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Termination Risk, Multiple Managers and Mutual Fund Tournaments

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Abstract. This study analyzes the risk-taking behavior of mutual funds in response to their relative performance over the 1992 to 1999 period. Our results show that managers of funds whose performance is closer to that of the top performing funds have greater incentives to increase their portfolios' risk than managers at the top who exhibit a tendency to lock in their positions. The evidence suggests that termination risk imposes a constraint on the risk taking behavior of underperforming fund managers and the *winner takes all* phenomenon generates a strong incentive for the fund managers to be the top manager. We also analyze the difference in the risk taking behavior of funds managed by multiple managers and single managers.

Key words: mutual fund, tournaments, multiple managers, termination risk

JEL classification codes: G2 L2

1. Introduction

The risk-taking behavior of mutual fund managers in response to their relative performance has recently attracted a great deal of attention. Brown, Harlow and Starks (1996) (hereinafter, BHS) pioneered the study of the tournament effect on mutual fund risk-taking behavior. Using monthly data on a sample of 334 growth-oriented mutual funds for the 1980–1991 period, BHS found that the mid-year loser funds, i.e., those with below median performance, tended to increase their funds' volatility in the latter part of the year more than did the mid-year winner funds, i.e., those with above median performance. The authors argued that their results support the hypothesis that mutual fund competition can be viewed as a tournament among mutual fund managers. This idea is based on the empirical finding that funds that have been winners attract the majority of assets, while the loser funds do not shrink, but rather stay the same. Therefore, the loser funds have nothing to lose and tend to increase the risk of their assets in order to catch up

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with the winner funds and to capture the reward; that is, new asset inflows. The authors further demonstrated that this effect became significant only in the subsample period 1986–1991. They attributed this finding to the investors' increased focus on relative fund performance, which reflects the change in emphasis that began in the mid-1980s.

In another study based on a similar sample period as that in BHS, specifically for 1983-1993, Chevalier and Ellison (1997) found that the worst funds had the lowest risk-taking incentive, while the funds with higher January-September returns increased their risk. In a more recent paper, Berkowitz and Kotowitz (2000) found that new fund investment is positively related to past fund performance with a significant nonlinearity at the upper end of the performance spectrum. The authors pointed out that the fund managers near the inflection point in the upper end of the performance range might have an incentive to increase risk as the marginal rewards to managers are asymmetric at this point.

Busse (2001) used the daily return data of 230 domestic equity funds from 1985 to 1995 to examine how fund managers adjust the risk of their portfolios in response to past returns. He found that the monthly results of BHS disappear with daily data and he attributed this difference to the biases in the estimation of monthly volatility due to daily return autocorrelation.

A couple of authors have tried to reconcile the seemingly contradictory empirical findings in mutual fund tournament behavior. In particular, Chen and Pennacchi (2001) argued that if the portfolio manager's compensation depends on the portfolio's performance relative to an exogenous benchmark, the fund will choose to deviate more from the benchmark portfolio as the fund's performance declines. However, an increase in the "tracking error" of poorly performing funds does not necessarily imply an increase in the variance of the fund's return. Taylor (2001) developed a simple two-period tournament model and showed that winner funds may be more likely to increase the risk of their portfolio if they expected the corresponding loser funds to take additional risks.

The key assumption in these studies is that incentives between portfolio managers and their management companies are perfectly compatible. Therefore, the relationship between new asset inflows and a fund's performance generates an implicit incentive for risk-taking behavior of portfolio managers. However, this assumption ignores the agency problem existing between portfolio managers and their management companies. More specifically, portfolio managers have their own career concerns and incentives for their risk-taking behavior might not be compatible with the incentives of their fund management company. Therefore, it might be too simplistic to explain the risk-taking behavior of fund managers only by the cash inflow-relative performance relationship.

Chevalier and Ellison (1999), to our knowledge, is the only study that has investigated the agency issue inside fund management companies. They examined the career concerns of portfolio managers and investigated how those career concerns affect the fund managers' portfolio choices. The authors found that the termination probability of portfolio manager is a convex function of the performance of the manager. Specifically, for a fund with negative excess returns, the probability of termination decreases steeply with performance, while it is insensitive to the difference in performance for funds with positive returns. In addition, the termination probability of young managers is more sensitive to their performance. As a result, young managers tend to hold less risky portfolios.

The direct implication of the convex relationship between the probability of termination and performance is that the risk-taking incentives of fund managers might be different from those of fund management companies. It is not necessary for mid-year loser fund managers to increase their portfolios' risk to a greater extent than that of the mid-year winner fund managers. For the mid-year under-performing fund managers, the termination probability will increase sharply if they take more risks and if their performance turns out to be even worse. On the other hand, the termination probability will only decrease slightly if their performance improves. Hence, under-performing fund managers might hesitate to increase their portfolios' volatility. In addition, management companies could terminate their contracts with fund managers if they took excess risks. It is an important component of fund managers' contracts that they keep the risk of their portfolios consistent with the objectives of the funds they are managing.

It is clear that termination risk is a serious concern for portfolio managers but not for management companies who can simply fire a portfolio manager and merge her fund to bury the record.[1] Portfolio managers, on the other hand, will try to avoid termination. Therefore, portfolio managers might not behave in a way that is compatible with the incentives facing the fund companies, though the cash inflow-performance relationship generates an implicit incentive for risk-taking behavior of fund companies. Essentially, the risk-taking behavior of mutual funds, in response to their relative performance, reflects the rational choices of fund managers who consider the benefit and cost of adjusting their portfolios' risk. Chevalier and Ellison (1999) pointed out, "... non-linearities in the relationship between the flow of new assets into mutual fund and fund performance may also lead to distortions in the fund's risk incentives. However, this literature does not consider incentives of the fund managers; these could well differ from those of the fund companies" (p. 406).

The first contribution of this paper is that it provides new insights into fund Managers' risk-taking behavior. This study analyzes the risk-taking behavior of fund managers in response to their relative performance from 1992 to 1999 and differs from previous studies in a number of ways. In this paper, we examine a sample of growth- oriented funds using a survivorship bias-free data set. Previous studies, like BHS and Chevalier and Ellison, were subject to survivorship bias and neglected to examine the risk-taking behavior of dead funds in the year before they were terminated. Busse (2001) did examine the risk-taking behavior of dead funds,

[1] For example, Elton, Gruber and Blake (1996) found that fund companies merge funds that are doing poorly into partner funds that have excellent performance.

but his sample is much smaller than the one used here. We show that dead funds, on the average, perform poorly in the mid- year before the year they are terminated. While BHS would predict that those funds would have a high risk adjustment in the second half of the year, we find that they had less of an incentive to take on additional risk. The results suggest that survivorship bias will result in an over-estimation of the risk adjustment of under-performing funds, when analyzing the relationship between fund managers' risk adjustments in the second half of the year and their relative performance in the first half of the year.

Using both a contingency table test and semi-parametric regression analysis, we find the unexpected result that mid-year loser funds have less incentives to increase their funds' risk relative to mid-year winner funds. Our results indicate that the tournament argument presented by the BHS (1996) (that loser funds take more risk than do winner funds in the second half of the year) does not hold in the sample period 1992-1999. In addition, top funds tend to "lock in" their position while funds whose performance is closer to top funds, have greater incentives to alter their portfolio risk. In the extreme, the poorest performing funds also exhibit a strong tendency to lock in their position.

Our study also documents new cash-inflow and relative-performance relationships in the period 1992–1999. We show that the mutual fund industry exhibited the "winner takes all" phenomenon in that period. The best funds enjoy a much higher average growth rate than do other funds. For example, the average growth rate of the funds in the top decile group is more than 2 times that of the funds in the next highest decile group. The termination risk, survivorship bias and "winner takes all" phenomenon could jointly explain the difference between our results and those of BHS. Most important, termination risk appears to impose a constraint on the excess risk-taking behavior of the fund managers.

The second contribution of this paper is that we highlight how the employment of multiple-manager arrangements in a fund company affects the risk-taking behavior of those fund managers. The implementation of this arrangement for investment management has been increasingly popular in the mutual fund industry, especially in recent years. Sharpe (1980) explored the motivation for employment of multiple managers for a single fund. The idea is that the danger of the overall fund performance being damaged by serious decision errors of a single manager could be mitigated by the employment of multiple managers. Barry and Starks (1984) propose yet another motivation for the employment of multiple managers. They show that due to the risk sharing between managers, the optimal risk level of the fund increases as the number of managers increases, and that investors may benefit from the higher risk taken by multiple managers.

Despite the theoretical justification for the employment of multiple managers, to the best of our knowledge, there has been no empirical evidence on how the multiple-manager arrangement affects the risk-taking behavior of mutual fund managers. Given the increasing popularity of this arrangement affects the risk-taking behavior of mutual fund managers. the increasing popularity of this arrangement in the mutual fund industry, it is important to provide insights of the effects of multiple-manager arrangements. This paper empirically tests whether the multiple-manager arrangement affects fund managers' risk-taking decision. We find that single managers, especially for loser funds, alter their portfolios' risk more than do multiple managers. The multiple-manager arrangement appears to be an effective way to reduce the overall risk-taking incentives of fund managers. These results, however, can be attributed to the different characteristics of single and multiple-manager arrangements as well as the difference in their decision-making processes.

The rest of the paper is organized as follows: The next section describes the data and provides background information on the governance structure inside a management company. Section 3 investigates risk-taking behavior of fund managers in response to their relative performance during the sample period 1992–1999. It also examines the risk-taking behavior of terminated funds and the relationship between cash inflow and relative performance. Section 4 examines how multi-manager arrangements affect fund managers' risk-taking behavior. The last section summarizes and concludes the paper.

2. Data

The sample funds are the growth-oriented funds in the CRSP Survivorship Bias Free Mutual Fund Database from 1992–1999. There are a number of reasons why the analysis is restricted to this period. The CRSP Supplementary Annual Data File provides complete information on the names of fund managers only after 1992. It lists the names of the individual fund managers who are responsible for each fund's sub-accounts' security choices. Moreover, within this sample period has been a dramatically increasing degree of competition among fund managers. The summary statistics for those funds are provided in Table I. In 1992, there were only 779 funds, and by 1999 this number increased to 3516. Clearly, the industry became much more competitive in the late 1990s. Therefore, the tournament effect on the risk-taking behavior of fund managers would have been expected to become more pronounced in the 1990s and even more so in the late 1990s. Hence, the period 1992–1999 provides a better experimental sample period relative to previous studies to investigate fund managers' risk-taking behavior in response to their relative performance.

Another important feature of this sample period is the consistent termination rate among funds. Although the whole industry grew very fast during the sample period, the number of funds that died also increased; in particular, from 41 in 1992, the number climbed to 137 in 1999. The termination rate was consistently around 4%–5%. This ratio is certainly not trivial and might influence the risk-taking behavior of mutual funds. Unfortunately, the studies by BHS (1996) and Chevalier and Ellison (1997) are all subject to survivorship bias issues.

Table I. Summary statistics of the data

Year	Number of funds	Average compounded return	Average size (millions)	Average growth rate	Average 12b1 fee	Number of dead funds	Percentage of multiple managers
1992	779	0.09	429.6	0.367	0.19%	41	16.11%
1993	996	0.12	469.9	0.370	0.20	43	15.73
1994	1261	−0.02	405.8	0.283	0.34	46	18.04
1995	1582	0.31	495.8	0.480	0.27	75	21.53
1996	1912	0.19	560.5	0.407	0.30	75	27.35
1997	2431	0.23	604.7	0.641	0.30	90	34.98
1998	2943	0.14	612.1	0.385	0.33	130	39.39
1999	3516	0.28	671.2	0.197	0.36	138	44.82

This table reports the summary statistics of sample funds for the period from 1992 to 1999. The sample funds are the growth-oriented equity funds in the CRSP database. Number of Funds is the number of funds that exist at the beginning of the year. The Average Size is the average of the total net assets of funds of the year. Growth Rate is defined in equation (3). Average 12b1 Fee is the average of each fund's 12b1 fee of year t. Number of Dead Funds is the number of funds terminated in the year t. Percentage of Multiple Managers is the percentage of funds managed by more than one manager.

Finally, within this period there has been increasing employment of multiple managers within funds. The governance structure within a mutual fund complex is unique relative to other corporate governance structures. Figure 1 describes the typical structure of a mutual fund complex. Within this governance structure, the management company is responsible for its mutual fund shareholders, but delegates to portfolio managers the decision-making responsibility regarding the composition of investment portfolios. There are two agency relationships associated with the delegation of decision-making responsibilities. First, shareholders delegate to management companies the choice of portfolio managers. Next, management companies delegate to portfolio managers security selection. Management companies may choose single manager or multiple managers to be responsible for the portfolio choice decisions. As of 1992, only 16% of funds were managed by more than one manager. This number increased to 46% in 1999. The increasing employment of multiple managers was due partially to an increase in the average size of funds. The average size of funds was $429.6 million as of 1992, and rose to $671.2 million in 1999.

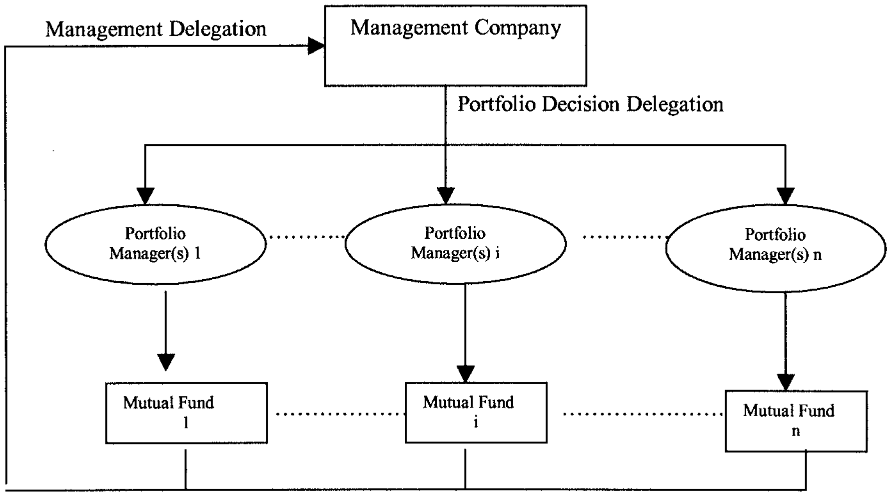

Figure 1. The governance structure of a mutual fund management company.

3. Termination Risk and Risk-taking Behavior of Fund Managers

3.1. CONTINGENCY TABLE TESTS

Following BHS, we test whether the funds' relative performances in the first period of the year explains the change in the volatility of fund returns in the second period of the year. For each year, we calculate each fund's relative risk adjustment ratio, RAR_i, for the first period and compounded return, RTN_i, for the second period. The RAR_i is defined as,

$$\mathrm{RAR}_i = \sqrt{\frac{\sum_{m=M+1}^{12}(r_{im} - \bar{r}_{12-M})^2}{(12-M)-1}} \div \sqrt{\frac{\sum_{m=1}^{M}(r_{im} - \bar{r}_{M})^2}{M-1}}, \tag{1}$$

where M is the number of months in period 1; $12 - M$ refers to the number of months in period 2. Since CRSP only provides monthly return information, the RAR_i in Equation (1) is calculated based on few monthly observations. As Busse (2001) pointed out, such a measure could be very noisy. The RTN for period 1 of fund p is defined as the compounded return of fund i in period 1,

$$\mathrm{RTN}_i = (1 + r_{i,1})(1 + r_{i,2}) \ldots (1 + r_{i,m}) - 1. \tag{2}$$

For each fund, we compute its relative risk adjustment ratio and compounded return for each year that the fund exists. Each fund is then allocated into a two-by-two contingency table according to the fund's RTN relative to the median fund RTN, and the fund's RAR relative to the median fund's RAR. The null hypothesis for the χ^2 tests is that each cell is independent and that the percentage in each cell is 25%, which means that the fund's risk adjustment ratio in period 2 is independent of its compounded return in period 1.[2] We also choose different first periods (e.g., January through April or January through May, etc.) to test the risk-taking behavior of fund managers.

3.2. SIMULATIONS

Busse (2001) and Goriaev, Nijman and Werker (2001) showed that the χ^2 tests used in BHS are incorrect. The reason is that the monthly returns of each mutual fund are cross-correlated and the assumption in χ^2 tests is that the fund returns are independent. The cross-correlation in fund returns will make the χ^2 tests reject the null hypothesis too often. In order to account for the bias in standard χ^2 tests, following Goriaev, Nijman and Werker (2001), we first estimated the variance and covariance of the mutual fund returns. Then, we simulated frequency distributions of the percentage of funds allocated to the low RTN, high RAR cell in two-by-two contingency tables. The experiment is based on 10,000 simulations under the null hypothesis that risk does not change, but assuming that the mutual funds' returns are normally distributed with variance-covariance estimated from the sample period. We report both the theoretic p-values and the empirical p-values, but we will interpret the results based only on the empirical p-values.

The results for the risking-taking behavior of loser and winner funds are presented in Table II. Panel A shows that a greater percentage of winner funds rather than loser funds exhibits a high RAR. For example, using January-July as the first period, 56.18% (28.09% $\times$ 2) of the winner funds and only 43.80% (21.90 $\times$ 2) of loser funds exhibit high RAR. Consistent with previous findings, the standard χ^2 statistics tend to over-reject the null hypothesis. For example, using January–April as the first period, the χ^2 statistics are significantly above the 10% level, but the empirical p-value is 0.3. The χ^2 statistics and empirical p-values are most significant for period 1, of January through July (i.e., 7, 5).[3] However, the results are the opposite of the tournament hypothesis proposed by BHS.

To avoid the "Window Dressing" behavior of the fund at the end of the year, we do not include the December returns from the analysis. The results for the

[2] The basic idea of BHS is that losers have nothing to lose and yet can attract new cash inflow by increasing their relative performance, so that they increase the volatility of their portfolios to catch up with winners. Winners, in turn, will try to lock in their position. Then, on the average, it would be expected that,

$$\text{RAR}_L > \text{RAR}_W.$$

The hypothesis of the above equation is that the risk adjustment ratio of loser funds in period 1 will be greater than the RAR_W of the winner funds. The RAR_i of fund i is calculated by Equation (1).

[3] As BHS (1996) pointed out, this pattern is consistent with the notion that fund managers respond to their positions after the release of the second quarter ranking information, which is the primary information that the financial press and information services report during the year.

Table II. Frequency distributions of 2 × 2contingency tables of return and risk adjustment ratio, 1992–1999

		Sample frequency (% of observations)						
		Low RTN		High RTN				
(Period 1, Period 2)	Obs.	"Low" RAR	"High" RAR	"Low" RAR	"High" RAR	χ^2	p-value	Empirical p-value
A: All monthly returns								
(4, 8)	15420	24.63	25.37	25.35	24.65	3.21	0.073	0.300
(5, 7)		26.58	23.42	23.09	26.59	62.64	0.000	0.094
(6, 6)		27.65	22.34	22.31	27.69	176.83	0.000	0.001
(7, 5)		28.08	21.90	21.90	28.09	236.26	0.000	0.000
(8, 4)		25.15	24.84	25.55	24.44	3.99	0.046	0.501
B: Excluding December returns								
(4, 8)	15420	24.72	25.29	25.57	24.43	4.46	0.035	0.300
(5, 7)		26.86	23.14	23.44	26.57	72.21	0.000	0.070
(6, 6)		27.34	22.67	22.96	27.05	118.10	0.000	0.002
(7, 5)		27.60	22.40	22.69	27.31	148.18	0.000	0.000
(8, 4)		25.97	24.04	25.97	24.04	16.62	0.000	0.263

This table reports the percentage of funds allocated to each of four cells in a two-by-two contingency table based on compounded return, RTN, of period 1 and risk adjustment ratio, RAR, in period 2 relative to median RTN and median RAR respectively. The null hypothesis for the χ^2 tests is that each cell is independent and that the percentage in each cell is 25%, which means that RAR is independent of RTN. The p-value is based on the standard χ^2 test. The empirical p-value is based on simulated frequency distributions of the percentage of funds allocated to the low RTN, high RAR cell in two-by-two contingency tables. Panel A shows the results for all monthly returns. Panel B shows the same results but excluding the December return. Obs. is the number of observation. (Period 1, period 2) indicates the number of months included in the first period and second period, respectively.

contingency table test, which excludes the December returns, are presented in Panel B. These results are similar as those in Panel A.

One explanation for these results may be the difference in risk-taking constraints imposed by different types of funds. The rationale is that managers of aggressive funds presumably may be allowed to invest in more risky stocks than are managers of long-term growth and growth and income funds. Therefore, low risk funds might, on the average, have lower returns in the first period and might also face greater constraints to increase their risk in the second period. Hence, there will be a spurious relationship between the return and the risk adjustment ratio. In order to see if the objectives of funds affect these results, funds are divided into three sub-groups according to their objectives: Aggressive Growth (AG), Long-Term Growth (LG) and Growth and Income (GI). The contingency table test was

Table III. Comparative frequency distributions for different objective funds' sub-tournaments, 1992–1999

Objectives	Obs.	Sample frequency (% of observations)				χ^2	p-value	Empirical p-value
		Low RTN		High RTN				
		"Low" RAR	"High" RAR	"Low" RAR	"High" RAR			
AG	4535	26.26	23.74	23.78	26.23	9.40	0.002	0.165
LG	6653	26.99	23.01	23.03	26.97	42.04	0.000	0.048
GI	4032	29.16	20.85	20.87	29.27	112.96	0.000	0.000

This table reports the contingency tests for different objective funds. The funds are divided into three groups according to their objective: aggressive growth (AG), long-term growth (LG) and growth and income (GI). For each group, the table shows the percentage of funds allocated to each four cells in a two-by-two contingency table based on compounded return, RTN, of period 1 and risk adjustment ratio, RAR, in period 2 relative to median RTN and median RAR in each group, respectively. The null hypothesis for the χ^2 tests is that each cell is independent and that the percentage in each cell is 25%, which means that RAR is independent of RTN. The p-value is based on the standard χ^2 test. The empirical p-value is based on simulated frequency distributions of the percentage of funds allocated to the low RTN, high RAR cell in two-by-two contingency tables.

performed for each group of funds. The results for the sub-tournaments for each type of fund are presented in Table III. These findings show that the tournament hypothesis, according to which interim losers increase their funds' risk more than interim winners, is not supported for sub-tournaments among different objective funds. We also perform our tests for the two sub-sample periods, 1992–1995 and 1996–1999. Table IV presents the risk-taking behavior for winners and losers in the two sub-sample periods. The results are not significant for the 1992–1995 sub-sample period, but are significant for the latter 1996–1999 period. Again, however, this result runs in the opposite direction from the one that is suggested by the tournament hypothesis.[4]

3.3. INCENTIVES AND TERMINATION RISK IN RISK-TAKING BEHAVIOR

Strikingly, the tournament effect documented by BHS, where the mid-year loser funds tend to increase their portfolios' risk to a greater extent relative to the mid-year winner funds in the second part of the year, disappears in the present sample period, which presumably is a much more competitive period. There are a number of reasons why we expect our results to differ from those in BHS.

As Chevalier and Ellison (1999) pointed out, the incentives for fund managers might not be the same as that for fund management companies. The risk-taking

[4] As a further check, we do the contingency table test across years, and only the result of year 1995 supports the tournament hypothesis. For the other years, the result based on empirical p is either insignificant at conventional levels or significant but in contrast to the tournament hypothesis.

Table IV. Frequency distributions of 2 × 2 contingency tables of return and risk adjustment ratio for the two sub-sample periods, 1992–1995 and 1996–1999

Sample period	Obs.	Sample frequency (% of observations) Low RTN "Low" RAR	Low RTN "High" RAR	High RTN "Low" RAR	High RTN "High" RAR	χ^2	p-value	Empirical p-value
A: Full sample period								
1992-1999	15420	27.65	22.34	22.31	27.69	176.83	0.000	0.001
B: Four-year periods								
1992–1995	4618	25.80	24.20	24.13	25.68	5.13	0.023	0.223
1996–1999	10802	28.44	21.56	21.54	28.46	207.24	0.000	0.000

This table reports the contingency tests for different sample periods: 1992–1995 and 1996–1999. It shows the percentage of funds allocated to each four cells in a two-by-two contingency table based on the compounded return, RTN, of period 1 and risk adjustment ratio, RAR, in period 2 relative to median RTN and median RAR, respectively. The null hypothesis for the χ^2 tests is that each cell is independent and that the percentage in each cell is 25%, which means that RAR is independent of RTN. The p-value is based on the standard χ^2 test. The empirical p-value is based on the simulated frequency distributions of the percentage of funds allocated to the low RTN, high RAR cell in the two-by-two contingency tables. Panel A shows the results for the full sample period. Panel B shows the results for the two sub-sample periods, 1992–1995 and 1996–1999. Obs. is the number of observations in each period.

behavior of fund managers might be affected by their own career concerns, as well as the performance of the fund – cash inflow relationship. When fund managers alter their portfolio risk, one serious concern for them, especially for under-performing fund managers, is the termination risk. Hence, fund managers will consider expected gain and expected loss when they adjust the risk of their portfolios. Under-performing fund managers, by increasing the risk of their portfolios in order to raise the probability of catching up with winners, also increase the probability of termination. If the probability of termination is a convex function of fund managers' performance (Chevalier and Ellison, 1999), then we would expect that the worse the mid-year performance of a fund, the more cautious the fund manager would be to take on additional risk. Moreover, excess risk-taking behavior could invoke the termination of fund managers since it might make a fund's risk level inconsistent with the fund's objective. Hence, unless the benefit of increasing the risk out-weighs the cost, a fund manager will not take on additional risk.

Due to increasing competition in the industry, information on the relative performance of mutual funds is more readily accessible from the 1990's. The relationship between cash inflows and relative performance might be different from earlier years. Sirri and Tufano (1998) examined the relationship between cash inflow and a fund's relative performance for the sample period 1971–1990. They found that a fund's cash inflow is a call option-like function of a fund's relative performance: Funds performing above the median attract new assets, while funds performing below the median do not lose assets. To see if there are any changes in the relationship between cash inflow and relative performance of a mutual fund in our sample period 1992–1999, we divide the funds into deciles according to their relative performance. For each decile, the mean growth rate of funds in that decile is calculated. The growth rate is defined as,

$$\text{Growth}_{i,t} = \frac{(\text{TNA}_{i,t} - \text{TNA}_{i,t-1})}{\text{TNA}_{i,t-1}} - \text{return}_{it}, \tag{3}$$

where the $\text{TNA}_{i,t}$ is the total net asset of a fund i in December of year t; $\text{return}_{i,t}$ is the compounded return of a fund i in year t.

Table V reports the average growth rate of different decile funds. These results show that new asset inflows are significantly related to the relative performance of the funds.[5] The annual growth rate of a fund declines with the decrease in its relative performance. However, the most interesting pattern in this period is that the best funds attract much more new assets than do the others. The average annual growth rate of the best funds is remarkably higher than the second best. The average annual growth rate of the first decile funds (best funds) is 0.821, which is more than twice the average growth rate of the second decile funds, 0.379. With further division of the first and last deciles into three groups respectively, the average growth rate of the best funds, decile 1.1, is much higher than the others. The average growth rate is 1.573 for the decile 1.1 funds, while it is only 0.572 for the decile 1.2 funds. Comparing the cash inflow-relative performance relationship before and after the 1990s, the fund industry exhibited the feature "winner takes all" in the period 1992–1999.[6]

[5] As in Chevalier and Ellison (1997), due to exceptional noise, funds whose ages were less than 2 at the end of year t and funds with less than 10 million in assets at the end of year t are excluded from the sample. One potential problem with this sample is that when the prior period total net assets are small, the growth rate defined by equation (3) might be high. As an alternative robustness check, we also define the growth rate as the min ($\text{Growth}_{i,t}$, 1) and do not exclude any data. Given that the maximum growth of the fund is constrained to 1, the average growth rates for each decile funds decrease. However, the average growth rate of the top funds is still significantly higher than that of the second best funds. The average growth rate of decile 1 funds is 0.60 while the average growth rate of decile 2 funds is 0.36. It is reasonable that the constraint has a greater impact on the average growth rate of decile 1 funds because more funds in decile 1 have growth rates exceeding 1.

[6] The growth rate defined by equation (3) is sensitive to the prior period's total net assets. The average size of the decile 1 funds is 783 million while the average size of decile 2 fund is 1043 million in our sample. To see if the high average growth rate of decile 1 funds is due to their relatively smaller sizes, we regress the growth rate of each fund in decile 1 and 2 on its lag size, year dummies and a dummy variable which is equal to 1 if the fund is in decile 1 and zero if the fund is in decile 2. The results, though not reported here, show that the coefficient of the lag size is not significant at the 5% level, while the coefficient of the decile 1 dummy is significant at the 5% level. The results suggest that the high growth of decile 1 funds is not due to their small initial size. In fact, the average initial size of decile 1 funds is only smaller than those of decile 2 and decile 3 funds, but bigger than the

Table V. The relationship between mutual fund growth and relative performance

Performance	Annual growth rate					
	1992–1999		1992–1995		1996–1999	
Decile	Mean	Std	Mean	Std	Mean	Std
1.1	1.573	5.64	1.610	6.47	1.555	5.21
1.2	0.572	1.89	0.307	0.59	0.682	2.20
1.3	0.429	1.68	0.454	1.82	0.419	1.68
1(best)	0.821	3.45	0.776	3.87	0.840	1.68
2	0.379	2.48	0.202	0.64	0.459	2.95
3	0.306	2.91	0.267	1.16	0.215	1.12
4	0.219	1.73	0.146	0.66	0.249	2.01
5	0.178	0.94	0.288	1.44	0.131	0.60
6	0.196	1.63	0.139	0.63	0.218	1.89
7	0.149	1.07	0.162	1.32	0.144	0.95
8	0.139	1.09	0.165	1.38	0.128	0.95
9	0.073	0.67	0.081	0.66	0.070	0.67
10 (worst)	0.070	0.66	0.067	0.61	0.072	0.68
10.1	0.063	0.44	0.064	0.41	0.063	0.44
10.2	0.088	0.69	0.059	0.36	0.100	0.79
10.3	0.062	0.80	0.077	0.90	0.055	0.76

This table shows the relationship between the growth rate of mutual funds in year t and their relative performance in year $t-1$. The funds are divided into deciles according to their year $t-1$ performance. The decile 1 (best) and decile 10 funds (worst) are further divided into three groups. The decile 1.1 funds are the best-performing group among the decile 1 funds. The decile 10.3 funds are the worst-performance group among the decile 10 funds. The annual growth rate is defined in equation (3). The funds whose ages are less than 2 at the end of year t and the funds whose total net assets are less than 10 million are excluded from the sample.

Given the huge gap between the payoff of the best fund and the other funds, there are strong incentives for fund managers to become top managers.[7] If fund managers consider the expected gain and the expected loss to adjust their portfolios' risk, one would expect that fund managers whose mid-year performance

average size of any other decile funds. Similar results are found in Berkowitz and Kotowitz (2000), who used the Jensen alpha as the performance measure.

7 Though a greater cash inflow provides a direct incentive for funds to become top funds, the benefit of being the top fund is certainly not restricted only to the cash inflow. For example, every year, many newspapers and websites list the top funds and managers in the industry. To be the top fund manager certainly would give the managers much better reputation than the second best managers.

is closer to top funds, would have greater incentives to increase the portfolios' risk since there is a higher probability of catching up with the winner and a lower probability of being terminated. In contrast, the poor performance fund managers might have less incentives to increase their risk due to the lower probability of catching up to top fund managers and a higher downside termination risk.

To test this hypothesis, we divide the funds into deciles according to their January–July compounded returns. The risk-taking behavior of different decile funds are presented in Table VI. As expected, the top decile funds exhibit the tendency to "lock in" their positions. The better performing funds, whose performance is below the top decile funds but above median funds, exhibit the greatest incentive to take more risk. Even more interesting is the fact that the poorer the performance of the under-performing funds, the lower is the incentive for them to take more risk. For example, only 53 percent of funds with a ranking in decile 7 belong to the low RAR, while 65 percent of funds within decile 10 belong to the low RAR.

3.4. SURVIVORSHIP BIAS: THE RISK-TAKING BEHAVIOR OF TERMINATED FUNDS

As we have shown above, under-performing funds have a lower risk adjustment than do high-performing funds. Therefore, if under-performing funds are more likely to be terminated, and if the sample includes only funds that survive, the results will over-estimate the risk adjustment ratio of under-performing funds. Previous studies (for example, BHS (1996) and Chevalier and Ellison (1997)) were affected by the survivorship bias. Table VII provides the relative performance and risk-taking behavior of those dead funds before they were terminated.[8] The relative performance of fund managers is measured as,

$$\text{RPM}_{i,t} = 1 - \frac{\text{Ranking}_{i,t} - 1}{N_t}, \tag{4}$$

where $\text{Ranking}_{i,t}$ is the ranking of fund i in time t according to its compounded return. N_t is the total number of funds in time t. The relative performance measure, $\text{RPM}_{i,t}$, indicates the proportion of fund managers whose performance is below fund i at time t. The higher the relative performance of fund manager, the greater is the RPM. Table VII reveals that terminated funds do have lower relative performance. The average RPM for terminated funds in the two years prior to when they were terminated is 0.383. Their average RPM decreases to 0.327 in the mid-year before the year they were terminated, suggesting persistence in their performance. The average relative performance of terminated funds is not extremely poor but does under-perform the median fund. Interestingly and counter-intuitively, these

[8] Chevalier and Ellison (1999) defined the termination of fund managers in two ways: first, fund managers whose positions are replaced by other fund managers. Second, the funds disappear in the data. Since the replacement of fund managers could mean demotion or promotion, we restrict our analysis to funds that disappear in our data.

Table VI. Risk-taking behavior of mutual funds ranked by deciles

Performance Decile	Risk adjustment ratio: All months Low	High	Excluding December Low	High
1.1	55.11	44.89	60.89	39.11
1.2	50.58	49.42	55.64	44.36
1.3	42.36	57.64	50.10	49.90
1 (best)	49.32	50.68	55.58	44.42
2	41.03	58.97	43.63	56.37
3	44.14	55.86	47.70	52.60
4	40.14	59.66	40.99	59.01
5	44.72	55.28	39.27	60.73
6	48.67	51.33	45.50	54.50
7	52.53	47.47	50.91	49.09
8	56.45	43.55	56.90	43.10
9	59.23	40.77	58.84	41.16
10 (Worst)	65.08	34.92	63.91	36.09
10.1	61.14	37.86	61.55	38.45
10.2	65.69	34.31	64.13	35.87
10.3	67.39	32.61	66.01	33.99

Table VI shows the risk-taking behavior of different decile funds. The funds are divided into deciles according to their January–July compounded returns. For each group, the table shows the percentage of funds belonging to the Low group, i.e., the funds whose RAR are below the median RAR, or High group, i.e., the funds whose RAR are higher than median RAR. All Months means all the monthly returns are included in calculating the RAR. Excluding December means the December returns are excluded in calculating the RAR. The best and worst deciles are further divided into three groups, respectively, according to their January–July compounded return Decile 1.1 is the best performing group among decile 1 funds, while decile 10.3 is the worst performing group among decile 10 funds.

fund managers do not take excess risks in the year before the termination year. We find that there are only 39.6% of fund managers who have high RAR, while 60.4% of them have a low value of RAR. Again, the results are the same for the two sub-sample periods. The results suggest that excluding the terminated funds in the sample will over-estimate the RAR of the under-performing funds.

Table VII. Risk-taking behavior of fund managers before termination

Sample periods	RPM in two years before the termination year	RPM in the mid-year of year before the termination year	Low RAR	High RAR
1992–1999	0.383	0.327	60.4%	39.6%
1992–1995	0.398	0.334	54.9%	45.1%
1996–1999	0.371	0.332	64.3%	36.7%

This table shows the risk-taking behavior of terminated funds in the year before they were terminated. RPM is the relative performance measure, which is measured as,

$$\mathrm{RPM}_{i,t} = 1 - \frac{\mathrm{Ranking}_{i,t} - 1}{N_t},$$

where $\mathrm{Ranking}_{i,t}$ is the ranking of fund i in time t according to their compounded return in time t. N_t is the total number of funds at time t. Column 2 and 3 show the average RPM of the terminated funds in two years before they were terminated and RPM in July of the year before they were terminated, respectively. For the terminated funds, columns 4 and 5 show the percentage of funds belonging to the Low RAR group, the funds whose RAR are below the median RAR, or High RAR group, the funds whose RAR are higher than median RAR. Row 1 reports the results for the full-sample period of 1992–1999, while row 2 and row 3 report the results for two sub-sample periods of 1992–1995 and 1995-1999, respectively.

3.5. SEMI-PARAMETRIC ANALYSIS

In this subsection, we examine in more detail how the fund managers manipulate their portfolio risk in response to their relative performance. The results in Table VI suggest a nonlinear relationship between changes in the portfolio risk by fund managers in the second part of the year and their relative performance in the first part of the year. The contingency table test, however, does not control for other fund characteristics that might affect the fund's portfolio risk. Previous studies suggest that the risk-taking behavior of fund managers is influenced by a fund's size, its age and its objectives. Therefore, in order to estimate the shape of the risk adjustment - relative performance relationship in more detail, but controlling for other fund characteristics as well as year effects, a semi-parametric regression model is particularly appropriate. In the semi-parametric regression model, we model the risk adjustment – relative performance relationship nonparametrically to avoid any functional form assumption on this relationship, while the other variables enter parametrically. Specifically, we estimate the following semi-parametric model,[9]

$$\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} = f(\text{RPM}_{i,t}^{(1)}) + \beta_1\sigma_{i,t}^{(1)} + \beta_2\text{AGE}_{i,t} + \beta_3(\text{Log(SIZE)}_{i,t}^{(1)}) + \beta_4\text{LG}_i + \beta_5\text{GI}_i + \sum_{t=1992}^{1999}\mu_t\text{YEARUM}_t + \varepsilon_{i,t}, \quad (5)$$

where $\text{RPM}_{i,t}$ is the relative performance of fund managers i at time t, which is defined in Equation (4). f denotes a generic smooth function, which represents the risk adjustment – relative performance relationship after controlling for the parametric effects of other – variables. The $\sigma_{i,t}(j)$ is the standard deviation of the return of fund i in period j of the year t. $\sigma_{i,t}^{(1)}$ is included to control for the initial risk level in period 1 and measurement error which is suggested by Koski and Pontiff (1999). $\text{AGE}_{i,t}$ is the age of fund i at time t. $\text{Log(SIZE)}_{i,t}^{(1)}$ is the logarithm of fund i's total net assets in period 1 in year t. LG_i is a dummy variable which is equal to 1 if fund i's objective is long-term growth and 0 otherwise. GI_i is also a dummy variable which is equal to 1 if fund i's objective is growth and income and 0 otherwise. YEARDUM_t is the dummy variable which is equal to 1 if the year is year t and 0 otherwise.

We estimate equation (5) using differencing techniques (Yatchew (1997, 1998) that substantially simplify the estimations and testing.[10] Table VIII reports the estimation results for the parametric effects. A fund's age and size do not have significant effects on its manager's risk adjustment. The objective of the fund,

[9] As a preliminary check, we first test a linear parametric model. The coefficient for RPM is positive and significant at the 1% level. Then we test the linear specification against non-linear specification. The z-statistic

$$Z = N^{1/2}(S_{\text{ols}}^2 - S_{\text{diff}}^2)/S_{\text{diff}}^2$$

follows an asymptotically normal distribution $N(0, 4\delta)$. S_{ols} is the sum of residuals from the parametric model while S_{diff} is the sum of residuals from the nonparametric model using the differencing method. δ is equal to $(10m + 14)/3m(m + 1)$ and m is the order of differencing, which is equal to 10. The specification test statistics is 3.65 and we are able to reject the null hypothesis of linear specification at the 1% level.

[10] The idea of differencing in estimating the nonsemiparametric model has been exploited in the literature (see, e.g., Powell (1987), Ahn and Powell (1993), and Hall et al. (1990)). In this paper, we use the differencing method proposed by Yatchew (1997). In order to estimate the nonparametric effect, $f(x)$, in a nonsemiparametric regression model $y = f(x) + z\boldsymbol{\beta} + \boldsymbol{\varepsilon}$, the data were first arranged in order and then differenced to remove the nonparametric effect. Then, standard parametric estimation techniques, such as OLS can be applied to reordered and differenced data to estimate the parametric coefficients $\boldsymbol{\beta}$ (under mild conditions, the OLS estimators are consistent). Finally, the estimated function form of f is obtained by employing a standard kernel regression of $y - z\boldsymbol{\beta}$ on x. The difference order here is set to 10. (See Yatchew (1998) for the details of the estimation procedure).

Table VIII. Semi-parametric analysis of risk-taking behavior in response to relative performance

Independent variables	Coefficient	t-statistics
$\sigma_{i,t}^{(1)}$	−0.438	−35.27
$\text{Age}_{i,t}$	0.17e-4	1.70
$\text{Log(SIZE)}_{i,t}^{(1)}$	−0.10e-3	−1.57
LG_i	−0.006	−8.00
GI_i	−0.003	−13.18
R^2	0.77	

This table provides the parametric estimation for the semi-parametric model,

$$\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} = f(\text{RPM}_{i,t}^{(1)}) + \beta_1\sigma_{i,t}^{(1)} + \beta_2\text{AGE}_{i,t} + \beta_3(\text{Log(SIZE)}_{i,t}^{(1)} + \beta_4\text{LG}_i + \beta_5\text{GI}_i + \sum_{t=1992}^{1999}\mu_t\text{YEARDUM}_t + \varepsilon_{i,t},$$

where $\text{RPM}_{i,t}$ is the relative performance of fund managers i at time i, which is defined in Equation (4). $\sigma_{i,t}^{(j)}$ is the standard deviation of the return of fund i in period j of year t. $\sigma_{i,t}^{(1)}$ is to control for the initial risk level and measurement error which is suggested by Koski and Pontiff (1999). $\text{AGE}_{i,t}$ is the age of fund i at time t. $\text{Log(SIZE)}_{i,t}^{(1)}$ is the logarithm of fund i's total net assets in period 1 in year t. LG_i is a dummy variable which is equal to 1 if fund i's objective is long-term growth and 0 otherwise. GI_i is also a dummy variable which is equal to 1 if fund i's objective is growth and income and 0 otherwise. YEARDUM_t is the year dummy variables. We estimate the model using Yatchew's (1998) differencing method.

however, does affect the risk-taking behavior of fund managers. The results appear to be reasonable. Other things being equal, especially if funds have the same level of initial risk, growth and income fund managers will be more constrained in taking on additional risk.[11]

Having estimated the parametric effects, we remove these from the dependent variable and estimate the RPM effect nonparametrically. Figure 2 presents the functional form of $f(\text{RPM})$, which represents the relationship between risk adjustment and relative performance of fund managers after removing the parametric effects of other variables. The results are similar to those of the contingency table analysis. Top fund managers tend to lock in their position while fund managers who are close to the top fund managers are more likely to adjust their portfolio risk. Further, under-performing fund managers whose performance is lower than median (RPM less than 0.5), exhibit less of an incentive to increase their portfolio's risk.

[11] The result here is not conflicting with the result in Table III. Here we control for the initial risk level, while in the contingency table analysis we did not.

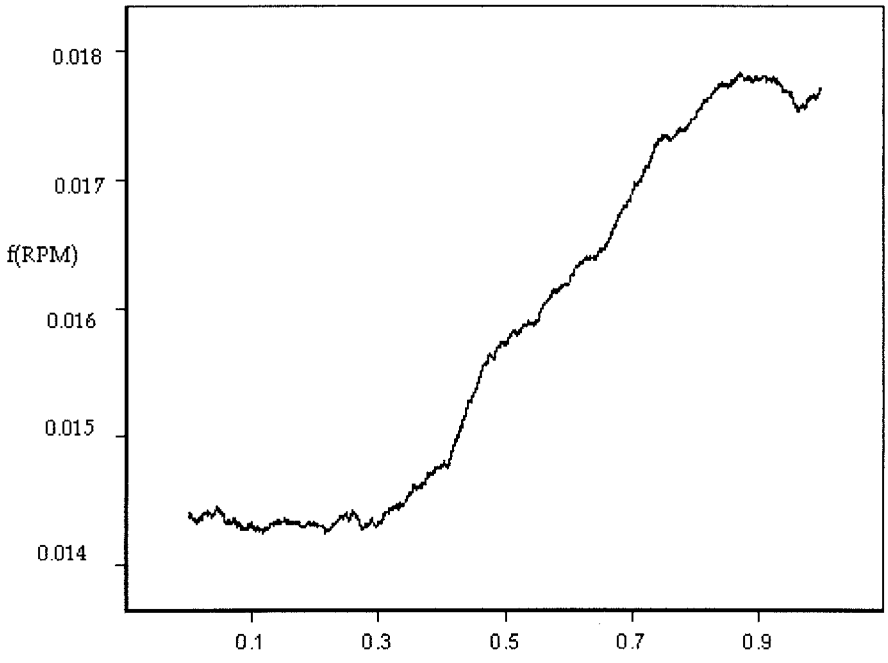

Figure 2. The relationship between risk-taking and relative ranking. This figure plots the estimated functional form of f(RPM) in the model

$$\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} = f(\mathrm{RPM}_{i,t}^{(1)}) + \beta_1 \sigma_{i,t}^{(1)} + \beta_2 \mathrm{AGE}_{i,t} + \beta_3 (\mathrm{Log(SIZE)}_{i,t}^{(1)}) + \beta_4 \mathrm{LG}_i + \beta_5 \mathrm{GI}_i + \sum_{t=1992}^{1999} \mu_t \mathrm{YEARDUM}_t + \varepsilon_{i,t},$$

where $\mathrm{RPM}_{i,t}$ is the relative performance of fund managers i at time t, which is defined in Equation (4). $\sigma_{i,t}^{(1)}$ is the standard deviation of the return of fund i in period j of year $\sigma_{i,t}^{(1)}$ is to control for the initial risk level and measurement error which is suggested by Koski and Pontiff (1999). AGEi, t is the age of fund t at time t. $\mathrm{Log(SIZE)}_{i,t}^{(1)}$ is the logarithm of fund i's total net assets in period 1 in year t. LG_i is a dummy variable which is equal to 1 if fund i's objective is long-term growth and 0 otherwise. GI_i is also a dummy variable which is equal to 1 if fund i's objective is growth and income and 0 otherwise. $\mathrm{YEARDUM}_t$ is the year dummy variables. We estimate the model using Yatchew's (1998) differencing method.

3.6. ROBUSTNESS TEST

The semi-parametric model could also be prone to false rejection of the null if the mutual fund returns are cross-correlated. In addition, the semi-parametric model may be sensitive to the smoothing method. To check the robustness of the results, we use the parametric specification but adopt the empirical p-values to test the significance of the estimated coefficients. Therefore, we simulate the mutual fund returns under the null hypothesis of no risk-taking behavior in response to their performance. The simulation is similar to Busse (2001), but here we use zero-factor simulation rather than factor-model simulation.[12] For each year, we re-sample randomly with replacement from all January–July returns, and then re-sample all August–December returns independently of the returns of the first period of the year. The sample numbers are the corresponding numbers of funds in the real data in each year. In this simulation, we remove any tournament effects but preserve the cross-correlation in the mutual fund returns. The change in the standard deviation and relative performance are calculated for each simulated fund in each year. Then, the regression is performed using the simulated fund returns. The empirical distributions of the estimated coefficients are obtained from 10,000 simulations. The empirical distributions are then used to calculate the empirical p-values of the coefficients estimated from the regression using the real data.

Linear and nonlinear versions of the parametric model are estimated to check the robustness of our semiparametric results. Table IX presents the regression results. The theoretic p-values and empirical p-values are both reported. The results from the parametric estimation are consistent with the semi-parametric model: the better-performing funds increase the variance of their portfolio more than the poorly-performing funds. The empirical p-values for the $\mathrm{RMP}_{i,t}^{(1)}$ in the first model and $\mathrm{RPM}_{i,t}^{(1)}$, $(\mathrm{RPM}_{i,t}^{(1)})^2$ and $(\mathrm{RPM}_{i,t}^{(1)})^3$ in the second model are all significant at the 1% level. Our results show that the significant and positive relationship between risk adjustment and relative performance is robust to the model specification and the potential bias generated from the cross-correlation of mutual fund returns.

3.7. COMPARING OUR RESULTS TO PREVIOUS STUDIES

In Sections 3.3, we proposed a simple but plausible argument that loser fund managers would not increase risk because if they took a bet and lost, they might lose their jobs. On the other hand, fund managers near the top would increase risk, because if they improved their performance, they would benefit from the large cash inflows that accrue to the best-performing funds. This argument is based on empirical evidence on the convex function of fund managers' termination risk with respect to their relative performance and the increasing *winner takes* all phenomenon in the relationship between cash inflows and mutual fund performance. The empirical results we present here are consistent with these hypotheses, which raise another question: how do we reconcile our findings with prior studies?

Given the empirical finding by Busse (2001), Goriaev et al. (2001) and the results presented here, it appears that the tournament hypothesis proposed by BHS (1996) (that managers of loser funds increase the risk of their portfolios more than do managers of winner funds) does not hold. In contrast, the empirical evidence,

[12] Goriaev, Nijman and Werker (2001) noted that zero factor simulation generates fund returns that are distributionally equal to those generated from factor models, given the standard orthogonality of the regression decomposition in the factor models.

Table IX. Robustness test

Indep. variable	Coeff.	p-value	Empirical p-value	Coeff.	p-value	Empirical p-value
$\sigma_{i,t}^{(1)}$	−0.419	0.000	0.000	−0.428	0.000	0.000
LG_i	−0.003	0.000	0.000	−0.003	0.000	0.000
GI_i	−0.006	0.000	0.000	−0.005	0.000	0.000
$Age_{i,t}$	0.111e-4	0.281	0.752	0.892e-5	0.388	0.168
$Log((SIZE)_{i,t}^{(1)})$	0.126e-4	0.819	0.788	0.231e-4	0.677	0.146
$RPM_{i,t}^{(1)}$	0.004	0.000	0.000	−0.015	0.000	0.004
$(RPM_{i,t}^{(1)})^2$				0.038	0.000	0.000
$(RPM_{i,t}^{(1)})^3$				−0.021	0.000	0.004
Adj. R^2	0.770			0.771		

This table provides the parametric estimation for the linear model,

$$\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} = \alpha_0 + \beta_1 \mathrm{RPM}_{i,t}^{(1)} + \beta_2 \sigma_{i,t}^{(1)} + \beta_3 \mathrm{AGE}_{i,t} + \beta_4 \log(\mathrm{SIZE})_{i,t}^{(1)} + \beta_5 \mathrm{LG}_i + \beta_6 \mathrm{GI}_i + \sum_{t=1992}^{1999} \mu_i \mathrm{YEARDUM}_t + \varepsilon_{i,t},$$

and nonlinear model,

$$\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} = \alpha_0 + \beta_1 \mathrm{RPM}_{i,t}^{(1)} + \beta_2 (\mathrm{RPM}_{i,t}^{(1)})^2 + \beta_3 (\mathrm{RPM}_{i,t}^{(1)})^3 + \beta_4 \sigma_{i,t}^{(1)} + \beta_5 \mathrm{AGE}_{i,t} + \beta_6 \log(\mathrm{SIZE})_{i,t}^{(1)} + \beta_7 \mathrm{LG}_i + \beta_8 \mathrm{GI}_i + \sum_{t=1992}^{1999} \mu_i \mathrm{YEARUM}_t + \varepsilon_{i,t},$$

where $\sigma_{i,t}^{(j)}$ is the standard deviation of the return of fund i in period j of year t. $\mathrm{RPM}_{i,t}^{(1)}$ is the relative performance of fund managers i in period 1 of year t, which is defined in equation (4). $\sigma_{i,t}^{(1)}$ is to control for the initial risk level and measurement error which is suggested by Koski and Pontiff (1999). $\mathrm{AGE}_{i,t}$ is the age of fund t at time t. $\mathrm{Log(SIZE)}_{i,t}^{(1)}$ is the logarithm of fund i's total net assets in period 1 in year t. LG_i is a dummy variable which is equal to 1 if fund i's objective is long-term growth and 0 otherwise. GI_i is also a dummy variable which is equal to 1 if fund i's objective is growth and income and 0 otherwise. $\mathrm{YEARDUM}_t$ is the year dummy variables. The theoretic p-values and empirical p-values are both reported. The empirical p-values are based on empirical distributions of the estimated regression coefficients, which are based on the simulated mutual fund returns under the null hypothesis that no strategic risk-taking behavior in response to the relative performance.

in general, tends to support the notion that managers of winner funds increase their portfolio risk more than managers of loser funds do, which is consistent with the argument we propose here.[13] However, our results should not be interpreted to mean that the tournament effect does not exist in the mutual fund industry. Rather, we argue that if an agency problem inside mutual fund management companies and the incentives of mutual fund managers are considered, the risk-taking behavior of mutual fund managers in response to their relative performance may be more complicated than those suggested by previous studies. Further, our results also help explain why mutual fund risk-taking behavior is not stable across time periods. Since the termination risk of fund managers is a function of the number of mutual funds and the supply of mutual fund managers, career concerns and risk-taking behavior of mutual fund managers are influenced by the dynamics of the managerial labor market.[14] In addition, the incentive for fund manager's risk-taking behavior, i.e., the relationship between cash inflow and mutual fund performance, is not constant over time. Given that both upside benefits and downside costs of risk-taking behavior are changing over time, it should be expected that mutual fund risk-taking behavior is not stable across time periods.

4. Risk-Taking Behavior: Single Manager Versus Multiple Managers

To further demonstrate that the inside organization of mutual fund companies could affect the risk-taking behavior of mutual fund managers, we divide funds into two groups: funds managed by single managers and funds managed by multiple managers. If the agency problem is important in the mutual fund tournament, it is expected that the mutual funds managed by single managers should behave in different ways from the funds managed by multiple managers. Investigating the difference in the behavior of single managers and multiple managers is interesting not only in how it could provide new evidence on agency issues inside mutual fund organizations, but is also interesting in its own right given the increasing popularity of multiple-manager mutual funds. From Table I, one can see that the employment of multiple managers has recently become a popular arrangement

[13] We replicate the results of BHS (1996) for the period of 1980–1991. Based on the *theoretic* P-values, the tournament only existed in the sub-sample period 1986–1991 but not in the period 1980–1985, which is consistent with BHS (1996). Goriaev et al. (2001) have shown that the tournament effect did not exist in this period if the p-values were adjusted for cross-correlation of the mutual fund. In addition, they found winner funds increased the volatility of their portfolio more than the loser funds did in some periods.

[14] According to the Investment Company Institute, as of 1999, the total number of mutual funds was 7791; this number is approximately double the number of funds in 1992. Although, one might think the job market for mutual fund managers was good during this period, the fast growth in the mutual fund industry does not necessarily imply a good market for fund managers. As indirect evidence of the strong competition in the financial professional labor market, according to the Association for Investment Management and Research, as of 1999 the number of Chartered Financial Analyst candidates was 58,532, which is around 4 times the number of candidates in 1992.

in the mutual funds industry. The primary motive for employing more than one manager is to make the portfolio choice decision diversified over the style and judgment of the managers.[15] The diversification of style usually means that a fund is divided into several sub-accounts that are allocated to different managers who manage their sub-accounts independently. The diversification of judgment refers to team management – where there are multiple individuals who manage the fund together. The final investment decision is the result of the aggregation of analyses of the management team rather than of a single manager.[16] Often, it is hard to distinguish between the diversification of style and judgment. For instance, in team management, each team member might specialize in specific sectors so their decisions may be relatively independent. Furthermore, in the case where multiple managers manage different sub-accounts of a fund, they might analyze different, but not completely diverse, subsets of securities, and they would communicate with each other when making an investment decision.

Even though the percentage of funds managed by multiple-manager arrangements has been increasing dramatically throughout the 1990's, the impact of such arrangements has never been assessed.[17] Theoretical insights for the employment of multiple managers have also been unexploited. Sharpe (1980) first proposed some theoretical justification for the decentralization of investment management. He argued that the employment of multiple managers could reduce the danger of overall fund performance being damaged by the serious decision errors of a single manager. In a follow-up paper, Barry and Starks (1984) proposed an alternative motivation for the employment of multi-managers. They argued that due to risk-sharing arrangements between multiple managers, investors might benefit from the higher risk taken by multiple managers.

This section focuses on the analysis of how multiple-manager arrangements affect the risk-taking behavior of a mutual fund. There are at least two reasons to believe that the number of managers will affect a manager's ability and willingness to alter the risk of her portfolios. First, a manager who is solely responsible for an investment decision usually is well recognized in the industry. It is unlikely that a person who has been in the industry for a few years only or who has had a poor record could become the sole manager of a fund. The termination risk for these individuals might not be a serious concern for them. Therefore, mid-year loser funds

[15] There are other main reasons for the employment of multiple managers: first, the multiple-manager system provides stable management. For example, if manager A leaves the job, manager B and others can still run the portfolio. Second, given that using multiple managers is a relatively new practice in the industry, it has become a sale point to the investor.

[16] The managers in the same team might not have the same weight in the final decision making. The weight of the contribution of each manager in the final decision usually depends on the seniority and the past performance of the manager.

[17] There are many interesting questions that could be asked about the multiple-manager system. For example, does the multiple-manager system provide better returns to investor than the single-manager system. Is the performance of a fund run by multiple managers more consistent than that of a fund managed by a single manager? These would be interesting topics for future research.

managed by single managers may have a greater incentive to take on higher risk. Second, while a multiple-manager fund, which is a mid-year winner fund, would try to become the top fund by adjusting its portfolio risk, it may be unable to make the adjustment in a timely manner because its managers have to coordinate their decisions.[18] Thus, we would expect that single managers have greater incentives and ability to alter the risk of their portfolios to a larger degree relative to the multiple managers. Loser single managers will be even more aggressive than loser multiple managers.

To test this hypothesis, we first estimate the following parametric model,

$$\begin{aligned}\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} \\ &= \alpha_0 + \beta_1 \mathrm{RPM}_{i,t}^{(1)} \beta_2 (\mathrm{RPM}_{i,t}^{(1)})^2 + \beta_3 (\mathrm{RPM}_{i,t}^{(1)})^3 + \beta_4 (\sigma_{i,t}^{(1)}) + \beta_5 (\mathrm{AGE})_{i,t} \\ &\quad + \beta_6 (\mathrm{Log(SIZE)})_{i,t}^{(1)} + \beta_7 (\mathrm{TWOYEARS})_{i,t-1} + \beta_8 \mathrm{LG}_i + \beta_9 \mathrm{GI}_i \\ &\quad + \beta_{10} \mathrm{MULTI}_{i,t} + \beta_{11} \mathrm{MULTI}_{i,t} \times \mathrm{RPM}_{i,t} + \beta_{12} \mathrm{MGTRET}_{i,t} \\ &\quad + \sum_{t=1992}^{1999} \mu_i \mathrm{DUMYEAR}_i + \varepsilon_{i,t}, \qquad (6)\end{aligned}$$

where the quadratic and cubic function of $\mathrm{RPM}_{i,t}^{(1)}$ are to control for the non-linearity effect of RPM on the adjustment of portfolio risk. The definitions of the other variables are the same as in Equation (5). In order to examine the difference in risk-taking behavior of single and multiple managers, we include a dummy variable $\mathrm{MULTI}_{i,t}$ which takes the value of one if fund i is managed by multiple managers in year t and zero otherwise. To allow for relative performance sensitivity of adjustment of risk to be different between single managers and multiple managers, we also include an interaction term between RPM_{it} and the dummy variable $\mathrm{MULTI}_{i,t}$. It has been suggested that the more consistently good the performance of a fund manager has been in the past, the less likely she is to take a greater risk.[19] Hence we add the fund's past two-year compounded returns to the right-hand side in order to examine whether a manager's risk-taking behavior is affected by her past long-term performance. We also add another variable, MGTRET_{it} – the average return of the management company – to examine the effect of the overall performance of management companies on fund managers' risk-taking behavior. The rationale is that, typically, in order to encourage cooperation among fund managers, fund managers often work for cooperation-enhancing incentive schemes. Therefore, part of the incentive payoff to the fund manager will depend on the overall performance

[18] Ley and Steel (1995) present a model of management teams where the time to make a decision is dependent on the size of the team. The team management usually involves a longer process to reach a decision than a single manager.

[19] See BHS (1997), for example.

of her management company.[20] Hence, it is expected that the better the performance of a management company, the less incentives fund managers have to take on additional risk.

The results are reported in Table X.[21] The coefficient on $\text{TWOYEARS}_{i,t}$ is indeed negative and significant, which supports the conclusion that a fund's risk-taking performance is affected by its long-term past performance.[22] The coefficient for the MGTRET_{it} is negative and significant at the 10% level but not at the 5% level. From the perspective of learning whether there is a difference in the risk-taking behavior in single versus multiple-manager arrangements the most interesting result in the table is that the coefficient for the multiple-manager dummy is negative and significant at the 1% level, suggesting that funds managed by multiple managers have, on the average, lower risk adjustments in the second half of the year. In addition, the coefficient for the interact term of $\text{MULTI}_{i,t} \times \text{RPM}_{i,t}$ is also significant at the 1% level, indicating that funds managed by multiple managers are more sensitive to their relative performance.

4.1. SHAPES OF RISK-TAKING FUNCTIONS: SINGLE VERSUS MULTIPLE MANAGERS

To examine in detail how multiple-manager arrangements affect the risk-taking behavior of fund managers, the sample is divided into two sub-samples: the 10,062 fund-years, for which the funds are managed by single managers; and 5,097 fund-years, for which the funds are managed by multiple managers. We then estimate the following model separately on the two sub-samples

$$\begin{aligned}\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} = \; & f(\text{RPM})_{i,t}^{(1)} + \beta_1(\sigma_{i,t}^{(1)}) + \beta_2(\text{AGE})_{i,t} \\ & + \beta_3(\text{Log(SIZE)}_{i,t}^{(1)}) + \beta_4(\text{TWOYEARS})_{i,t-1} \\ & + \beta_5\text{AG}_i + \beta_6\text{GI}_i + \sum_{t=1992}^{1999} \mu_t \text{DUMYEAR}_t + \varepsilon_{i,t}. \end{aligned} \tag{7}$$

The functional forms of $f(\text{RPM})$, estimated from applying the semi-parametric model to single-manager and multiple-manager sub-samples, are presented in Fig-

[20] According to a survey on the compensation of investment management professionals done by the Association for Investment Management and Research (AIMR) and Russell Reynolds Associates (1999), the four most important bonus determinant factors for fund managers are: the overall business of the organization, an individual's own investment performance, an organization's performance and an individual's business development performance. Hence, the overall performance of a management company could affect the incentive of risk-taking by fund managers.

[21] To account for the possibility that multiple observations for the same fund may be correlated, we adjust the standard errors by Rogers' (1993) methodology.

[22] We also use the past four years' compounded return as a measure for the long-term past performance; the results are quite similar to the two-year return.

Table X. The basic risk-taking behavior of single managers vs. multiple managers

Variables	Coefficients
$RTM_{i,t}$	−0.017
	(−3.345)
RTM_{i,t^2}	0.045
	(3.766)
RTM_{i,t^3}	−0.025
	(−3.136)
$\sigma_t^{(1)}$	−0.425
	(−35.163)
Age_t	−0.351e-5
	(−0.322)
$Log(SIZE)_{i,t}^{(1)}$	−0.136e-5
	(−0.017)
$TWOYEARS_{i,t-1}$	−0.007
	(−8.380)
LG_i	−0.004
	(−9.005)
GI_i	−0.007
	(−14.455)
$MULTI_{i,t}$	−0.001
	(−2.294)
$MULTI \times RPM_t$	0.003
	(2.934)
$MGTRET_{i,t}$	−0.006
	(−1.775)
Constant	0.017
	(15.822)
Adjusted R^2	0.778

This table reports the estimation results for the model,

$$\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} = \alpha_0 + \beta_1 RPM_{i,t}^{(1)} + \beta_2 (RPM_{i,t}^{(1)})^2 + \beta_3 (RPM_{i,t}^{(1)})^3 + \beta_4 (\sigma_{i,t}^{(1)}) \beta_5 (AGE)_{i,t} + \beta_6 (Log(SIZE)_{i,t}^{(1)}) + \beta_7 (TWOYEARS)_{i,t-1} + \beta_8 IG_i + \beta_9 GI_i + \beta_{10} MULTI_{i,t} + \beta_{11} MULTI_{i,t} \times RPM_{i,t} + \beta_{12} MGTRET_{i,t} + \sum_{t=1999}^{1999} \mu_i DUMYEAR_t + \varepsilon_{i,t},$$

where $RPM_{i,t}$ is the relative performance measure of fund i at time t. The quadratic and cubic function of $RPM_{i,t}^{(1)}$ are to control for the non-linearity effect of RPM on the adjustment of portfolio risk. $AGE_{i,t}$ is the age of fund i at time t. $Log(SIZE)_{i,t}^{(1)}$ is the logarithm of fund i's total net assets in period 1 in year t. LG_i is a dummy variable which is equal to 1 if fund i's objective is long-term growth and 0 otherwise. GI_i is also a dummy variable which is equal to 1 if fund i's objective is growth and income and 0 otherwise. $YEARDUM_t$ is the year dummy variable. $MULTI_{it}$ which takes the value of one if the fund i is managed by multiple managers in year t and zero otherwise. $MULTI \times RPM_{i,t}$ is an interaction term between RPM_{it} and the dummy variable $DUMMGR_{i,t}$. $TWOYEARS_{i,t}$ is the fund's past two-year compounded returns, and $MGTRET_{it}$ is the average return of the management company at time t. To account for the possibility that multiple observations for the same fund may be correlated, we adjust the standard errors by Rogers' (1993) methodology. (t-statistics are in the parentheses).

ure 3. The figure is consistent with the present hypothesis that funds managed by an individual manager adjust their risk more readily, especially for loser funds. For loser funds, both types of funds have a lower risk adjustment. At the same time, the functional form, f(RPM), of the funds managed by single managers is much higher than that of funds managed by multiple managers, suggesting that single loser managers have greater incentives to increase their portfolio's risk. For winner funds, those managed by a single manager also have a greater risk adjustment than those funds managed by multiple managers. Both types of managed funds, however, show a similar tendency; the closer a fund manager is to being the top manager, the greater risk adjustment she will take. In general, the functional form of f(RPM) is relatively flatter for funds managed by single managers, which is consistent with the basic regression that funds managed by multiple managers are more sensitive to their relative performance.

These results appear to support the notion that the multiple-manager arrangement is an effective way to reduce the excess risk-taking behavior of fund managers. Without a richer database, however, it is difficult to determine whether this stems from differences in the characteristics between single manager and multiple managers, such as experience and age, from the differences in their decision-making processes, or from some other reason. For example, incentive contracts for multiple managers could be quite different from those of single managers (see Hart and Holmstrom (1987)). The result documented here is simply a fact; the theoretical justification is beyond the scope of this paper, but it is certainly an interesting issue for future research.

5. Summary and Conclusion

This paper has investigated the risk-taking behavior of mutual funds in response to their relative performance from 1992–1999. We find that managers of funds whose performance is closer to that of the top performing funds have greater incentives to increase their portfolios' risk than managers at the top who exhibit a tendency to lock in their positions. Manager of loser funds, whose performance is below that of median funds in the first period, in contrast, adjust their portfolios' risk lower than do those of winner funds. Furthermore, the risk-taking behavior of manager of terminated funds reveals that they are less likely to increase their portfolios' risk. In general, the results seem to be consistent with the argument that risk-taking behavior of funds is determined by the benefits and costs of the risk taken by fund managers. The termination risk for fund managers reduces the risk-taking incentive of loser fund managers. The implication of our results is that even though the relationship between cash inflow and relative performance might generate potential agency problems between investors and fund companies, the termination risk faced by fund managers might mitigate these problems.

Secondly, this study has shown how multiple-manager arrangements of funds affect their risk-taking behavior. We find that single managers of funds alter their

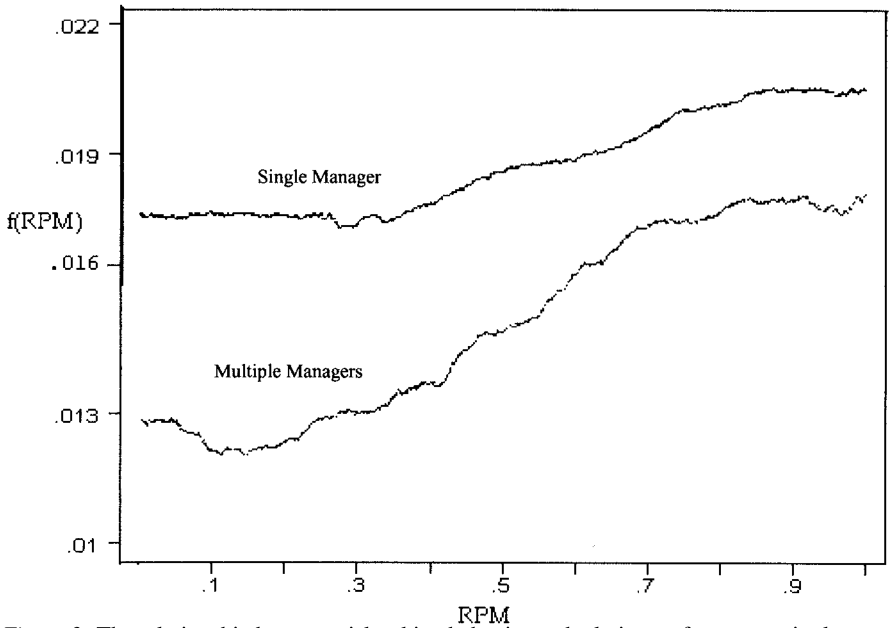

Figure 3. The relationship between risk-taking behavior and relative performance: single managers vs. multiple managers. This figure presents the functional forms of $f(\text{RPM})$ estimated from applying the semi-parametric model to the single and multi-manager sub-samples. The semiparametric model

$$\sigma_{i,t}^{(2)} - \sigma_{i,t}^{(1)} = f(\text{RPM})_{i,t}^{(1)} + \beta_1(\sigma_{i,t}^{(1)}) + \beta_2(\text{AGE})_{i,t}$$

$$\beta_3(\text{Log(SIZE)}_{i,t}^{(1)} + \beta_4(\text{TWOYEAR})_{i,t-1} + \beta_5 LG_i$$

$$+ \beta_6 GI_i + \sum_{t=1992}^{1999} \mu_i \text{DUMYEAR}_i + \varepsilon_{i,t},$$

where $\sigma_{i,t}(j)$ is the standard deviation of the return of fund i in period j. $\text{RPM}_{i,t}$ is the relative performance of fund managers i at time t, which is defined in Equation (4). $\text{AGE}_{i,t}$ is the age of fund t at time t. $\text{Log(SIZE)}_{i,t}^{(1)}$ is the logarithm of fund i's total net assets in period 1 in year t. $\text{TWOYEARS}_{i,t}$ is the two year compounded return of fund i in period t. LG_i is a dummy variable which is equal to 1 if fund i's objective is long-term growth and 0 otherwise. GI_i is also a dummy variable which is equal to 1 if fund i's objective is growth and income and 0 otherwise. YEARDUM_t is the year dummy variables. We estimate the model using Yatchew's (1998) differencing method.

portfolios' risk to a much greater extent than multiple managers of funds do in the second half of the year. The loser funds managed by a single manager appear to be particularly more aggressive than loser funds managed by multiple managers in the second half of the year. This result could be explained by the potential difference in the characteristics between single and multiple managers or the difference in their decision-making processes. Single managers, usually, are well-entrenched figures in the industry and might have less concern about termination risk and, furthermore, will take higher risk if they find themselves in the position of losers in mid-year. In addition, single managers have greater freedom in altering their portfolios' risk. This allows them to take greater risks in order to catch up with the top fund. These results appear to support the notion that multiple managers provide an effective way of reducing the risk-taking incentives of funds in response to their relative performance.

One important area for future research is to investigate the structure of multiple-manager arrangements. For example, are the characteristics of fund managers in a management team correlated with each other? That is, are the experienced and inexperienced, old and young, risk-loving and risk-averse managers usually put together in a management team? Since fund managers with different characteristics might have different career concerns, the incentive to take excess risk in response to relative performance, might be very different from those managed by single managers. Without knowing the structure of multiple-manager arrangements, it would be difficult to answer why and how it affects the performance of mutual funds.

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