main differences between the separating equilibrium and the pooling equilibrium with HWM are two fold. First, in the pooling equilibrium type B managers' quality is below socially optimal level for entering the industry and hence there is subsidy from G to B managers in order to ensure that the market does not collapse at Time 0. On the other hand, type G managers in the pooling equilibrium are not good enough (p_G not high enough) to force type B managers out of the market at Time 0 (they can do this by charging a low performance fee but this is costly for them). These results can also explain why there is fund outflow at Time 1, as investors' (partially) Bayesian updating on manager types complements the use of HWM to ensure that the average quality of the managers in the industry is high enough to ensure investors to earn their reservation payoffs. In the separating equilibrium, however, type B managers are good enough to cover their reservation payoffs by choosing a lower performance fee used by type G managers but without using the HWM. Type G managers, on the other hand, must use the HWM in order to prevent type B managers from mimicking; the cost of using HWM is compensated by the higher performance fee set by type G managers.

Second, as indicated above, (partially) informed investor flow is an important mechanism to lower costs of adverse selection in the pooling equilibrium, since type G managers cannot separate from type

B managers from setting a different fee structure. In the separating equilibrium this can be achieved and hence there is no need for investor flow to serve as a device to reduce costs of adverse selection.

2.3.3 Restrictions on Investor Flows

In this subsection, we examine the joint use of restrictions on share redemption (e.g., lockup) and a HWM. As prior research has shown, the use of lockups is to reduce the costs associated with (informationless) investor flows when the fund invests in illiquid assets (e.g., Chordia 1996; Edelen 1999; Nanda et al. 2000; Aragon 2005), or to screen for long-term investors at Time 0 (e.g., Lerner and Schoar 2004). However, in our model, restrictions on fund outflow worsens adverse selection. As shown above, a type G manager can 'signal' his type by allowing investors to leave the fund following poor performance, i.e., by placing *no* restrictions on fund outflows, since investors are much more likely to withdraw their capital from a type B manager Time 1 ($p_G > p_B$). But this means prohibiting investor outflows (due to the exogenous reason of managing illiquid assets) provides type B managers a stronger incentive to mimic and also impose restrictions on outflows – doing so allows type B managers to (possibly) earn fees for two periods. The solution for this worsened adverse selection problem is the use of HWM by type G managers.

Suppose first that type G managers invest in a liquid asset so that a lockup is not needed. As shown in Lemma 1 and Proposition 2, even without a HWM these managers can signal their type based on investor flows as long as $p_G \gg p_B$ ($p_G \to 1$ and $p_B \to .5$) or as $\alpha \to 0$. This is our starting point on the type G managers. Moreover, we assume that $p_B < \underline{p}_B^P$, where $\underline{p}_B^P$,defined in Assumption 2a), is the minimum required quality of type B managers to enter the pooling equilibrium without a HWM. These assumptions on type G and B managers imply that type B managers will *not* enter the industry as long as type G manager do not invest illiquid assets and use lockups, regardless of whether a HWM is used or not by type G managers.

Now assume instead type G managers must use lockups as part of the contract to manage illiquid assets. This means there is no fund outflows at Time 1, and the mechanism of investors' Bayesian updating is not applicable. The fact that a lockup prevents fund outflows also implies that any fund set up at Time 0 can earn fees in two periods, an attractive proposition for type B managers.

Definition 4 f_P^{LC} *is the fee consistent with a* pooling *equilibrium such that* $\Pi\left(f_P^{LC}\right) = (1+r_0)^2 - 1$, *where* Π *denotes expected after-fee payoff over* two *periods*; f_{H-B}^{LC} *is a percentage fee such that type* B

managers are indifferent between entering the industry and earning w_0.

From Proposition 2, in a pooling equilibrium funds charge a fee set by a fund whose quality is the average of the funds in the population, i.e., a fund with probability $p_0 \equiv \alpha p_G + (1-\alpha) p_B$. The difference between the current case and that in Definition 2 is that without fund outflows at Time 1 investors must decide, at Time 0, whether to invest in a fund (of quality p_0) for *two* periods.

Proposition 5 *Without the use of HWMs, there is a* pooling *equilibrium with all managers enter the industry, set the same fee f_P^{LC} and impose restrictions on investor outflows. When HWMs are available, there are two cases:*

a) *if $p_B \geq \underline{p}_B^{H-P}$, there is a pooling equilibrium in which both types managers enter, set the same fee f_{H-P}^{LC}, and use lockups; moreover, $f_{H-P}^{LC} \geq f_P^{LC}$;*

b) *if $p_B < \underline{p}_B^{H-P}$, type G managers set performance fee at f_{H-B}^{LC} and impose lockups, while type B managers do not enter the industry.*

Proof. See Appendix A.6. ■

The first part of Proposition 5 shows that the lockup provision worsens adverse selection, in that type B managers in our current setup would not enter the industry (even without the use of the HWM) in Proposition 2, but they are entering the industry here by mimicking type G managers' fee structure including the use of lockups. Hence, in the current case, type G manager must significantly lower percentage fees as they can charge under symmetric information and subsidize B managers to induce investment capital from investors.

Results from Proposition 5a) and 5b) indicate that a HWM alleviates the severity of adverse selection by increasing the entry costs for type B managers at Time 0. In particular, if the quality of type B managers is below the critical level to enter in a pooling equilibrium, they will not enter the industry and type G managers can set a much higher fee and impose lockups to efficiently manage illiquid assets.

2.4 Discussions and Empirical Predictions

The main argument in our model is that high-water marks provide an ex ante signaling tool for high-quality managers, and increase the entry barrier for low-quality managers. One implication is that the use of HWMs is more likely among funds face a more severe degree of asymmetric information, as proxied by the length of the fund's track record at the date of fund inception. Our other main prediction is on the joint use of lockup and HWM provisions. Taking share restrictions as exogenous, our model illustrates that restrictions on flows worsen the adverse selection problem since low-quality managers find restrictions on flows as an opportunity to earn more fees by repeating the same 'gamble' in multiple periods. Since HWM now becomes the only signaling device, the value of using HWM becomes higher for high-quality managers. Our prediction is that funds imposing restrictions on flows are more likely to use HWMs.

We have also shown that there can be either a pooling or separating equilibrium with HWM. In the pooling equilibrium, all funds set the same fee structure including the use of HWM and there is fund outflow following poor performance. In the separating equilibrium, high-quality managers/funds use HWM and set higher performance fees, while low-quality managers/funds do not use HWM and set lower fees. In addition, there is no outflow following bad performance in the separating equilibrium, since investors already inferred the types of the managers at Time 0 upon observing fee structures and understand that both types of managers can deliver high enough return per period as compared to their alternative investment opportunities. We address this question by studying the sensitivity of investor flows to past performance.

3 Empirical Evidence

3.1 Description of Data

We examine a dataset of 2,448 management firms that contains the organizational characteristics and historical returns for 5,699 individual hedge funds. These data were provided by TASS Tremont Ltd., a major hedge fund data vendor. Each fund reports a monthly time series of returns, calculated net of fees. Each fund also reports a single, updated snapshot of its organizational characteristics, including the form of manager compensation and restrictions on fund redemptions. Each individual fund is matched with its corresponding management firm. It is common for a single management firm to list multiple funds with the TASS database. For example, the average number of funds for a given management firm is 2.32, and ranges from 1 to 58. We restrict our analysis to all hedge funds that were organized during the period 1994-2005. The organization date for each individual fund is taken as the date of the fund's first available return observation. Of our sample of 5,699 individual funds, 3,760 were live as of April 2006. The remaining 1,939 funds are considered defunct. Defunct funds have ceased reporting to TASS but perhaps have not ceased operations. The characteristics of a defunct fund are those disclosed in the fund's final report to TASS.

TASS describes the form of manager compensation in three separate fields. First, the fixed management fee equals the percentage of total net assets awarded to the manager during each management fee payable period. Second, the performance fee equals the percentage of total profits awarded to the manager during each management fee payable period. Third, an indicator variable that equals one of the fund uses a high-water mark to calculate performance fees.

Our analysis reveals a new form of survivorship bias in the TASS database. Data are periodically provided by individual funds to TASS in response to a survey of questions about the fund's performance and organizational characteristics, including the form of compensation. To our knowledge, the survey has added at least one new field-the high-water mark indicator-since the start of 2000.[10] Therefore, the high-water mark data for funds that were assigned to the graveyard before 2000 are unknown. A survivorship bias arises because TASS assigns a zero value to the high-water mark field for these defunct funds, rather than a missing value, thereby overpopulating the non-high-water mark fund sample with defunct funds. In contrast, other fields of interest for our analysis-management fee, incentive fee, and lockup-are included in earlier surveys. In the following we control for this bias and show that ignoring this bias leads to qualitatively different inferences about the relation between the form of compensation and ex-post fund performance.

We follow Gompers and Lerner (1999) and construct, for each individual fund, two measures of manager reputation at the date of fund organization. First, we consider the length of the management firm's track record when the fund was opened. This is defined as the number of months between the fund's first observation date and the earliest of the first observation dates across all funds belonging to the same management firm. Second, we consider the sum of total net assets across all funds, excluding the individual fund, managed by the corresponding management firm. This variable is intended to control for the possibility that individual managers starting a new management firm may have accumulated substantial experience in other management firms.

A fund's redemption policy often involves a lockup provision or a redemption notice period or both. A lockup provision requires that all initial monies allocated to the fund not be withdrawn before the

[10]We thank Mr. Stephen Jupp of Lipper/TASS for providing this information.

end of a pre-specified period, or, lockup period. In our sample, lockup periods are clustered around one year and exhibit little variability across funds. Therefore, following Aragon (2006), we focus on an indicator variable that equals one if the fund has a lockup period. The redemption notice period is the amount of notice the investor is required to provide before redeeming shares. Unlike the lockup period, the notice period is a rolling restriction and applies throughout the investor's tenure with the fund. Other fund characteristics include an indicator variable that equals one if the fund is domiciled offshore; the minimum initial investment amount required by the fund; and a measure of the fund's underlying asset liquidity. We follow Getmansky, Lo, and Makarov's (2004) procedure for estimating underlying asset liquidity from reported fund returns.[11]

3.2 Summary Statistics

Table 1 reports summary statistics for the sample of hedge funds. The first two rows correspond to the restrictions on investor redemptions. A minority (26%) of all funds require a one-year lockup period, and the average redemption notice period is 35 days. On average, 89% of the true monthly economic return is reflected in the contemporaneous reported return. This point estimate indicates some degree of stale price bias in a fund's net asset value. The typical hedge fund management firm includes both the domestic U.S. hedge fund and the offshore hedge fund. This allows hedge fund managers to attract capital from all over the world. Our finding that 60% of the funds are domiciled offshore is in line with Brown, Goetzmann, and Ibbotson's (1999) finding that the majority of the funds in the TASS database are domiciled offshore. The last two rows summarize our proxies for a fund's reputation at the date of inception. The track record length of the management firm at the organization date of an individual fund is approximately 30 months, on average, and ranges from 0 to 292 months. On average, the hedge fund management firms are already managing $475 million when they decide to open a new fund.

TASS provides the compensation data as an updated snapshot for each fund. However, our sample includes funds that were organized between 1994 and 2005, and ignoring time effects might confound inferences about contemporaneous cross-sectional relations. Therefore, before proceeding with the

[11] Specifically, we estimate the smoothing parameter θ_0, which reflects the proportion of the funds economic return that is contemporaneously reflected in its reported return. See Getmansky, Lo, and Makarov (2004) for a detailed description of how the smoothing parameter is estimated. Many funds do not report total net assets. Also, we require at least six monthly return observation to estimate mean and standard deviation of returns.

cross-sectional analysis, we first explore potential time effects in the organizational characteristics of hedge funds by conditioning on fund inception dates. Table 2 presents summary statistics of the key organizational characteristics for the sample of 5,699 hedge funds by the year of fund organization. As stated earlier, a fund's organization date is defined as the date of the earliest return observation found in the TASS database. The first row shows the number of funds organized in a given year. For example, there are 270 funds in the TASS database, as of April 2006 and including funds that have ceased reporting prior to April 2006, for which the earliest return observation date appears in 1994. The steady increase in this number from 270 in 1994 to 758 in 2004 is consistent with the reported growth in the industry as a whole.[12]

Panel A of Table 2 summarizes the form of compensation and other organizational characteristics for all new funds in each year of our sample period. The time variation in the mean fixed management fee and performance fee exhibits no clear pattern across 1994-2005. In fact, the median performance fee is flat (20%) over this period. In contrast, the proportion of funds using a high-water mark increases monotonically from 1994 (21%) to 2005 (94%). Row five shows an increasing trend in the proportion of new funds started by well-established management firms. For example, the proportion of funds started by new management firms decreases from 65% in 1994 to 31% in 2005. Consistent with this trend, row six reveals that the median length of initial track record increases over time. Finally, row seven shows that share restrictions also display an upward trend over the sample period. The mean redemption notice period of new funds increases from 20 days in 1994 to 48 days in 2005. In addition, only 10% of the funds organized in 1994 impose lockups, as compared to 27% in 2005.

However, the positive trend in the high-water mark variable may be an artifact of TASS backfilling the high-water mark field of pre-2000 defunct funds with a value of zero. Indeed, this is reflected in a sharp 20% rise in the adoption rate of the high-water mark from 1999 to 2000. This is unlikely to change our inferences about a positive trend in the adoption rate, however, because we observe an increase in the adoption rate from 82% to 94% among new funds organized over the 2000-2005 period. However, we address this issue by dropping all funds that were added to the database before 2000. The remaining funds are those for which the high-water mark field has not been backfilled. Panel B reveals larger adoption rates in the early part of our sample period. Still, there is a secular

[12]The drop from 758 in 2004 to 426 in 2005 most likely reflects the preference of many funds to generate a track record of at least one year before being added to the TASS database. Therefore, funds that were organized in May 2005 or later are currently generating a track record and have not yet decided to advertise to the TASS database as of April 2006.

trend in the adoption rate of high-water marks over the period 1994-2005. This suggests that time effects are important control variables for studies of cross-sectional variation in the form of hedge fund compensation.

3.3 Analysis and Results

This section examines the relation between the high-water mark provision and fund characteristics. We also examine how the high-water mark is related to measures of ex-post performance.

3.3.1 The Use of High-water Marks

Table 3 tabulates the frequency of the use of high-water marks across our sample of hedge funds. We find no univariate relation between the frequency of high-water marks and our proxies for manager reputation. In fact, the second set of rows suggests that high-water marks are less common among funds started by smaller management firms. However, the earlier discussion suggests that an analysis of the high-water mark variable for funds added to the database before 2000 is problematic. Therefore, we form two subgroups from the full sample of funds, depending on whether funds were organized in 2000 or later, or were added to TASS in 2000 or later. We find a negative relation between adoption rates of high-water marks and manager reputation for the two subgroups. For the sample of funds organized in 2000 or later, for example, approximately 90% of the initial fund of a management firm use high-water marks, as compared to 76% for management firms with at least eight years of track record and/or in the top decile of assets under management at the date of fund inception. Funds with lockups are also approximately 7%-10% more likely to use a high-water mark as compared to funds without a lockup.

Table 4 shows the results from a multivariate probit analysis of the high-water mark provision. Consistent with our univariate results, we find no relation between high-water marks and the track record length using the full sample of funds and without controlling for the year the fund was organized. However, Panels B and C of Table 4 reveal qualitatively different results for the two subgroups that control for the bias in the high-water mark variable. We find higher adoption rates of high-water marks among newer and smaller funds. Specifically, a one standard deviation increase in the logarithm of a management firm's track record is associated with a 5.0% increase in the probability of using a high-water marks. In economic terms, a five year increase in the track record of a management firm is associated with a 4.9% decrease in likelihood of a new fund using a high-water mark. This is consistent with the hypothesis that high-water marks are an important certification device for funds with shorter trace records.

The probit analysis also reveals a positive relation between high-water marks and share restrictions. The presence of lockups are associated with a 6%-10% increase in the use of high-water marks, depending on the subgroup. We interpret these results as support for the hypothesis that, when investors face costs in withdrawing from poorly performing funds, managers have a greater incentive to certify their quality ex-ante by adopting a high-water mark.

3.3.2 Sensitivity of Investor Flows to Past Performance

In this section we examine how net investor flows are related to past fund performance. To the extent that there is a pooling equilibrium in which both types of managers use a high-water mark, we expect to see greater flow-performance sensitivity for funds with high-water marks. We estimate the pooled regression of annual net investor flows on past relative performance over the sample period 1994-2005. Specifically,

$$\begin{aligned} \text{net flow}_{i,y} = \beta_0 + \beta_1 \text{rnk}_{i,y-1} + \beta_2 \text{logage}_{i,y-1} + \beta_3 \text{lognav}_{i,y-1} + \gamma_0 \text{hwm}_i + \\ \gamma_1 \text{rnk*hwm}_{i,y-1} + \gamma_2 \text{logage*hwm}_{i,y-1} + \gamma_3 \text{lognav*hwm}_{i,y-1} + \epsilon_{i,y}, \end{aligned} \tag{16}$$

where net flow$_{iy} = (A_{iy} - A_{i,y-1} * (1 + R_{i,y}))/A_{iy}$, A_{iy} denotes the net asset value of fund i at the end of year y, and R_{it} denote the net raw return of fund i during year y. The independent variable rnk$_{i,y}$ denotes the fractional rank of fund i's raw return across all funds in year y. $logage_{iy}$ and $lognav_{iy}$ denote the natural logarithm of the number of available monthly return observations and net asset value, respectively, for fund i at the end of year y. The variable hwm is an indicator variable that equals one if the fund has a high-water mark. Standard errors are heteroskedasticity-consistent and allow for clustering at each quarter.

Table 7 reports the results from estimating Eq. (16). 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, a fund that moves from the worst to the best performer is associated with a net flow of 68% of total assets. However, the net flows to funds with high-water marks are more sensitive to past performance as compared to funds without high-water marks. Specifically, a non-high-water mark fund that moves from the worst to the best performer is associated with a net flow of 55% of total assets, as compared to an 85% increase for a similar fund that has a high-water mark. This evidence is consistent with a pooling equilibrium in which low and high-ability managers with short track records enter the industry and choose a high-water mark. Meanwhile, the lower flow-performance sensitivity of funds without high-water marks is reflective of these funds having well-established track records.

3.3.3 Ex-ante Compensation and Ex-post Fund Performance

In this section we examine whether the form of manager compensation is related to measures of ex-post fund performance. Our estimates are obtained using two approaches: Fama-Macbeth (1973) cross-sectional regressions of annual raw returns on fund characteristics; and a two-pass approach involving fund-level time series regressions, followed by a single cross-sectional regression. The Fama-Macbeth approach uses the entire return history for each fund; the two-pass approach involves measures of risk-adjusted returns, but omits funds without a sufficient number of return observations. An additional 1,222 funds are dropped for this analysis because they do not report returns in US dollars. Returns are reported to TASS net of fees. Our analysis also controls for a potential survivorship bias in the high-water mark variable.

We consider the following cross-sectional regression of excess fund returns ($\hat{\alpha}$) on fund characteristics:

$$\hat{\alpha}_i = \gamma_0 + \gamma_1 \cdot hwm_i + \gamma_2 \cdot pfee_i + \gamma_1 \cdot dlock_i + \gamma_2 \cdot notice_i + \gamma_3 \cdot min_i + \gamma_4 \cdot notice_i^2 + \gamma_5 \cdot min_i^2 + e_i. \quad (17)$$

where hwm is an indicator variable that equals one if the fund has a high-water mark, $pfee$ is the percentage performance fee, $dlock$ is an indicator variable that equals one if the fund has a lockup, $notice$ is the redemption notice period (in 30 day units), and min is the minimum investment requirement (in millions of dollars). Aragon (2006) finds a positive cross-sectional relation between hedge fund performance and the use of share restrictions, like lockups, redemption notice periods, and minimum investment requirements. However, Tables **??** and 4 find a positive relation between share restrictions and the level of performance fee and use of high-water mark provision. Therefore, share restrictions are important control variables to isolate the marginal relation between average hedge fund returns and compensation structure. The coefficients γ_3, γ_4, and γ_5 are intended to estimate the degree to which a fund's share illiquidity characteristics contribute to excess returns. More precisely, they could be interpreted in the context of Fama and Macbeth cross-sectional regression coefficients, as premiums on share illiquidity factors. The coefficients, γ_4 and γ_5, provide a test of whether the return and share restriction relation is linear.[13]

Table 5 presents the results from the Fama-Macbeth approach. Consistent with Aragon (2006) we find a positive relation between average returns and share restrictions. For example, the use of a lockup provision is associated with a 2.6% per year increase in average fund returns. Panel A also reveals a positive relation between average returns and the form of compensation for the full sample of funds. Specifically, high-water marks funds are associated with 1.9% per year higher average returns as compared to non-high-water mark funds. In addition, an increase in the performance fee from zero to the median of 20.0% is associated with a 5.0% increase in average fund returns.

Our earlier discussion suggests that our inferences about the relation between fund performance and high-water marks might be affected by a survivorship bias. We control for this issue by dropping the funds that were added to the database prior to 2000. The results are reported in Panel B. In contrast to our results for the full sample, we find no statistically significant relation between average returns and the high-water mark variable. This result is consistent with a survivorship bias in performance estimates due to backfilling the high-water mark variable for funds in the pre-2000 graveyard. However, the positive relation between average returns and lockups and performance fees is robust to the exclusion of funds that were added to the database before 2000. This is consistent with the fact that these fields are not backfilled.

The Fama-Macbeth uses the entire return history, however small, for each fund in the sample, but does not adjust for differences in risk and other style-specific characteristics across funds. Therefore, we also consider a two-pass approach that involves the following: first, fund-level alphas are estimated using the regression

$$r_{i,t} = \alpha_i + \sum_k \beta_{i,k} I_{k,t} + \epsilon_{i,t} \tag{18}$$

where $r_{i,t}$ denotes the after-fee return on fund i, in excess of the 1-month risk-free interest rate; $I_{k,t}$ is the monthly excess return on the k'th traded portfolio during month t; and $\beta_{i,k}$ is the sensitivity of the excess return on the i'th fund to the excess return on the k'th index. We consider two different sets of indices to control for other sources of risk in the estimates of performance. The models are intended to control for differentials in risk and other style-specific characteristics across funds, and to

[13]A concave relation between after-fee returns and restrictions is consistent with the clientele effect of Amihud and Mendelson (1986) and Constantinides (1986), whereby longer-horizon investors hold the shares with greater restrictions.

compare fund-level returns to a portfolio that is a mixture of both passive and dynamic benchmarks and a risk-free asset that has the same exposure as the fund.

The first specification uses raw returns. The second model (FF4) controls for variation in the market return, as well as payoffs to size, value, and momentum strategies. The third specification-the lagged market model (LAG)-includes both contemporaneous and lagged observations on the value-weighted market index as benchmarks. This specification is intended to account for variation in the market returns, as well as the impact of non-synchronous trading, or, 'stale prices,' on reported fund returns, due to the fund's holding of illiquid assets.[14]

The total number of estimated alphas equals 3305, since we drop 1,147 funds because they do not have at least 24 monthly observations. The second step involves the cross-sectional regression of estimated alphas ($\hat{\alpha}$) on fund characteristics in Eq. (17). Table 6 presents the estimated parameters in Eq. (17). Consistent with Aragon (2006), we find a positive relation between after-fee returns and share restrictions. Specifically, funds with a lockup provision are associated with a 2.00% per year higher raw after-fee return. In addition, an increase in redemption notice period of 30-days is associated with a 1.58% per year higher raw return. These estimates are statistically significant and robust to whether returns are adjusted by the FF4 or LAG models.

In contrast to the results in Table 5, we find a significant negative relation between excess fund performance and the use of high-water marks after controlling for survivorship bias. Specifically, high-water mark funds are associated with a 1-2% lower annualized excess returns as compared to funds without high-water marks. We interpret this evidence as being consistent with an equilibrium in which the average quality of well-established managers (i.e., funds without high-water marks) exceeds that for managers with short track records (i.e., high-water mark funds).

4 Summary and Conclusion

This paper studies the role of high-water marks (loss-recovery provisions) in hedge fund compensation. The industry's lack of transparency due to hedge funds' exemption from the Investment Company Act

[14] Asness, et al. (2001) show that the inclusion of lagged market observations increases the explanatory power for hedge fund returns, and shows that the increase is larger for funds which are more likely to hold illiquid assets. Early discussions of non-synchronous trading include Scholes and Williams (1977), Dimson (1979), and Lo and MacKinlay (1990). It is also appropriate to include benchmarks that control for time-varying risk exposure, as shown by Fung and Hsieh (1997, 2001) and Agarwal and Naik (2004).

of 1940 makes information asymmetry between managers and investors a reasonable premise. We argue that the use of high-water marks in manager compensation provides a means through which high-quality managers can signal their quality. We develop a multi-period model and show that, when managers have complete information about their own ability, asymmetric information is a necessary ingredient for high-water marks to arise endogenously as part of the compensation contract that maximizes a manager's expected fees. In this case, high-water marks raise the entry costs for low-quality managers, and complement investor flows in reducing adverse selection. In addition, we find that if investor flows are restricted by lockups, managers have a greater incentive to certify their quality ex-ante, because flow restrictions remove the mechanism of investor flows and therefore lowers the entry barrier for low-ability managers. Our model therefore predicts the joint use of high-water marks and share restrictions.

We find empirical support for our model using a data set on $5,699$ hedge funds over the period 1994-2005. A high-water mark is more commonly used by funds that are operated by management firms with shorter track records and by funds that impose share redemption restrictions (e.g., lockups). Consistent with a pooling equilibrium in which both low and high-ability managers with short track records incorporate a high-water mark into their compensation contract, the sensitivity of investor flows to past performance is greater for high-water mark funds. We also find that funds that do not use high-water marks are associated with $1-2\%$ higher annualized excess returns as compared to high-water mark funds. This evidence is consistent with an equilibrium in which the average ability of well-established managers is greater than that for managers with short track records. Finally, we document a positive trend in the adoption rate of the HWM provision by new funds. We conjecture that this could reflect diminishing returns for the industry due to a growth in total hedge fund capital from \$200 billion in 1994 to over \$1,200 billion at the end of 2005.

Appendix: Proofs

A.1 Proof of Proposition 1 (Symmetric information):

First, to see why it is never optimal to use the HWM with symmetric information, from (5), $\pi_{i2}^{H}(f|1d) > \pi_{i2}(f|1d)$ for all $f > 0$. Hence whichever f chosen in the case without the HWM to retain investors at Node $1d$ will also retain investors with the HWM, because the investors are strictly better off with the HWM given the same f. But since the f that retains investors at each node is the same due to the i.i.d. structure of the returns, using the HWM overpays investors to stay at Node $1d$ (and it has no effect at Node $1u$). Notice that given the HWM, it is possible that the fund can charge a higher f and retain investors, because investors can only invest in the fund at Time 0 and not Time 1. However, while a higher f can generate higher fees in Period 1, the fund runs the risk of losing investors at Node $1u$ (and making no fees at all once reaching Node $1d$). It turns out that as long as $p > 0.5$ and $u < 2$, charging a higher f with HWM is never optimal, because the gain from higher expected fees in Period 1 is dominated by the losses of fees at Node $1u$ (and since $p > .5$ this node will be reached more often than not). Therefore, a HWM can never be associated with a fee structure that maximizes expected fees.

Second, the maximum percentage fee $\overline{f}$, defined in (11), is derived from (2), while the minimum fee $\underline{f}$ is derived from the (IR) constraint in (P_0). Finally, $\underline{p}^0$ is given by solving $\overline{f}(p) \geq \underline{f}(p)$, or

$$[pu + (1-p)d + 1][pu + (1-p)d - (1+r_0)] \geq w_0.$$

Let $A \equiv pu + (1-p)d$, and the above inequality becomes $A^2 - r_0 A - (1 + r_0 + w_0) \geq 0$. The solution of this quadratic inequality in A,given that $A > 0$, is that $A \geq c_0$, where $c_0 \equiv \frac{r_0 + \sqrt{r_0^2 + 4(1+r_0+w_0)}}{2}$. Hence,

$$pu + (1-p)d \geq c_0, \qquad \Leftrightarrow \qquad pu^2 + (1-p) \geq uc_0, \qquad \Leftrightarrow \qquad p \geq \frac{uc_0 - 1}{u^2 - 1} \equiv \underline{p}^0. \qquad \blacksquare$$

A.2 Proof of Lemma 1 (Investors' Bayesian Updating):

Based on (15), we have

$$\Pr(B|1d) = \frac{(1-\alpha)(1-p_B)}{\alpha(1-p_G) + (1-\alpha)(1-p_B)} = \frac{1-\alpha}{1-(1-\rho)\alpha},$$

where $\rho \equiv \frac{1-p_G}{1-p_B} < 1$. First, as $\alpha \to 0$,

$$\underset{\alpha\to 0}{Lim} \Pr(B|1d) = \underset{\alpha\to 0}{Lim} \frac{1-\alpha}{1-(1-\rho)\alpha} = 1;$$

and second, as $\rho \to 0$, or $p_G \to 1$ (and as long as p_B is not close to 0),

$$\underset{\rho\to 0}{Lim} \Pr(B|1d) = \underset{\rho\to 0}{Lim} \frac{1-\alpha}{1-(1-\rho)\alpha} = 1.$$

Hence investors' updating of a type B manager at Node $1d$ approaches perfection. $\blacksquare$

A.3 Proof of Proposition 2 (Pooling equilibrium *without* a HWM):

We first derive the entry conditions. p_0, the average quality at Time 0, decreases with p_B given p_G and α. Since without a HWM, there is *no* mechanism at Time 0 to deter the entrance of type B managers – they can always enter and with prob. p_B earning a fee in Period 1 (even though the prob. of investor outflow at Time 1 occurs with prob. $1 - p_B$). The lowest p_B consistent with a pooling equilibrium is such that $\pi_1 \left[\overline{f}(p_0)\right] = r_0$, so that investors are indifferent between investing in a randomly matched fund and earning their reservation payoff at Time 0. Solving this gives $\underline{p}_B^P$. On the other hand, $\underline{p}_0^B$, the minimum level of quality for a type B manager entering the industry with symmetric information satisfies

$$E\left[F_B|\,\overline{f}\left(\underline{p}_0^B\right), r_0\right] = w_0.$$

Hence, type B managers enter the industry as long as type G managers enter, and for a fixed pair (p_G, α), if $p_B \in \left[\underline{p}_B^P, \underline{p}_0^B\right]$, investors are willing to invest in a randomly matched fund at Time 0.

Second, we examine the incentives of fund managers at Time 0. Instead of setting the pooling equilibrium fee $f_P = \overline{f}(p_0)$, type G managers may want to deviate and set a different fee to separate from type B managers. But the only alternative would be to set a lower fee in order to drive B managers out of the industry. Given the quality of G managers this is not profitable and thus they are willing to pool with type B managers. The other reason that G managers do not want to lower the fee at Time 0 is because this fee cannot be revised upward at Time 1; while partially informed investor outflow at Time 1 will be more costly for type B managers than type G managers. In the pooling equilibrium, the investors' belief at Time 0 is such that any fund setting the equilibrium fee structure (f_P without the HWM) will be thought of as having average quality p_0, while any fund setting any other fee structure will be regarded as type B with certainty.

Finally, at Time 1, since the posterior belief on manager quality at Node $1d$, p_{1d}, falls below the minimum level to induce investment (Assumption 2b), investors rationally decide to withdraw capital from a poor performing fund and receive (the higher alternative) r_0. Since this is more likely to occur for type B managers, it serves as the only mechanism to (partially) resolve the adverse selection problem. ■

A.4 Proof of Proposition 3 (Pooling equilibrium *with* HWM):

The proof is similar to Proposition 2 above, with the main difference being the entry conditions for type B managers. With the HWM, there is now an ex ante screening device for managers at Time 0. The lowest p_B consistent with a type B manager entering is such that $E\left[F_B|\,\overline{f}\left(\underline{p}_B^{H-P}\right), r_0\right] = w_0$, so that he is indifferent between entering and setting $f_P^H = \overline{f}\left(p_0^H\right)$ and earning his reservation payoff w_0. Solving this gives $\underline{p}_B^{H-P}$. $\underline{p}_0^H$, the minimum level of quality for a type B manager entering the industry with symmetric information satisfies $E\left[F_B^H|\,\overline{f}\left(\underline{p}_0^H\right), r_0\right] = w_0$; since expected fees are lower with the HWM, we have

$$\overline{f}\left(\underline{p}_0^H\right) > \overline{f}\left(\underline{p}_B^{H-P}\right) \qquad \text{hence} \qquad \underline{p}_0^H > \underline{p}_B^{H-P}.$$

For a fixed pair (p_G, α), as long as $p_B \in \left[\underline{p}_0^H, \underline{p}_B^{H-P}\right]$, type B managers will enter the industry and investors are willing to invest in a randomly matched fund at Time 0.

Note that since the entry-level quality for type B managers is higher given the HWM, when $p_B \in \left[\underline{p}_B^P, \underline{p}_0^H\right]$, type B managers will not enter the industry under HWM but will enter without the use of HWM. In this range, type G managers' payoff is strictly higher with the use of HWM. ■

A.5 Proof of Proposition 4 (Separating equilibrium with HWM):

In the separating equilibrium, type B managers does not use the HWM, and the performance fee is given by:

$$f_B^* = \overline{f}_B = \frac{p_B u^2 + (1-p_B) - u(1+r_0)}{p_B u(u-1)};$$

where $\overline{f}_B$ makes investors indifferent between investing in a non-HWM fund and earning r_0. Type B managers' total expected fees are given by:

$$E\left[F_B | \overline{f}_B, r_0\right] = p_B\left[(u-1)\overline{f}_B + p_B(u-1)\left(u-(u-1)\overline{f}_B\right)\overline{f}_B\right] + (1-p_B)\left[p_B d(u-1)\overline{f}_B\right]. \tag{19}$$

On the other hand, since in the separating equilibrium investors can infer manager types upon observing announced fee structure at Time 0, a candidate for equilibrium fee set by type G managers is:

$$\overline{f}_G^H = \frac{p_G u^2 + (1-p_G) - u(1+r_0)}{p_G u(u-1)},$$

which would make investors indifferent between investing with an HWM-fund and earning r_0. Clearly, $\overline{f}_G^H > \overline{f}_B$, which may induce type B managers to mimic and set the same performance fee and HWM. If type B managers deviate from their equilibrium strategy and mimic type G managers, their expected fees are given by:

$$E\left[F_B^H | \overline{f}_G^H, r_0\right] = p_B\left[(u-1)\overline{f}_G^H + p_B(u-1)\left(u-(u-1)\overline{f}_G^H\right)\overline{f}_G^H\right]. \tag{20}$$

Type B managers will not deviate if $E\left[F_B^H | \overline{f}_G^H, r_0\right] \leq E\left[F_B | \overline{f}_B, r_0\right]$. Solving the equality case yields f_{BG}^H,and it is easy to show that $f_{BG}^H < \overline{f}_G^H$, since $p_G > p_B$. Given the definition of f_{BG}^H, we know that $f_G^* = Min\left(f_{BG}^H, \overline{f}_G\right)$, which ensures type B managers will not mimic in the separating equilibrium. To prove $f_G^* > f_B^*$, notice that $E\left[F_B^H | \overline{f}_G^H, r_0\right] \leq E\left[F_B | \overline{f}_B, r_0\right]$ and using (19) and (20) we have:

$$\begin{aligned}
f_{BG}^H &= \frac{(u-1)p_B(1+p_B u)f_B^* + (1-p_B)p_B d(u-1)f_B^*}{p_B(u-1)(1+p_B u)} \\
&\geq f_B^* + \frac{(1-p_B)}{u(1+p_B u)}f_B^* \\
&= \frac{(u+1)\left[p_B u + (1-p_B)\right]}{u(1+p_B u)}f_B^* \\
&> f_B^*.
\end{aligned}$$

The last inequality is based on the fact that $u > 1$ and $p_B < 1$.Finally, investors' belief at Time 0 is given by: A fee structure of (f_G^*, HWM) is associated fund is of type G; a fee structure of (f_B^*, no HWM) is associated fund is of type B; and any other fee structure is associated with type B. ■

A.6 Proof of Proposition 5 (Equilibrium with lockups):

First, let's consider the benchmark case where type G managers invest in a liquid asset so that a lockup is not needed. We assume $p_G \gg p_B$ ($p_G \to 1$ and $p_B \to .5$) and/or $\alpha \to 0$, and as shown in Lemma 1 and Proposition 2, even without a HWM these managers can signal their type based on investor flows since investors' Bayesian updating is extremely informative so that type B managers can at most earn fees for one period (initial period). Moreover, we assume that $p_B < \underline{p}_B^P$, where $\underline{p}_B^P$,defined in Assumption 2a), is the minimum required quality of type B managers to enter the pooling equilibrium without a HWM. These assumptions on type G and B managers imply that type B managers will *not* enter the industry as long as type G manager do not invest illiquid assets and use lockups, regardless of whether a HWM is used or not by type G managers. To summarize, in the benchmark case, costs of adverse selection are minimized due to very informative investor flows and significant difference between the quality of type G and B managers.

Second, when type G managers invest in illiquid asset (not verifiable by an outsider) and HWMs are not used, there is no ex ante or ex post screening device in the industry. Hence, type B managers always enter the industry at Time 0 and by imposing the lockup they can earn fees in both periods. When investors consider investing in the fund at Time 0, they need to compare the cumulative after-fee return with that of returns from investing in the alternative for two periods. Similar to the proof of Proposition 2 above, the lowest p_B consistent with a pooling equilibrium is such that $\Pi\left[\overline{f}\left(p_0\right)\right] = \left(1+r_0\right)^2 - 1$, so that investors are indifferent between investing in a randomly matched fund and earning their (two period) reservation payoff at Time 0. Solving this gives $\underline{p}_B^{LC}$. On the other hand, the pooling equilibrium fee, $f_P^{LC} = \overline{f}\left(p_0\right)$.

Third, with the HWM in place as the ex ante signaling device, the equilibrium is similar to the equilibria with HWM above, except there is no fund outflows. There are two cases. First, if $p_B \geq \underline{p}_B^{H-P}$, there is a pooling equilibrium in which both types managers enter. This is similar to Proposition 3. Both types of managers enter, set the same fee f_{H-P}^{LC}, and use lockups. $\underline{p}_B^{H-P}$, the lowest p_B consistent with a type B manager entering is such that $E\left[F_B|\,\overline{f}\left(\underline{p}_B^{H-P}\right), r_0\right] = w_0$. Since expected fees are lower with the HWM so that minimum entrance level fees must be higher with the HWM, we have $f_{H-P}^{LC} \geq f_P^{LC}$. Results from Proposition 5a) and 5b) indicate that a HWM alleviates the severity of adverse selection by increasing the entry costs for type B managers at Time 0. In particular, if the quality of type B managers is below the critical level to enter in a pooling equilibrium, they will not enter the industry and type G managers can set a much higher fee and impose lockups if $p_B < \underline{p}_B^{H-P}$, type G managers set performance fee at f_{H-B}^{LC} and impose lockups, while type B managers do not enter the industry. ■

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Table 1: Summary statistics of hedge fund characteristics

The table presents summary statistics for the hedge funds in the sample. The lockup variable is an indicator variable that equals one if the fund's lockup period exceeds zero. The notice period is the number of days required notice before an investor may redeem his shares. The underlying asset liquidity is the return-based measure of Getmansky, Lo, and Makarov (2004). The offshore variable is an indicator variable that equals one if fund's domicile country is an offshore location. The live variable is an indicator variable that equals one if the fund has not stopped reporting to TASS as of April 2006. The length of the initial track record is the number of available monthly return observations, across all funds managed by the same advisor, that precede the fund's initial date. The initial net asset value is the natural logarithm of the fund's net asset value measured at its initial date.

	Number of obs.	mean	median	sd
Lockup?	5699	0.26	0.00	0.44
Redemption notice period (days)	5699	35.10	30.00	28.40
Underlying asset liquidity	4086	0.89	0.83	0.31
Is the fund domiciled offshore?	5699	0.60	1.00	0.49
Is the fund live as of April 2006?	5699	0.66	1.00	0.47
Track record length of hedge fund organization at fund inception (months)	5686	30.75	7.00	43.62
Total net assets of hedge fund organization at fund inception ($ millions)	5686	474.87	0.00	5165.27

Table 2: Hedge fund organization characteristics over 1994-2005

The table presents summary statistics for the full sample of 5,699 hedge funds (Panel A) and for the sub-sample of 4,557 funds that were added to the TASS database in 2000 or later (Panel B). The sample means of fund characteristics are reported by the year of fund organization. The fixed management fee is the percentage of total assets the manager receives as compensation. The performance fee is the percentage of profits the manager receives as compensation on any profits above the high-water mark. The high-water mark is an indicator variable that equals one if the fund is required to recover losses. The management firm variable is an indicator that equals one if the fund represents the initial fund offered by the fund's management firm. The lockup variable is an indicator variable that equals one if the fund's lockup period exceeds zero. The notice period is the number of days required notice before an investor may redeem his shares.

Panel A: All funds	Year of fund inception											
Characteristic	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of funds	270	314	355	379	378	454	456	590	619	700	758	426
Fixed management fee (%)	1.50	1.49	1.38	1.33	1.37	1.36	1.34	1.36	1.45	1.44	1.51	1.53
Performance fee (%)	16.35	17.04	16.97	17.21	17.13	17.91	17.68	16.85	16.71	15.85	16.23	17.37
High-water mark?	0.21	0.27	0.30	0.35	0.42	0.63	0.82	0.82	0.85	0.83	0.89	0.94
Lockup?	0.10	0.15	0.16	0.19	0.23	0.30	0.35	0.29	0.34	0.30	0.29	0.27
Redemption notice period (days)	20.04	24.07	26.14	25.89	31.52	33.75	36.59	34.89	36.73	40.40	42.18	48.04
Minimum investment (millions of dollars)	0.50	0.64	0.61	0.62	0.72	1.31	1.22	0.75	0.87	1.29	1.66	1.12
Initial fund of management firm?	0.65	0.57	0.58	0.54	0.59	0.56	0.55	0.42	0.41	0.34	0.30	0.31
Track record length of management firm (months)	15.30	16.02	17.74	20.95	21.61	24.29	23.93	28.63	37.24	40.81	45.44	43.78

Table 2: cont.

Panel B: Funds added in 2000 or later	Year of fund inception											
Characteristic	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Number of funds	80	97	130	142	190	373	454	590	618	699	758	426
Fixed management fee (%)	1.56	1.51	1.35	1.30	1.34	1.35	1.33	1.36	1.45	1.44	1.51	1.53
Performance fee (%)	16.27	16.93	16.38	16.82	17.02	17.63	17.67	16.85	16.70	15.84	16.23	17.37
High-water mark?	0.49	0.60	0.62	0.63	0.70	0.71	0.82	0.82	0.85	0.83	0.89	0.94
Lockup?	0.25	0.32	0.30	0.33	0.37	0.32	0.35	0.29	0.34	0.30	0.29	0.27
Redemption notice period (days)	33.98	34.35	34.34	29.56	38.24	34.77	36.55	34.89	36.76	40.39	42.18	48.04
Minimum investment (millions of dollars)	0.69	0.92	0.71	0.71	0.92	0.82	1.23	2.45	0.87	8.45	8.25	1.12
Initial fund of management firm?	0.75	0.69	0.66	0.51	0.58	0.57	0.55	0.42	0.41	0.34	0.30	0.31
Track record length of management firm (months)	11.70	11.35	13.21	21.90	22.06	22.74	23.73	28.63	37.14	40.87	45.44	43.78

Table 3: Use of the high-water mark provision by hedge funds

The table presents summary statistics of the percentage performance fee for the full sample of 5,699 hedge funds. The table presents summary statistics of the decision to use a loss-recovery (i.e, "high-water mark") provision for the full sample of 5,699 hedge funds, a subsample of 3,549 funds that were organized in 2000 or later, and a subsample of 4,557 funds that were added to TASS in 2000 or later. The age of the management firm is the number of months between the fund's inception date, and the earliest inception date across all funds under the same fund management firm. The size of the management firm is the total net assets (in millions of dollars) under management, across all funds under the same management firm, at the date of the fund's inception. The lockup is an indicator variable that equals one if the fund has a lockup period exceeding zero. Redemption notice period is the number of days notice fund investors must provide before they can redeem their shares.

	All funds			Organized 2000 or later			Added to TASS 2000 or later		
Use of high-water mark provision	mn	sd	n	mn	sd	n	mn	sd	n
Track record length of management firm									
No earlier funds	0.68	0.47	2592	0.91	0.29	1349	0.85	0.36	1957
Four years or less	0.68	0.46	1692	0.86	0.35	1107	0.82	0.39	1363
Between four and eight years	0.69	0.46	841	0.83	0.38	630	0.78	0.41	720
More than eight years	0.66	0.47	574	0.76	0.43	463	0.73	0.44	517
Size of management firm									
No earlier funds	0.67	0.47	2984	0.90	0.31	1586	0.83	0.37	2266
Less than 108.6	0.67	0.47	1282	0.87	0.34	791	0.83	0.38	992
Between 108.6 and 620.82	0.70	0.46	851	0.84	0.37	639	0.79	0.41	737
More than 620.82	0.73	0.44	569	0.76	0.43	531	0.75	0.44	556
Lockup?									
No	0.61	0.49	4197	0.84	0.37	2468	0.78	0.41	3148
Yes	0.86	0.34	1502	0.91	0.29	1081	0.88	0.32	1409
Redemption notice (days)									
Less than or equal to 30	0.62	0.49	3520	0.86	0.34	1941	0.81	0.40	2593
Between 30 and 45	0.76	0.43	857	0.83	0.38	644	0.81	0.39	774
Between 45 and 70	0.81	0.40	753	0.89	0.31	546	0.86	0.35	679
Greater than 70	0.76	0.43	569	0.84	0.37	418	0.80	0.40	511

Table 4: Probit analysis of the decision to use a high-water mark

The table reports the results from a probit analysis of a hedge fund's decision to use a high-water mark to calculate performance fees. Results are presented for the full sample of funds (Panel A), for the sub-sample of funds that were organized in 2000 or later (Panel B), and for the sub-sample of funds that were added to the TASS database in 2000 or later (Panel C). The age of the management firm is the number of months between the fund's inception date, and the earliest inception date across all funds under the same fund management firm. The size of the management firm is the natural logarithm of the total net assets (in millions of dollars) under management, across all funds under the same management firm, at the date of the fund's inception. The underlying asset liquidity is the return-based measure of Getmansky, Lo, and Makarov (2004). The offshore variable is an indicator variable that equals one if fund's domicile country is an offshore location. The lockup is an indicator variable that equals one if the fund has a lockup period exceeding zero. Redemption notice period is the number of days notice fund investors must provide before they can redeem their shares. The independent variables are standardized to have a zero mean and variance of one across funds. Marginal effects are reported for each variable. Heteroskedasticity-consistent t-statistics are presented beneath each estimate.

Panel A: All funds

Dependent variable: High-water mark indicator variable

Logarithm of initial track record length	0.00 -0.22	-0.06 -7.41	0.01 0.74	-0.06 -6.32				
Logarithm of initial net asset value					0.03 2.51	-0.06 -4.34	0.03 2.19	-0.06 -4.19
Underlying asset liquidity	0.00 0.10	-0.05 -1.75	0.04 1.35	-0.03 -0.83	-0.01 -0.21	-0.09 -2.39	0.02 0.68	-0.07 -1.71
Is the fund domiciled offshore?	-0.04 -2.27	-0.05 -3.03	0.01 0.59	-0.01 -0.84	-0.01 -0.33	0.00 0.05	0.01 0.40	0.02 0.57
Lockup?			0.22 13.11	0.18 9.49			0.18 6.69	0.15 4.90
Redemption notice period (days)			0.00 7.20	0.00 4.59			0.00 6.05	0.00 3.87
time effects	0	1	0	1	0	1	0	1
number of obs.	4077	4077	4077	4077	1853	1853	1853	1853

Table 4: (cont.)

Panel B: Funds organized in 2000 or later

Dependent variable: High-water mark indicator variable

Logarithm of initial track record length	-0.03	-0.04	-0.03	-0.03				
	-3.93	-4.65	-3.64	-4.33				
Logarithm of initial net asset value					-0.05	-0.06	-0.05	-0.06
					-3.60	-4.41	-3.71	-4.45
Underlying asset liquidity	-0.01	-0.01	-0.01	0.00	-0.07	-0.06	-0.06	-0.06
	-0.50	-0.21	-0.26	-0.03	-2.30	-2.00	-2.01	-1.77
Is the fund domiciled offshore?	0.02	0.02	0.03	0.03	0.06	0.05	0.07	0.06
	1.12	0.96	1.85	1.68	2.42	2.21	2.58	2.39
Lockup?			0.06	0.06			0.07	0.06
			3.89	3.69			2.75	2.59
Redemption notice period (days)			0.00	0.00			0.00	0.00
			1.07	0.82			1.54	1.25
time effects	0	1	0	1	0	1	0	1
number of obs.	2183	2183	2183	2183	1179	1179	1179	1179

Panel C: Funds added to TASS in 2000 or later

Dependent variable: High-water mark indicator variable

Logarithm of initial track record length	-0.02	-0.05	-0.02	-0.05				
	-3.41	-6.66	-2.77	-6.03				
Logarithm of initial net asset value					-0.03	-0.07	-0.04	-0.07
					-2.60	-5.08	-2.80	-5.14
Underlying asset liquidity	0.02	-0.01	0.03	0.00	-0.02	-0.06	0.00	-0.04
	0.68	-0.30	1.18	0.12	-0.64	-1.71	-0.12	-1.26
Is the fund domiciled offshore?	0.02	0.00	0.04	0.02	0.05	0.03	0.06	0.04
	1.55	0.16	2.58	1.18	2.23	1.39	2.48	1.66
Lockup?			0.09	0.08			0.10	0.09
			5.48	5.07			3.87	3.64
Redemption notice period (days)			0.00	0.00			0.00	0.00
			2.45	1.98			2.93	2.53
time effects	0	1	0	1	0	1	0	1
number of obs.	3163	3163	3163	3163	1499	1499	1499	1499

Table 5: Hedge fund returns and fund characteristics over the 1994-2005 period

The table reports the time series of the estimated cross-sectional differences in fund performance that can be attributed to fund characteristics. For each year, annual hedge fund returns are regressed on the high-water mark indicator variable, along with the percentage performance fee, lockup indicator, and redemption notice period. The coefficient estimate and corresponding t-statistic are reported in the table. The final column (Avg) correspond to the sample mean of the time-series coefficients. Results are reported for the full sample of funds (Panel A) and the subsample of funds that were added to TASS in 2000 or later (Panel B).

Panel A: Full sample

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg
high-water mark?	0.57	0.71	5.26	3.56	3.06	3.07	6.09	3.93	1.61	-2.52	-0.54	-2.23	1.88
	0.21	0.21	2.52	1.96	1.82	0.85	4.50	3.94	2.17	-1.40	-0.94	-3.26	2.36
performance fee (%)	0.30	0.37	0.20	0.25	0.29	0.09	0.23	0.10	0.14	0.84	0.10	0.08	0.25
	2.45	2.18	1.77	2.31	2.71	0.38	2.38	1.45	2.79	6.99	2.70	1.83	4.16
lockup?	0.51	2.20	3.60	4.04	0.94	11.06	4.10	1.20	-1.96	2.28	2.80	0.55	2.61
	0.15	0.54	1.42	1.84	0.46	2.63	2.74	1.15	-2.73	1.40	5.70	0.99	2.84
redemption notice	6.86	9.53	5.89	7.77	1.35	7.55	3.16	0.14	-2.82	2.21	2.34	-0.71	3.61
	2.15	2.79	3.06	4.32	0.74	1.75	1.76	0.10	-2.94	1.40	4.83	-1.41	3.23
redemption notice^2	-2.14	-2.47	-1.09	-1.29	-0.53	-2.38	-0.81	0.34	0.85	-0.07	-0.13	0.15	-0.80
	-1.93	-2.27	-2.14	-2.70	-1.07	-2.06	-1.71	0.94	3.38	-0.22	-1.34	1.71	-2.51
minimum investment	6.60	2.78	-1.38	-2.33	1.22	1.32	1.67	0.06	0.37	-0.76	-0.14	-0.12	0.77
	2.12	1.01	-0.76	-1.65	1.50	0.71	2.44	0.13	1.08	-1.35	-0.93	-0.69	1.16
minimum investment^2	-1.19	-0.28	0.05	0.15	-0.02	-0.03	-0.03	0.00	-0.01	0.00	0.00	0.00	-0.11
	-1.81	-0.78	0.23	1.11	-1.21	-0.71	-1.51	0.07	-0.62	1.28	0.85	0.68	-1.11

Table 5: (cont.)

Panel B: Added to TASS in 2000 or later

	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	Avg
high-water mark?	-0.43	-0.85	1.98	1.28	-0.47	2.52	-1.83	0.69	-0.76	-3.52	-0.33	-1.77	-0.29
	-0.12	-0.17	0.71	0.57	-0.22	0.79	-0.96	0.57	-0.84	-1.55	-0.49	-2.43	-0.59
performance fee (%)	0.36	0.53	0.49	-0.03	0.61	0.45	0.44	0.09	0.22	0.99	0.13	0.08	0.36
	1.56	1.67	2.57	-0.20	3.83	1.93	3.28	1.08	3.74	7.15	3.32	1.92	4.40
lockup?	1.06	5.62	4.99	8.91	-2.44	5.86	2.85	2.03	-2.15	2.18	2.73	0.73	2.70
	0.28	1.15	1.76	3.86	-1.12	1.85	1.59	1.87	-2.82	1.21	5.34	1.38	2.84
redemption notice	8.12	4.91	-4.39	-4.66	-8.63	4.71	6.11	-1.76	-4.68	2.56	2.50	-0.48	0.36
	1.33	0.67	-0.95	-1.22	-2.31	1.00	2.15	-0.98	-3.88	1.46	4.92	-0.99	0.24
redemption notice^2	-2.21	-1.85	1.85	0.78	2.13	-0.95	-1.81	0.61	1.40	0.00	-0.12	0.13	0.00
	-1.21	-0.84	1.29	0.65	1.81	-0.70	-2.19	1.15	4.09	0.01	-1.22	1.58	-0.01
minimum investment	4.39	1.15	-0.71	-1.08	0.67	-0.73	1.05	0.37	0.33	-0.49	-0.08	-0.05	0.40
	0.82	0.29	-0.29	-0.53	0.64	-0.46	1.20	0.67	0.88	-0.77	-0.52	-0.34	0.96
minimum investment^2	-0.88	-0.24	-0.13	0.05	-0.01	0.01	-0.02	-0.01	-0.01	0.00	0.00	0.00	-0.10
	-0.86	-0.45	-0.43	0.20	-0.57	0.28	-0.83	-0.44	-0.62	0.73	0.47	0.35	-1.38

Table 6: Hedge fund excess returns and fund characteristics

The table reports the parameter estimates of a cross-sectional regression of excess returns on fund characteristics over the period 1994-2005. After-fee performance is measured as the intercept of the time-series regression of fund i's returns against a set of benchmark indices. The high-water mark variable is an indicator that equals one if the fund has a high-water mark provision. The percentage of profits is the performance fee outlined in the fund's compensation structure. The lockup variable is an indicator that equals one if the fund has a lockup period. Redemption notice is measured in 30-day units. Minimum investment requirement is measured in millions of dollars. Time effects correspond to the year of fund inception. Funds are required to have at least 24 observations (months) to be included in the analysis. Results are reported for Fama-French four factor (FF4) and lagged market (LAG) models. Results are reported for the full sample of funds and the subsample of funds that were added to TASS in 2000 or later. Heteroskedasticity-consistent t-statistics reported below each estimate.

	Full sample						Added to TASS in 2000 or later					
	Raw		FF4		LAG		Raw		FF4		LAG	
intercept	1.10	-0.66	-2.41	-5.23	-3.38	-6.94	2.83	1.21	0.58	-2.41	1.81	-2.65
	1.92	-0.57	-3.92	-4.03	-4.99	-5.22	3.78	0.96	0.91	-1.83	2.77	-2.00
high-water mark?	0.88	1.24	0.76	1.22	2.29	2.31	-1.09	-0.81	-1.97	-1.21	-1.93	-0.94
	2.17	2.77	1.84	2.85	5.11	5.10	-2.07	-1.46	-4.12	-2.45	-3.91	-1.88
performance fee (%)	0.22	0.22	0.25	0.23	0.25	0.22	0.27	0.27	0.30	0.27	0.30	0.26
	8.77	8.55	9.49	8.61	8.70	7.64	9.58	9.48	11.50	10.64	11.62	10.09
lockup?	2.01	2.04	1.41	1.39	2.15	2.05	1.96	1.92	1.21	1.16	1.90	1.84
	4.82	4.91	3.95	3.94	5.48	5.37	4.34	4.28	3.21	3.12	4.57	4.57
redemption notice	1.58	1.65	1.60	1.60	1.92	1.74	0.69	0.75	0.36	0.50	-0.07	0.12
	3.91	4.12	4.27	4.34	4.66	4.49	1.08	1.20	0.73	1.01	-0.15	0.26
redemption notice^2	-0.07	-0.08	-0.09	-0.07	-0.18	-0.11	0.09	0.08	0.09	0.10	0.10	0.12
	-0.63	-0.83	-1.45	-1.11	-2.75	-2.00	0.50	0.43	0.75	0.77	0.96	1.10
minimum investment	0.04	0.04	0.19	0.17	0.18	0.16	0.03	0.02	0.17	0.12	0.16	0.09
	0.35	0.33	1.54	1.32	1.58	1.30	0.24	0.18	1.29	0.89	1.31	0.70
minimum investment^2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	-0.31	-0.31	-1.55	-1.27	-1.59	-1.20	-0.22	-0.17	-1.32	-0.87	-1.38	-0.64
time effects?	no	yes	no	yes	no	yes	no	yes	no	yes	no	yes

Table 7: Sensitivity of annual net investor flows to past performance

The table presents the results from the pooled regression of annual net investor flows on past relative performance over the sample period 1994-2005. Specifically,

$$\text{net flow}_{i,y} = \beta_0 + \beta_1 \text{rnk}_{i,y-1} + \beta_2 \text{logage}_{i,y-1} + \beta_3 \text{lognav}_{i,y-1} + \gamma_0 \text{hwm}_i +$$
$$\gamma_1 \text{rnk*hwm}_{i,y-1} + \gamma_2 \text{logage*hwm}_{i,y-1} + \gamma_3 \text{lognav*hwm}_{i,y-1} + \epsilon_{i,y},$$

where net $\text{flow}_{iy} = (A_{iy} - A_{i,y-1} * (1 + R_{i,y}))/A_{iy}$, A_{iy} denotes the net asset value of fund i at the end of year y, and R_{it} denote the net raw return of fund i during year y. The independent variable $\text{rnk}_{i,y}$ denotes the fractional rank of fund i's raw return across all funds in year y. $logage_{iy}$ and $lognav_{iy}$ denote the natural logarithm of the number of available monthly return observations and net asset value, respectively, for fund i at the end of year y. The variable *hwm* is an indicator variable that equals one if the fund has a high-water mark. Standard errors are heteroskedasticity-consistent and allow for clustering at each quarter. t-statistics are reported below each estimate.

Dependent variable: Annual net flows				
intercept	1.11	-0.11	0.85	-0.11
	9.51	-2.25	4.82	-2.25
rank	0.68	0.69	0.54	0.55
	12.41	13.83	12.28	12.06
logage	-0.22	-0.23	-0.16	-0.17
	-12.94	-12.90	-5.55	-6.82
lognav	-0.03	-0.03	-0.02	-0.03
	-3.15	-4.34	-3.07	-3.56
hwm			0.58	0.44
			2.94	2.48
rank*hwm			0.30	0.30
			5.68	6.26
logage*hwm			-0.10	-0.08
			-4.10	-4.56
lognav*hwm			-0.02	-0.01
			-1.92	-1.51
time effects?	no	yes	no	yes
fund style effects?	no	yes	no	yes

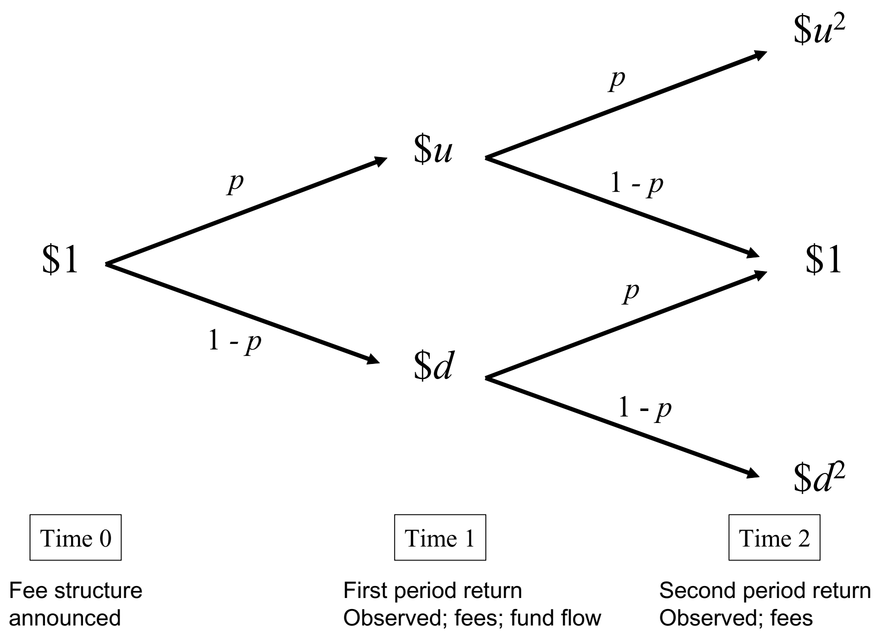

Figure 1 Timeline and Payoffs of Asset