Effort, Risk and Walkaway Under High Water Mark Contracts

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Comments Welcome

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Abstract

We study a hedge fund style contract in which management fees, incentive fees and a high water mark provision drive a fund manager's effort and risk choices as well as walkaway decisions by both the fund manager and the investor. We model this relationship and calibrate the model to observed data. The model yields empirical predictions regarding the impact of a fund's distance from the high water mark (HWM) on effort, risk and walkaway behavior. Testing the model on empirical data, we find that as funds fall from the HWM, future expected returns fall, the incidence of fund closure increases and the variance of future returns increases. All of these effects are most stark for funds closer to the HWM and are milder for funds further away. Additionally, we find that risks taken by funds further below their HWMs tend to generate lower expected returns than those closer to their HWMs. In addition to being consistent with predictions from our model, these results resonate well with the economic intuition that such contracts function as if fund managers hold call options with varying degrees of moneyness (depending on distance from the HWM) on the return stream to the investor's funds. Finally, using the calibrated model, we consider welfare implications of changes to the standard 2/20 contract. We find that lowering incentive fees and increasing management fees (e.g., a 2.5/10 contract) leads to Pareto improvement.

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1 Introduction

The number of hedge funds has exploded from a thousand to seven thousand in the most recent half decade. Compensation for portfolio managers at top hedge funds, including compensation for some former academics-turned-money managers, has reached astronomical levels. And at the heart of hedge funds is the fabled "2/20", high water mark (HWM) fee structure, which has received much attention in recent financial press. The fee structure consists of a 2% management fee on all assets and a 20% incentive fee on all profits generated above the high water mark (HWM), or the maximum level the fund has reached historically. Indeed, the fee structure is such an integral part of hedge funds that hedge funds have recently been characterized as "a compensation scheme masquerading as an asset class."[1]

The central role of the high water mark feature in driving fund managers' and investors' behavior is readily apparent. Following the beginnings of the credit-related market correction in August 2007, a well known hedge fund at a bulge bracket bank, which had lost a lot of money and was reportedly more than 30% below its high water mark, offered a 'sale' on new fund inflows. Fees charged on new money would consist solely of a 10% incentive on any profits generated, and the management fee would be waived. That is, the fund adopted a "0/10" structure rather than the standard "2/20." The implications of such a move were manifold. Original monies in the fund were sufficiently far away from their high water mark that fund employees, discouraged about prospects of ever hitting the high water mark (and earning substantial bonuses), considered leaving and joining other funds. As a result, original investors in the fund questioned whether the fund would be able to maintain its team through the crisis and considered withdrawing funds. Investors might also have been concerned that managers would take inordinate risks in a desperate attempt to generate returns above the high water mark. The infusion of new capital, fresh and untethered to the old high water mark, alleviated these concerns. Employees would stand to earn incentive fees (and thus bonuses) on this new money immediately, although the fees would accrue at the rate of 10% rather than the full 20%. The original investors were reassured that the fund would be able to maintain its team and did not withdraw their funds.[2]

We focus this study on this intricate set of risk, effort and walkaway decisions driven by the high

[1] An example highlighting the features of the "2/20" HWM fee structure can be found in the Appendix.

[2] Although the fund staved off immediate closure and the cash inflows from the sale led to a positive bounce, the hedge fund eventually lost money over the rest of the year as the credit crisis worsened, ending the year with a 38% loss.

water mark (HWM) feature of the hedge fund contract. Modeling a simple one period principal-agent relationship governed by such a contract, we derive the empirical predictions in terms of risk choices, effort choices and walkaway behavior of the parties. Extending the model to infinite periods, we highlight the disciplining role of investor walkaway on manager behavior. We calibrate parameters in the infinite period model using observed hedge fund return data and use the calibrated model to posit welfare enhancing modifications to the current '2/20' contract.

Although the model itself is fairly complex due to the optionality embedded in the hedge fund contract, the empirical implications of the model resonate with the intuition that the contract functions as if the fund manager simply has a call option on the returns of the fund. The strike price of this option is the HWM and the return required to hit the HWM (RR) is a measure of the moneyness of this option. In particular, we predict differences in both fund manger and investor behavior depending on how close the manager's option is to being in the money. We expect the following: (i) The lower the return required to hit the HWM (RR), the more likely the fund manager is to expend costly effort, and the higher the subsequent period returns will be. (ii) The manager of a fund far below from the HWM is likely to increase the risk of his portfolio in the hopes of breaking the HWM barrier again and earning performance fee based bonuses. (iii) Once a fund falls to a certain point below the HWM, the danger of walkaway increases, as the principal may worry that the agent is no longer expending an appropriate level of effort and is taking too much risk.

We test these hypotheses against empirical data and find them to be consistent with observed return data and walkaway behavior, demonstrating support for our model. In particular, we find that future expected returns for funds close to the HWM are higher than those for funds far below the HWM. On average, funds requiring a 10% return to hit their HWM will underperform funds which are at their HWM by up to 2.8% over a 6 month period. We interpret this as evidence of additional effort expenditure by managers in funds closer to the HWM.[3] The incidence of walkaway increases with distance from the HWM. Funds requiring between 0 and 10% to hit their HWM experience a 7.9% increase in fund closure rate over the next six months for every additional 1% return they need to hit the HWM. Thus, funds requiring a 10% return to hit the HWM are twice as likely to dissolve over the next 6 months than funds at the HWM. Finally, we also find higher variance of future returns for funds further away from the HWM. The standard deviation of monthly

[3]For our purposes, effort is best interpreted as the cost of hiring alpha generating talent for a hedge fund promoter. We discuss effort further in the model section of the paper.

returns for the next 6 months are 1.6% higher for funds which are 10% below their HWM than for funds which are at their HWM. We also find that the variance of future returns is most sensitive to distance from the HWM when the fund is near the HWM. In addition to the increased variance, we find evidence that fund managers take poorer risks the further their funds' distance from the HWM. Specifically, an additional 1% of return standard deviation for funds within 10% return of hitting their HWM increases expected returns by 1.6% whereas the same 1% increase in standard deviation for funds requiring more than 10% to hit the HWM only increases expected returns by 0.6%.

Finally, using the calibrated model, we examine various other permutations of a "x/y%" management/incentive fee contract in search of a contract that provides better incentives for the fund manager without raising the expected fees paid by the investor. We find that substituting an increased management fee in lieu of incentive fees (e.g., a "2.5/10" contract rather than the standard "2/20" contract) leads to improved outcomes for both the investor and the fund manager. For funds near the HWM, this is achieved through improved risk sharing. In addition to improved risk sharing, for funds further away from the HWM, the increased continuation value of such a contract, combined with the enhanced ability to maintain a costly alpha-generating team through periods of poor returns, leads to more investor-friendly behavior by the fund manager and a correspondingly lower incidence of walkaway by the investor.

The implications of these results are far reaching. Portfolio allocation decisions by investors and fund-of-funds would find direct use for these findings in optimizing their portfolios. In particular, investors should carefully consider how far they should let their funds drop below the HWM before renegotiating or walking away entirely. Additionally, the welfare analysis suggests higher management fees and lower incentive fees (e.g., the "2.5/10" contract above) may lead to improved outcomes for both investor and manager. Our conclusions also have implications for hedge fund marketing strategies. The anecdote above, where the fund had the '0/10' sale to mitigate many of these concerns, exemplifies this. A clearer level of disclosure about a fund's high water mark(s), might also generate value for current and potential investors alike.

Extant literature related to this study includes Goetzmann, Ingersoll, and Ross (2003), a foundational paper in this field which examines the unique, high watermark (HWM) structure of the hedge fund compensation contract and computes the alpha-generation potential necessary to justify paying a fund manager according to such a contract. Panageas and Westerfield (2008), looks at how in an infinite time horizon setting, even a risk neutral agent will not increase risk indefinitely despite the optionality of the compensation contract to maintain the continuation value of the contract. Hodder and Jackwerth (2007) model a finite period hedge fund contract with the fund manager choosing optimal risk and effort to maximize their utility under such a contract. The model we use in this paper is most similar to an infinite period version of the Hodder and Jackwerth (2007) model with an endogenous walkaway choice by the principal or the Panageas and Westerfield (2008) model with an effort choice and endogenous principal walkaway. Christoffersen and Musto (2008) considers the impact of the HWM in a two period model with Bayesian learning and show the how varying levels of performance, in conjunction with the HWM, affect fund flows, fund closure and alpha generation by the hedge fund. Metrick and Yasuda (2007) looks at the empirical differences between the "2/20" fee structures of hedge funds, venture capital firms and private equity shops. The Aragon and Qian (2006) study of liquidation risk finds that funds investing in illiquid assets are more likely to have HWMs to reduce risk of investor-driven liquidation when the fund performs poorly. Brown, Goetzmann, and Park (2001) studies survival rates among hedge funds and commodity trading advisors (CTAs) and factors leading to fund demise. While they identify poor returns as a factor, this study additionally pinpoints the return required to hit a fund's HWM (RR) as a separate factor in determining fund closure. There is a large body of literature on the reporting and survivorship bias in hedge fund returns (Fung and Hsieh (2002), Horst and Verbeek (2007), Fung and Hsieh (1999) and Rouah (2005)). Although our study does not explicitly address the magnitude of this bias, we do note when tests we perform are likely to exhibit bias, and we specify the direction of the bias. Ackermann, McEnally, and Ravenscraft (1999) and Agarwal and Naik (2007) find superior performance for hedge funds with a fixed percentage and bonus-based incentive structure. Additionally, a wide body of literature examines the impact of incentives on investment and risk choices: Basak, Pavlova, and Shapiro (2007), Carpenter (1997), Carpenter (2000) and Chevalier and Ellison (1997).

Our paper contributes to this body of research through two extensions. The first contribution is to theory; our model is the first to formalize endogenous investor walkaway in the context of a hedge fund HWM contract. This feature has been explicitly suggested in Panageas and Westerfield (2008). Using this extension, we are able to posit clear empirical predictions of the impact of the HWM on walkaway. We are also able to calibrate our model to match hedge fund walkaway rates, among other moments, and obtain economically meaningful model parameters, such as the manager's risk aversion and the fraction of investors who monitor their investments. The second contribution is empirical, in that we use the historical return series to approximate the HWM for each fund at any given point. This, in turn, allows us to conduct various empirical analyses of the effect of a fund's distance from its HWM on the fund manager's effort and risk choices and the investor's walkaway decision. Brown, Goetzmann, and Park (2001) do note that funds that fail to exceed their HWMs in the first 6 months of a year tend to have higher variance in the second six months. We refine this result and show that, in general, the further funds are from their HWMs, the more risk the managers take and the poorer those risks are. Additionally, we also find that returns are lower for funds further from their HWM and walkaway rates are higher.

The remainder of this paper is divided into four sections. In section 2, we present our model and the various empirical implications resulting from the current HWM contract form. In section 3, we present results of the empirical tests of our model. In section 4, we discuss welfare considerations of alternate contract specifications, and in section 5 we conclude.

2 Model

We model a risk averse hedge fund manager (the agent) and a risk neutral principal in a hedge fund contract, with management fees, incentive fees, and a high water mark driving manager actions and investment decisions. We begin by examining a one period model under such a setup and use this to gain insight into the manager's decision making. We then extend the model to infinite periods and incorporate the investor's walkaway decision (Section 2.3).

2.1 One period model without continuation value

In this single period model, we have a hedge fund manager who has been given a sum of money, v_0, by the principal at time t_0. The manager will be compensated at t_1 according to the returns to the fund. The fund starts at the high water mark and all returns will be subject to the incentive fee over the $t_0 \rightarrow t_1$ period.

$$w_1 = kv_0 + sv_0 max(\tilde{r}, 0), \tag{1}$$

where

$$\begin{aligned} \tilde{r} &= a + \sigma\tilde{\epsilon} \\ \tilde{\epsilon} &\sim U(-1, 1) \end{aligned}$$

w_1 denotes the compensation of the hedge fund manager at t_1. Thus, in a standard 2/20 contract, $k = 2\%$ and $s = 20\%$. The $\tilde{r}$ is the return before fees in the next period, a and σ are effort and risk choices made by the manager. Effort is costly to produce, and risk can be increased costlessly. The manager has CRRA utility and strives to maximize his utility from t_1 wealth. The shock is uniform over the $[-1, 1]$ interval. The manager's problem can be represented as follows:

$$V_m = \max_{a,\sigma} \mathbb{E}\beta\Big[u(kv_0 + sv_0 \max(0, \tilde{r}) - \frac{v_0}{2}c_a a^2)\Big] \tag{2}$$

where

$$u(x) \quad = \quad \frac{x^{1-\gamma}}{1-\gamma} \tag{3}$$

V_m is the value of the contract to the agent, which he seeks to maximize. $u(x)$ represents the agent's utility function and β and γ are the agent's discount rate and coefficient of risk aversion, respectively. $\frac{v_0}{2}c_a a^2$ is the term that represents the cost of effort that is paid at t_1. We assume a quadratic cost of effort, scaled by v_0. This is similar to the form used in Hodder and Jackwerth (2007) and is consistent with decreasing returns to scale with respect to increased effort expenditure. Although effort can be interpreted traditionally as how hard the manager works, a more apt interpretation views it as hiring costly alpha-generating talent from a common portfolio manager pool. c_a is a parameter representing the cost of effort in this market for alpha-generating talent.

We solve this simple model and show that effort, a, has an interior solution (given a finite and fixed σ). σ will not have an interior solution - it is either 0% or infinity, depending on the choice of a, the distribution of shocks, ϵ, γ and other contract parameters. The solution for a is characterized in Figure 1 for a given set of parameters and a fixed σ choice of 5%. Note that optimal effort expended decreases with increasing return required to hit the HWM. Although this is a highly simplified case, this theme will persist through the rest of the section.

2.2 One period model with continuation value and investor walkaway

We can extend this one period model to capture investor walkaway and some of the effects of the HWM by treating this as a hedge fund that has been in existence for some time. Thus, the fund may potentially be below the HWM. The distance of the fund from the HWM is characterized by the return required to hit the HWM (RR), denoted by rr_0.

$$1 + rr_0 = \max(h_0/v_0, 1), \tag{4}$$

rr_0 is the return required to hit the HWM at t_0. v_0 is the value of the fund at t_0 and h_0 is the HWM at t_0. If the fund is at the HWM, $h_0 = v_0$ and the return required to hit the HWM is zero ($rr_0 = 0$). Additionally, the model allows the investor to withdraw the investment, v_0, before the manager can make his effort and risk choices. The investor will withdraw the investment if the expected value of the fund after fees in the second period is lower than the value of the fund currently. If the investor decides to continue, then the manager will make effort and risk choices, the return will be realized, and the contract will terminate at t_1. To capture the continuation value of the contract to the manager, the investor will also have the opportunity to withdraw funds in t_1. If the investor withdraws the funds, the manager will receive his outside option, v_y. If the investor remains invested, the manager will immediately receive a lump sum value, v_c, representing the continuation value of the contract. We will assume that the continuation value of the contract is higher than the manager's outside option ($v_c > v_y$).

A timeline for this extension is as follows, and a graphical representation of the timeline can be found in figure 2:

- At time t_0:
  - The firm value is v_0, high watermark is at h_0 and required return is rr_0. rr_0 represents the return required to reach the last watermark (RR).
  - The investor remains invested in the firm if she anticipates that the effort and variance chosen by the manager will lead to positive expected returns after fees are deducted.
  - However, if she chooses to walk away from the fund, the contract is terminated, the investor receives the fund value v_0, and the agent receives his outside option.
  - If the investor chooses to continue with the portfolio manager at t_0, then the manager chooses effort, a, and variance, σ. (See section 2.2.1).

- At time t_1:
  - At time t_1, rate of return $\hat{r}_{01}$ is realized and if $\hat{r}_{01} > rr_0$, then an incentive fee of $s \times v_0(\hat{r}_{01} - rr_0)$ is paid to the fund manager.
  - The return required to hit the HWM (RR) at t_1, rr_1, is computed, and the investor makes a decision based on rr_1 whether to continue investing in the fund going forward. There is a walkaway threshold, rr_1^*, above which the investor will walk away at time t_1. rr_1^* is set exogenously in the one period model, although this will become endogenous in the infinite period model.

– If the investor does not walk away, then the manager receives a lump sum v_c, which represents the continuation value of the contract - a stylized way to capture future incentive and management fees. If walkaway occurs, the manager will receive his outside option, v_y. We will assume that $v_c > v_y$. In the infinite period model, v_c will be replaced by a function of RR, allowing us to construct a Bellman equation for the manager's problem.

– The contract then terminates at time t_1.

We solve for the manager's effort and risk decisions at time t_0, depending on what rr_0 is, such that the manager maximizes expected utility from incentive fees, management fees, and potential contract continuation. Given the manager's actions, we can determine the investor's expected returns after fees as a function of rr_0 and the region of rr_0 for which this expected return is negative. In this region, the investor will walk away before the manager makes the decision.

2.2.1 Portfolio Manager's Problem

The portfolio manager will act to maximize his expected utility at t_1. V_m is the fund manager's expected utility at t_0:

$$V_m = \max_{a,\sigma} \beta \mathbb{E}\left[u(kv_0 + sv_0 \max(0, \tilde{r}_{01} - rr_0) - \frac{v_0}{2} c_a a^2) + p(\tilde{r}_{01} > r^*_{01}) \times \pi\right], \tag{5}$$

where

$$\begin{aligned} u(x) &= \frac{x^{1-\gamma}}{1-\gamma} \\ 1 + r^*_{01} &= \frac{1 + rr_0}{1 + rr^*_1} \\ \tilde{r}_{01} &= 1 + a + \sigma\tilde{\epsilon} \\ \pi &= u(v_c) - u(v_y) \\ \tilde{\epsilon} &\sim U(-1, 1) \end{aligned}$$

where $\tilde{r}_{01}$ represents the rate of return from time t_0 to t_1. The utility function remains the same as before, with γ representing the coefficient of risk aversion for the CRRA manager and β representing his discount rate. The cost of effort also remains the same as before, $\frac{v_0}{2} c_a a^2$. The difference now is that the fund may not be at the HWM, and thus, the incentive fee is paid only on returns above the HWM ($sv_0 \max(0, \tilde{r}_{01} - rr_0)$). The shock retains the uniform distribution, $\epsilon \sim U(-1, 1)$. $p(\tilde{r}_{01} > r^*_{01})$ is the probability that the return over the period leads to a RR in the second period that is low enough to ensure the continuation of the fund, and π is the increased utility to the manager from receiving this continuation value instead of the outside option. The manager will choose effort a and risk σ for the next period to maximize his expected utility:

$$\{a^*, \sigma^*\} = \arg\max_{a,\sigma} \beta\mathbb{E}\Big[u(kv_0 + sv_0 \max(0, \tilde{r}_{01} - rr_0) - \frac{v_0}{2}c_a a^2) + p(\tilde{r}_{01} > r^*_{01}) \times \pi\Big] \tag{6}$$

2.2.2 Investor's problem

The investor's walkaway decision at t_0 depends on the returns after fees that she can expect given rr_0, the RR at time t_0, and the manager's optimal effort and risk choices for this rr_0. The value of the fund after fees at t_1 can be represented as follows:

$$\mathbb{E}[v_1] = \mathbb{E}[v_0\tilde{r}_{01} - kv_0 - sv_0 \max(0, \tilde{r}_{01} - rr_0)|\tilde{r}_{01} = 1 + a^* + \sigma^*\tilde{\epsilon}], \tag{7}$$

where v_0, v_1 are fund values at time t_0, t_1, respectively, and $\tilde{r}_{01}$ is the return given the manager's anticipated choice of effort, a^*, and variance, σ^{*2}, as given in equation 6. Fees paid to the manager in the above equation are simply the management and incentive fees from the contract ($kv_0 + sv_0 \max(0, \tilde{r}_{01} - rr_0)$). As the investor is risk neutral, if $\mathbb{E}[v_1] \leq v_0$, the investor will walk away at time t_0. This walkaway point is denoted by rr^*_0.

At time t_1, the investor walks away if return required, rr_1, is greater than an assumed and fixed rr^*_1 (akin to rr^*_0 walkway point discussed above, but fixed by assumption in the one period model). This leads to a t_1 walkaway point in terms of the realized return for the period:

$$1 + r^*_{01} = \frac{1 + rr_0}{1 + rr^*_1} \tag{8}$$

If $r_{01} < r^*_{01}$, the investor will walk away at t_1. In the infinite period model, this walkaway point will be determined endogenously using the Bellman equation.

2.2.3 Optimal Effort, Risk and Walkaway in the one period case

The solutions to the manager's problem, a^* and σ^*, can be characterized implicitly. However, it is easier to glean intuition from graphical representations of these solutions which are shown in Figure 3. We can see that optimal effort generally decreases with RR: optimal effort remains at its maximum, 5%, until $RR = 1.8\%$, then falls to about 2% and then slowly decreases to near-zero levels at $RR = 10\%$. Optimal risk is at the minimum when $RR < 1.8\%$. Above this, risk spikes to its maximum value, 10%, and remains there for $RR \geq 1.8\%$.

Given this set of optimal effort and risk choices, we solve for the fund manager's value from the contract (given no investor walkaway at t_0) as a function of RR. This is shown in figure 4. This graph has three lines. The "Payoff from Present Period" is the utility derived from the net of the management fees, incentive fees and cost of effort $(u(kv_0 + sv_0 \max(0, \tilde{r}_{01} - rr_0) - \frac{v_0}{2} c_a a^2)$ from equation 5. The "Payoff from Continuation" is the expected utility from receiving the continuation value over the outside option $(p(\tilde{r}_{01} > r^*_{01}) \times \pi$ from equation 5. Finally, the "Total Payoff" is the sum of these and reflects the total expected utility to the manager from this contract, given the RR. We see that this utility decreases monotonically with RR, and the contract continues with certainty until $RR = 1.8\%$. Beyond that, the probability of continuation in the second period decreases linearly with RR.

Finally, using the optimal effort and risk policies above, we can determine the expected return after fees, given fund continuation. This is shown as a function of RR in figure 5. We see that this increases from 1% to its peak at 2.25% as the fund goes from 5% above the HWM to 1.8% below it. Then it precipitously falls to -0.6% and slowly decreases with RR, finally settling at about -2% for $RR > 10\%$. The precipitous fall coincides with the switch in optimal risk policy from minimum risk to maximum risk. A rational investor would thus withdraw the funds at t_0 if $RR > 1.8\%$. We also note the initial increasing expected return after fees (over the domain $-5\% \leq RR \leq 1.8\%$) is due to the reduced incidence of fees. The further the fund is below the HWM, the less it will have to pay in terms of incentive fees, as these fees are only charged on returns over the HWM.

2.3 Infinite Period Model and Solution

To extend this model to a more realistic infinite period contract, we convert equation 5 into a Bellman equation. We retain the timing of the decisions made by the players from section 2.2. Specifically, during each period, the decisions are made as follows:

1. The investor, who has funds with the manager indexed to a HWM, decides whether to remain invested with the manager or whether to withdraw funds

2. If the investor remains invested, the manager chooses how much effort to expend and how much risk to take

3. The return is realized as per the shock and the effort and risk choices

4. Management and incentive fees, if any, are paid to the manager

5. Any returns to the fund are disbursed, and if the fund loses money, the investor replenishes the fund to v_0 with new money entering indexed to the old HWM

6. A new HWM is established if the old one is exceeded and the investor contemplates the walkaway decision all over again

Once we replace the lump sum continuation value in the second period in equation 5 with a function of the RR to represent the continuation value of the contract, the agent's value function becomes the Bellman equation shown in section 2.3.1 below. We assume (in step 5 above) that the investor will maintain assets of the fund at v_0. That is, she will withdraw funds above v_0 if the fund made a profit and will replenish the fund to v_0 if it made a loss. We will further assume that the contract allows her to replenish the fund with monies indexed to her old watermark, although this is not a central assumption.[4] We can appeal to an optimal fund size for alpha-generation to justify this assumption. An S-shape alpha-generation function (with initial economies of scale followed by decreasing returns to scale) will provide some justification for this optimal v_0 fund size. Additionally, a number of hedge fund investors, such as pension funds, fund of funds, and high net worth individuals, often have portfolio allocation targets, which comport with maintaining the investment in the fund at a given size. These assumptions greatly increase tractability and allow us to isolate the impact of the watermark on the incentives of the fund manager, rather than reflecting the manager's incentive to grow the fund to increase fee revenue. While flow of funds constitutes an important part of the asset management literature (see Christoffersen and Musto (2008) and Berk and Green (2004)), the natural convexity of the '2/20' contract allows us to discern the impact of incentives on the control variables without considering fund flows.

2.3.1 Portfolio Manager's Problem

The portfolio manager's value function can be represented as the Bellman equation below:

$$V_m(rr) = \max_{a,\sigma} \beta \, \mathbb{E}\left[u(kv_0 + sv_0 \max(0, \tilde{r} - rr) - \frac{v_0}{2} c_a a^2) + V_n(rr') \right] \tag{9}$$

[4] Allowing the investor to replenish funds such that the funds invested have a blended HWM also produces qualitatively similar results.

where

$$
\begin{aligned}
u(x) &= \frac{x^{1-\gamma}}{1-\gamma} \\
rr' &= \max(0, \frac{rr - \tilde{r_{pf}}}{1+\tilde{r_{pf}}}) \\
\tilde{r} &= a + \sigma\tilde{\epsilon} \\
\tilde{r_{pf}} &= \tilde{r} - k - s\max(0, \tilde{r} - rr) \\
\tilde{\epsilon} &\sim N(0,1)
\end{aligned}
$$

and

$$
V_n(rr') = \begin{cases} V_m(rr') & \text{for} \quad W(rr') = 0 \\ \alpha V_y + (1-\alpha)V_{nwa}(rr') & \text{for} \quad W(rr') = 1 \end{cases} \tag{10}
$$

The payoff in the next period from incentive fees, management fees and cost of effort remains the same as in the one period model. Note that all payouts (including the cost of effort paid by the manager) occur at the end of the current period. This allows us to avoid a savings decision for the manager. There is an active literature on other specifications for agent consumption and savings (Browne (1997), Browne (2000) and Williams (2008)), however, in our paper, the manager will consume all income from a given period. He will not have a savings decision, nor is he able to invest in his own fund. $W(rr') = 1$ and $W(rr') = 0$ represent the walkaway point, in terms the RR, being breached or not being breached in the second period, respectively. This function is described further in section 2.3.2 below. V_y and V_{nwa} are the value functions for a manager receiving his outside option, and a manager with an investor who does not monitor, respectively. Given the specification of the cost of effort and the utility function, together with the replenishing of the fund (step 5 in the timing above), the fund size, v_0 is not a state variable and is normalized to 1 in the solution and calibration sections. α is the fraction of investors who monitor their investments. We discuss this fraction in further detail in section 2.3.2 below. Setting $\alpha = 1$ would represent a world in which all investors monitored, and the manager would always receive the outside option if the walkaway threshold were to be breached. V_y and $V_{nwa}(rr)$ can be represented as follows:

$$
V_y = \sum_{i=0}^{\infty} \beta^i u(yv_0) \tag{11}
$$

and

$$
V_{nwa}(rr) = \max_{a,\sigma} \beta\, \mathbb{E}\Big[u(kv_0 + sv_0\max(0, \tilde{r} - rr) - \frac{v_0}{2}c_a a^2) + V_{nwa}(rr')\Big] \tag{12}
$$

If the manager learns that the investor monitors (this happens once the walkaway threshold is breached, with probability α), his choices are no longer relevant, as the fund would have been terminated; the manager will take up his outside option and earn yv_0 into perpetuity. This can be interpreted as taking up a position at an actively managed mutual fund with the same AUM as the hedge fund at the time of closure and making a fixed expense ratio, y, on these investments forever. However, if the manager learns that the investor does not monitor (this happens once the walkaway threshold is breached, with probability $1-\alpha$), he will correctly determine that the investor will never walk away and will act as if this contract will never be terminated. Note that the continuation value ($V_{nwa}(rr')$) in the no walkaway Bellman equation remains of the same form, regardless of how far the fund falls from the HWM. This is in contrast to the case for the manager who does not yet know if the investor monitors, and the continuation value is of a different form ($V_n(rr')$ rather than $V_m(rr)$ in equation 9).

Before solving the manager's problem, we consider the investor's walkaway decision in order to obtain $W(rr')$ above.

2.3.2 Monitoring Investor's Problem

We modify the investor's walkaway decision from equation 7 in the one period model. We assume that only a fraction of investors, α, monitor their investments.[5] The investors who do not monitor will never walk away. This section discusses the monitoring investor's walkaway decision.

The "monitoring" parameter, α, represents the fraction of investors who constantly monitor their investments. Each fund either has an investor who constantly monitors the fund at zero cost, or has an investor who has a prohibitively high cost of monitoring the fund and does not monitor. α is the fraction of total investors who costlessly monitor the fund. If the investor does not monitor, she will never walk away. Initially, the manager does not know what type of investor he works for; the manager will act such that there is α probability that the investor monitors and $1-\alpha$ probability that the investor will not monitor and will never walkaway. This concept of the attentive/inattentive actor is not new in the literature. Both the mutual fund literature and mortgage literature have extensively studied this phenomenon (see Berk and Tonks (2007), Christoffersen and Musto (2002), Carhart, Carpenter, Lynch, and Musto (2002) and Schwartz and

[5] The purpose of α becomes clear in the calibration section as we try to match the dispersion of fund observations by distance from the HWM. For now, setting $\alpha = 1$ would represent a world where all investors monitor and the remaining analysis would go through.

Torous (1989)). While it might be argued that investors in hedge funds are different and are much less likely to leave their funds unattended, we note that there is a large variation in the type of hedge fund investors. A large fund of hedge funds would be unlikely to leave its funds unmonitored indefinitely, but retired high net worth individuals and pension funds might well adopt this "set it and forget it" stance seen among non-monitoring investors.

The monitoring investor is risk neutral and seeks to maximize expected funds by deciding when/if to withdraw funds from this alternative investment and to deposit them into an account bearing no interest.[6] In order to posit an equilibrium, we assume the investor believes that if she does not walk away when she should, the manager will behave as if the investor is of the unmonitoring type and will never walk away (i.e. the manager will determine a^* and σ^* by solving $V_{nwa}(rr)$ from equation 12). This is an off the equilibrium path belief. In equilibrium, the monitoring investor will always walk away when the walkaway condition is met.

Even with these beliefs, there may still be multiple equilibria for the investor's walkaway threshold. We take a number of steps to identify one such equilibrium. We posit a walkaway rule consistent with the off the equilibrium path beliefs discussed above, and we verify that this rule, combined with the manager's actions under that walkaway policy, constitutes a stable equilibrium. We propose the following walkaway policy: The investor will walk away based on the outcome of returns and fees over the next N periods. More specifically, the investor will walk away if expected returns from the next N periods are negative, regardless of interim walkaway, given the RR and that the manager's investment decisions are as in the no walkaway case (i.e. given a^* and σ^* from the solution to $V_{nwa}(rr)$ for each given rr from equation 12). Thus, the walkaway rule can be expressed as:

$$W(rr) = \begin{cases} 1 & \text{for} \quad E_{nwa}[\tilde{r}_{pf,t_0 \to t_n} | rr] < 0 \\ 0 & \text{for} \quad \text{otherwise} \\ \forall & n \quad \in [1, 2, 3 ... N] \end{cases} \tag{13}$$

Where $E_{nwa}[\tilde{r}_{pf,t_0 \to t_n} | rr]$ represents the expected return after fees under the belief that the manager will behave as if the investor never monitors over the next n periods. Such a rule can be interpreted as assuming a bounded rational investor who is willing to analyze the next N periods to make the right decision. We now have to verify that this rule is consistent with the behavior

[6] Although we do not consider reinvestment into another fund as an admissible strategy in our model, if such a reinvestment were to be accompanied by an upfront sales fee that expropriated all investor surplus from entering a contract at the HWM, this would be equivalent to having a zero-interest bearing deposit account as an alternative.

of a value maximizing investor. It is easy to show that the investor should never walk away when $W(rr) = 0$ because (1) expected returns will always be higher when the manager is uncertain if the investor is monitoring than when the manager knows for sure the investor is not monitoring (this is shown for the calibrated model in section 2.3.3 below) and (2) expected returns for the investor will be positive (over some period from t_1 to t_N) under the belief that the manager acts as if the investor is not monitoring. (1) and (2) together imply that walking away when $W(rr) = 0$ would mean walking away from positive expected returns and depositing the funds in a zero interest bearing account, which is suboptimal. We also to verify that continuing the contract when $W(rr) = 1$ is suboptimal in terms of returns over the next N periods. This is trivially true given the walkaway condition in equation 13. Note that while this is a walkaway threshold consistent with the investor's beliefs, we do not identify it as a unique walkaway threshold. It is possible that a different walkaway threshold may be a feasible policy function in equilibrium as well. This walkaway policy does, however, provide us a clear path to solving the problem: (1) We solve for the manager's optimal policy in a world where he believes the investor does not monitor. (2) Using these policies, we determine the walkaway policy for the investor from equation 13. (3) Using the walkaway policy, we solve for the manager's policy functions using the Bellman equation, equation 9.

2.3.3 Optimal effort, risk and walkaway in the infinite period case

We solve for the optimal effort and risk policy functions for the manager in the no walkaway case using value function iteration. The functions are shown in figure 6. These simply represent how a manager would behave if he knew the investor would never walk away, and they are the solutions to the maximization problem in equation 12. Using these functions, we can determine the regions of walkaway as per the walkaway condition above (equation 13). The walkaway decision is shown in figure 7 and is the function presented in equation 13. Under the model, only α fraction of the investors monitor their funds. The only way for the manager to find out if the investor is of the monitoring type is if the fund ever reaches a point where the return required is higher than the walkaway threshold shown in figure 7. At that point, the value function is resolved into either V_y or $V_{nwa}(rr)$. Once we add in the walkaway policy for the monitoring investor, we can model the manager as choosing a and σ as per the Bellman equation above (equation 9) with investor walkaway policy in figure 7, conditional on the monitoring investor not walking away. Using value function iteration, we solve for the manager's optimal policy and value function. The policy functions are shown in figure 6. Combining the optimal policy functions for the manager and the investor, we determine the value function for the manager, which is shown in figure 8. Note the steep dropoff to the right of the walkaway point indicating the potential loss of the contract. The expected moments for investors' returns under the solved model are shown in figure 7. We can see that expected return next period decreases and expected return variance increases with RR.

Finally, we confirm that both the attentive investor's behavior and the manager's actions constitute a Nash equilibrium. The investor will never walk away in regions to the left of the walkaway boundary in figure 7, as it is unprofitable to do so. To right of the boundary, she will always walk away as she believes that the manager will revert to a no-walkaway effort and risk policy if she does not. She will end up paying more in fees than she can hope to recoup in expected returns according to her off the equilibrium path beliefs, and thus, she will walk away. The manager will also not deviate, as every control decision taken by the manager optimizes the Bellman equation shown in equation 9, and deviation can only lower the manager's expected utility. Given that no unilateral deviation on the part of either party can improve their outcomes, these policy functions constitute a Bayesian Nash equilibrium.

2.4 Model Calibration

Using the moments from the CISDM dataset (described below in section 3), we calibrate a number of free parameters in our model. In particular, we are interested in the agent's risk aversion (γ), the cost of effort (c_a), the fraction of investors that monitor their funds (α), and the time horizon of the monitoring investor, N. Additionally, we also determine the impact of the outside option, y, and the discount factor for the agent, β. We also calibrate the domain of choice variables considered (the range of potential effort choices, a, and potential risk choices, σ). Using these parameters, we attempt to match observed data moments, including the population average after fee returns, the variance of the average after fee returns, walkaway rates, the relationship between investor returns and return required to hit the HWM, and the dispersion of fund-period observations in terms of how far funds are from the HWM.

Table 2 shows the moments generated by simulating the model under various sets of parameters. We simulate 20,000 funds running for between 1 and 200 periods, each starting at the HWM. The fund starting points are distributed uniformly over the interval to simulate the staggered starting points of hedge funds in the CISDM dataset. The funds all have a 1.5/17.5 fee structure, mirroring the average management and incentive fees seen in the CISDM dataset. The first column in the table shows observed moments, and the second column shows our base parameters. The observed sample moments can be matched quite closely by the simulation. In particular, the average returns and return standard deviation are slightly lower (0.86% vs. 0.95% and 5.78% vs. 5.99%)). The walkaway rate predicted by the model (0.74%) is also slightly lower than that observed in the data (0.87%). The coefficients describing the relationship between expected returns, return variance and distance from the HWM also match directionally and in magnitude. δ_1 suggests the model predicts that a fund 10% below the HWM will underperform a fund at the HWM by 1.9% in the next period. Multivariate regression analysis described in the following sections shows that in observed actual data, a fund 10% below the HWM will underperform a fund at the HWM by 2.8% over the following six months. Unreported regression results of the next 1 month return on RR suggest a fund 10% below the HWM will underperform a fund at the HWM by 0.6% in the following month. Similarly, the model predicts that the standard deviation of monthly returns for a fund 10% below the HWM will be 9.4% higher than the standard deviation of a fund at the HWM. Multivariate regressions of observed data suggest that the standard deviation of monthly returns using 6 months of data are 1.6% higher for funds requiring a 10% return to hit the HWM compared to funds at the HWM. We face a tradeoff between using more periods to obtain a more accurate standard deviation of returns and diluting the impact of the HWM on risk in the next period, or using fewer periods and introducing noise into the measure of standard deviation. We use six months of returns to estimate the standard deviation of returns. We are not concerned that the sensitivity of risk to RR predicted by the model is higher than the observed sensitivity because risk calculation for the observed sensitivity relies on returns further into the future, which are less likely to be affected by the RR in the current period.[7] We analytically compute investor-observed moments (average returns and return standard deviation), and how they vary depending on the return required to hit the HWM. These moments are displayed in figure 7 and are used to determine the regression coefficients above. Finally, we note that the dispersion of the simulated observations by the distance required to hit the HWM also comports with observed data, except for a higher concentration in the $RR > 100\%$ category at the expense of lower concentration in $10\% < RR \leq 100\%$ category.

The third column shows an increase in the cost of effort c_a to 0.85. It principally shows that due to the endogeneity of the walkaway, c_a (and many other parameters) affects almost all the moments. As the cost of effort increases, expected returns decrease, and the contract has less value to the manager. Thus, the manager is more willing to gamble because losing the less valuable

[7]The multivariate regressions for the impact of RR on average returns and return variance can be found in Table 8 and Table 10 respectively.

contract and receiving the outside option are less distressing now than when the cost of effort was lower. This naturally leads to increased risk and walkaway incidence. In general, the Jacobian of the parameter-moment relationship has very few zero elements, reflecting generally that parameters affect all moments due to the endogeneity of walkaway and choice variables. Additionally, to confirm that the parameters in the model can be uniquely identified, we note that this Jacobian matrix, evaluated at the base parameter set, has full rank.

The fourth column shows the impact of setting $\alpha = 1$. In a world where all investors monitor, we note that the dispersion of observations will never have any fund periods with $RR > 10\%$. The manager's discount rate (β) and outside option (y) are left unchanged through the results presented in the table. The outside option can be thought of as the manager leaving the hedge funds to go manage an actively managed mutual fund with similar assets under management. We set the expense ratio of the fund at 1.5%, although reducing this has little effect on the results, save to reduce the variance of the simulated returns. β also has a limited impact, and the higher β is, the less risk the manager takes. Additionally, at very high levels of β ($\beta > 0.99$), the value function convergence slows, and obtaining meaningful solutions numerically becomes a time-intensive process. The parameters restricting policy function choice variables ($a \in [0\%, 2\%]$ and $\sigma \in [3\%, 11\%]$) primarily allow us to control the overall level of risk and excess return. While it is possible to introduce additional parameters in the cost of effort function or a Sharpe ratio to achieve similar results, we opt for a more transparent approach of simply limiting the range of a and σ. We note that Hodder and Jackwerth (2007) similarly restrict their alpha-generation choices. We also note that in addition to risk aversion and the threat of walkaway, hedge funds typically have risk management divisions that often prohibit egregious risk taking.

Despite our ability to match a number of the moments quite closely with the model, we note that our model, like all models, does not capture the reality of these contracts in its entirety. In particular, we do not capture Bayesian learning, by which the investor learns more about the skill of a manager through the return process (see Christoffersen and Musto (2008) for a model of this feature and its interaction with the HWM). In our empirical tests of the model, we will account for this by using historical returns as a control variable, but such learning will also affect the decisions made by the players in our model, and thus the calibration. Also, we do not capture renegotiation or new fund flows. The anecdote cited in the introduction, in which a fund below its HWM had a sale, shows both of these at work. In particular, fees can be renegotiated downwards to stave off fund closure, and new money introduced into a fund below the HWM will also prevent fund closure. Finally, we also note that reporting and survival biases will likely affect a number of the moments we seek to match. In particular, given the general positive bias of fund reporting, average investor returns are likely to be lower than observed, and walkaway rates are likely to be higher. These, together with the continued evolution of the hedge fund space, suggest that the calibration exercise does the best with the data we have and bears revisiting as new data become available and regulations surrounding the reporting of returns are codified.

2.5 Model Empirical Predictions

In both the one period model and the infinite period model, as the fund falls further from the HWM, walkaway by the investor is more likely, expected returns for the investor decrease, and the variance of investor returns increases. Additionally, the infinite period model also predicts how behavior would differ between funds where the manager knows that the investor is not monitoring and will not walk away, and funds that haven't faced the test yet. In section 3, we test some of these empirical predictions on observed fund returns and fund closure data.

3 Data and Empirical Results

The empirical portion of this study uses data from the CISDM database. The CISDM database provides information on fees, returns, assets under management (AUM) and active/inactive status for close to 9,000 hedge funds, funds of funds, commodity pool operators (CPOs) and commodity trading advisers (CTAs). Summary statistics for the data can be found in Table 3. Panel A reports characteristics for the funds in our sample. There are a total of 8,752 funds in our sample with monthly return observations spanning from January 1990 to December 2005. The variables are defined as per CISDM documentation. The funds in our sample have average management and incentive (performance) fees of 1.51% and 17.23% respectively. Additionally, some funds also have a sales fee of 0.56% per year. The active flag is equal to 1 if the fund is currently reporting and is 0 otherwise. The gate percent is the maximum percentage of a fund that may be withdrawn in a given period. Only 175 funds in our sample report a gate, and the average gate percentage for these funds is 12.7%. CTA, Hedge Fund, Fund of Funds (FoF), CPO and Index flags are set to 1 if the funds are identified as such by the CISDM database. 872 funds responded to the question of whether they used a HWM, and 96% of responders said they used a HWM in their compensation contracts. The high incidence of the HWM feature gives us confidence in running the empirical study for the entire sample of returns.

Panel B reports summary statistics for these walkaway results and for the returns. Excess returns are computed by subtracting the average of all fund returns for a given month from the monthly return of each fund. Monthly returns are simply raw monthly returns for each fund, net of fees. The return process is defined as beginning at 1 for each fund at inception (or at the beginning of the sample period) and reflects the compound impact of all monthly returns until that period. It can also be thought of as the value of a dollar invested in the fund at inception in the current period. The HWM is defined as the maximum of the return process until the current point in time for each fund. The return required to hit the HWM (RR) is the HWM divided by the current return process minus one. If the return process is at its maximum, the return required to hit the HWM is 0.[8] We assume that the incentive fees are paid out monthly, there is no hurdle rate and that the HWM is reset monthly. In practice, funds generally pay incentive fees quarterly, half yearly or yearly, but CISDM does not report when the fees are paid and the reset takes place. Additionally, funds sometimes have a hurdle rate, in addition to the HWM feature, which has to be met before incentive fees are paid out. This hurdle rate is often the LIBOR. In robustness checks, we confirm that our results hold for an annual incentive payout/HWM reset and a 3 month LIBOR hurdle rate. Walkaway (basic) is simply the frequency of fund periods in which funds stop reporting. Although there are a variety of reasons why funds stop reporting (see Grecu, Malkiel, and Saha (2006)), our conversations with CISDM suggest that the two principle reasons are: (1) the fund ceases operating because the investors withdraw their funds or the managers close shop, that is, either party walks away, and (2) the fund does exceedingly well and stops taking new investment, with the former being the more likely cause. In our base results, in the interest of transparency, we identify walkaway as simply a stoppage of reporting. In robustness tests, we refine this walkaway measure by restricting it to funds that stop reporting in a period during which AUM does not increase. Fund which have a net AUM increase in the final period of reporting are classified as those that have closed to new investment and have thus stopped reporting. Walkaway, as defined in the base case, appears in 0.87% of the fund periods. Walkaway, restricted to the funds that stop reporting during a period when AUM does not grow, occurs in 0.52% of the fund periods.

We note that the HWM level, as constructed, does not factor in new money. For example, a fund that receives new money during a dip in their return process will have some money that is indexed to a lower HWM than what our empirical analysis suggests. CISDM does not report

[8] An example detailing the mechanics of the HWM can be found in the Appendix.

inflow and outflow numbers separately, and even with AUM/net flow numbers for each period, it is impossible to correct for this effect. However, despite this limitation, we note that the return required to hit to the HWM that we use in our analysis is the theoretical maximum. The actual return required to hit the HWM can only be lower than this number, as no money could possibly have entered the fund while it was higher than the maximum in the return process. Thus, if we find a statistically and economically significant impact on our dependent variable assuming the maximum return required, actual return required would produce only a magnified impact. For example, we calculate that a fund requires 20% to hit the HWM, but in actuality, it requires only 10% to hit the HWM, as some money entered the fund after the maximum in the return process was hit, and the new money is benchmarked to a lower HWM. Comparing this fund to other funds which are at their HWM, we find it is more likely to experience walkaway, and the fund manager is likely to exert less effort. We conclude that a 20% return required to hit a HWM produces these effects; in actuality, only a 10% return required is needed to produce these effects. Thus, in some sense, if our results do err due to this construction of the HWM, they err conservatively. To further address concerns regarding this issue, we conduct robustness tests by eliminating the portion of the sample we believe to suffer most from this issue. We discuss this further in the robustness section below.

3.1 Univariate Analysis

Table 4 shows the univariate analysis of the impact of the return required to hit the HWM on next 6 month excess returns, monthly return standard deviations over the next 6 months and walkaway incidence. The sample is divided into deciles by return required to hit the HWM, and columns 3, 4 and 5 present the average excess returns, average standard deviations and average walkaway rates for funds in each of these deciles, respectively. Note that for the lowest three deciles, the fund is at the HWM, and hence, they are condensed into a single group, and the return required to hit the HWM for these funds is 0.

We note that funds at the HWM (Lowest RR decile) and funds far below the HWM (9th and Highest RR decile) have positive excess returns over the next 6 months. All other funds on average have negative excess returns over the next 6 months. Average return standard deviation generally rises as RR increases, although there is a slight U-shaped pattern with standard deviations dropping from 2.93% to 2.16% just slightly below the HWM before climbing to a high of 7.27% for funds furthest away from the HWM. Expected walkaway incidence over the next 6 months uniformly increases from 3% to 12% as RR increases. Univariate analysis of the impact of returns required to hit the HWM on effort (as proxied by expected returns), risk and walkaway provides some preliminary support for our hypotheses from the model. Persistence of returns and the need to control for the risk/return tradeoff requires either bivariate or multivariate analysis, both of which are performed below. Controlling for historical returns and realized variance or average returns allows us clarify the choice decisions of the manager.

3.2 Bivariate Analysis Controlling for Historical Returns

The return required to hit the HWM depends heavily on historical returns. In particular, the lower the recent historical returns, the higher the RR is likely to be. To disentangle the effect of the distance from the HWM from historical returns, we perform a bivariate analysis of the impact of the RR after sorting the fund periods by historical returns. The results are presented in table 5, 6 and 7. In each case, in addition to sorting by return required to hit the HWM, we also sort the observations by historical returns over the last year. Note that funds that have performed exceptionally poorly over the last year (lowest and 2nd decile in terms of historical returns) cannot possibly be at or close to the HWM. Thus there are no observations in the upper left corner of these tables.

Table 6 presents the average standard deviation for returns over the next 6 months for funds sorted by RR and historical returns. We see that, for most of the historical return deciles (lowest, 2nd, 7th, 9th and to a lesser extent for the 3rd, 5th and 8th deciles), the U-shaped relationship between risk and RR from the univariate analysis is no longer as prominent, and risk now generally increases monotonically with RR. Only for the 4th, 6th and highest historical return deciles is there still a prominent U-shape. This provides more evidence that the risk taken by funds increases as they fall further away from the HWM, as predicted by the model. The corresponding results for average returns over the next 6 months are presented in Table 5. Although overall, there are clearly positive excess returns at the HWM, once split into historical return deciles, this trend is less clear. However, once again, we note that the higher risk taken by firms further from the HWM could explain some of these returns. We will control for this in the multivariate regressions. Finally, Table 7 presents the average walkaway rates over the next 6 months for funds sorted by RR and historical returns. Generally, across all deciles of historical returns, walkaway rates increase with return required to hit the HWM. This is in line with predictions from our model.

These results are generally robust to using longer periods of historical returns, and they strengthen our initial results for the impact of the HWM on risk taken by the funds and on walkaway rates. Using multivariate regression techniques, we control for extended periods of historical returns and various other differentiating factors across the funds. These are shown below.

3.3 Impact of HWM on Average Returns

Table 8 shows the impact of RR on next 6 month returns. The dependent variable is excess returns over the next 6 months, and the controls include next 6 month return standard deviation, components of RR, months in operation, calendar time, the type of fund (unreported) and historical returns going back 2 years. We see that for all specifications that include control variables, the impact of the returns required to hit the HWM at the end of the last period are negative and significant on the returns for the following 6 months. The coefficient for the base regression is not significant because of the countervailing effect of the increased variance for funds further away from the HWM, and the increased returns due to the risk-return tradeoff. Looking at the regressions with control variables, we find that the effect is most significant when the funds are near the HWM, or the option is close to the money. The coefficient for the return to the HWM for funds that are within 10% of the HWM is an economically and statistically significant -28.06. This means that a fund 10% from the HWM is likely to underperform a fund at the HWM by 2.8% in the next 6 months. Given that the average returns for funds is about 1% a month, this is a significant fraction of expected returns. The corresponding coefficient for funds that are more than 10% away from the HWM is -0.077. Although statistically significant, this would mean a fund requiring a 100% return to hit the HWM would only underperform a fund requiring 10% to hit the HWM by 6.9 basis points (7.7 bp * 90% increase in return required) over the next 6 months. As economic intuition would suggest, the effect of changing the RR is much stronger while the compound call option is near the money.

We also note that the coefficient on next 6 months return standard deviation is positive and significant for all specifications. This suggests evidence of a risk-return tradeoff. On average, for every 1% increase in standard deviation, expected returns over the next 6 months go up by 1.14%. For funds with $RR < 10\%$ and $RR \geq 10\%$, the increase in expected return is 1.58% and 0.61%, respectively. These numbers can also be interpreted as average Sharpe ratios: the average Sharpe ratio over six months for funds with $0\% \leq RR \leq 10\%$ is 157.7% and that for funds with $RR > 10\%$ is 61.2%. This suggests that funds closer to the HWM take more profitable risks than funds further away.

These regressions provide support for our empirical prediction that effort exerted decreases as funds drop below their HWMs. While we interpret the increased expected returns closer to the HWM to be a sign of increased effort, a more cynical interpretation would involve a fund manager's ability to time returns. If a fund manager has any discretion over when returns would actually be realized, as is often the case for investors in illiquidly traded assets, he would certainly try to realize as much return as possible on winning positions and minimize realizations of losses while the fund is at the high watermark. Such an interpretation also comports with findings from Aragon and Qian (2006) which suggest that funds with illiquid assets are more likely to use a HWM structure in their compensation scheme. Pool and Bollen (2007) also find evidence of such timing of returns, looking at a sample of hedge fund returns and noting that the number of small positive returns far outnumber the number of small negative ones.

3.4 Impact of HWM on Walkaway Decisions

Brown, Goetzmann, and Park (2001) study the survival rates among hedge funds and CTAs, which show that poor returns in previous periods increases the mortality rates of hedge funds. While historical returns are an integral part of generating the distance from the HWM, we show that this distance has an independent effect on the walkaway rates. Table 9 shows a logistic regression of walkaway outcomes on a fund's distance from the HWM. The dependent variable is 1 if there is a walkaway within the next 6 months and 0 if the fund continues. The coefficients presented are the odds ratios for walkaway for a unit change in each independent variable. The first column presents odds ratios for all fund periods (with the RR truncated at 200% to obtained meaningful odds ratios). A unit change in RR is 100%. The second and third column split the sample into $RR < 10\%$ and $RR \geq 10\%$. In these cases, a unit change in RR is 1%. Controls for the regressions include the overall return process and the fund's recent performance, time, the amount of time the fund has been in operation and what type of fund it is (these results are not displayed). We note that funds are more likely to experience walkaway when recent returns are lower (similar to Brown, Goetzmann, and Park (2001)). We also note that funds are more likely to experience walkaway when they are further away from the HWM. We obtain a positive and significant odds ratio of 1.6 for the entire sample. The interpretation of this odds ratio is

$$\frac{P(W|100\%rr)/P(NW|100\%rr)}{P(W|0\%rr)/P(NW|0\%rr)} = 1.6, \tag{14}$$

ignoring the second order terms, an approximation of this relationship would mean that

$$P(W|200\%rr) \approx 1.6 \times P(W|100\%rr) \approx 1.6 \times P(W|0\%rr) \quad (15)$$

where W and NW defines a walkaway and no walkaway outcome, respectively, and rr is the return required to hit the HWM. In particular, the probability of walkaway for a fund that requires 100% returns to hit the HWM is 1.6 times higher than a fund at the HWM. This is exactly what our model predicts: the further the fund is from the HWM, the higher the incidence of walkaway. Additionally, we note that the impact of RR on walkaway is much stronger closer to the HWM than further away. When $RR < 10\%$, we see that increasing RR by 1% leads to an increase in walkaway odds by 7.9%, whereas increasing RR by 1% when $RR \geq 10\%$ only increases walkaway odds by 0.3%. Again, this resonates with predictions from our model, where we see a binary walkaway point close ($RR < 10\%$) to the HWM. Once that threshold is passed, our model predicts no further changes in the likelihood of walkaway.

3.5 Impact of HWM on Variance

Economic intuition and empirical predictions from our model suggest that managers further away from the HWM take increased risk. Table 10 shows the regression of fund return standard deviation on a fund's distance from the HWM. The dependent variable is the standard deviation of a fund's returns for the next 6 months (including the current month). We see that, across the board, the further funds are from the HWM, the higher the standard deviation is for the next 6 months once we control for historical returns and the returns during this time period. For the entire sample with controls, the coefficient is significant and positive at 0.054. Splitting the sample into funds that are close to the HWM ($RR < 10\%$) and those that are far from the HWM, the coefficients are positive and significant at 16.33 and 0.033, respectively. Economically, the 16.33 coefficient can be interpreted as suggesting that a fund with RR of 10% will have next 6 month return standard deviation that will be 1.6% higher than that for a fund at the HWM. Similar to average return, we see that variance is much more sensitive to the RR when the fund is close to the HWM.

We noted in our univariate analysis a U-shaped pattern in which variance initially fell and then rose as distance from the HWM increased. However we also noted that the U-shape was not as prominent in the bivariate analysis. We further analyze the cause of the U-shaped pattern in the univariate analysis, which gives way to a more monotonic relationship between return required and variance in the bivariate analysis. We run the regression in Table 10 with progressively fewer covariates until we observe the U-shaped pattern seen in the univariate analysis. As it turns out, simply removing all historical returns as covariates produces the U-shaped pattern seen before. The results are shown in Table 11. Panel A shows the regression with historical returns as controls, and Panel B shows the regression without any historical returns as controls. Only the coefficient on the RR is shown. We see that in Panel B, variance of returns initially falls with distance from the HWM and then increases again; however, controlling for historical returns, variance simply increases with distance from the HWM (Panel A). This suggests that when funds at their HWM experience a period of poor performance, managers decrease variance choices (this effect has been documented in Brown, Goetzmann, and Park (2001)). However, this effect is not due to an increase in the distance from the HWM, but rather, due to the poor past returns. We also see evidence of this in Table 10. We note that for funds within a 10% return of their HWM, return variance going forward increases with historical returns. For example, if returns in the preceding month were lower by 1% (controlling for distance to HWM and all the other variables), we expect standard deviation of returns for the next 6 months to be lower by 8.9 basis points. This is consistent with managers of funds close to their HWM taking less risk as a result of losing money. Panel A in Table 10 also clearly shows the decreasing impact of the RR as the fund falls further from the HWM. The coefficient on RR progressively decreases as RR increases.

The intricate relationship between historical returns and distance from the HWM and the different effect of the two factors on future variance is evident in an extreme, hypothetical example. Consider two funds currently at their HWM. The first fund loses 3% in the first year and has 0% returns for the next 9 years. The second fund has 0% returns for all ten years. The regression results suggest that, at the 10 year mark, the first fund is expected to have a higher return variance than the second, since the recent historical returns for the two funds are similar, and the first fund is further from the HWM. However, at the second year, the first fund will have lower variance because recent historical returns are lower.

3.6 Impact of AUM and Fee Structure on the effect of the HWM

While we do not explicitly consider fund flows or changing fee structures in our model, we examine the effects of differing assets under management (AUM) and differing fee structures on the empirical results we have detailed above. These results are shown in tables 12 and 13 respectively. Table 12 shows the impact of the returns required to hit the HWM on returns, risk and walkaway for funds with AUM between \$20MM and \$500MM and funds above \$500M AUM. Table 13 shows the impact of the returns required to hit the HWM on returns, risk and walkaway for funds with incentive fees less than 20% and above 20%. Coefficients presented are those for next 6 month return, return standard deviation and walkaway on RR for $0\% \leq \text{RR} \leq 10\%$. Walkaway and risk regressions are generally consistent with all previous regressions: walkaway increases with RR, and risk taken also increases with RR for funds across the AUM and incentive fee spectrum. We do note that walkaway rates only increase directionally with RR for funds with incentive fees above 20%. In particular, the point estimate suggests that for a 1% increase in RR, walkaway rates increase by 1.8%. This compares to 4.9% for the overall sample and a statistically significant 6.7% and 7.3% for funds with 20% incentive fees and less than 20% incentive fees, respectively. This resonates well with the intuition that funds with higher incentive fees have built up reputational capital that bolsters support for the fund during rough patches.

The most stark result is that funds with lower AUM have a negative relationship between next 6 month returns and RR (funds with a 10% RR underperform funds at the HWM by 2.4% over the next 6 months) while funds with higher AUM, on the other hand, have a positive relationship between RR and subsequent returns (funds with a 10% RR outperform funds at the HWM by 2.7% over the next 6 months). Similarly, we see that funds with higher incentive fee structures also have a positive RR-return relationship (funds with 10% RR outperform funds at the HWM by 5.2% over the next 6 months), and those with lower incentive fees have a negative RR-return relationship (funds with an incentive fee of 20% with 10% RR underperform those at the HWM by 2.0%; funds with an incentive fee of less than 20% with 10% RR underperform those at the HWM by 3.2%). We interpret this as a confluence of two effects: (1) The increased continuation value of the higher AUM/fees funds provides a larger incentive to keep the fund alive when returns dip and (2) the higher management fees from the higher AUM/fees (and presumably higher personal funds of a manager with a fund with high AUM/high fee structure) allow the fund to retain high priced alpha generating talent through periods of poor performance. This theme also arises in section 4 where we see that the management fee plays a critical role in welfare outcomes in this model, and we discuss the role of continuation value and the ability to retain costly talent through periods of poor performance further below.

3.7 Impact of having exceeded the walkaway threshold on the effect of the HWM

Our model predicts that managers at funds that have historically been above the walkaway RR threshold have determined that the investors do not monitor. Our model predicts that manager effort and risk choices will be different for these funds. In particular, it predicts that effort (and thus expected returns) is likely to drop more steeply with RR and risk is likely to increase more steeply with RR. Additionally, our model predicts that walkaway incidence is likely to be much less frequent. We test this on the empirical data by splitting fund periods which have RR less than the walkaway threshold ($RR\ s.t.\ W(RR) = 0$) into those that have had a historical maximum RR above the walkaway threshold and those which have not.

The results are shown in Table 14. We note that the untested sample behaves much like the overall sample. Unfortunately, given the small number of observations in the tested sample (where RR has historically exceeded the walkaway), the point estimates on coefficients are not statistically significant. However, we do see that walkaway is less sensitive to changes in RR, although it still increases. It is also interesting to note that, comparing point estimates of coefficients, average returns decrease with RR, but they do so more gradually compared to untested funds (coefficients are -2.986 for the tested sample vs. -28.534 for the untested sample). Risk taken by the tested funds decreases with RR, as compared to the untested funds where risk increases (coefficients are -1.399 for the tested sample vs. 16.549 for the untested sample). The reduced incidence of walkaway by the investor as RR increases for the tested sample comports with model empirical predictions. Although the directional coefficients on the average return and return risk regressions on RR are not consistent with our model, they suggest that the fund managers treat such funds left by unmonitoring investors as their own money and manage it in order to maximize fund value, instead of maximizing fees in the short term.

3.8 Robustness and Discussion

Our results are robust to a wide variety of changes among various dimensions of our tests. The robustness checks conducted can broadly be classified into 5 distinct types. (1) We vary the historical return series lengths used as controls for the tests (2) We try to identify and eliminate portions of our sample in which the HWM as constructed is less likely to accurately reflect the actual HWM (3) We adjust our calculation of return required to hit the HWM to moderate the impact of outliers (4) We adopt fixed effects 'within' regressions structure to control for innate differences in our funds and (5) We use different hurdle rates and HWM reset frequencies to calculate the HWM at each point in time. Our results are, by and large, robust to these various specifications.

The results presented control for historical excess returns of the funds going back two years before our period of interest. We do tests to control for returns going back even further. Our results are robust to the addition of up to five years of returns for walkaway and return standard deviation regressions. For the regressions of average returns, our results are robust to adding in historical returns going back 4 years. Given the half-lives of these funds, the sample shrinks significantly for each additional year of historical returns added to the controls. When adding the 5th year (i.e., controlling for the return series from t-60 to t-1), the results are no longer significant, although they are still directionally consistent. We also note that the sample size drops to about a quarter of the total number of observations. However, rather than interpreting this as a failure of our hypotheses, we believe that these results are due to other effects. For example, a fund that has existed for 5 years will have built up a significant reputation, and effort and walkaway decisions will no longer solely be based on maximizing the value of payoffs from returns above the HWM. Additionally, a fund that has existed for 5 years will likely also have monies that have been deposited after that HWM was reached, such that the return required to hit the HWM calculation we use will not measure the incentives of the fund managers as accurately.

The construction of the HWM, as mentioned in section 3 above, doesn't adequately reflect monies that might have been invested after a fund reached a HWM which are benchmarked to a lower HWM than what we use. Partly to mitigate this and partly to control for what we call a 'seasoning' effect, we perform a robustness test examining observations where the following condition is met: the current return required to hit the HWM is the maximum return required to hit the HWM in the fund's history. In other words, observations for this test include funds that have never been this far away from their HWM before and are unseasoned as to their actions under this condition. Additionally, it is less likely (although still possible) that the HWM as constructed will not be representative for such a sample. The results are robust to this specification and, in fact, are stronger than in the original test.

One of the problems with the current construction of the RR is that when the return process declines significantly, the return required rises astronomically. For example, a fund that started at 100, reached 200 and then fell to 10 has a return required of 1900%. To mitigate this effect, we perform the overall sample regressions with controls for the impact of returns required on the next period return and variance (second column of Tables 8 and 10), capping the return required at 200%. Our results are robust to this specification.

Results presented throughout the paper assume a monthly HWM reset. This means the incentive fee is paid out if the old HWM is breached and a new HWM is established at the end of each month. In practice, quarterly and annual payments are more common. The current HWM calculation also does not use a hurdle rate (all returns in a period counts towards hitting the HWM), whereas in practice, funds often face a hurdle rate, such as the 3 month LIBOR or a flat annual 6% hurdle. Our results are robust to all of these specifications. Results of the impact of the HWM on expected returns and return variance for a 1 year incentive fee payout/HWM reset horizon and a 3 month LIBOR hurdle are shown in Tables 15 and 16, respectively. The results for observations where the fund is below the HWM remain qualitatively similar. It is interesting to note that funds above the HWM take more risk the further they are above the HWM. From table 16, we see that next 6 month return standard deviation for funds 10% above the HWM is, on average, 0.39% higher than for funds at the HWM. This can be interpreted in the context of our model, as a manager being less worried about the fund dropping to a point where the investor will withdraw funds, and thus being more comfortable taking risk to maximize incentive payouts.

We conduct regressions under a fixed effects 'within' regression structure. This entails adding a dummy variable for each fund in the sample to control for innate differences in the funds. We find that if we use a fund dummy that controls for the entire series of observations (including periods in the future), our results remain directionally consistent, although they lose statistical significance and are smaller in magnitude. However, the fund dummy captures some of the explanatory power of the HWM. An example in a regression of average returns on RR makes this clear. Consider two funds with two periods of returns each: the first fund makes 25% in the first period and then loses 20% in the second period, while the second fund loses 20% in the first period and then makes 25%. Thus the first fund is below its HWM while the second fund is at its HWM, although both funds have exactly the principal with which they started. Our model predicts the first fund is likely to do worse than the second in the third period. Even if this were true in reality, if we were to use the average return of the fund over the three periods as the fund characteristic (as a fixed effect regression would do), this average would fully capture the third period return and would likely reduce the economic and statistical significance of the coefficient on the HWM. We also perform a fixed effect regression where we control for fund characteristics until a given point in time to mitigate this effect. Our results are robust to this modified fixed effects specification.

In general, our results are robust to a number of specifications. Additionally, corrections for our construction of the HWM, such as using only 'unseasoned' funds, produce crisper results.

4 Welfare Analysis

Using the calibrated model, we can analyze welfare considerations from modifying the specifications of the contract. Rather than adopting a completely free contract form, we maintain the basic HWM structure, where there is a fixed management fee and an incentive fee based on performance relative to a historical HWM. Thus the return required to hit the HWM, rr', follows the same laws of motion from equation 9. We vary the management fee (the 2% in 2/20 contracts) and the linear incentive fee (the 20% in 2/20 contracts). The initial metrics for measurement of welfare are the expected return for the investor after fees at the inception of the contract ($E[\tilde{r_{pf}}]$ evaluated at $rr = 0$) and the value function for the agent evaluated at $rr = 0$. Since these two metrics cannot be added together, we look for Pareto improvements on the existing 2/20 contract, rather than finding a contract that maximizes "societal" welfare.

Optimal contract literature has benefitted from strong theoretical research - some of the representative papers include, but are not limited to, Holmstrom and Milgrom (1987), Jewitt (1988), Laffont and Tirole (1988), Kuhn (1994), Ou-Yang (2003), Demarzo and Sannikov (2004), Cadenillas, Cvitanic, and Zapatero (2005) and Sannikov (2006) among others. These papers provide optimal contracts for agents, such as portfolio managers, often focusing on proving that a linear (or other) contract form is optimal. This paper does not consider the optimality of a "x/y", HWM contract, but focuses instead on identifying exact specifications that lead to Pareto improvement over the standard 2/20 contract under the calibrated model.

The methodology used for this analysis is as follows:

- We assume different contract forms, as given by different management and incentive fee specifications, while retaining the HWM structure of the contract
- Using the calibrated model from section 2.3 and section 2.4, we solve for the optimal effort and risk policy for the manager and the corresponding walkaway threshold for the investor for each contract specification
- This obtains the value function for the hedge fund manager and the expected return after fees for the investor in the next period across the domain of RR
- We compare the proposed welfare metrics across the different contract specifications. In particular, we compare the expected return for the investor after fees at the inception of the contract ($E[\tilde{r_{pf}}]$ evaluated at $rr = 0$ from equation 9) and the value function for the agent

evaluated at $rr = 0$ and search for Pareto improvements over the base (2/20) case

The results are shown in table 17. The columns show varying management fee levels from 1.5% to 3%, and the rows show varying incentive fee levels from 2.5% to 40%. We see that, in general, lowering the incentive fee and increasing the management fee leads to Pareto improvement for both the fund manager and the investor. In particular, we focus on a 2.5/10 contract and see that the investor expects to make a 1.33% return from a fund at the HWM compared to a 1.15% return from a 2/20 contract fund at the HWM. The manager, too, is better off by 75% (this simply means $\frac{-(v_n(0|2.5/10)-v_n(0|2/20))}{v_n(0|2/20)} = 75\%$), where v_n is the manager's value function from equation 9, the Bellman equation.

The policy functions for the manager under these 2 contracts sheds light on this interesting finding. Figure 9 illustrates the policy functions under these two cases. Although there is no difference in manager policy at the HWM, as the manager is on his "best" behavior in both cases, the Pareto improvement comes from improved risk sharing. However, in the regions with $RR > 0$, we see that the manager exerts in more effort and takes lower risk for the 2.5/10 contract compared to the 2/20 contract. These management policy functions also serve to increase the walkaway threshold for the investor. These differences in the policy functions suggest that the higher continuation value of contracts and the enhanced ability of high-management-fee funds to retain costly alpha generating talent through periods of poor returns also improve manager and investor outcomes across the entire spectrum of RR. In figure 10, we graph the expected return after fees for the investor and the value function for the manager over RR for these two cases and find that for both investor and the manager, the 2.5/10 contract outcomes dominate the 2/20 contract outcomes across the RR spectrum. This also comports with the results observed when comparing funds across the AUM and fee structure spectrum. We see that large funds and funds with higher fee structures have a positive relationship between RR and expected returns after fees, which further supports the hypothesis that these funds are able to retain their costly alpha generating teams through periods of poor returns.

5 Conclusion

The HWM structure of hedge fund contracts has definite implications for investor and manager behavior. Using a principal-agent model with endogenous investor walkaway to describe the relationship found in hedge fund contracts, we derive empirical predictions in terms of the investor's walkaway behavior as well as the manager's effort expenditure and portfolio risk decisions. Consistent with economic intuition, our model predicts that walkaway incidence will generally be greater as the fund falls further below the HWM. Effort expenditure is likely to be greater when the fund is closer to the HWM. Fund managers are also likely to take more risks the further their funds are below the HWM.

We test these hypotheses on fund return and walkaway data obtained from CISDM. Empirical results are consistent with predictions from our model. Walkaway is more likely when a fund is further from its HWM. We also find that funds closer to the HWM are more likely to generate superior returns going forward, which we interpret as evidence of increased effort expenditure.

In addition to walkaway and effort, we test the impact of the HWM on how much risk fund managers decide to take. Our findings are consistent with economic intuition: the further away a fund is from the HWM, the higher the variance of the returns going forward. In addition, we find that a period of poor returns tends to reduce risk-taking. We interpret this is as a manager decreasing portfolio risk to maintain the continuation value of the contract. This intuition resonates with Panageas and Westerfield (2008), who suggest that a fund manager will not choose an infinite amount of risk even when far from the HWM because of the continuation value of the contract. Finally, we also see that the risks taken by fund managers when the fund is further away from the HWM are less profitable than those taken by managers of funds close to the HWM: the increase in expected returns due to the increase in risk is lower when the fund is further away from the HWM. Our empirical results are consistent with the model's predictions and with economic intuition.

We calibrate our model to the return data obtained from CISDM. Moments from simulated data using the calibrated model align well with observed moments. We use the calibrated model to test modifications to the 2/20 HWM contract that may increase both investor returns and manager value. Using as welfare metrics the value function of the manager and the expected returns after fees for the investor evaluated at contract inception, we find that increasing the management fee and decreasing the incentive fee (e.g., a 2.5/10 contract) leads to Pareto improvement due to improved risk sharing. Additionally, the higher continuation value of a 2.5/10 contract moderates the risk taking tendencies of the manager when the contract is below the HWM. The certain cash flow afforded by a higher management fee also allows the fund to retain costly alpha generating talent through periods of poor returns when the fund is below its HWM. Taken together, the improved risk sharing, higher continuation value and enhanced ability to maintain alpha generating talent result in a 2.5/10 contract dominating a 2/20 contract across the entire spectrum of return required to hit the HWM.

The implications of our results documenting the effects of the HWM are manifold: from contracting and portfolio allocation decisions of real money managers, to marketing decisions on the part of hedge funds, to regulatory decisions regarding hedge fund disclosure rules. These applications, among many others, would benefit from a closer look at the impact of the HWM structure on fund manager and investor behavior.

Appendix

High Water Mark: Definition and Construction

The return process, ret_t, is simply the value of a dollar invested in the fund at inception.

$$ret_t = (1 + r_1) \times (1 + r_2) \times (1 + r_3) \times ....(1 + r_t),$$

where r_t is the after-fee return realized by the fund during period t. The high water mark (HWM) process at any time period, t, is the maximum the return process has achieved:

$$HWM_t = \max(HWM_{t-1}, ret_t) \text{ where } HWM_0 = 1,$$

The return required (RR) to reach high water mark is the difference between the HWM at time t and cumulative return at time t:

$$RR_t = HWM_t/ret_t - 1$$

thus if the return process is at the highest point and the HWM is reset, then the required return is 0 as that point is also the high water mark. Note that if the HWM is not reset every period, it is possible for the return required to be negative if the fund's return process is above the HWM.

The table below shows a return process and the corresponding HWM with a numerical example. The fund manager in the example charges 0% management fee and 20% incentive fee - i.e. the manager keeps 20% of the returns above the high water mark. As the table illustrates, fees are charged only when the fund exceeds the HWM. The HWM is calculated on principal in the fund after fees.

Note that we can recreate the HWM by simply using the after-fee return numbers to recreate the return process of the fund. We can also use these return numbers to determine the return required to hit the HWM at each point in time. The HWM used for empirical work in this paper is created in this manner using monthly after-fee return series from the CISDM dataset.

Table 1: A numerical example of a return process and the corresponding high water mark

	Principal before fee	Return before fee	Fee ($)	Principal after fee	Return after fee	HWM
1	100.0			100.0		100.0
2	130.0	30%	6.0	124.0	24%	124.0
3	62.0	-50%	-	62.0	-50%	124.0
4	93.0	50%	-	93.0	50%	124.0
5	148.8	60%	5.0	143.8	55%	143.8

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Figure 1: Optimal effort given fixed risk under a one period model without continuation value

This graph presents the solution for optimal effort as a function of RR. The policy function is under the one period setup without continuation value described in section 2.1. The parameters used for these solutions are $k = 0.02, s = 0.2, c_a = 3, \sigma = 5\%, \gamma = 3.5, \epsilon \sim U[-1, 1]$. Note that σ is fixed at 5% as optimal value of sigma is not an interior solution under this setup.

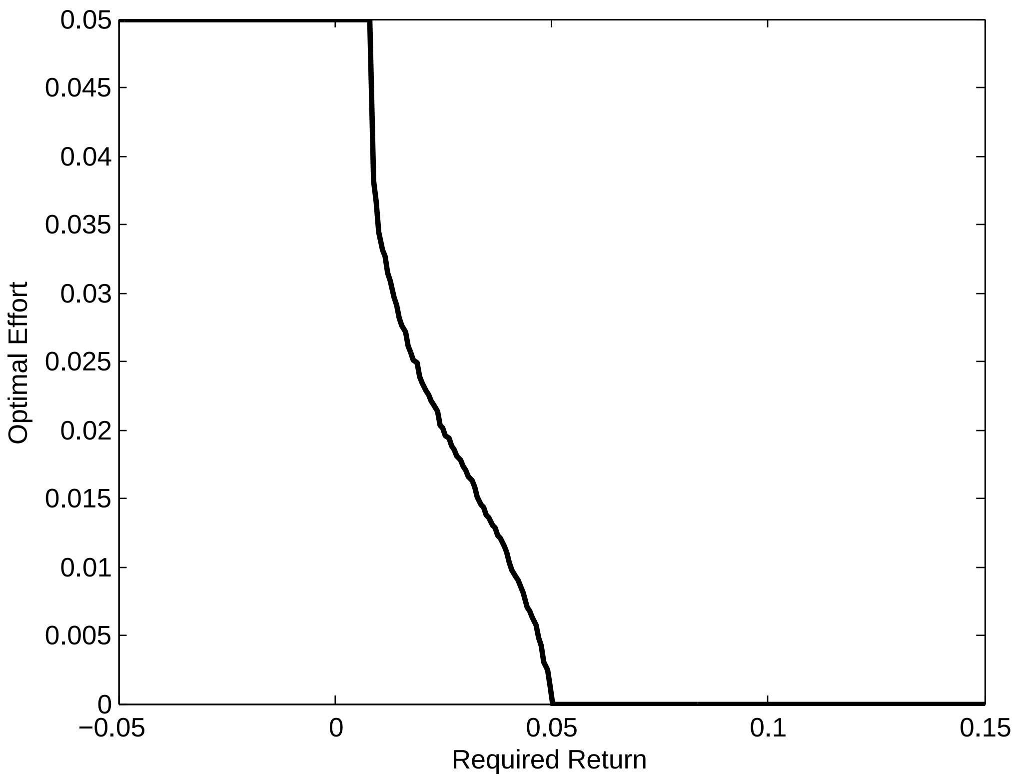

Figure 2: One period model timeline

The figure illustrates the timing of the decisions and the realization of shocks.

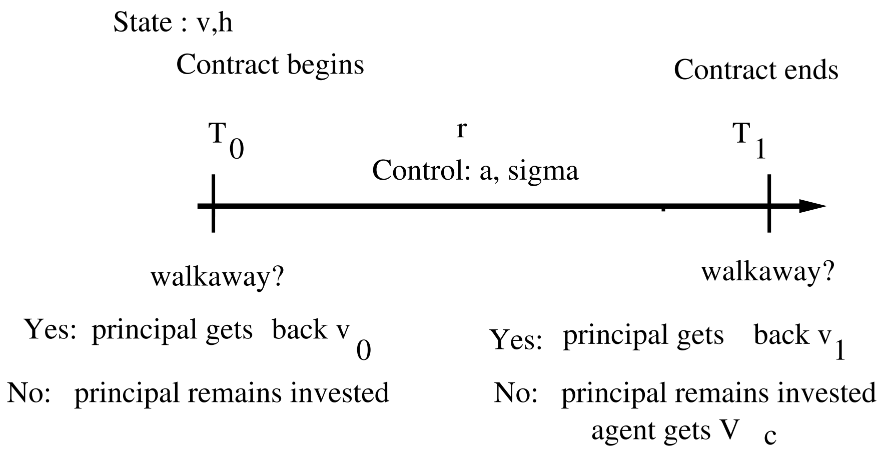

Figure 3: Optimal effort and risk under a one period model with continuation value

The graphs present the joint solution for optimal effort and optimal variance as a function of RR. These policy functions are under the one period setup with continuation value described in section 2.2. The parameters used for these solutions are $k = 0.02, s = 0.2, rr_1{}^* = 5\%, c_a = 3, \pi = u(0.2) - u(0.05), \gamma = 3.5, \epsilon \sim U[-1, 1]$.

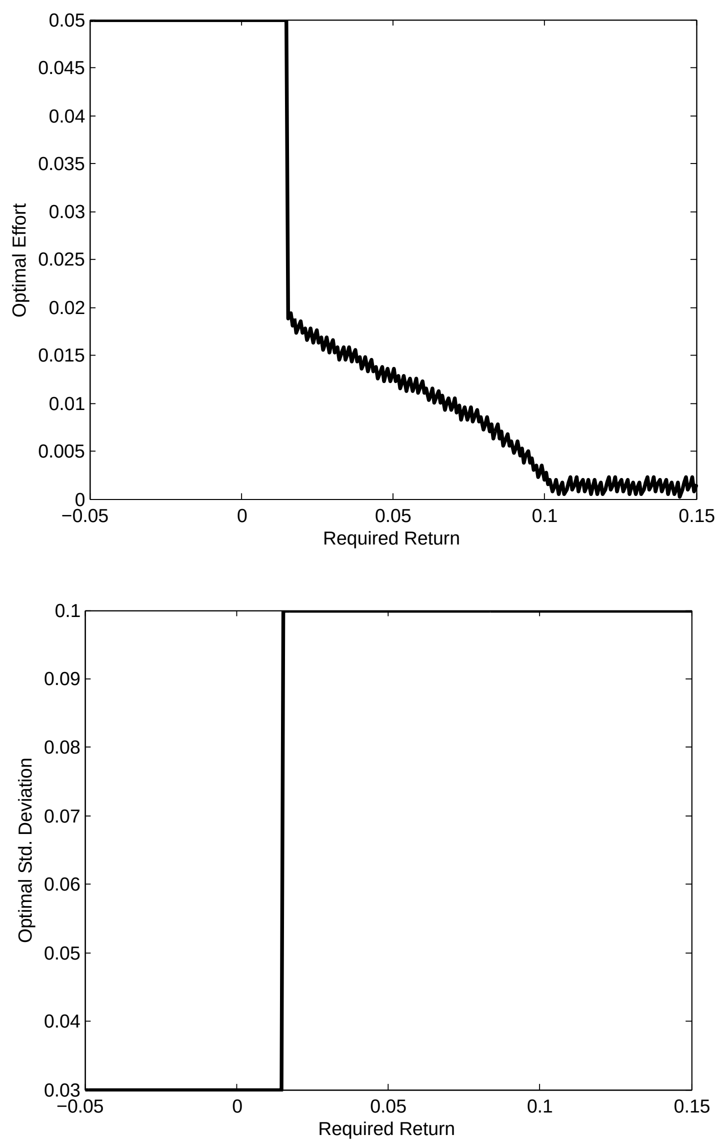

Figure 4: Manager's value function and components under a one period model with continuation value

Manager's value from the hedge fund contract as a function of RR under the one period setup with continuation value described in section 2.2. The parameters used for these solutions are $k = 0.02, s = 0.2, rr_1{}^* = 5\%, c_a = 3, \pi = u(0.2) - u(0.05), \gamma = 3.5, \epsilon \sim U[-1, 1]$. These values assume no investor walkaway in period t_0.

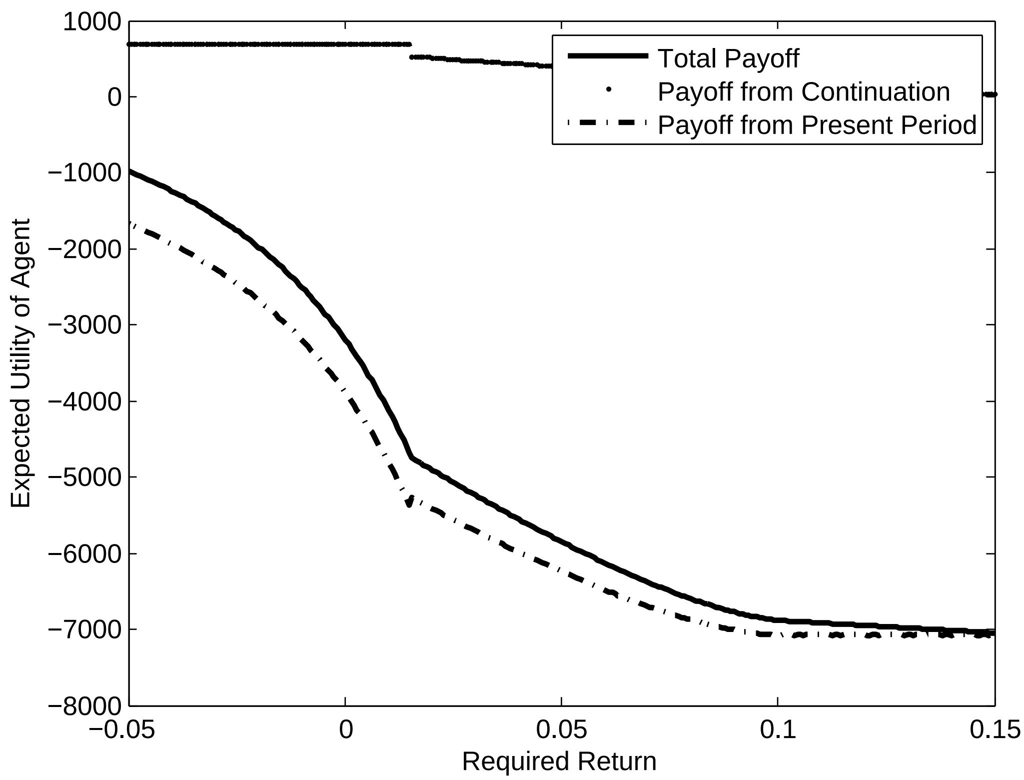

Figure 5: Expected value of fund after management fees at time t_1

Investor's expected return after fees as a function of RR under the one period setup with continuation value described in section 2.2. The parameters used for these solutions are $k = 0.02, s = 0.2, rr_1{}^* = 5\%, c_a = 3, \pi = u(0.2) - u(0.05), \gamma = 3.5, \epsilon \sim U[-1, 1]$. These values assume no investor walkaway in period t_0. A horizontal reference line of $v_1 = 1$ represents the investor's outside option if she chooses to walk away at t_0.

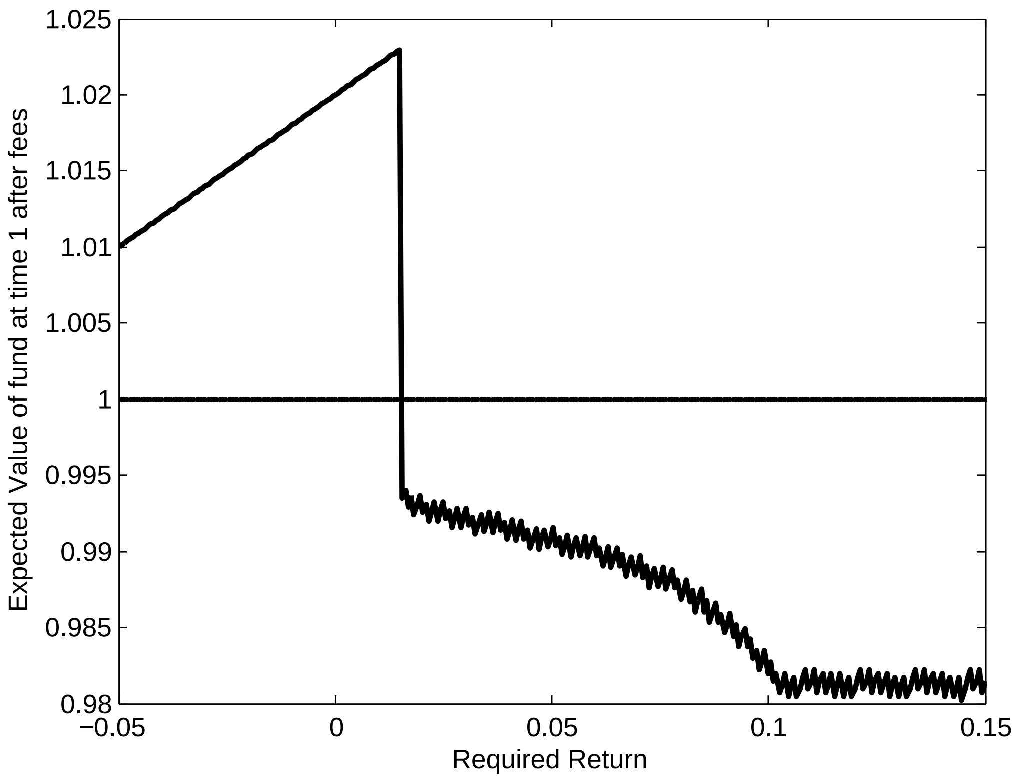

Figure 6: Optimal Effort and Risk Choices for Manager

This figure presents the joint solutions for optimal effort and optimal variance in the infinite period model described in section 2.3. The parameters used are the base parameter set presented in table 2 and discussed in section 2.4.

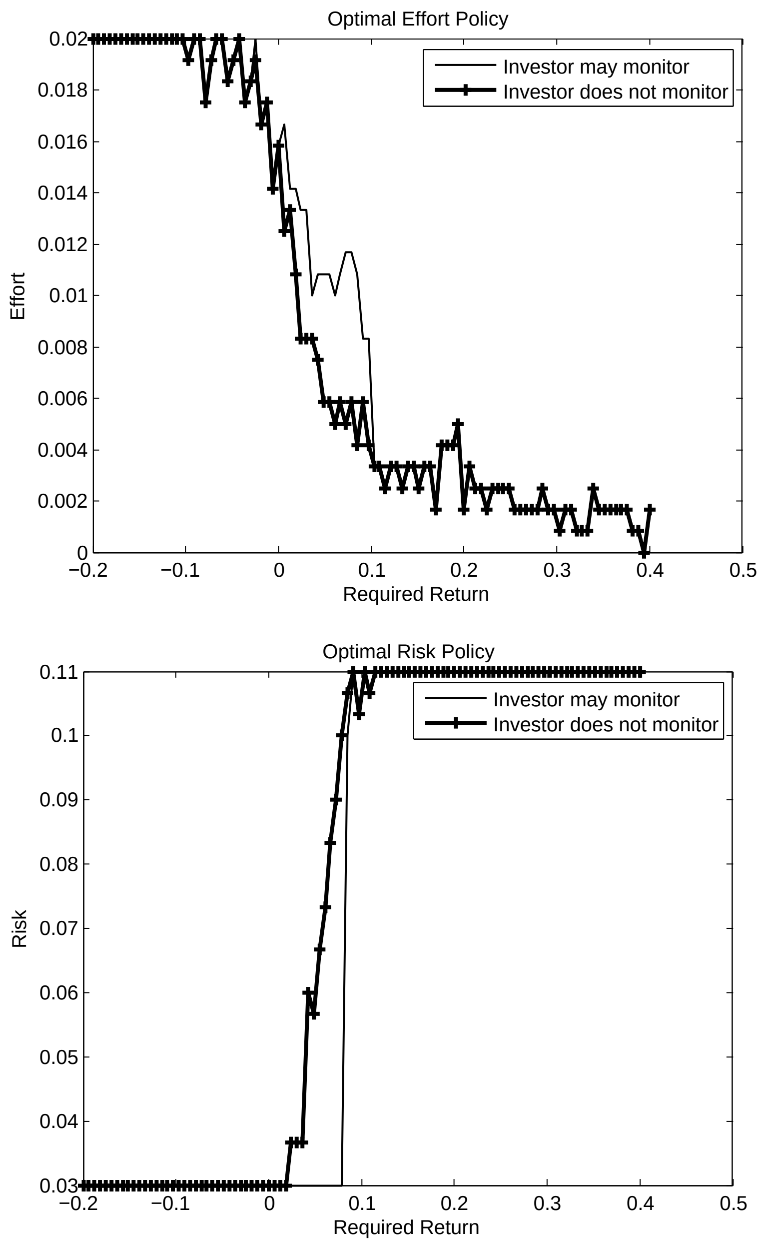

Figure 7: Walkaway decision and return moments as observed by Investor

This figure presents the walkaway decision taken by the investor and investor observed moments in the infinite period model described in section 2.3. The parameters used are the base parameter set presented in table 2 and discussed in section 2.4.

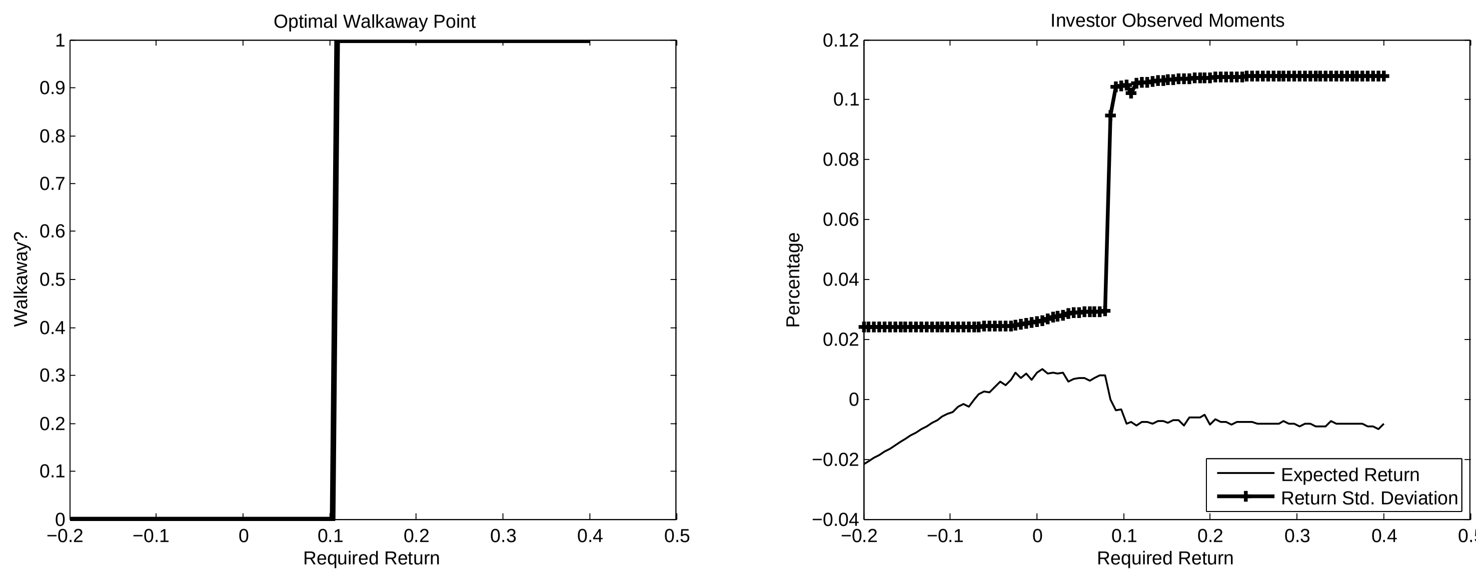

Figure 8: Value function for manager

The figure presents the value function for the manager in the infinite period model described in section 2.3. The parameters used are the base parameter set presented in table 2 and discussed in section 2.4.

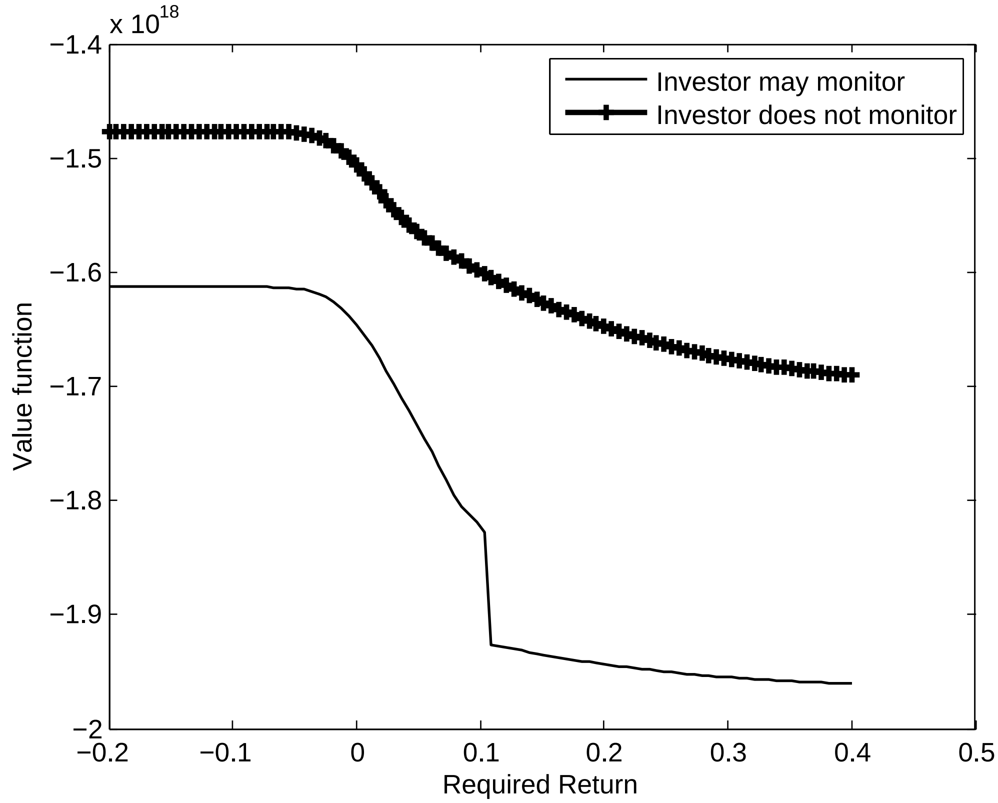

Figure 9: Effort and Risk Choices of Fund Manager under 2.5/10 vs. 2/20

This figure shows the manager's policy functions for the base 2/20 contract and those for a contract with increased management fees and decreased incentive fees (2.5/10). The top graph shows optimal effort exerted as a function of RR and the bottom graph shows optimal risk taken as a function of RR.

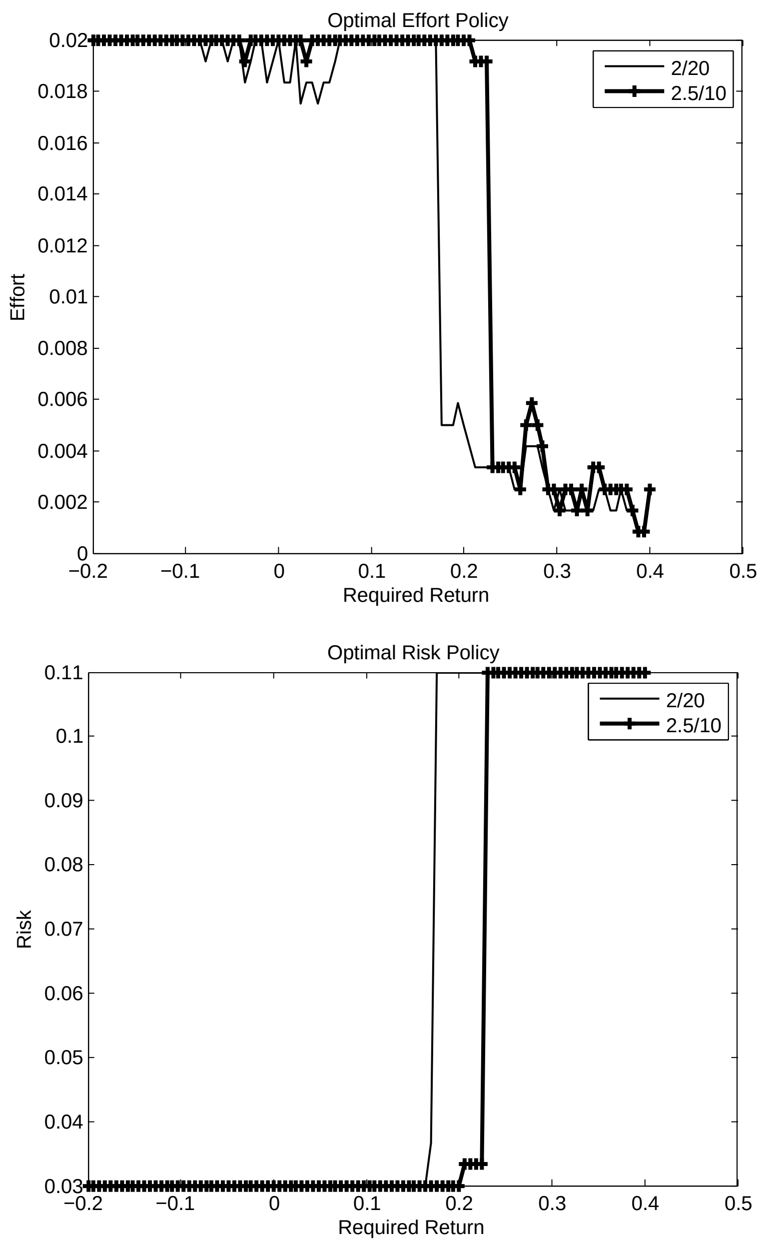

Figure 10: Manager's value function and investor's expected return after fees under 2.5/10 vs. 2/20

This figure shows the manager's value functions and investor's expected return after fees for the base 2/20 contract and the same graphs for a contract with increased management fees and decreased incentive fees (2.5/10). The top graph shows the manager's value function across the RR spectrum and the bottom graph shows expected returns after fees as a function of RR.

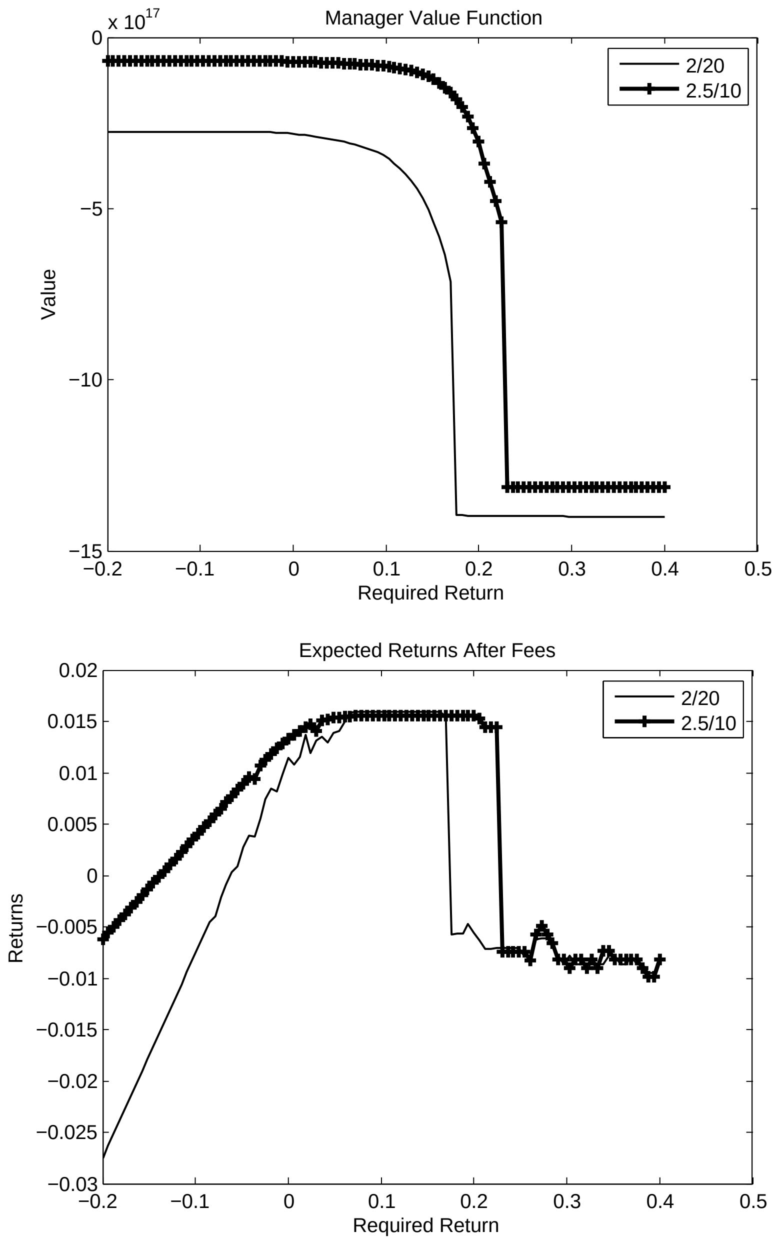

Table 2: Model Calibration

The table shows model generated simulated moments alongside moments observed in empirical data. The rows display the parameters used, population moments, regression results and observation dispersion across return required. The first column shows actual moments observed in the data, the second column shows results for base parameters, the third column shows results for a higher cost of effort and the fourth column shows results where all principals constantly monitor their investments. The regression coefficients are those obtained from the following two regressions.

$$r = \alpha + \delta_1 RR + \delta' controls + \epsilon$$

and

$$\sigma = \alpha + \delta_2 RR + \delta' controls + \epsilon$$

	Observed	Base	$c_a = 0.85$	$\alpha = 1$
Parameters				
c_a		0.775	0.85	0.775
γ		7	7	7
α		0.6	0.6	1
y		0.015	0.015	0.015
β		0.98	0.98	0.98
$a \in [\underline{a}, \bar{a}]$ (%)		[0,2]	[0,2]	[0,2]
$\sigma \in [\underline{\sigma}, \bar{\sigma}]$ (%)		[3,11]	[3,11]	[3,11]
N		12	12	12
Population Moments				
Avg. Investor Returns (%)	0.95	0.83	0.57	1.08
Return Std. Dev (%)	5.99	5.78	6.87	3.11
Walkaway Rate (%)	0.87	0.74	1.05	1.34
Coefficients				
δ_1(0% $\leq$ RR $<$ 10%)	-28.0	-19.03	-19.93	-13.4
δ_2(0% $\leq$ RR $<$ 10%)	+16.3	+94.35	+94.64	+73.3
δ_1(RR $\geq$ 10%)	-0.1	-0.5	-0.5	-0.5
δ_2(RR $\geq$ 10%)	+0.0	+0.9	+0.9	+0.9
Observation Dispersion(%)				
RR = 0%	39.7	45.4	38.4	54.8
0% $<$ RR $\leq$ 10%	37.4	34.8	30.1	45.2
10%$<$RR$\leq$100%	20.7	10.2	15.9	0.0
100% $<$ RR	2.2	9.6	15.6	0.0

Table 3: Summary Statistics

The table reports the summary statistics of the database of hedge fund returns used. Panel A reports the characteristics of the funds and Panel B reports the return and walkaway characteristics of the funds.

Panel A: Fund Types and Fee Structures

Variable	Mean	Std. Dev	N
Incentive Fee (%)	17.23	6.45	8143
Management Fee (%)	1.51	0.91	8304
Sales Fee (%)	0.56	2.11	6326
Active	0.51	0.5	8752
Gate Percent (%)	12.7	15.92	175
HWM Used?	0.96	0.19	872
CPO Flag	0.13	0.33	8752
CTA Flag	0.13	0.33	8752
Hedge Fund Flag	0.5	0.5	8752
Fund of Fund Flag	0.24	0.43	8752
Index Flag	0.01	0.08	8752

Panel B: Return and Walkaway Characteristics

Variable	Mean	Std. Dev	N
Excess Returns (%)	0	5.786	493719
Monthly Returns (%)	0.947	5.997	493719
Return Process	1.991	2.397	493719
RR	0.325	40.443	493719
Walkaway - Basic (%)	0.87	0.09	493719
Walkaway - Restricted (%)	0.52	0.07	493719

Table 4: Impact of the HWM on 6 month returns, return standard deviation and fund closure rates

The table presents the average returns over the next 6 months, the average monthly return standard deviation over the next 6 months and the average fund closure rate over the next 6 months split by return required to hit the HWM. The sample is divided into deciles according the return required to hit the HWM (RR) at the end of the last period. The first column shows the deciles of RR. The second column show sthe average RR of funds within each decile. The third, fourth and fifth columns present the average returns over the next 6 months, the average monthly return standard deviation over the next 6 months and the average fund closure rate over the next 6 months, respectively. Note that a large portion of the sample is at the HWM, hence the first decile with a positive return required to hit the HWM is the fourth decile.

Return Req'd Decile	Return Req'd	6m Excess Return	Return Std. Deviation	6m Fund closure rate
Lowest	0.00	0.83	2.93	0.03
4th	0.00	-1.23	2.16	0.03
5th	0.01	-0.96	2.28	0.04
6th	0.02	-0.87	2.77	0.05
7th	0.04	-0.60	3.41	0.06
8th	0.09	-0.10	4.20	0.06
9th	0.18	0.27	5.12	0.08
Highest	1.36	0.68	7.27	0.12
Total	0.17	0.17	3.67	0.05

Table 5: Impact of the historical returns and HWM on 6 month returns

The table shows the average next 6 month returns rates for a fund given the return required to hit the HWM and the historical returns. The sample is divided into deciles according the return required to hit the HWM at the end of the last period (rows) and according to last year return (columns). Note that a large portion of the sample is at the HWM, hence the first decile with a positive return required to hit the HWM is the fourth decile. The numbers in the body of the table are average next 6 month excess returns for all fund-periods which have the given RR and historical return characteristics.

	Deciles of t_{-12} to t_{-1} returns										
Deciles of RR	Lowest	2nd	3rd	4th	5th	6th	7th	8th	9th	Highest	Total
Lowest	.	.	-2.22	-1.27	-1.12	-0.50	-0.08	0.69	1.29	3.26	0.45
4th	.	.	-2.72	-2.51	-1.48	-0.67	-0.24	-1.39	0.84	0.32	-1.31
5th	.	-2.13	-2.45	-2.22	-1.77	-1.11	-0.36	0.12	0.28	1.25	-1.14
6th	.	-2.13	-2.16	-1.70	-1.24	-0.95	-0.83	-0.44	-0.04	1.40	-1.05
7th	.	-1.88	-1.48	-1.16	-1.03	-0.96	-0.64	-0.44	0.28	1.19	-0.85
8th	-1.69	-1.31	-1.21	-0.45	-0.48	-0.30	0.06	0.23	1.10	0.70	-0.54
9th	-0.62	-0.56	-0.65	-0.15	0.58	0.86	1.13	0.72	1.61	-0.46	-0.18
Highest	0.59	-1.09	-0.69	0.40	-0.44	-0.01	1.61	1.41	0.78	2.18	0.39
Total	0.17	-1.18	-1.66	-1.28	-1.06	-0.57	-0.11	0.40	0.97	2.31	-0.17

Table 6: Impact of the historical returns and HWM on 6 month return standard deviation

The table shows the average next 6 month returns rates for a fund given the return required to hit the HWM and the historical returns. The sample is divided into deciles according the return required to hit the HWM at the end of the last period (rows) and according to last year return (columns). Note that a large portion of the sample is at the HWM, hence the first decile with a positive return required to hit the HWM is the fourth decile. The numbers in the body of the table are standard deviations of the next 6 month excess returns for all fund-periods which have the given RR and historical return characteristics.

	Deciles of t_{-12} to t_{-1} returns										
Deciles of RR	Lowest	2nd	3rd	4th	5th	6th	7th	8th	9th	Highest	Total
Lowest	.	.	5.85	21.01	8.71	15.55	7.23	9.19	11.27	26.53	15.53
4th	.	.	3.54	4.18	6.34	5.68	9.21	8.30	12.13	15.13	7.73
5th	.	6.31	5.47	5.51	6.37	7.22	8.10	9.44	11.50	18.45	8.65
6th	.	8.67	6.64	6.98	7.64	8.96	9.71	11.88	12.27	21.31	10.53
7th	.	8.62	8.73	9.09	9.97	11.02	11.39	11.93	13.60	21.53	11.70
8th	12.39	10.63	11.09	12.58	12.65	13.27	13.73	13.76	19.35	24.88	14.14
9th	14.27	14.31	15.94	18.29	16.81	16.20	18.07	18.23	21.77	28.09	16.94
Highest	27.85	19.67	19.99	19.36	19.34	20.15	28.21	23.22	28.00	37.38	26.43
Total	24.28	13.28	10.36	14.91	9.95	13.77	10.57	11.46	14.15	26.22	15.95

Table 7: Impact of the historical returns and HWM on 6 month fund closure rates

The table shows the average next 6 month returns rates for a fund given the return required to hit the HWM and the historical returns. The sample is divided into deciles according the return required to hit the HWM at the end of the last period (rows) and according to last year return (columns). Note that a large portion of the sample is at the HWM, hence the first decile with a positive return required to hit the HWM is the fourth decile. The numbers in the body of the table are average next 6 month fund closure rate for all fund-periods which have the given RR and historical return characteristics.

	Deciles of t_{-12} to t_{-1} returns										
Deciles of RR	Lowest	2nd	3rd	4th	5th	6th	7th	8th	9th	Highest	Total
Lowest	.	.	2.47	1.71	1.48	1.56	1.41	1.31	1.56	1.57	1.54
4th	.	.	4.62	0.79	0.41	0.57	3.68	0.00	3.88	1.30	1.76
5th	.	3.18	4.43	2.85	2.61	2.47	2.65	1.82	2.27	2.14	2.80
6th	.	6.11	5.52	3.96	3.63	2.89	2.54	2.86	2.70	1.54	3.66
7th	.	7.69	6.75	5.29	4.99	3.75	3.63	3.11	3.06	2.05	4.96
8th	11.10	8.37	7.25	5.72	5.36	4.76	3.98	3.40	3.78	2.75	6.11
9th	9.58	8.79	8.38	6.48	6.21	6.92	5.80	5.01	4.61	4.70	7.84
Highest	13.36	12.08	11.10	8.67	9.35	9.19	8.25	8.92	7.48	8.00	11.94
Total	12.20	8.86	6.19	3.66	3.07	2.75	2.48	2.29	2.46	2.36	4.63

Table 8: Fund 6-month Returns and Returns Required to hit the HWM

The table reports the results of a regression of fund returns on returns required to hit a HWM and various controls. The sample of returns is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. The dependent variable is excess return for next 6 month period, including the current period. The first column presents a basic regression showing the impact of the return required to hit the HWM at the end of the previous period. The second column presents the same results but adds in control variables, including dummy variables for the type of fund, returns from previous periods and variance of returns for the next 6 months. The third and fourth column present the results with control variables, but split the sample into funds requiring less than a 10% return to hit the HWM and those requiring more than a 10% return to hit the HWM, respectively. The standard errors adjust for heteroskedasticity. $^+$, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Variable	Basic	Controls	Return Req'd < 10%	Return Req'd > 10%
RR	0.009	-0.116	-28.059	-0.077
	(0.021)	(0.027)**	(3.429)**	(0.022)**
t to t+5 Return Std. Dev. (%)		1.137	1.577	0.612
		(0.124)**	(0.141)**	(0.061)**
Return Process	-0.025	0.678	0.420	-0.073
	(0.081)	(0.130)**	(0.432)	(0.119)
High Watermark	0.157	-0.650	-0.412	-0.034
	(0.074)*	(0.123)**	(0.415)	(0.089)
Months in Operation	-0.022	-0.004	-0.003	-0.008
	(0.001)**	(0.001)**	(0.001)**	(0.002)**
Time	0.006	0.016	0.017	0.021
	(0.001)**	(0.001)**	(0.001)**	(0.002)**
L. Excess Returns (%)		0.052	-0.108	0.105
		(0.013)**	(0.034)**	(0.018)**
L2. Excess Returns (%)		0.004	-0.098	0.030
		(0.010)	(0.028)**	(0.018)+
L3. Excess Returns (%)		0.016	-0.071	0.049
		(0.011)	(0.021)**	(0.018)**
L4. Excess Returns (%)		0.025	-0.047	0.062
		(0.011)*	(0.016)**	(0.018)**
L5. Excess Returns (%)		0.056	0.006	0.078
		(0.013)**	(0.011)	(0.018)**
L6. Excess Returns (%)		0.088	0.034	0.125
		(0.016)**	(0.015)*	(0.018)**
t-12 to t-7 Return (%)		-0.035	-0.036	-0.040
		(0.004)**	(0.006)**	(0.006)**
t-24 to t-13 Return (%)		-0.009	0.002	-0.010
		(0.002)**	(0.002)	(0.003)**
Observations	442877	281404	203406	77998
Adjusted R-squared	0.002	0.101	0.219	0.030

Table 9: Walkaway and Returns Required to hit the HWM

The table reports the results of a logistic regression of fund walkaway outcomes on returns required to hit a HWM and various controls. The sample is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. The dependent variable is a walkaway outcome in the next 6 months. The odds ratios are presented in the table along with standard errors for these ratios, The first column presents a regression showing the impact of the return required to hit the HWM at the end of the period on next month walkaway for all observations where the fund is not at the HWM. The second column presents the same results but only for funds where return required to hit the HWM are less than 10%. The third column presents the same results as column 1 but only for funds which require more then 10% to hit the HWM. Note that the unit change in the logistic regressions in column 2 and 3 is defined as a change in RR of 1% while the unit change in column 1 is a change in RR of 100%. The standard errors adjust for heteroskedasticity. $^{+}$, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Variable	All	0 < RR < 10%	RR > 10%
RR (200% cap)	1.600	1.079	1.003
	(0.041)**	(0.007)**	(0.000)**
Return Process	1.009	1.463	0.979
	(0.011)	(0.302)+	(0.013)
High Watermark	0.982	0.689	0.994
	(0.007)*	(0.142)+	(0.007)
Months in Operation	0.999	1.000	0.996
	(0.000)**	(0.000)	(0.000)**
Time	1.007	1.007	1.008
	(0.000)**	(0.000)**	(0.000)**
Excess Returns (%)	0.975	0.990	0.981
	(0.002)**	(0.004)**	(0.002)**
L. Excess Returns (%)	0.979	0.982	0.986
	(0.002)**	(0.004)**	(0.002)**
L2. Excess Returns (%)	0.981	0.985	0.985
	(0.002)**	(0.003)**	(0.002)**
L5. Excess Returns (%)	0.983	0.975	0.988
	(0.002)**	(0.003)**	(0.002)**
L6. Excess Returns (%)	0.985	0.977	0.989
	(0.002)**	(0.003)**	(0.002)**
t-12 to t-7 Return (%)	0.994	0.985	0.997
	(0.001)**	(0.001)**	(0.001)**
t-24 to t-13 Return (%)	0.995	0.993	0.996
	(0.000)**	(0.001)**	(0.000)**
Observations	311490	223317	88173
Pseudo R-squared	0.048	0.037	0.034

Table 10: Return Variance and Returns Required to hit the HWM

The table reports the results of a regression of fund return variance on returns required to hit a HWM and various controls. The sample of returns is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. The dependent variable is the variance of excess returns for next 6 month period, including the current period. The first column presents a basic regression showing the impact of the return required to hit the HWM at the end of the previous period. The second column presents the same results but adds in control variables, including dummy variables for the type of fund, returns from previous periods and returns for the next 6 months. The third and fourth column present the results with control variables, but split the sample into funds requiring less than a 10% return to hit the HWM and those requiring more than a 10% return to hit the HWM, respectively. The standard errors adjust for heteroskedasticity. +, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Variable	Basic	Controls	Return Req'd $<$ 10%	Return Req'd $>$ 10%
RR	0.100	0.054	16.332	0.033
	(0.011)**	(0.008)**	(1.166)**	(0.006)**
Return Process	-0.830	-0.311	-0.000	-0.222
	(0.038)**	(0.027)**	(0.141)	(0.028)**
High Watermark	0.908	0.316	0.024	0.168
	(0.036)**	(0.027)**	(0.137)	(0.021)**
Months in Operation	-0.003	-0.001	-0.001	-0.001
	(0.000)**	(0.000)*	(0.000)*	(0.000)*
Time	-0.018	-0.007	-0.010	-0.004
	(0.000)**	(0.000)**	(0.000)**	(0.000)**
t-6 to t-1 Return Std. Dev.		0.406	0.080	0.536
		(0.029)**	(0.035)*	(0.007)**
Excess Returns t to t + 5 (%)		0.079	0.131	0.022
		(0.014)**	(0.024)**	(0.003)**
L. Excess Returns (%)		-0.036	0.089	-0.038
		(0.015)*	(0.030)**	(0.004)**
L6. Excess Returns (%)		-0.035	0.014	-0.018
		(0.015)*	(0.012)	(0.004)**
t-12 to t-7 Return (%)		0.014	0.025	0.008
		(0.001)**	(0.002)**	(0.001)**
t-24 to t-13 Return (%)		0.005	0.006	0.003
		(0.001)**	(0.001)**	(0.001)**
Constant	5.664	1.782	2.361	1.652
	(0.022)**	(0.093)**	(0.096)**	(0.085)**
Observations	476500	281404	203406	77998
Adjusted R-squared	0.082	0.335	0.335	0.377

Table 11: Return Variance Regressions - Impact of Historical Returns

The table reports the results of a regression of fund return variance on returns required to hit a HWM and various controls. The sample of returns is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. The dependent variable is the variance of excess returns for next 6 month period, including the current period. Panel A presents the regression with all controls shown in Table 10 Column 2 but split more finely by return required to hit the HWM. The first column shows only observations where the return required at the end of the previous period was less than 3%, the second column shows observations where the return required was between 3% and 7%. The third column show observations where return required was between 7% and 15% and the fourth column shows observations with greater than 15% return required. Panel B shows this same regression but removes all historical returns from the controls.The standard errors adjust for heteroskedasticity. $^{+}$, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Panel A: Historical Returns in Controls

Variable	RR < 3%	3% ≤ RR < 7%	7% ≤ RR < 15%	RR ≥ 15%
RR	23.920	8.769	4.487	0.031
	(2.935)**	(1.351)**	(0.863)**	(0.006)**
Observations	152898	34259	34635	59612
Adjusted R-squared	0.381	0.369	0.330	0.372

Panel B: Historical Returns not in Controls

Variable	RR < 3%	3% ≤ RR < 7%	7% ≤ RR < 15%	RR ≥ 15%
RR	-3.077	6.504	4.860	0.048
	(0.661)**	(0.934)**	(0.612)**	(0.006)**
Observations	251056	53476	50570	79700
Adjusted R-squared	0.157	0.329	0.292	0.335

Table 12: Impact of fund size on the effect of the HWM

The table reports the results of the three regression of returns, walkaway and return variance (Tables 8, 9 and 10) on the sample split by the assets under management (AUM). The sample of returns is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. Only hedge fund returns which report AUM are used. The first column shows the impact return required to hit the HWM (RR) on returns for the following six month. The second column show the impact of RR on walkaway incidence for the following six months and the final column shows the impact of RR on fund return variance. Panels A and B present the results for funds with more than \$500MM under management and those with between \$20MM and \$500MM under management, respectively. Only the coefficient showing the impact of changes in RR from 0% to 10% on each of the three dependent variables is shown. Note that the unit change in the logistic regressions is defined as a change in RR of 1%. The standard errors adjust for heteroskedasticity. $^{+}$, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Panel A: AUM $\geq$ \$500MM

Variable	Return	Walkaway	Return Std. Dev.
RR	27.196	1.064	22.758
	(13.503)*	(0.025)**	(1.773)**
Observations	5466	6248	6087
Adjusted R-squared	0.037		0.445
Pseudo R-squared		0.033	

Panel B: \$20MM $\leq$ AUM $<$ \$500MM

Variable	Return	Walkaway	Return Std. Dev.
RR	-23.821	1.065	22.755
	(5.193)**	(0.009)**	(0.873)**
Observations	51837	57269	56202
Adjusted R-squared	0.024		0.317
Pseudo R-squared		0.031	

Table 13: Impact of incentive fee percentage on effect of HWM

The table reports the results of the three regression of returns, walkaway and return variance (Tables 8, 9 and 10) on changes in the return required to hit the HWM between 0% and 10% for the sample split by the incentive fee percentage. The sample of returns is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. Only hedge fund returns which report incentive fee percentage are used. The dependent variable is the excess returns for the following 6 months in the first and fourth column, walkaway incidence in the next 6 months in the second and fifth column and the next 6 month return standard deviation in the third and sixth column. Panels A, B and C present results for funds that charge incentive fess higher than 20%, 20% and lower than 20% respectively. Only the coefficient showing the impact of changes in RR from 0% to 10% on each of the three dependent variables is shown. Note that the unit change in the logistic regressions is defined as a change in RR of 1%. The standard errors adjust for heteroskedasticity. $^{+}$, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Panel A: Incentive fee above 20%

Variable	Return	Walkaway	Return Std. Dev.
RR	52.144	1.018	13.867
	(14.262)**	(0.019)	(3.155)**
Observations	7192	8190	7192
Adjusted R-squared	0.054		0.361
Pseudo R-squared		0.034	

Panel B: Incentive fee equal to 20%

Variable	Return	Walkaway	Return Std. Dev.
RR	-19.808	1.067	14.616
	(4.125)**	(0.008)**	(0.711)**
Observations	72044	80464	72044
Adjusted R-squared	0.038		0.423
Pseudo R-squared		0.035	

Panel C: Incentive fee less than 20%

Variable	Return	Walkaway	Return Std. Dev.
RR	-31.568	1.073	12.876
	(9.133)**	(0.018)**	(3.677)**
Observations	12655	13750	12655
Adjusted R-squared	0.778		0.781
Pseudo R-squared		0.038	

Table 14: Impact of whether the fund has previously been above the walkaway threshold on the effect of the HWM

The table reports the results of the three regression of returns, walkaway and return variance (Tables 8, 9 and 10) on the sample split by where the fund has historical had RR above the walkaway threshold. The sample of returns is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. The first column shows the impact return required to hit the HWM (RR) on returns for the following six month. The second column show the impact of RR on walkaway incidence for the following six months and the final column shows the impact of RR on fund return variance. Panels A and B present the results for funds have never had an RR above the walkaway threshold historically and those that have had an RR above this threshold, respectively. Only the coefficient showing the impact of changes in RR from 0% to the walkaway RR threshold on each of the three dependent variables is shown. Note that the unit change in the logistic regressions is defined as a change in RR of 1%. The standard errors adjust for heteroskedasticity. $^{+}$, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Panel A: Untested (RR has never been above walkaway threshold)

Variable	Return	Walkaway	Return Std. Dev.
RR	-28.534	1.047	16.549
	(3.295)**	(0.006)**	(1.326)**
Observations	198803	219181	215026
Adjusted R-squared	0.235		0.149
Pseudo R-squared		0.038	

Panel B: Tested (RR has been above walkaway threshold)

Variable	Return	Walkaway	Return Std. Dev.
RR	-2.986	1.023	-1.399
	(13.479)	(0.012)+	(3.079)
Observations	8541	9177	9022
Adjusted R-squared	0.031		0.352
Pseudo R-squared		0.040	

Table 15: Fund 6-month Returns and RR - 1 year HWM reset, 3m LIBOR Hurdle

The table reports the results of a regression of fund returns on returns required to hit a HWM and various controls. The sample of returns is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. The dependent variable is excess return for next 6 month period, including the current period. The HWM is calculated assuming a 3 month LIBOR hurdle and a January 1st HWM reset and incentive payout date. The first column presents a basic regression showing the impact of the return required to hit the HWM at the end of the previous period. The second column presents the same results but adds in control variables, including dummy variables for the type of fund, returns from previous periods and variance of returns for the next 6 months. The third, fourth and fifth columns present the results with control variables, but split the sample into funds above the HWM, funds requiring less than a 10% return to hit the HWM, and those requiring more than a 10% return to hit the HWM, respectively. The standard errors adjust for heteroskedasticity. $^{+}$, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Variable	Basic	RR	RR $\leq$ 0%	0% $\leq$ RR $<$ 10%	RR $>$ 10%
RR	-0.005	-0.087	-11.325	-19.725	-0.053
	(0.011)	(0.017)**	(1.850)**	(3.748)**	(0.013)**
t to t+5 Return Std. Dev. (%)		1.124	1.384	1.618	0.680
		(0.124)**	(0.210)**	(0.217)**	(0.057)**
Return Process	0.227	0.592	-0.288	-0.524	-0.015
	(0.086)**	(0.137)**	(0.206)	(1.144)	(0.146)
High Watermark	-0.014	-0.612	0.383	0.453	-0.034
	(0.081)	(0.136)**	(0.244)	(1.088)	(0.113)
Months in Operation	-0.018	-0.004	-0.004	-0.001	-0.010
	(0.001)**	(0.001)**	(0.001)*	(0.001)	(0.002)**
Time	0.006	0.017	0.019	0.014	0.021
	(0.001)**	(0.001)**	(0.002)**	(0.002)**	(0.002)**
		(0.327)**	(0.360)**	(0.383)**	(0.272)**
L. Excess Returns (%)		0.053	-0.078	-0.024	0.107
		(0.013)**	(0.031)*	(0.022)	(0.017)**
L6. Excess Returns (%)		0.087	-0.003	0.011	0.126
		(0.015)**	(0.019)	(0.019)	(0.017)**
t-12 to t-7 Return (%)		-0.036	-0.075	-0.072	-0.023
		(0.004)**	(0.010)**	(0.014)**	(0.006)**
t-24 to t-13 Return (%)		-0.009	-0.018	-0.005	-0.006
		(0.002)**	(0.004)**	(0.003)+	(0.003)+
Observations	407478	281404	102870	86673	99012
Adjusted R-squared	0.002	0.100	0.172	0.254	0.034

Table 16: Return Variance and RR - 1 year HWM reset, 3m LIBOR Hurdle

The table reports the results of a regression of fund return variance on returns required to hit a HWM and various controls. The sample of returns is obtained from the CISDM database and spans from 1/1/1990 to 12/31/2005. The dependent variable is the standard deviation of monthly excess returns for next 6 month period, including the current period. The HWM is calculated assuming a 3 month LIBOR hurdle and a January 1st HWM reset and incentive payout date.The first column presents a basic regression showing the impact of the return required to hit the HWM at the end of the previous period. The second column presents the same results but adds in control variables, including dummy variables for the type of fund, returns from previous periods and returns for the next 6 months. The third, fourth and fifth columns present the results with control variables, but split the sample into funds above the HWM, funds requiring less than a 10% return to hit the HWM, and those requiring more than a 10% return to hit the HWM, respectively. The standard errors adjust for heteroskedasticity. +, * and ** denote statistical significance at the 10%, 5% and 1% levels, respectively.

Variable	Basic	RR	RR $\leq$ 0%	0% $\leq$ RR $<$ 10%	RR $>$ 10%
RR	0.061	0.034	-3.928	5.151	0.018
	(0.006)**	(0.005)**	(0.829)**	(0.849)**	(0.004)**
t-6 to t-1 Return Std. Dev.		0.415	0.088	0.368	0.550
		(0.029)**	(0.035)*	(0.045)**	(0.007)**
Return Process	-0.562	-0.280	-0.195	0.288	-0.321
	(0.031)**	(0.028)**	(0.075)**	(0.298)	(0.034)**
High Watermark	0.793	0.320	0.311	-0.252	0.253
	(0.029)**	(0.028)**	(0.092)**	(0.284)	(0.027)**
Months in Operation	-0.002	-0.001	-0.002	-0.000	-0.001
	(0.000)**	(0.000)*	(0.000)**	(0.000)	(0.000)**
Time	-0.018	-0.007	-0.009	-0.007	-0.003
	(0.000)**	(0.000)**	(0.001)**	(0.001)**	(0.000)**
Excess Returns t to t + 5 (%)		0.079	0.112	0.151	0.025
		(0.014)**	(0.031)**	(0.038)**	(0.003)**
L. Excess Returns (%)		-0.037	0.050	-0.053	-0.037
		(0.015)*	(0.026)+	(0.035)	(0.004)**
L6. Excess Returns (%)		-0.035	0.024	-0.051	-0.015
		(0.016)*	(0.017)	(0.031)	(0.004)**
t-12 to t-7 Return (%)		0.015	0.031	0.025	0.007
		(0.001)**	(0.003)**	(0.004)**	(0.001)**
t-24 to t-13 Return (%)		0.005	0.011	0.005	0.003
		(0.001)**	(0.001)**	(0.001)**	(0.001)**
Observations	438740	281404	102870	86673	99012
Adjusted R-squared	0.067	0.333	0.312	0.378	0.405

Table 17: Welfare Analysis

This table shows model expected returns for the investor and for the hedge fund manager for different contracts. The columns vary management fee from 1.5% to 3.0%. The rows vary the incentive fees from 2.5% to 40.0%. The body of the table presents the expected return after fees (ERAF) for the investor in the next period for a fund at the HWM and the change in utility vis-a-vis the standard 2/20 contract for the fund manager managing a fund at the HWM ($\Delta\ v_m(.)$ is computed as $\frac{-(v_m(0|x/y)-v_m(0|2/20))}{v_m(0|2/20)}$). For example, for a 2.5/10 contract, the investor expects a 1.33% return in the following period and the manager is happier by 74.94% compared to the 2/20 contract.

		Management Fee			
Incentive Fee	Data	1.50%	2.00%	2.50%	3.00%
2.50%	r_{pf}	0.76%	1.54%	1.50%	1.46%
	$\Delta\ v_m(.)$	-563.02%	-115.96%	17.88%	57.69%
5.00%	r_{pf}	0.88%	1.48%	1.44%	1.40%
	$\Delta\ v_m(.)$	-524.75%	-27.78%	71.10%	88.61%
7.50%	r_{pf}	1.08%	1.43%	1.39%	1.34%
	$\Delta\ v_m(.)$	-512.99%	-11.58%	73.13%	91.51%
10.00%	r_{pf}	1.03%	1.37%	1.33%	1.29%
	$\Delta\ v_m(.)$	-505.96%	-12.85%	74.94%	91.16%
12.50%	r_{pf}	0.98%	1.32%	1.27%	1.23%
	$\Delta\ v_m(.)$	-501.18%	-1.31%	75.47%	92.01%
15.00%	r_{pf}	0.93%	1.26%	1.22%	1.18%
	$\Delta\ v_m(.)$	-497.80%	-0.06%	74.86%	92.14%
17.50%	r_{pf}	0.88%	1.20%	1.16%	1.12%
	$\Delta\ v_m(.)$	-489.12%	0.11%	75.13%	92.24%
20.00%	r_{pf}	0.83%	1.15%	1.10%	1.06%
	$\Delta\ v_m(.)$	-493.28%	0.00%	75.33%	92.31%
22.50%	r_{pf}	0.78%	1.09%	1.05%	1.01%
	$\Delta\ v_m(.)$	-491.64%	0.60%	75.50%	91.71%
25.00%	r_{pf}	0.73%	1.03%	0.99%	0.95%
	$\Delta\ v_m(.)$	-490.24%	1.12%	74.08%	92.42%
27.50%	r_{pf}	0.68%	0.98%	0.93%	0.89%
	$\Delta\ v_m(.)$	-489.06%	0.48%	74.82%	91.80%
30.00%	r_{pf}	0.63%	0.92%	0.88%	0.84%
	$\Delta\ v_m(.)$	-487.98%	-1.95%	72.56%	90.63%
32.50%	r_{pf}	0.58%	0.86%	0.82%	0.78%
	$\Delta\ v_m(.)$	-487.08%	-1.61%	72.65%	90.19%
35.00%	r_{pf}	0.53%	0.81%	0.76%	0.72%
	$\Delta\ v_m(.)$	-486.24%	-3.25%	72.72%	88.84%
37.50%	r_{pf}	0.48%	0.75%	0.71%	0.67%
	$\Delta\ v_m(.)$	-485.54%	-8.26%	71.69%	88.87%
40.00%	r_{pf}	0.43%	0.69%	0.65%	0.61%
	$\Delta\ v_m(.)$	-508.08%	-8.04%	68.43%	86.88%