# Compensation Option, Managerial Incentives and Risk-Shifting in Hedge Funds*

By

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**Abstract**

We examine the impact of the optionality of performance fee on the risk-shifting behavior of hedge fund managers. Since performance fees earned by hedge fund managers have the characteristics of a call option, the moneyness of the option may have an impact on the risk-taking behavior of managers. We seek to determine if hedge fund managers adjust their fund's volatility in reaction to the moneyness of the performance option. We find that managers increase their fund's volatility when the compensation option is "out of the money". We find that managers of less liquid, small or young funds do not display that type of risk-shifting behavior. Further, we report that the longer a manager does not collect performance fees, the more likely she is to increase the fund volatility in the hope of increasing the fund value and thus collecting performance fees. Finally, we find that compared to absolute performance, relative performance has a stronger influence on the risk-taking behavior of hedge fund managers. This result is not uniform over all strategies.

This version: Oct 20, 2007

* We thank Alternative Investment Analytics for providing the raw data and colleagues at University of Massachusetts Amherst for their helpful comments, especially those from Bing Liang, Mila Getmansky Sherman. The remaining errors are our own.

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# Compensation Option, Managerial Incentives and Risk-Shifting in Hedge Funds


**Abstract**

We examine the impact of the optionality of performance fee on the risk-shifting behavior of hedge fund managers. Since performance fees earned by hedge fund managers have the characteristics of a call option, the moneyness of the option may have an impact on the risk-taking behavior of managers. We seek to determine if hedge fund managers adjust their fund's volatility in reaction to the moneyness of the performance option. We find that managers increase their fund's volatility when the compensation option is "out of the money". We find that managers of less liquid, small or young funds do not display that type of risk-shifting behavior. Further, we report that the longer a manager does not collect performance fees, the more likely she is to increase the fund volatility in the hope of increasing the fund value and thus collecting performance fees. Finally, we find that compared to absolute performance, relative performance has a stronger influence on the risk-taking behavior of hedge fund managers. This result is not uniform over all strategies.

## 1. Introduction

The significant growth in the number of hedge funds and the amount of asset under their management, together with the increasing economic significance of hedge funds has brought focus to the risk-taking behavior of hedge fund managers. Past literature suggests that managers with asymmetric performance-based compensation packages may have the incentive to "manage" the risk exposure of their funds in hope of improving their performance measures. For example, mutual fund managers who are paid with incentive fees are found to vary their exposures to benchmarks (Elton, Gruber, and Blake, 2003), while hedge fund managers may manipulate certain performance measures through dynamic trading and derivatives usage (Goetzmann, Ingersoll, Spiegel, and Welch, 2006), and smooth their return (Getmansky, Lo and Markarov (2004), Bollen and Pool (2007)) to reduce estimated volatility.

In this paper, we investigate risk shifting in response to absolute performance and relative performance and explore the underlying managerial incentives. A hedge fund typically charges both asset management fee and performance fee, which is earned if the fund's absolute cumulative return is above its "high-water mark".[1] Since a typical hedge fund has less money under management than a typical mutual fund and may not be part of a large family of funds, it may not survive on asset management fee alone. Therefore, earning performance fee is essential for the long-term survival of small- to medium-sized hedge funds.[2] Incentive fee with high-water mark resembles payoff from an option and the option value should increase with the increase in the NAV of the fund as well as the volatility of its rate of return.

[1] The "high-water mark" is the highest net asset value (NAV) ever since capital flows into the fund, and is different even for the same investor when they invest in the fund at different times.

[2]The mean and median of incentive fees in hedge funds are documented to be 15-20%, while the mean and median of management fees in hedge funds are documented to be 1-2%. See Goetzmann, Ingersoll, and Ross (GIR, 2003) footnote 1 for an example of the magnitude of incentive fees for a hedge fund.

Gruber (1996), Chevalier and Ellison (1997) and Sirri and Tufano (1998) discuss risk taking on the part of mutual fund managers when their compensation is related to fund flows. A mutual fund manager may select sub-optimal allocation in order to increase the expected future fund flows. Carpenter (2000), Goeztmann, Ingersoll and Ross (GIR) (2003), Basak, Pavlova and Shapiro (2007) and Hodder and Jackwerth (2007) analyze the relationship between performance fee and risk exposure of hedge funds and argue that an asymmetric compensation structure creates incentives for the manager to increase its risk exposure.

GIR model the incentive fee with high-water mark and show that when funds do not need to worry about liquidation, managers have incentives to manipulate their risk profile as described in Carpenter (2000). When a lower boundary for liquidation is specified, however, they find that the optimal behavior for hedge fund managers would be to reduce fund volatility when fund value falls close to that boundary. Brown, Goetzmann, and Park (2001) present empirical evidence that hedge fund managers and CTAs do not increase their risk taking when facing poor absolute performance. Their reasoning is that hedge fund managers and CTAs face high cost from liquidation and getting reestablished, and their argument is consistent with GIR where funds face a lower boundary for liquidation.

Basak, Pavlova, and Shapiro (2007) and Hodder and Jackwerth (2007) analytically examine a fund manager's risk-taking incentive when her compensation is a convex function of fund performance. Basak et. al. (2007) show that such an incentive structure will lead the manager to increase or decrease her exposure to the benchmark depending on her risk aversion and whether the fund has outperformed or underperformed the benchmark. Hodder and Jackwerth (2007) build on Basak et. al. (2007) work and show that when the fund value is somewhat below the high-water mark a manager with a short-term perspective is willing to take added risks in order to increase

the probability of her incentive option finishing in-the-money. A manager with a short-term horizon also reduces her risk-taking slightly above the high-water mark and only slowly ramps back up to the level of risk-taking that she would have chosen without the incentive option. Brown, Harlow, and Starks (BHS) (1996) document increase in risk-taking of mutual funds managers who find themselves below average in half-year fund evaluation. They state that this behavior is due to the tournament-like environment that prevails in the mutual fund industry. Brown, Goetzmann, and Park (BGP) (2001) provide some empirical evidence consistent with the theoretical results reported in Hodder and Jackwerth (2007) and those of BHS (1996). They find hedge funds that had above average performance during the first half of a year reduce their volatility while those having below average performance tend to increase volatility. However, when they condition on estimated high-water marks, the significance disappears.

This paper seeks to find answers to the following question: empirically, what is likely to trigger shift of risk-taking behavior in hedge funds? Specifically, does the compensation option lead to increase in risk-taking when it is out-of-the-money? Is this behavior impacted by size, age, strategy or illiquidity of the fund?

We start with building a new proxy for the compensation option, which includes two components: the moneyness of the compensation option and the length of time that the compensation option is out-of-the-money. The moneyness of the compensation option determines if the hedge fund manager is able to collect incentive fee. We stipulate that managers are more likely to increase their risk-taking when the compensation option is out-of-the-money. On the other hand, survival and prestige pressure documented in BGP (1996) and Fung and Hiseh (1997) may restrain hedge funds managers from increasing risk-taking even with an out-of-money compensation option. However, if a fund stays below high-water mark and does not

collect incentive fees for a long period of time, the fund manager will have more incentive to take excessive risk in order to increase the probability that performance fee is collected.

Given available data on fund flows it is not possible to build a perfect measure of high-water mark for a fund. The reason is that different high-water marks apply to pools of capital that differ in terms of their initial subscription dates. So fund managers actually hold multiple compensation options on assets in the fund and these compensation options may have very different moneyness at the same time. As Agarwal, Daniel, and Naik (2006) put it, "two different managers that charge the same incentive fee rate could be facing different dollar incentives depending on the timing and magnitude of investors". We address the challenge by assuming a threshold for the fund manager, which decides the actual or psychological moneyness for her compensation option. The threshold is calculated as the percentage of fund's prevailing NAV compared to the maximum value of NAV within a certain time window. Our hypothesis is that there exists such a threshold that when fund's NAV falls below it, fund manager takes action in changing fund's risk profile and hopes that by doing so, she can push the compensation option into money.

Even when the fund's NAV falls below the threshold, manager may not accumulate enough incentive to change fund's risk profile as survival and prestige incentives may dominate. But if the fund continues to perform poorly and hovers below the threshold for a long period of time, the incentive to increase the value of the compensation option may dominate as fund may not be able to survive on asset management fee alone. Thus, our hypothesis is that the longer a fund stays below the threshold, the more likely a fund manager increases her risk-taking to push the compensation option into money.

We test these two hypotheses using a comprehensive hedge fund database that we construct from the three major hedge fund databases: CISDM, HFR, and Lipper Tass. Conditioned on a

given threshold, we find that consistent with our hypothesis, out-of-money compensation option leads to higher fund volatility in the second half of the year and vice versa. Furthermore, the longer a fund stays under the threshold the more likely the increase in the fund's volatility.

We conduct the same analysis for each hedge fund style and find that the shift of risk-taking is only significant for equity hedge and emerging markets managers. The reverse relationship between risk-taking and moneyness of compensation option is either insignificant or with opposite signs (not statistically significant, though). Equity hedge and emerging market funds usually invest in highly liquid instruments and they can change risk profiles rather easily compared to other styles like distressed securities and convertible arbitrage.

Following BHS (1996) and BGP (1996), we investigate whether tournament pressure induces shift in risk-taking in our larger sample of hedge funds and CTAs. We find that even though hedge funds' performances are publicly disclosed, competition in the industry leads to shift of fund volatility in response to their relative performances. We test for each strategy and find that results vary by strategies: the more liquid strategies, for example, equity hedge and managed futures, are more likely to shift their risk-taking in response to relative performance, while less liquid strategies, are less likely to practice shifts in risk-taking. Finally, we identify important factors that affect shifts in risk-taking. They include fund's age (entrenchment), asset under management (size), as well as levels of management fees of the funds.

The paper is organized as follows: Section 2 discusses the data and construction of proxy measures, Section 3 examines the shift in risk-taking in response to compensation option, Section 4 investigates the relationship between risk-taking and relative performance, Section 5 explores fund characteristics that affect the above relationship, Section 6 conducts robustness check, and Section 7 concludes.

## 2. Data and Construction of Proxy

We construct a comprehensive hedge funds database with funds from the three major hedge funds databases: CISDM, HFR, and Lipper-Tass. Since hedge funds report to databases on a voluntary basis, many which choose not to report are not included in the databases. On the other hand, a same hedge fund may choose to report to multiple databases and its entry into various databases may start at different times. A fund can also stop reporting to a database for some time before it starts reporting to the same database again. These possibilities lead to duplicated information if each such entry as reported in the databases is counted as a different fund. We try to avoid duplicated funds by a three-step cleaning procedure: First, we identify different funds by examining their names, inception date, and their management company. Secondly, we capture funds that report to databases on an irregular basis and identify them as "ghost" funds. Thirdly, we run correlation and cluster analysis to distinguish funds that closely resemble each other in characteristics we examine in the first step.

We include only funds that have monthly return series between January 1994 and August 2005 to reduce survivorship bias as the three databases started including defunct funds as well as live funds since then. The comprehensive database after the above procedure has 6282 funds with rich information, including funds' net-of-fee returns, asset under management (AUM), fund's initiation date, high-water mark, percentage incentive fees and management fees, self-reported style based on trading strategies, etc. Fund return history runs until August 2005, the end of our sample period, with some funds' return history tracing back to as early as 1976. In the process of removing duplicated funds, we stick to the following priority in picking funds from the three databases: Lipper TASS, then HFR, then CISDM. This priority in drawing funds explains why most funds in our data are from Lipper TASS, while HFR and CISDM contribute

much fewer funds. For our sample, TASS funds contribute to more than 50% of our sample (3755 out of 6282 funds), 2996 HFR funds represent close to another 50%, and there are 132 funds that report only to CISDM[3].

We separate the full sample into several sub-samples, each with complete return series over three years and call each sub-sample a sample year. The full sample runs from January 1994 to August 2005, so that we have eight sample years, each is consisted of a sample year's return and three-year return history, ranging from 1997 to 2004. The three-year return history requirement imposes a reasonable time frame for us to investigate changes in manager risk-taking behavior and is consistent with the return history requirement in prior studies so that we focus on funds that are of practical meaning. Table 1 reports the summary statistics of our sample of hedge funds. We see that the number of hedge funds in each sample year increases significantly over time, from fewer than 500 to more than 2000, mean and median AUM fluctuate over time, with a range of $140 to $180 million and $36 to $50 million, respectively. The skewed AUM distribution shows that most funds in our sample are small. Mean and median fund age is kind of stable at 70 and 60 months, while mean and median management fees have been on the increase from 1.3% to 1.99% and from 1% to 1.25%, respectively.

[Table 1 about here]

We then continue to construct proxy for management compensation option by focusing on measure of moneyness and length of "under-water"[4] time. We calculate the percentage of funds

[3] We have a different distribution of funds from the three databases from that of Agarwal, Daniel, and Naik (2004, 2006). Possible reasons include different fund sample period: ours is from Jan 1994 to Aug 2005 while theirs ends in 2002; duplicates are less likely in our sample after the thorough cleaning, especially with the help of a series of correlation and cluster analysis.

NAV at the beginning of each sample year to the maximum NAV[5] of the fund in the previous three-year period and compare it to the assumed threshold level. If the percentage is above or equal to the threshold, fund manager considers her compensation option to be in or at the money, while if the percentage is below the threshold, fund manager decides that she holds an "out-of-the-money" compensation option and as the length of under-water time stretches, she accumulates incentives to increase risk-taking. The length of under-water time (Time-under) is counted as the number of months the fund stays under its past three-year maximum NAV. If the fund is above-water, Time-under is set to be zero. Table 2 presents the summary statistics for the proxy measure with the threshold set to be 0.9. Through the eight sample years, the percentage of hedge fund managers with "in-the-money" compensation option increases in general, from 4.15% in sample year 1997 to 68.92% to 2004. Those with "out-of-money" compensation option increases from 8.76% in sample year to 25.45% in 2003, before it decreases to 7.10% in 2004. Since the choice of threshold does not affect the percentage of funds that are in the money, we see that many hedge funds actually have had good performance over time and are able to collect incentive fees. The mean Time-under ranges from a low of two months in 1997 to a high of seventeen months in 2004 and the median Time-under has a similar range. The percentage of minimum fund NAV compared to past three-year maximum ranges from a low of 1% in 2002 to 48% in 2004. The above summary statistics are in general consistent with the performance of stock market in those years, and with the fact that equity hedge (long/short equity) is the most popular style in hedge funds.

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[4] We will be using "above-water" interchangeably with "in-the-money" compensation option, and "under-water" interchangeably with "out-of-the-money" throughout the article.

[5] Implicitly, we are making an assumption that fund inflows center around continuous good performance and we treat the maximum NAV in the three-year period as the *fund*'s high-water mark during the period.

[Table 2 about here]

### 3. Shift of Risk-taking in Response to Compensation Option

There are many possible measures for the risk level at a hedge fund, for example, return volatility, semi-deviation, expected shortfall, VaR, etc. We use return volatility to track funds' risk-taking behavior as it is simple and effective, and consistent with what has been used in previous studies (BHS, BGP). With construction of our proxy to compensation option, the stage is set for measuring shift of risk-taking in hedge funds. To test our hypothesis that fund managers will act to increase risk-taking if their compensation option is out-of-money for a certain time, we examine how the return volatility in the second half of a sample year varies in response to the moneyness of management compensation option, and the "under-water" time. We control for influence on fund volatility from other factors by including them in a regression on the future fund volatility. These factors include return volatility in the first half year as volatility is known to be persistent[6], and relative performance since higher return is usually related to higher risk. What is more, to be intact from changes in market volatility, we use relative return volatility[7] as a dependent variable and write the regression equation as follows:

$$\begin{aligned}\text{Stdev Ratio } 2_i = {} & \alpha_i + \beta_1 \times \text{Moneyness}_i + \beta_2 \times \text{Time-under}_i \\ & + \beta_3 \times \text{Avg Relative Return}_i + \beta_4 \times \text{Stdev Ratio } 1_i + \varepsilon_i\end{aligned} \tag{1}$$

[6] Volatility persistence in financial returns has been discussed in many academic work, for example, Engle and Mustafa (1992), Lamoureux and Lastrapes (1993), etc.

[7] The relative volatility is calculated as the ratio of fund return volatility to stock market volatility during the same half year. S&P 500 is used as market index for this study.

$\text{Stdev Ratio } 2_i$ represents relative return volatility in the second half year of fund *i*, while $\text{Stdev Ratio } 1_i$ is the volatility in the first-half of the year. $\text{Time Under}_i$ is the number of months that a fund stays under the threshold at the beginning of that sample year. $\text{Moneyness}_i$ is a dummy variable which takes values of 1, -1, and 0, representing "in-the-money", "out-of-money", and "at-the-money" management compensation option based on the assumed threshold. Avg. Relative Return is the average six-month return excess of hedge fund index return[8]. Table 3 reports the correlation between the above explanatory variables and clears the concern for multicollinearity as none of them is very high.

[Table 3 about here]

Table 4 presents the results from regression (1) with the threshold assumed to be 0.9. It documents highly significant reverse relationship between future fund relative volatility and moneyness of management compensation option: when the compensation option is out-of-the money, future volatility increases and vice versa. On the other hand, the longer the management compensation is out-of-money, the more likely the increase in fund volatility. The magnitude of parameter estimates shows that when compensation option moves from "at-the-money" to "out-of-the-money", the relative volatility increases by 6%. On the other hand, increase of Time-under by one month leads to 1% increase in relative volatility and 1% increase in the relative fund return is followed by 1.77% increase in relative volatility as higher return is usually associated with higher volatility. As the shift for compensation option from at-the- to out-of-the- money is a significant change, the increase of relative volatility is also economically significant.

[8] Lipper TASS comprehensive hedge fund index is used for benchmark to calculate the relative return as most of the funds in our sample are taken from Lipper TASS database.

[Table 4 about here]

BGP uses annual performance as a proxy for moneyness of the fund's compensation option and does not find supporting evidence for risk-shifting. We argue that the difference in results may be due to several reasons, ranging from a more comprehensive and flexible proxy for the management compensation option, to different funds and sample period. Our results show that even with survival and prestige pressure, economic significance of incentive fees inspire strong incentives for hedge fund managers that allure them to shift risk-taking in hope of pushing the compensation option back into money. Our results are consistent with theories developed in Carpenter (2000) and arguments put forth in Grinblatt and Titman (1989).

Our finding has enormous implications for investors and regulators, in an era when hedge funds and similar private funds are booming9 and in a field that investors hardly have any control on the on-going risk-taking behavior of fund managers. Complicated by the multiple compensation options that have different moneyness, search for better proxies for fund managers' compensation option demands more effort and input in the future.

## 4. Shift of Risk-taking in Response to Relative Performance

Like mutual funds, most hedge funds compete for new capital flow into the fund. As more and more hedge funds are started in the past decade, the competition between hedge funds may well fit into the tournament theory documented by BHS for mutual funds. To conform to the requirement by Investment Company Act 1940, hedge funds cannot publicize their returns like

[9] The hedge fund industry is reported to have more than 8,000 funds and more than $1 trillion under management by Aug 2006. (Wall Street Journal) Hedge funds and private equity funds have and are seeking to be publicly traded companies as well, Fortis and Black Stone are good examples of this trend.

mutual funds do, so there is no ranking by the media to public. But on the other hand, as wealthy investors' club, hedge funds are scrutinized by sophisticated investors. Performance evaluation conducted by these investors might be even more careful and thorough, therefore provides hedge fund managers with incentives to adjust their risk taking in response to relative performance. As a matter of fact, BGP finds that this is the case for their sample of hedge funds and CTAs in most of their sample years.

We carry out the same tests as BGP for our sample using technologies proposed in BHS. The assumed time for performance evaluation is mid-year, Jun 30. The hypothesis is that hedge fund managers increase their volatility in the second half year if their performance in the first half year is below median, and vice versa. The variance ratio hence is defined as the ratio of excess return[10] in the second half year to that of the first half year. To test for our hypothesis, a contingency table test is conducted by counting the number of funds with high and low variance ratios conditioned on their first-half years' relative performance.

The variance ratio and relative performance deciles plot in Figure 1 shows evidence that funds with high relative return in the first six months tend to reduce volatility but not in the reverse direction. Contingency table test, on the other hand, confirms BGP results for both directions. The funds that increase their volatility (with a variance ratio greater than the median) when their relative return in the first 6 months is below median outnumber those that decrease their return volatility, and vice versa. As reported in Table 4, a chi-square test on the log odds ratio shows that the results are significantly different from an independent draw in ten out of eleven years.

[Figure 1 about here]

[10] The excess return is excess of style benchmark provided by Lipper TASS.

[Table 5 about here]

If hedge funds shift their volatility strategy in response to their half-year absolute performance, we would see similar results in a contingency table test using raw returns. To test for this possibility, we conduct the contingency table test for the same funds using the raw returns on the funds and find results in half of the sample years are no longer significant, in some sample years they even have opposite implications. This is in agreement with BGP findings that annual absolute performance does not affect managers' risk-taking behavior. This further confirms BHS results that relative performance is what counts in a "tournament". It also shows that the desire to thrive in a "tournament" represents a strong incentive that guides hedge funds managers' risk-taking behavior. Absolute return, on the other hand, does not seem to have such a powerful effect.

## 5. Other Factors for Compensation Option Effects

As described in Section 3, we find strong evidence that hedge fund managers shift their volatility strategies in response to the moneyness of their compensation option, and the length of time the option has been "under-water". In this Section, we study this effect by examining controlled hedge fund sub-samples, to see whether certain fund characteristics have impact on the effect, and if yes, how.

### 5.1 Size

Although no final consensus yet, fund size is considered to affect fund's performance. Liang (1999), Koh, Koh, and Teo (2003) find that there is a positive relationship between size and performance. Liang (2000), BGP, and Li (2006) also find size to be important to fund's survival probability. This raises the question: how does size affect funds' risk-taking behavior? We

collect all funds in our sample with information on asset under management (AUM) for January of the sample year to test for the size effect. If the AUM currency is not USD, we convert it to USD using January exchange rate. Based on the equivalent AUM in USD, we then divide all qualified funds into quintiles and run regression (1) for all quintiles. The results are reported in Table 6. We see that medium-sized funds (quintile 3 especially) have a strong tendency to increase return volatility when they are faced with an "out-of-the-money" compensation option. Neither the smaller nor the larger funds, however, have a significant factor loading on moneyness. This is interesting since presumably, there can be more than one interpretation: Large funds may be able to collect enough management fees with their asset base and do not feel so much pressure, or they tend to be the well-established ones that have a lot of confidence in their strategies and are more concerned about their names; small funds may be those that are inexperienced and are more cautious in shifting risk profiles. Another observation is that all funds seem to increase volatility when the fund has been "under-water" for some time as the coefficient estimate for Time-under is always positive significant.

[Table 6 about here]

**5.2 Age**

As discussed in Chevalier and Ellison (1997, 1999), Liang (2000), and Li (2006), age is believed to be another important factor that might affect fund managers' risk-taking behavior. All funds in our sample with non-conflicting[11] information on their age based on reported funds' started date and based on their actual return series are used to test for age effect. Regression (1) is run for all funds after excluding unqualified funds and the result is comparable to that in Table

[11] We calculate the age of each fund based on the length of their up-to-date return series and compare it to the age based on reported initiated date of the fund. If both ages agree with each other, the fund has non-conflicting information on its age.

4[12]. We then test for funds with age range in 0-1 years to 10+ years and find that start-up funds and entrenched funds do not seem to react to moneyness of the compensation option by shifting their risk-taking as much as the middle-aged funds do. This leads us to suggest that young funds are cautious about their shift of risk-taking, while experienced ones are either confident in their strategies or their incentive to shift risk taking is suppressed by incentives to maintain their prestige. But all funds have the tendency to increase fund volatility when the compensation option has been "out-of-money" for some time, which is evidenced by positive significant parameter estimate on Time-under.

[Table 7 about here]

**5.3 Level of Management Fees**

Hedge funds managers mainly have two income sources: management fees and performance fees. Our hypothesis is that funds with higher level of management fees should have less pressure to shift their risk-taking when faced with out-of-the-money compensation option, as everything else being equal, these funds are less dependent on performance fees to thrive. All funds in our sample with information on the level of management fees are used to test for the effect of management fees and the result for the full sample is very much like that reported in Table 4[13]. The result from regression (1) for various levels of management fees is reported in Table 8. From Table 8, we see exactly the opposite empirical result: funds with higher management fees actually are more sensitive to the moneyness of their compensation option. This result seems confusing and we plan to explore the reasons in future research.

[Table 8 about here]

[12] Results are not reported here to avoid repetition.
[13] Not reported here to save space.

## 6. Robustness

### 6.1 Shift of risk-taking in response to compensation option: different thresholds

The threshold is predetermined and the assumed value of a threshold is always below 1 so that we can accommodate different high-water marks for capital subscribed at different times. A high threshold (0.9 and above) assumes that hedge funds would be under pressure to collect incentive fees if they are not continuously generating positive absolute returns. A low threshold (0.4 and under), however, assumes that hedge fund managers take it much more easier when their absolute return is not great or even poor. We use different thresholds in regression (1) to examine how different assumed values change our empirical results. Our flexible threshold possesses a great advantage that it can help test GIR model where hedge fund managers are modeled to behave differently when the portion of fund's under-water assets is different. GIR argue that theoretically, managers tend to increase their risk-taking when the amount of fund assets under-water is seen as manageable. When a fund faces a positive lower bound for liquidation, however, reduction of return volatility is an optimal behavior to preserve the value of performance fees. Based on their model, we expect to see different responses to the high-water mark provision under different thresholds in our study. With high threshold, the majority of managers categorized as "under-water" is not troubled by survival pressure, while when the threshold is set to be low, more managers categorized as "under-water" are likely to face liquidation, which leads to stronger incentives to survive rather than to make incentive fees. To test for this hypothesis, we consider different levels of threshold between 0.20 and 0.99 and carry out the same exercise as in section 3 for thresholds to be 0.95, 0.80, 0.70, 0.50, 0.30, and 0.20, respectively. We expect to see stronger evidence of managers shifting their risk taking when the threshold is set neither too high nor too low, and weaker evidence when the threshold is set to be

low. We find that when the threshold is very high or very low, fund management are no longer so sensitive to the moneyness of their compensation option. When the threshold is set to be between 0.3 and 0.9, the coefficient on moneyness is highly negative significant. There are at least two implications from our findings: On the one hand, hedge funds managers have a certain tolerance for poor absolute performance and stick to their strategies/risk-taking behavior within the tolerance level. On the other hand, there is some evidence supporting GIR theoretical model, that when the fund management is facing a close to liquidating NAV, they no longer gamble for performance fees. What is more, neither very high nor very low assumed threshold does a good job differentiate "above-water" and "under-water" managers. This may also contribute to the loss of explanatory power for variable moneyness. We report the representative results (Threshold = 0.95 and 0.2) in Table 9. Even with a threshold of 0.2, the response of volatility in the next period to moneyness is still negative, but no longer significant compared to when threshold is set higher.

[Table 9 about here]

Our findings imply that there might be subtleties in regimes where managers face an "out-of-the-money" incentive fees option as discussed in GIR. Managers may have different incentives when the fund is facing liquidation, as evidenced by their reaction in risk-taking behavior changes. But before we further explore the reason for the above findings, we do not want to come to a quick conclusion that within a certain range of threshold, moneyness of performance fees option matters for shift of risk-taking in hedge funds, and that it no longer impacts risk-

shifting when one moves outside the range. We believe it is more of an empirical problem and may be sample dependent. We leave this question open for future research.

**6.2 Shift of risk-taking and Compensation option within styles**

Hedge funds are a collection of managers with highly idiosyncratic risks as they adopt various strategies. So hedge funds are usually evaluated within their claimed styles. Similarly, our former results on risk-taking behavior in response to compensation option based on all funds in sample may not reflect the full picture. We conduct the same analysis as in Section 3 within each style and find that emerging market funds and equity hedge funds are most prone to shift in risk-taking when faced with an "out-of-the money" compensation option. The results are either not significant or even the opposite for other fund styles. Since equity hedge funds dominate our fund sample, the full sample of all funds with style descriptions is reported to have significant coefficient estimates as well. We report the results for equity hedge funds and emerging market funds separately in Table 10.

[Table 10 about here]

**6.3 Shift of risk-taking to relative performance – different return evaluation basis**

BHS report that mutual funds' risk-taking behavior in response to relative performance in a tournament is most remarkable when monthly returns are evaluated in July, after the second-quarter performance rankings are released. Since there is no public ranking for hedge funds, we do not expect the time when evaluation is done to be a reason for more significant results in the contingency table test. However, for hedge funds that collect performance fees based on quarterly performance, comparison of volatility ratio of based on different periods of return may yield different result. We conduct the same contingency table test with return evaluation basis

being January to July vs August to December and January to May vs June to December and report the results in Table 11. Despite some minor variations in couple of sample years, the result remains quite strong that hedge funds managers shift their volatility in response to relative performance.

[Table 11 about here]

### 6.4 Shift of risk-taking to relative performance – within styles

As stated earlier, hedge funds managers are much more heterogeneous compared to mutual funds managers. Getmansky, Lo, and Markarov (2004), for example, points out that various hedge fund strategies can have very different asset holdings in terms of liquidity level. Aragon (2007) documents that some hedge funds impose long-term share restrictions, like lock-up period of more than one year so that they could generate good returns from illiquid asset holdings. BHS, BGP and this study all examine the shift of risk-taking within half a year and for some illiquid funds, six months may not be enough to carry out risk-shifting. To explore this possibility, we separate our full sample into two sub-samples, one with liquid strategies and the other with illiquid strategies. The measure for liquidity is first order autocorrelation, which we calculate based on the full return series of each fund. We compare the mean autocorrelation for each strategy and find that convertible arbitrage, distressed securities, as well as event driven funds have the highest first-order autocorrelation and categorize them as illiquid strategies. We conduct the same tests as in Section 4 and report the results for the illiquid strategies in Table 12.

[Table 12 about here]

We see that consistent with our conjecture, the funds with illiquid strategies do not exhibit so strong evidence on shift of risk-taking as the full sample. In only three out of the eleven sample years we are able to find statistically significant supporting results, in contrast to ten out of eleven years in our full sample.

## 7. Conclusion

We explore the managerial incentives related to the unique compensation structure in hedge funds, and examine the shift of risk-taking in response to various states of the moneyness of the compensation option. With a more comprehensive and quantified proxy for fund managers' compensation, we find that moneyness of the compensation option does affect the shift of risk-taking for managers in certain regimes. We also find strong evidence that the longer a fund stays under its high-water mark, the more likely management is going to increase fund volatility. On the other hand, consistent with the findings of BHS (1996) for mutual funds and BGP (2001) for hedge funds and CTAs, our sample of hedge funds is shown to adjust risk-taking in response to their relative performance as well.

We further investigate the impact of important fund characteristics on the shift of risk-taking as a response to performance. We find that medium-sized, medium-aged, as well as funds that charge a relatively high percentage of management fees are prone to shift risk-taking in response to the status of compensation option. We attribute the empirical evidence to various reasons, for example, capability to resist pressure from poor performance, caution, confidence in strategies, among other possibilities.

We also notice that the above results are most significant in certain styles of hedge funds: equity hedge funds and emerging market funds, but not obvious for other styles. We believe this

may be due to the ability of managers to shift risk-taking for certain strategies. Equity hedge and emerging market manager both invest in the equity market and it is relatively easier for them to shift risk-taking compared to others that invest in distressed securities or merger arbitrage.

We also want to point out that, as discussed in Fung and Hsieh (2001), Agarwal and Naik (2004), Goetzmann, Ingersoll, Spiegel, and Welch (2003), hedge funds managers are flexible in utilizing various trading strategies and volatility as a measure of risk may lack strength in evaluating riskiness in dynamic trading. Volatility is used as the measure of risk in this study to explore the shift of risk-taking of hedge funds management in response to their performance, and it may not be able to unveil the actual magnitude of shift of risk-taking in response to performance. In this study, we do not find experienced managers to display a significant movement in risk-taking in response to performance. But we still have questions marks on the underlying reason: is it because more entrenched fund managers have more confidence in their strategies, or is it because they are better at hiding their risk under the veil of dynamic trading strategies, or both? But one thing is for sure, our results that there is significant shift of risk-taking in response to performance reminds investors to scrutinize fund's strategy and related risk level before making a quick conclusion on their performance.

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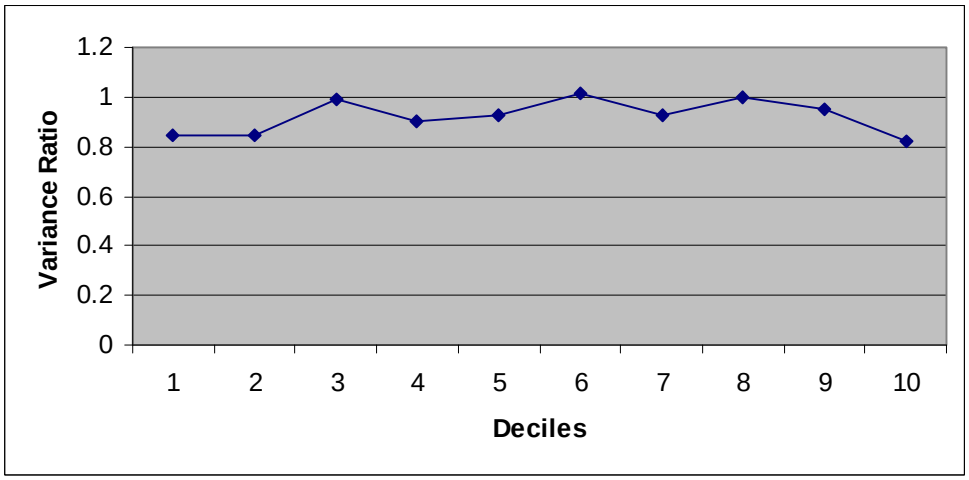
Figure 1: The ratio of second-half year variance to the first-half year variance for each decile decided by the first half year's relative performance of the fund.



## Table 1
## Summary Statistics of a Sample of Hedge Funds, 1997-2004

Summary information is reported for the sample of hedge funds that we collect from three major databases after cleaning duplicates. We include only funds that have return in our databases after January 1994 to avoid survivorship bias. To be included in the sample, each fund must have at least three years return history, as well as return for the entire year to enable further exploration. Summary statistics of AUM, age, and management fees are based on funds with reported information, hence do not represent every fund that is included in study for that sample year. For funds that report AUM in a currency other than USD, we use monthly average foreign exchange rates downloaded from Datastream to convert the currency into USD. Fund age is calculated based on the reported inception date of the fund and reflects the length of time a fund has been in operation. In calculation of funds age, if there is a conflict between information on inception date and actual return series, the fund is excluded.

| Year | Number of Funds | Mean AUM ($million) | Median AUM ($million) | Mean Age (month) | Median Age (month) | Mean Mgmt Fees (%) | Median Mgmt Fees (%) |
|---|---|---|---|---|---|---|---|
| 1997 | 434 | 150 | 49 | 71 | 59 | 1.30 | 1.00 |
| 1998 | 651 | 183 | 50 | 71 | 62 | 1.30 | 1.00 |
| 1999 | 829 | 172 | 40 | 72 | 59 | 1.31 | 1.00 |
| 2000 | 1004 | 177 | 41 | 72 | 59 | 1.36 | 1.00 |
| 2001 | 1170 | 172 | 42 | 73 | 61 | 1.36 | 1.00 |
| 2002 | 1411 | 161 | 40 | 72 | 63 | 1.40 | 1.25 |
| 2003 | 1725 | 140 | 36 | 71 | 59 | 1.39 | 1.40 |
| 2004 | 2014 | 179 | 45 | 72 | 59 | 1.99 | 1.25 |

## Table 2
## Summary Statistics of Proxy Measure for "Compensation Option

Summary information on our proxy for hedge fund managers compensation option: the moneyness of the compensation option based on a chosen threshold, and the length of time that a fund has stayed under its maximum in the past three years (Time-under). Moneyness is the status of hedge funds management compensation option at the observational point of July of the sample year, which is calculated based on the percentage of the then NAV compared to the maximum NAV in the past 36 months based on the certain threshold. (Percentage= NAV in July of Sample Year/Maximum NAV in the past three years.) moneyness equals to 1 if percentage is greater than 1, meaning the option is in the money. moneyness is equal to -1 if percentage is less than the threshold, meaning the option is out of the money. moneyness is equal to 0 if percentage is between threshold and 1. Time-under is the number of months that the fund's NAV has stayed below past maximum in the 36 months. Time-under=max (0, number of months that the fund stays under its maximum NAV of past 36 months). Min NAV (%) is the minimum percentage of NAV to the maximum in past 36 months at the observational point.

| Year | "In-the-Money" (%) | "Out-of-the-Money" (%) | Mean Time-Under(month) | Median Time-Under(month) | Min NAV (%) |
|---|---|---|---|---|---|
| 1997 | 4.15 | 8.76 | 2 | 0 | 47 |
| 1998 | 43.78 | 7.68 | 2 | 0 | 32 |
| 1999 | 39.20 | 16.65 | 13 | 12 | 13 |
| 2000 | 47.51 | 10.86 | 4 | 0 | 12 |
| 2001 | 47.78 | 15.21 | 5 | 3 | 8 |
| 2002 | 40.96 | 17.50 | 7 | 3 | 1 |
| 2003 | 34.32 | 25.45 | 17 | 14 | 5 |
| 2004 | 68.92 | 7.10 | 5 | 0 | 48 |

## Table 3
## Correlation Matrix of Explanatory Factors

Moneyness is the status of hedge funds management compensation option at the observational point of July of the sample year, which is calculated based on the percentage of the then NAV compared to the maximum NAV in the past three years based on the certain threshold. (Percentage= NAV in July of Sample Year/Maximum NAV in past 36 months.) moneyness equals to 1 if percentage is greater than 1, meaning the option is in the money. moneyness is equal to -1 if percentage is less than the threshold, meaning the option is out of the money. moneyness is equal to 0 if percentage is between threshold and 1. Time-under is the number of months that the fund's NAV has stayed below past maximum in the 36 months. Time-under=max (0, number of months that the fund stays under its maximum NAV of past 36 months). Avg. return is the mean return of the first 6 months in the sample year. Past volatility is the return volatility in the first 6 months of the sample year.

| Year | Moneyness & Time-Under | Moneyness & Avg. Return | Moneyness & Past Volatility | Time-under & Avg. Return | Time-under & Past Volatility | Avg. Return & Past Volatility |
|---|---|---|---|---|---|---|
| 1997 | -0.44 | -0.28 | -0.30 | -0.28 | 0.28 | 0.16 |
| 1998 | -0.50 | 0.41 | -0.54 | -0.28 | 0.36 | -0.21 |
| 1999 | -0.66 | -0.11 | -0.27 | 0.25 | 0.30 | 0.69 |
| 2000 | -0.57 | 0.28 | -0.16 | -0.08 | 0.04 | 0.24 |
| 2001 | -0.61 | 0.17 | -0.44 | 0.04 | 0.25 | 0.09 |
| 2002 | -0.70 | 0.38 | -0.41 | -0.36 | 0.30 | 0.13 |
| 2003 | -0.74 | -0.17 | -0.34 | 0.19 | 0.27 | 0.54 |
| 2004 | -0.61 | 0.06 | -0.21 | 0.02 | 0.10 | 0.19 |

## Table 4
## Shift of Volatility – Cross-sectional Regression of Proxy of Compensation Option, Past Return and Volatility Ratio (Threshold = 0.9)

Panel A reports the summary statistics for 6834 sample year-fund observations with at least three years continuous return history, with a selected threshold of 0.9. The sample period covers 1994-2004 and the first sample year is 1997.Time-under is the number of months that the fund's NAV has stayed below past maximum in the 36 months. Time-under=max (0, number of months that the fund stays under its maximum NAV of past 36 months). Avg. return is the mean return of the first 6 months in the sample year. Stdev ratio 1 is the ratio of fund's return volatility in the first 6 months to that of S&P 500 in the sample year. Stdev ratio 2 is the ratio of fund's relative return volatility in the second 6 months to that of S&P 500 in the sample year. Panel B reports the parameter estimates from regression (1) for this sample.

Panel A. Summary Stats of Explanatory Factors

| | Mean | Minimum | Maximum | Stdev |
|---|---|---|---|---|
| Time-under (month) | 7.74 | 0.00 | 42.00 | 10.40 |
| Avg. Return (%) | 1.07 | -12.79 | 31.58 | 2.15 |
| Stdev Ratio 1 | 1.08 | 0.00 | 14.63 | 1.08 |
| Stdev Ratio 2 | 0.86 | 0.00 | 8.24 | 0.81 |
| Moneyness | 0.25 | -1.00 | 1.00 | 0.73 |

Panel B. Parameter Estimates

| | Estimate | Std Error | t-value | p-value |
|---|---|---|---|---|
| Intercept | 0.23 | 0.01 | 20.65 | <0.0001 |
| Moneyness | -0.06 | 0.01 | -6.39 | <0.0001 |
| Time-under | 0.01 | 0.00 | 11.81 | <0.0001 |
| Avg. Return | 1.77 | 0.29 | 6.01 | <0.0001 |
| Stdev ratio 1 | 0.50 | 0.01 | 86.49 | <0.0001 |

Adj. $R^2 = 0.51$

## Table 5
## Returns and Subsequent Volatility Change
## (Contingency Table Test)

Numbers in the body of the table give the number of funds falling in each classification for all the funds in the sample. Each fund is required to have a complete return history for each calendar year, January to June return is defined as the total fund return measured over the first six months of each year, and is measured relative to TASS hedge fund index. The variance ratio is defined as the ratio of variance of return in excess of style benchmark for the second six-month period to the variance of the first six-month excess return. Variance ratio low is defined as a variance ratio less than the median for all funds in the calendar year, and variance ratio high is defined as a variance ratio greater than or equal to the median for all funds. Similar results are obtained defining the variance ratio in terms of raw returns as opposed to excess returns. The log-odds ratio is the log of the ratio of the product of the first and fourth columns to the product of the second and third, and the t-value measures significance of this quantity. The Chi-square numbers represent the $\chi^2(1)$ statistics from the 2x2 contingency tables. Note that this contingency table statistic is mis-specified in this application since the cell counts are not in this application since the cell counts are not independent. The log odds ratio statistic is robust to this mis-specification.

| | Funds with January to June Return Less Than Median | | Funds with January to June Return Greater Than Median | | | |
|---|---|---|---|---|---|---|
| Year | Variance Ratio Low | Variance Ratio High | Variance Ratio Low | Variance Ratio High | Log Odds Ratio | Chi-square Test Stat |
| 1994 | 84 | 132 | 133 | 86 | 0.89 | <0.0001 |
| 1995 | 151 | 164 | 164 | 152 | 0.16 | 0.3196 |
| 1996 | 160 | 252 | 253 | 163 | 0.89 | <0.0001 |
| 1997 | 211 | 324 | 324 | 211 | 0.86 | <0.0001 |
| 1998 | 316 | 356 | 356 | 318 | 0.23 | 0.0335 |
| 1999 | 298 | 563 | 563 | 300 | 1.27 | <0.0001 |
| 2000 | 506 | 578 | 578 | 508 | 0.26 | 0.0023 |
| 2001 | 592 | 699 | 703 | 597 | 0.33 | <0.0001 |
| 2002 | 723 | 874 | 874 | 725 | 0.38 | <0.0001 |
| 2003 | 892 | 990 | 991 | 894 | 0.21 | 0.0015 |
| 2004 | 1046 | 1110 | 1110 | 1047 | 0.12 | 0.0531 |

## Table 6
## Shift of Volatility in Response to Proxy of Compensation Option, Past Return and Volatility Ratio (Threshold = 0.9) – Size Effect

The quintiles are based on the size (asset under management, AUM) of each fund in our hedge fund sample with qualified funds between 1997 and 2004. AUM is the reported AUM at the beginning of each sample year. If the currency of AUM is not USD, the equivalent AUM in USD is calculated based on foreign exchange rate in January of the sample year. 1st quintile contains funds with the smallest size and 5th quintile contains largest funds. For each quintile, the regression (1) is run and the parameter estimates are reported in Panel A-E for the five quintiles.

| | Estimate | Std Error | t-value | p-value | Adj. $R^2$ |
|---|---|---|---|---|---|
| Panel A. Funds with AUM in the 1st Quintile | | | | | |
| Intercept | 0.26 | 0.04 | 6.61 | 0.00 | 0.50 |
| Moneyness | -0.01 | 0.04 | -0.24 | 0.82 | |
| Time-under | 0.01 | 0.00 | 5.92 | 0.00 | |
| Std ratio 1 | 0.53 | 0.02 | 33.01 | 0.00 | |
| Panel B. Funds with AUM in the 2nd Quintile | | | | | |
| Intercept | 0.32 | 0.04 | 8.65 | 0.00 | 0.44 |
| Moneyness | -0.03 | 0.03 | -0.90 | 0.42 | |
| Time-under | 0.01 | 0.00 | 5.03 | 0.01 | |
| Std ratio 1 | 0.47 | 0.02 | 29.04 | 0.00 | |
| Panel C. Funds with AUM in the 3rd Quintile | | | | | |
| Intercept | 0.29 | 0.03 | 10.02 | 0.00 | 0.50 |
| Moneyness | -0.08 | 0.02 | -3.34 | 0.03 | |
| Time-under | 0.01 | 0.00 | 5.46 | 0.01 | |
| Std ratio 1 | 0.49 | 0.02 | 32.08 | 0.00 | |
| Panel D. Funds with AUM in the 4th Quintile | | | | | |
| Intercept | 0.17 | 0.03 | 5.35 | 0.01 | 0.51 |
| Moneyness | -0.02 | 0.03 | -0.67 | 0.54 | |
| Time-under | 0.01 | 0.00 | 6.16 | 0.00 | |
| Std ratio 1 | 0.57 | 0.02 | 33.22 | 0.00 | |
| Panel E. Funds with AUM in the 5th Quintile | | | | | |
| Intercept | 0.15 | 0.03 | 5.55 | 0.01 | 0.50 |
| Moneyness | -0.02 | 0.02 | -0.95 | 0.40 | |
| Time-under | 0.01 | 0.00 | 6.28 | 0.00 | |
| Std ratio 1 | 0.59 | 0.02 | 31.85 | 0.00 | |

## Table 7
## Shift of Volatility in Response to Proxy of Compensation Option, Past Return and Volatility Ratio (Threshold = 0.9) – Age Effect

Fund's age is the number of years that a fund has been in operation, based on the reported "initial date of the fund". We only include funds that have consistent actual reported length of return time series and calculated one based on the "initial date". Panel A-I report parameter estimates from regression equation (1) for funds with different ages, ranging from 0 to more than 10 years.

| | Estimate | Std Error | t-value | p-value | Adj. $R^2$ |
|---|---|---|---|---|---|
| Panel A. Funds Age = 0-2 Years | | | | | |
| Intercept | 0.26 | 0.04 | 6.16 | 0.00 | 0.44 |
| Moneyness | -0.03 | 0.04 | -0.89 | 0.42 | |
| Time-under | 0.00 | 0.00 | 1.96 | 0.12 | |
| Std ratio 1 | 0.38 | 0.02 | 16.93 | 0.00 | |
| Panel B. Funds Age = 1-3 Years | | | | | |
| Intercept | 0.26 | 0.03 | 8.32 | 0.00 | 0.52 |
| Moneyness | -0.06 | 0.03 | -2.30 | 0.08 | |
| Time-under | 0.01 | 0.00 | 2.96 | 0.04 | |
| Std ratio 1 | 0.47 | 0.02 | 29.07 | 0.00 | |
| Panel C. Funds Age = 2-4 Years | | | | | |
| Intercept | 0.28 | 0.02 | 12.11 | 0.00 | 0.48 |
| Moneyness | -0.09 | 0.02 | -4.51 | 0.01 | |
| Time-under | 0.01 | 0.00 | 5.76 | 0.00 | |
| Std ratio 1 | 0.48 | 0.01 | 43.82 | 0.00 | |
| Panel D. Funds Age = 3-5 Years | | | | | |
| Intercept | 0.26 | 0.02 | 12.14 | 0.00 | 0.48 |
| Moneyness | -0.09 | 0.02 | -4.84 | 0.01 | |
| Time-under | 0.01 | 0.00 | 6.65 | 0.00 | |
| Std ratio 1 | 0.51 | 0.01 | 48.24 | 0.00 | |
| Panel E. Funds Age = 4-6 Years | | | | | |
| Intercept | 0.18 | 0.02 | 7.80 | 0.00 | 0.52 |
| Moneyness | -0.04 | 0.02 | -1.76 | 0.15 | |
| Time-under | 0.01 | 0.00 | 8.49 | 0.00 | |
| Std ratio 1 | 0.55 | 0.01 | 45.18 | 0.00 | |
| Panel F. Funds Age = 5-7 Years | | | | | |
| Intercept | 0.15 | 0.03 | 5.99 | 0.00 | 0.55 |
| Moneyness | 0.00 | 0.02 | -0.12 | 0.91 | |
| Time-under | 0.01 | 0.00 | 9.34 | 0.00 | |
| Std ratio 1 | 0.55 | 0.01 | 41.88 | 0.00 | |
| Panel G. Funds Age = 6-8 Years | | | | | |
| Intercept | 0.19 | 0.03 | 6.39 | 0.00 | 0.53 |
| Moneyness | -0.03 | 0.03 | -1.06 | 0.35 | |
| Time-under | 0.01 | 0.00 | 6.64 | 0.00 | |
| Std ratio 1 | 0.54 | 0.01 | 36.26 | 0.00 | |

## Table 7 Continued

| | | | | | |
|---|---|---|---|---|---|
| Panel H. Funds Age = 7-9 Years | | | | | |
| Intercept | 0.15 | 0.03 | 4.66 | 0.01 | 0.54 |
| Moneyness | 0.01 | 0.03 | 0.28 | 0.79 | |
| Time-under | 0.01 | 0.00 | 6.27 | 0.00 | |
| Std ratio 1 | 0.56 | 0.02 | 32.46 | 0.00 | |
| Panel I. Funds Age = 10+ Years | | | | | |
| Intercept | 0.16 | 0.03 | 5.39 | 0.01 | 0.60 |
| Moneyness | -0.01 | 0.03 | -0.27 | 0.80 | |
| Time-under | 0.01 | 0.00 | 6.96 | 0.00 | |
| Std ratio 1 | 0.56 | 0.02 | 34.67 | 0.00 | |

## Table 8
## Shift of Volatility in Response to Proxy of Compensation Option, Past Return and Volatility Ratio (Threshold = 0.9) – Management Fees Effect

Management fees are reported by funds voluntarily. We exclude funds that do not have this information and divide all the qualified funds based on the percentage they charge on the asset under management. Panel A represents results from regression (1) for management fees at 0-1%; Panel B shows results for management fees at 1-3% and Panel C has those for management fees at 3-5% (5% is the highest).

| | Estimate | Std Error | t-value | p-value | Adj. $R^2$ |
|---|---|---|---|---|---|
| Panel A. Management Fees 0-1% | | | | | |
| Intercept | 0.26 | 0.04 | 6.16 | 0.00 | 0.44 |
| Moneyness | -0.03 | 0.04 | -0.89 | 0.42 | |
| Time-under | 0.00 | 0.00 | 1.96 | 0.12 | |
| Std ratio 1 | 0.38 | 0.02 | 16.93 | 0.00 | |
| Panel B. Management Fees 1-3% | | | | | |
| Intercept | 0.26 | 0.03 | 8.32 | 0.00 | 0.52 |
| Moneyness | -0.06 | 0.03 | -2.30 | 0.08 | |
| Time-under | 0.01 | 0.00 | 2.96 | 0.04 | |
| Std ratio 1 | 0.47 | 0.02 | 29.07 | 0.00 | |
| Panel C. Management Fees 3-5% | | | | | |
| Intercept | 0.28 | 0.02 | 12.11 | 0.00 | 0.48 |
| Moneyness | -0.09 | 0.02 | -4.51 | 0.01 | |
| Time-under | 0.01 | 0.00 | 5.76 | 0.00 | |
| Std ratio 1 | 0.48 | 0.01 | 43.82 | 0.00 | |

## Table 9
## Shift of Risk-Taking and Compensation Option - Different Thresholds

Panel A reports the parameter estimates from regression (1) with a selected threshold of 0.20. Panel B reports the results for a threshold of 0.95. The sample period covers 1994-2004 and the first sample year is 1997.Time-under is the number of months that the fund's NAV has stayed below past maximum in the 36 months. Time-under=max (0, number of months that the fund stays under its maximum NAV of past 36 months). Avg. return is the mean return of the first 6 months in the sample year. Stdev ratio 1 is the ratio of fund's return volatility in the first 6 months to that of S&P 500 in the sample year. Stdev ratio 2 is the ratio of fund's relative return volatility in the second 6 months to that of S&P 500 in the sample year.

| | Estimate | Std Error | t-value | p-value | $R^2$ |
|---|---|---|---|---|---|
| Panel A. Threshold = 0.20 | | | | | |
| Intercept | 0.24 | 0.01 | 20.13 | <0.0001 | 0.48 |
| Moneyness | -0.02 | 0.01 | -1.67 | 0.10 | |
| Time-under | 0.01 | 0.00 | 13.43 | <0.0001 | |
| Avg. Return | 0.16 | 0.34 | 0.48 | 0.63 | |
| Std ratio 1 | 0.50 | 0.01 | 73.00 | <0.0001 | |
| Panel B. Threshold = 0.95 | | | | | |
| Intercept | 0.25 | 0.01 | 17.04 | <0.0001 | 0.48 |
| Moneyness | -0.03 | 0.02 | -1.64 | 0.08 | |
| Time-under | 0.01 | 0.00 | 13.43 | <0.0001 | |
| Avg. Return | 0.16 | 0.34 | 0.48 | 0.63 | |
| Std ratio 1 | 0.49 | 0.01 | 74.80 | <0.0001 | |

## Table 10
## Shift of Risk-Taking and Compensation Option – Stylewise Results

Panel A reports the parameter estimates from regression (1) with a selected threshold of 0.90 for equity hedge funds. Panel B reports the results for a threshold of 0.90 for emerging market funds. Panel C contains results for all funds with style description. The sample period covers 1994-2004 and the first sample year is 1997.Time-under is the number of months that the fund's NAV has stayed below past maximum in the 36 months. Time-under=max (0, number of months that the fund stays under its maximum NAV of past 36 months). Avg. return is the mean return of the first 6 months in the sample year. Stdev ratio 1 is the ratio of fund's return volatility in the first 6 months to that of S&P 500 in the sample year. Stdev ratio 2 is the ratio of fund's relative return volatility in the second 6 months to that of S&P 500 in the sample year.

| | Estimate | Std Error | t-value | p-value | R-square |
|---|---|---|---|---|---|
| Panel A. Equity Hedge Funds | | | | | |
| Intercept | 0.33 | 0.03 | 11.00 | 0.00 | 0.42 |
| Moneyness | -0.10 | 0.02 | -4.09 | 0.01 | |
| Time-under | 0.01 | 0.00 | 6.58 | 0.00 | |
| Std ratio 1 | 0.49 | 0.01 | 33.45 | 0.00 | |
| Panel B. Emerging Market Funds | | | | | |
| Intercept | 0.25 | 0.01 | 17.04 | <0.0001 | 0.48 |
| Moneyness | -0.03 | 0.02 | -1.64 | 0.08 | |
| Time-under | 0.01 | 0.00 | 13.43 | <0.0001 | |
| Std ratio 1 | 0.49 | 0.01 | 74.80 | <0.0001 | |
| Panel C. All Funds with Style Description | | | | | |
| Intercept | 0.24 | 0.01 | 17.43 | 0.00 | 0.51 |
| Moneyness | -0.04 | 0.01 | -3.58 | 0.02 | |
| Time-under | 0.01 | 0.00 | 13.32 | 0.00 | |
| Std ratio 1 | 0.53 | 0.01 | 78.37 | 0.00 | |

## Table 11
## Contingency Table Test - Different Time Frame for Return Evaluation

This is the same test as in Table 5 with different time basis for return evaluation. Panel A shows the result for return evaluation based on January to July, and Panel B show the result for return evaluation based on January to May. Numbers in the body of the table give the number of funds falling in each classification for all the funds in the sample. Each fund is required to have a complete return history for each calendar year, January to July (May) return is defined as the total fund return measured over the first seven (five) months of each year, and is measured relative to TASS hedge fund index. The variance ratio is defined as the ratio of variance of return in excess of style benchmark for the second six-month period to the variance of the first six-month excess return. Variance ratio low is defined as a variance ratio less than the median for all funds in the calendar year, and variance ratio high is defined as a variance ratio greater than or equal to the median for all funds. Similar results are obtained defining the variance ratio in terms of raw returns as opposed to excess returns. The log-odds ratio is the log of the ratio of the product of the first and fourth columns to the product of the second and third, and the t-value measures significance of this quantity. The Chi-square numbers represent the $\chi^2(1)$ statistics from the 2x2 contingency tables. Note that this contingency table statistic is mis-specified in this application since the cell counts are not in this application since the cell counts are not independent. The log odds ratio statistic is robust to this mis-specification.

| | Panel A: Funds Return January to July | | | | | Panel B: Funds Return January to May | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Funds with January to July Return Less Than Median | | Funds with January to July Return Greater Than Median | | | Funds with January to May Return Less Than Median | | Funds with January to May Return Greater Than Median | | |
| Year | Variance Ratio Low | Variance Ratio High | Variance Ratio Low | Variance Ratio High | Chi-square Test p-value | Variance Ratio Low | Variance Ratio High | Variance Ratio Low | Variance Ratio High | Chi-square Test p-value |
| 1994 | 61 | 106 | 106 | 62 | <0.0001 | 73 | 94 | 94 | 74 | 0.0251 |
| 1995 | 96 | 148 | 148 | 98 | <0.0001 | 126 | 118 | 118 | 128 | 0.4163 |
| 1996 | 181 | 135 | 135 | 182 | 0.0002 | 141 | 175 | 175 | 142 | 0.0077 |
| 1997 | 186 | 219 | 219 | 187 | 0.0225 | 168 | 237 | 237 | 169 | <0.0001 |
| 1998 | 232 | 279 | 279 | 233 | 0.0036 | 255 | 255 | 256 | 257 | 0.9751 |
| 1999 | 224 | 422 | 422 | 226 | <0.0001 | 246 | 400 | 400 | 248 | <0.0001 |
| 2000 | 346 | 453 | 453 | 347 | <0.0001 | 364 | 435 | 435 | 365 | 0.0004 |
| 2001 | 436 | 505 | 505 | 436 | 0.0015 | 440 | 501 | 501 | 440 | 0.0049 |
| 2002 | 495 | 632 | 632 | 496 | <0.0001 | 519 | 607 | 608 | 521 | 0.0002 |
| 2003 | 609 | 694 | 694 | 610 | 0.0009 | 562 | 741 | 741 | 563 | <0.0001 |
| 2004 | 656 | 805 | 805 | 657 | <0.0001 | 669 | 791 | 792 | 671 | <0.0001 |

## Table 12
## Contingency Table Test for Illiquid Styles

This is the same test as in Table 5, but only on the less liquid hedge fund styles. The first-order autocorrelation is used as our liquidity measure. We categorize all styles into liquid styles and illiquid styles, where the latter includes convertible arbitrage, distressed securities, event driven funds, which are less liquid based on the average liquidity measure for all funds within that style. Numbers in the body of the table give the number of funds falling in each classification for all the funds in the sample. Each fund is required to have a complete return history for each calendar year, January to June return is defined as the total fund return measured over the first six months of each year, and is measured relative to TASS hedge fund index. The variance ratio is defined as the ratio of variance of return in excess of style benchmark for the second six-month period to the variance of the first six-month excess return. Variance ratio low is defined as a variance ratio less than the median for all funds in the calendar year, and variance ratio high is defined as a variance ratio greater than or equal to the median for all funds. Similar results are obtained defining the variance ratio in terms of raw returns as opposed to excess returns. The log-odds ratio is the log of the ratio of the product of the first and fourth columns to the product of the second and third, and the t-value measures significance of this quantity. The Chi-square numbers represent the $\chi^2(1)$ statistics from the 2x2 contingency tables. Note that this contingency table statistic is mis-specified in this application since the cell counts are not in this application since the cell counts are not independent. The log odds ratio statistic is robust to this mis-specification. # refers to a significant p-value but with opposite result from the contingency table.

| | Funds with January to July Return Less Than Median | | Funds with January to July Return Greater Than Median | | | |
|---|---|---|---|---|---|---|
| Year | Variance Ratio Low | Variance Ratio High | Variance Ratio Low | Variance Ratio High | Log Odds Ratio | Chi-square Test p-value |
| 1994 | 10 | 16 | 16 | 12 | 0.7577 | 0.1698 |
| 1995 | 20 | 29 | 29 | 22 | 0.6478 | 0.1086 |
| 1996 | 26 | 33 | 33 | 27 | 0.4391 | 0.2330 |
| 1997 | 32 | 42 | 42 | 34 | 0.4832 | 0.1410 |
| 1998 | 46 | 42 | 42 | 47 | -0.2034 | 0.4990 |
| 1999 | 39 | 70 | 70 | 40 | 1.1445 | <.0001 |
| 2000 | 54 | 71 | 70 | 56 | 0.4968 | 0.0503 |
| 2001 | 85 | 65 | 65 | 86 | -0.5482 | 0.0181# |
| 2002 | 87 | 96 | 96 | 88 | 0.1855 | 0.3748 |
| 2003 | 110 | 110 | 110 | 112 | -0.0180 | 0.9246 |
| 2004 | 102 | 129 | 131 | 106 | 0.4466 | 0.0162 |