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ABSTRACT

Mutual Fund Tournament: Risk-Taking Incentives Induced by Ranking Objectives

There is now extensive empirical evidence showing that fund managers have relative performance objectives and adapt their investment strategy in the last part of the calendar year to balance their performance in the early part of the year. Emphasis was, however, put on returns in excess of some exogenous benchmark return. In this Paper, we investigate whether fund managers have ranking objectives (as in a tournament). First, in a two-period model, we analyse the game played by two risk-neutral fund managers with ranking objectives. We show that ranking objectives provide incentives for an interim loser to increase risk in the last part of the year. In the second part of the Paper, we test some predictions of the model. We find evidence that funds ranked in the top decile after the first part of the year have risk incentives generated by ranking objectives and that risk induced by ranking objectives is mainly systematic.

JEL Classification: G11, G24
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NON-TECHNICAL SUMMARY

There is now extensive empirical evidence showing that fund managers have relative performance objectives and adapt their investment strategy in the last part of the calendar year to balance their performance in the early part of the year. A particular feature of these studies is the assumption that managers are evaluated against some index return.

Information presented to the crowd, however, often refers to rankings as a measure of relative performance. For example, in the 'Managed and Personal Investing' section of the *Wall Street Journal Europe*, the 'Fund Scorecard' provides the return of the top fifteen performers in a category. Furthermore, empirical studies also suggest that ranking is a measure of relative performance, which investors take into account. As pointed out by Patel, Zeckhauser and Hendricks (1994): 'the inclusion of ranks drives out the significance of other performance measures'. Therefore, since open-end fund managers receive asset-based compensation and investors take ranking into account when choosing funds, it generates ranking-based objectives for managers.

The risk-taking incentives generated by ranking objectives are different from risk-taking incentives generated by excess return (i.e. returns in excess of the market return) objectives. If funds are evaluated with respect to the market return, the benchmark is *exogenous*. Conversely, if ranking matters, then the benchmark against which a fund is evaluated is *endogenous*. How much money a fund attracts depends on the performance of its competitors. Therefore, portfolio selection is the outcome of a game played between funds.

The goal of this Paper is to investigate how ranking objectives influence managers' investment strategies, and test empirically whether managers respond to ranking objectives. To study the influence of ranking objectives on investment strategies, we develop a model in which, during two investment periods, two risk-neutral managers compete for funds to manage in the future and observe their interim relative performance. In each period, managers have one unit of money to invest and there is a continuum of investment strategies which differ in their expected returns and variances.

In the basic model, we assume that returns are uncorrelated. It follows that managers cannot influence the covariance of the returns. We show that in the first period, managers maximize their expected return, while in the second period, the riskiness of the investment strategy chosen by managers depends on their relative interim performance: an interim loser increases risk in the last part of the year while an interim winner locks in his gain, i.e. chooses a conservative strategy. Moreover, the loser's incentives to gamble for resurrection and the winner's incentives to lock in the first-period relative gain are increasing in the difference in first-period performances.

These results also hold when managers choose portfolios with (possibly) correlated returns. In such a case, in the second period, the optimal strategy of the interim winner is to choose the same portfolio as the loser since, in such a case, the interim winner wins the contest with probability 1. Conversely, the objective of the interim loser is to choose a portfolio that generates a return correlated as little as possible with the return of the interim winner. It follows that such a game has only equilibria in mixed strategies. For some of these equilibria, we can derive results about the relative amount of risk undertaken by the two managers. We show that on average, the interim loser takes more risk than the interim winner.

A second extension of the basic model we look at is the case in which managers' compensation depends also on their performance relative to some market return. We show that the results of the basic model still hold. Furthermore, we establish that when the weight of the ranking component in the objective function is large relative to the weight of the excess return component, then the risk-taking incentives of the interim loser are increasing with the distance to the interim winner. Also, the larger the weight of the ranking component, the larger the risk-taking incentives for an interim loser for a given difference in performance.

In the second part of the Paper, we test some empirical predictions of the model. The data set we use comes from Morningstar Incorporated. It consists of monthly returns of three categories of US funds: growth, aggressive growth (including small company funds) and growth-and-income funds from 1976 to 1994. The data set includes the funds that ceased to exist since the beginning of 1989. Thus, our data are not survivorship biased during the period 1989–94.

For funds in the top decile at interim stage, we find evidence of a significant positive relation between the distance to the top performer at interim stage (i.e. the difference in interim performance between the top interim performer and the considered fund) and the change of risk in the last part of the year. These results suggest that a good interim performance (i.e. belonging to the top decile) generates strong incentives to take risks in order to end the year ranked first.

One could argue that there is an alternative explanation for our results: the allocation of money into funds is convex in excess return (i.e. return in excess of the chosen benchmark), hence generating a compensation convex in performance and risk-taking incentives for managers. We test for such a possibility. We do not find any evidence that the sensitivity of change in risk to excess return is different for funds well ahead of the market and for funds slightly ahead of the market.

1 Introduction

There is now extensive empirical evidence showing that fund managers have relative performance objectives and adapt their investment strategy in the last part of the calendar year to their performance in the early part of the year (see Brown, Harlow, and Starks (1996), Chevalier and Ellison (1997), Koski and Pontiff (1999), and Chen and Pennachi (1999)). A particular feature of these studies is the assumption that managers are evaluated against some index return.[1] However, information presented to the crowd often refers to rankings as a measure of relative performance. For example, in the Managed and Personal Investing section of the Wall Street Journal Europe, the Fund Scorecard provides the return of the top fifteen performers in a category. The importance of ranking is also illustrated by Gould (1998):

"Bartlett Europe has returned an annual average of 27.2 *percent for the three years through Dec. 4, ranking first among the 46 European stock funds tracked by Moningstar Inc., the financial publisher."*

Furthermore, empirical studies also suggest that ranking is a measure of relative performance investors take into account. As pointed out by Patel, Zeckhauser and Hendricks (1994): "The inclusion of ranks drives out the significance of other performance measures".[2] Therefore, since open-end fund managers receive asset-based compensation (see Khorana (1996)) and investors take ranking into account when choosing funds[3], it generates ranking-based objectives for managers.

The goal of this paper is to investigate how ranking objectives influence managers' investment strategies, and test empirically whether managers respond to ranking objectives. To study the influence of ranking objectives on investment strategies, we develop a model in which, during two investment periods, two risk-neutral managers compete for funds to manage in the future and observe their interim relative performance. We show that in the first period, managers maximize

[1]Chevalier and Ellison (1997) and Chen and Pennachi (1999) take an exogenous market return index, Koski and Pontiff (1999) take the average return in the considered category while Brown, Harlow and Stark (1996) use the median return.

[2]See also Massa (1997) for additional evidence

[3]Other evidence that investors' choice of funds is positively correlated to funds' past performances includes Ippolito (1992), Sirri and Tuffano (1993), Chevalier and Ellison (1997) and Lettau (1997).

their expected return while in the second period, the interim loser *(i)* takes more risk than the interim winner and *(ii)* the level of risk undertaken by the interim loser is increasing with the difference in interim performances. These results hold even if compensation depends also on performance relative to some benchmark return.

The risk-taking incentives generated by ranking objectives are different from risk-taking incentives generated by excess return (i.e., returns in excess of the market return) objectives. If funds are evaluated with respect to the market return, the benchmark is *exogenous*. Conversely, if ranking matters, then the benchmark against which a fund is evaluated is *endogenous*. How much money a fund attracts depends on the performance of its competitors. Therefore, portfolio selection is the outcome of a game played between funds.

In the second part of the paper, we test some empirical predictions of the model. Considering US growth, aggressive-growth and growth-and-income funds, we show that for funds in the top decile in their category at interim stage, there is a significantly positive relation between the distance to the top performer at interim stage[4] and the change of risk in the last part of the year. These results suggest that a good interim performance (i.e., belonging to the top decile) generates strong incentives to take risk in order to end the year ranked first.

One could argue that there is an alternative explanation for our results: the allocation of money into funds is convex in excess return (i.e., return in excess of the chosen benchmark), hence generating a compensation convex in performance and risk-taking incentives for managers. We test for such a possibility. As Chevalier and Ellison (1997), we choose a market return (here, the S&P500 index) as a benchmark. We do not find any evidence that the sensitivity of change in risk to excess return is different for funds well ahead the market and for funds slightly ahead of the market.

The organization of this paper is as follows. Section 2 reviews the related literature. Section 3 presents the model and derives the equilibrium. Section 4 considers some extensions. Section 5 presents the empirical results. Section 6 concludes.

[4]The difference in interim performance between the top interim performer and the considered fund.

2 Related literature

A growing body of literature studies the mutual fund tournament both theoretically and empirically.

On the empirical side, Brown, Harlow, and Starks (1996), Chevalier and Ellison (1997) and Koski and Pontiff (1999) provide evidence that the mutual fund tournament generates incentives for managers not to act in the interest of investors. Assuming that managers are evaluated on a calendar year basis, Brown, Harlow, and Starks (1996) provide evidence that mid-year "losers" increase fund volatility in the latter part of the year relative to mid-year "winners". However, replicating Brown, Harlow and Starks' study with daily returns, Busse (1998) finds that "the strong tendency for poorly performing funds to increase risk relative to better performers completely disappears".

Chevalier and Ellison (1997) study how relative performance after three quarters of the year influence investment strategy in the last quarter. Considering two-year-old funds, they show that funds that are somewhat behind the market increase risk to a greater extent than funds that are ahead of the market. Koski and Pontiff (1999) focus on the use of derivatives by mutual funds. They show that changes in risk are less severe for funds that use derivatives.

These studies assume that changes in risk in the last part of the year depend on the difference between the realized return and a benchmark return over the first part of the year. Therefore, these studies differentiate the behavior of funds ahead of the benchmark from those behind the benchmark after the first part of the year. Our goal is different, we want to test whether funds have ranking objectives. More precisely, we want to test whether some funds engage in a winner-takes-all contest toward the end of year.

The most related paper is that of Taylor (2000) who also studies the impact of top perfomance objectives of investment decisions. Assuming that funds aims at ending the year in the top 10%, he finds evidence that interim performance influences investment decision in the last part of the year.

Closely related theoretical papers studying relative performance evaluation in financial markets are those of Huddart (1999), Hvide (1999), Palomino (1999) and Taylor (2000) who consider a game played by several fund managers. In this respect, our model is different from those which analyzes the behavior of a manager evaluated against an exogenous benchmark (see, for example, Grinblatt and Titman (1989), Admati and Pfleiderer (1996), Chen and Pennachi (1999)).

Hvide (1999) and Palomino (1999) study the consequences of relative performance objective in the context of a single investment decision. Hvide shows that in a situation with moral hazard on both effort and risk, standard tournament rewards induce excessive risk and lack of effort. Palomino (1999) assumes that managers with different levels of information compete in oligopolistic markets and aim at maximizing their relative performance against the average performance in their category. He shows that despite the objective function being linear in performances, managers have incentives to choose overly-risky strategies.

Huddart (1999) considers a two-period model in which interim performances are observable. He shows that asset-based compensation schemes generate incentives for managers to invest in overly-risky portfolio in the first period, and that performance fees align managers' incentives with those of investors.

Das and Sundaram (1998) study another aspect of the competition in the mutual fund industry: the fee structure. They consider a model in which fund managers use fee structures to signal their higher ability. They provide conditions under which investors are better off under an incentive fee regime than under a "fulcrum" fee regime.

Our results should be compared with those of Cabral (1997) on the choice of R&D projects. Cabral considers an infinite-period race between two firms that choose between low variance projects (low gains with high probability) and high variance projects (large gains with low probability). If the two firms choose a project of the same type then outcomes are perfectly correlated. Cabral shows that in equilibrium, both firms choose overly risky R&D strategies. There are three main differences between Cabral's model and ours. First, in Cabral's model, players have an infinite horizon. It follows that strategy choices are not influenced by an "end of the game" effect. Second, players receive a payoff in every period. This is equivalent to assuming observable interim performance. Conversely, in our model, players face an end of the game and only receive a payoff at the end of the game. Last, in Cabral's R&D race, projects' payoffs are different only in case of success. If projects fail, the costs faced by firms are independent of the projects chosen. This implies that an intermediate loser only catches up with the leader if a good outcome is realized. The situation is different in the mutual fund tournament. An intermediate loser has two ways of catching up with the winner: by winning more in case of good outcomes or by losing less is case of bad outcomes.

The consequences of dynamic incentives and relative performance evaluation have also been studied by Meyer and Vickers (1997). They show that in a dynamic principal-agent relationship, relative performance evaluation can be either welfare increasing or decreasing. The reason is that in a dynamic setting, there may be both explicit and implicit incentives and better information may decrease implicit incentives. Our model is different from that of Meyer and Vickers in two ways. First, in their model, intermediate performance is observable. In our context, if investors observe fund performances at the end of the first period, then managers always act in the interest of investors. Second, in our model, portfolio decisions are costless, i.e., they do not require any effort from fund managers. This is different from standard principal-agent models in which agents' output results from an costly effort.

3 Presentation of the model

There are two periods, 1 and 2, and two risk-neutral money managers. In each period, managers have one unit of money to invest. There is a continuum of investment strategies and the return of each strategy is normally distributed.[5] Strategies differ in their expected return and variance, however, the expected return of a strategy is a function $m(.)$ of the variance v of the strategy. Hence, the return of a strategy is normally distributed with mean $m(v)$ and variance v. The function $m(.)$ is assumed to be positive, twice differentiable, strictly concave and has a maximum at $\hat{m} = m(\hat{v})$ with $\hat{v}$ strictly positive.

A possible interpretation for the shape of $m(.)$ is that there is no borrowing constraint but bor-

[5] A more realistic model would assume that in period 1 a manager has one unit to invest, and for a realized return R_1 in period 1, the manager invests an amount R_1 in period 2. We have assumed the constant investment framework for tractability. Qualitatively, our results hold if we assume compounded returns. However, this latter formulation requires more assumptions since we must define what happens if a fund realizes a negative return in the first period. Hence, a manager must take into account in the first period the probability that he will still have amount positive amount of money to manage in the second period and the expected return conditional on having a positive amount to manage in the second period.

rowing is increasingly costly. Therefore, there is a borrowing treshold beyond which the marginal borrowing cost exceeds the marginal expected return of investment.

Information about realized returns. After assets are liquidated at the end of period 1, managers observe both their performance and the performance of their opponent.

Compensation Schemes. Managers are compensated at the end of period 2 on the basis of their ranking. Denote $R_{i,t}$ the realized return of manager t in period t, the compensation of manager i (C_i) is as follows.

$$\begin{array}{ll} C_i = B & \text{if } R_{i,1} + R_{i,2} > R_{j,1} + R_{j,2} \ (i \neq j) \\ C_i = B/2 & \text{if } R_{i,1} + R_{i,2} = R_{j,1} + R_{j,2} \ (i \neq j) \\ C_i = 0 & \text{otherwise} \end{array} \tag{1}$$

with $B > 0$.

The better performing manager receives a strictly positive compensation B and the worse performing manager gets nothing. If the two managers perform equally well, they both receive a compensation of $B/2$.

Our model captures the following idea in a simple framework. First, investors use rankings as a rule of thumb to evaluate managers and allocate capital into funds (as empirical evidence provided by Patel, Zeckhauser and Hendricks (1994) and Massa (1997) suggests). Second, fund managers are risk-neutral agents who are compensated on the basis of the size of the fund they manage. Hence, managers' objective is to outperform their opponent.

It can be argued that investors choose some type of relative performance scheme to evaluate money managers only if the two managers are of different qualities. This may not be the case. It is sufficient that investors *believe* that managers are of different qualities. For example, consider the following situation. With probability 1/2, manager i is a high quality manager and with probability 1/2 he is a bad quality manager, and probabilities of being a good manager are independent across managers. Moreover, the two managers observe the realized types while investors do not. In such a situation, with probability 1/2, it is common knowledge among managers that they are of the same type. However, investors do not know whether managers are of the same type. According to investors' beliefs, with probability 1/2, there is a good and a bad manager, and they uses a relative performance rule to evaluate managers.

Here, in order to concentrate on incentives generated by differences in intermediate performances, we solely study the case in which managers are of the same quality. If managers were of different qualities, incentives in period 2 would be driven by both interim performances and difference in quality.

Also, we assume that returns realized by managers are uncorrelated. This implies that the only strategic decision of the managers is the variance of their portfolio. A more complete model would assume that a manager can also influence the covariance of returns. Such a case is considered in Section 4.

The benchmark case. We consider as a benchmark the case in which managers maximize their expected return. In such a situation, both managers choose $v = \hat{v}$ in each period. The goal of our model is to show how ranking objective alter the managers' investment strategies.

Equilibrium investment strategies

We solve the model using backward induction. Hence, we start by deriving the equilibrium of the game played by the two managers in period 2. Denote $R_{t,w}$ and $R_{t,l}$ the return obtained in period by t by the interim winner and loser, respectively. Let $\Delta = R_{1,w} - R_{1,l}$. The objective of the interim loser is to maximize $\text{Prob}(R_{2,l} > \Delta + R_{2,w})$ while the objective of the interim winner is to minimize this probability. From the assumption about the distribution of returns, $R_{2,l} - R_{2,w}$ is normally distributed with mean $m(v_l) - m(v_w)$ and variance $v_l + v_w$. Hence, the objective of the interim loser is to minimize

$$G(v_w, v_l, \Delta) = \frac{\Delta + m(v_w) - m(v_l)}{(v_l + v_w)^{1/2}} \tag{2}$$

over v_l while the objective of the interim winner is to maximize $G(v_w, v_l, \Delta)$ over v_w.

An equilibrium in pure strategies in the period 2 subgame is a pair (v_l^*, v_w^*) such that

$$\frac{\partial G}{\partial v_w}(v_l^*, v_w^*, \Delta) = 0 \quad (3)$$

$$\frac{\partial G}{\partial v_l}(v_l^*, v_w^*, \Delta) = 0 \quad (4)$$

$$\frac{\partial^2 G}{\partial v_w^2}(v_l^*, v_w^*, \Delta) < 0 \quad (5)$$

$$\frac{\partial^2 G}{\partial v_l^2}(v_l^*, v_w^*, \Delta) > 0 \quad (6)$$

We derive the following proposition.

Proposition 1 *Assume that managers' compensation is given by (1). If* $\Delta \neq 0$*, then* $v_w^* < \hat{v} < v_l^*$ *in the second period. Furthermore,* v_l^* *and* v_w^* *are increasing and decreasing in* Δ*, respectively. If* $\Delta = 0$*, then both managers chooses* $\hat{v}$*.*

Proof: See Appendix.

In the last period, an interim loser takes more risk than an interim winner, hence (relatively) gambling for resurrection. Furthermore, when both managers have performed equally well in the first period, they both maximize their expected return in the second period. The reason is that if manager i chooses $\hat{v}$ and manager $j \neq i$ does not then manager i has a probability strictly larger than 1/2 of winning the contest, while if manager j chooses $\hat{v}$, both managers have a probability 1/2 of winning the contest. Hence, when managers have performed equally well in the first period, they both choose $\hat{v}$ in the second period.

By the same argument, we derive equilibrium strategies played in the first period.

Proposition 2 *There exists an equilibrium such that both managers choose* $\hat{v}$ *in the first period.*

Proof: See Appendix.

From Propositions 1 and 2, we deduce that an interim loser increases risk in the last part of the year while an interim winner locks in his gain, hence playing a conservative strategy. Moreover, the loser's incentives to gamble for resurrection and the winner's incentives to lock in the first-period relative gain are increasing in the difference in performances in the first period.

Also, it should be noted that given the reward scheme of the type "the winner takes all", Propositions 1 and 2 extend to the case in which managers are risk averse and have a strictly increasing utility function U. Let F be the distribution function of a random variable normally distributed with mean zero and variance equal to one. In such a case, the expected utility of an interim loser is

$$\begin{aligned} E(U_l) &= U(0)[1 - \text{Prob}(R_{2,l} > \Delta + R_{2,w})] + U(1)\text{Prob}(R_{2,l} > \Delta + R_{2,w}) \\ &= U(0) + [U(1) - U(0)]\text{Prob}(R_{2,l} > \Delta + R_{2,w}) \\ &= U(0) + [U(1) - U(0)][1 - F(G(v_w, v_l, \Delta))] \end{aligned} \tag{7}$$

and the expected utility of an interim winner is

$$\begin{aligned} E(U_w) &= U(0)\text{Prob}(R_{2,l} > \Delta + R_{2,w}) + U(1)[1 - \text{Prob}(R_{2,l} > \Delta + R_{2,w})] \\ &= U(0) + [U(1) - U(0)][1 - \text{Prob}(R_{2,l} > \Delta + R_{2,w})] \\ &= U(0) + [U(1) - U(0)]F(G(v_w, v_l, \Delta)) \end{aligned} \tag{8}$$

Therefore, as in the case of risk neutrality, in the second period, the objective of an interim loser is to minimize $G(v_w, v_l, \Delta)$ over v_l while the objective of the interim winner is to maximize $G(v_w, v_l, \Delta)$ over v_w. Hence, Propositions 1 and 2 extend to the case in which managers are risk averse and have a strictly increasing utility function.

4 Extensions

The model presented in the previous section assumes that returns are uncorrelated and concentrates on incentives generated by ranking objectives, i.e., funds participate in a winner-takes-all contest and do not take into account their performance relative to some benchmark return.

In this section, we extend the previous model to the case in which managers' compensation depends *both* on their ranking and their performance relative to an exogenous benchmark and consider the case in which managers choose among portfolios with correlated returns.

4.1 Compensation based on market-adjusted return and ranking

Denote $R_{b,t}$ the realized benchmark return in period t. We assume that the compensation of manager i is as follows.

$$\hat{C}_i = \alpha \sum_{t=1}^{2} (R_{i,t} - R_t^b) + \beta C_i \tag{9}$$

with $\alpha > 0$, $\beta \geq 0$ and where C_i is given by (1).

Compensation scheme (9) means that managers' compensation is increasing both in ranking and in performance relative to some exogenous benchmark.

In period 2 the objective of the interim loser is to maximize

$$H_l(v_l, v_w, \Delta) = \alpha m(v_l) - \beta BF[G(v_w, v_l, \Delta)] \tag{10}$$

while the objective of the interim winner is to maximize

$$H_w(v_w, v_l, \Delta) = \alpha m(v_w) + \beta BF[G(v_w, v_l, \Delta)] \tag{11}$$

We have the following propositions.

Proposition 3 *Assume that managers' compensation is given by (9) with $\beta > 0$. Then*
(i) *If $\Delta \neq 0$, then $v_w^* < \hat{v} < v_l^*$ in the second period.*
(ii) *There exists an equilibrium such that both managers choose $\hat{v}$ in the first period.*
(iii) *Let $\theta = \beta/\alpha$. There exists $\bar{\theta}$ such that if $\theta > \bar{\theta}$, then v_w^* and v_l^* are decreasing and increasing in Δ, respectively.*
(iv) *For a given Δ, v_w^* and v_l^* are decreasing and increasing in β, respectively.*

Proof: See Appendix.

Proposition 4 *Assume that managers' compensation is given by (9) with $\beta = 0$. Then $v_w^* = v_l^* = \hat{v}$ in the second period.*

Proof: If $\beta = 0$, then managers maximize their expected return. Hence manager j ($j = l, w$) chooses $v_j^* = \hat{v}$. □

Proposition 3 establishes that Propositions 1 and 2 still hold under the new compensation scheme: the existence of a ranking component in the compensation scheme (i.e., $\beta > 0$) generates risk-taking incentives in the last period for an interim loser. Part *(iii)* of the proposition states that when the weight of the ranking component in the objective function is large relative to the weight of the excess return component, then the risk taking incentives of the interim loser are increasing with the distance to the interim winner (i.e., Δ). Part *(iv)* states that the larger the weight of the ranking component (i.e., β), the larger the risk taking incentives for an interim loser for a given difference in performance.

4.2 Correlated returns

In this section, we analyze the case in which managers choose among portfolios with correlated returns. To do so, we modify the model of Section 3 in the following way. Assume that a safe asset (S) with return normalized to 1, and two risky portfolios are available. These two portfolios (hereafter p_a and p_b) have returns (R_a and R_b) independently and normally distributed with variance $v_a = \hat{v}$ and $v_b > \hat{v}$, and means $m_a = m(v_a)$ and $m_b = m(v_b)$ (with $m_a > 1$ and $m_b > 1$), respectively; the function $m(.)$ and $\hat{v}$ being as defined in Section 3. Therefore, $m_b < m_a$.

Denote l the interim loser and w the interim winner. In the second period, manager j ($j = l, w$) has one unit of money to invest and chooses an allocation $(\alpha_{aj}, \alpha_{bj})$, α_{aj} and α_{bj} being invested in portfolio p_a and p_b, respectively, and $(1 - \alpha_{aj} - \alpha_{bj})$ being invested in asset S. It follows that the return of manager j in the second period is

$$R_{2j} = 1 + \alpha_{aj}(R_a - 1) + \alpha_{bj}(R_b - 1)$$

For tractability, we restrict the set of choices to $\alpha_{aj} \geq 0$, $\alpha_{bj} \geq 0$ and $\alpha_{aj} + \alpha_{bj} < 1$. This implies that shortselling the safe asset or the two risky portfolios is forbidden.

The main difference with the previous section is that now returns are correlated, and their covariance is endogenous:

$$\text{cov}(R_{2,l}, R_{2,w}) = \alpha_{al}\alpha_{aw}v_a + \alpha_{bl}\alpha_{bw}v_b$$

We concentrate on allocation choices in the second period. Assume that the difference in returns after period 1 between the interim winner and the interim loser is Δ.[6] It is straightforward that the best reply of the interim winner is to choose the same allocation as the loser since in such a case, he wins the contest with probability 1. Conversely, the objective of the interim loser is to choose an allocation that generates a return correlated as little as possible with the return of the interim winner. It follows that such a game has only equilibria in mixed strategies. For some of these equilibria, we can derive results about the relative amount of risk undertaken by the two managers.

Proposition 5 *Consider any equilibrium such that* (i) *managers only invest in the risky portfolios (i.e.,* $\alpha_{aj} + \alpha_{bj} = 1$, $j = l, w$*) and* (ii) *managers randomize between the two same allocations* $(\alpha_{aj}, \alpha_{bj}) = (\alpha', 1 - \alpha')$ *or* $(\alpha_{aj}, \alpha_{bj}) = (\alpha'', 1 - \alpha'')$ $(j = l, w)$ *with* $\alpha' > \alpha''$. *Denote* q_j *the equilibrium probability that manager* j *chooses* $\alpha_{aj} = \alpha'$. *Then, in such an equilibrium, the interim loser takes more risk than the interim winner on average: the interim loser chooses* α' *with a lower probability than the interim winner, i.e.,* $q_l < q_w$.

Proof: See Appendix.

If managers do not buy the risk-free bond, then the larger α_{bj}, the larger the amount of risk taken by manager j. Proposition 5 states that in any equilibrium such that managers do not buy the risk-free bond and choose among the same two allocations, the interim loser takes more risk than the interim winner, on average.

This result is different from Taylor (2000) for one main reason. Taylor considers an economy with a risk free asset and *one* risky asset. It follows that an interim winner increasing risk also increases the expected return of his portfolio. He does not face a trade-off between increasing the variance and decreasing the expected return. Conversely, we consider a situation such that managers have the possibility to choose low-expected-return-high-variance portfolios.

We can derive further results on the interim loser's risk taking incentives.

[6] In the previous sections, it was assumed that managers are identical ex-ante. Here, there always exists an equilibrium such that $\Delta = 0$ with probability 1 given the two risky portfolios available. Therefore, $\Delta > 0$ requires that managers did not choose the same portfolio in period 1. One possibility is that they were heterogeneously informed in period 1 while this is not the case in period 2.

Proposition 6 *Assume that the interim winner chooses a portfolio such that* $\alpha_{aw} + \alpha_{bw} = 1$ *(i.e., does not buy the risk free bond). If* $\alpha_{aw} \leq 1/2$*, then the best reply of the interim loser is* $\alpha_{al} = 1$*. If* $\alpha_{aw} > 1/2$*, then the best reply of the interim loser is* $\alpha_{bl} = 1$*.*

Proof: See Appendix.

This proposition tells us that the best reply of the interim loser to an allocation of only risky portfolios is to choose the allocation of only risky portfolios that minimizes the correlation with the return of the interim winner.

From Propositions 5 and 6. We derive the following result.

Proposition 7 *There exists an equilibrium such that*

(i) *the interim winner chooses* $\alpha_{aw} = 1$ *with probability* q_w *and* $\alpha_{bw} = 1$ *with probability* $(1 - q_w)$

(ii) *the interim loser chooses* $\alpha_{al} = 1$ *with probability* q_l *and* $\alpha_{bl} = 1$ *with probability* $(1 - q_l)$

(iii) $q_w > q_l$*.*

Proof: See Appendix.

This proposition states that there exist equilibria such that Proposition 5 holds: when both the variance and the covariance of the portfolios are strategic variables, then on average, the interim loser takes more risk than the interim winner. Hence, the results derived in section 3 still hold (qualitatively) when returns are correlated and their covariance level is a strategic variable.

5 Empirical results

5.1 Data

The dataset we use comes from Morningstar Incorporated. It consists of monthly returns of three categories of US funds: growth, aggressive-growth (including small company funds) and growth-and-income funds from 1976 to 1994. The dataset includes the funds that ceased to exist since the beginning of 1989. Thus, our data are not survivorship-biased during the period 1989-1994. For each category, the number of funds in the dataset each year is given in Table 1.

[Insert Table 1]

To illustrate the difference between mid-year ranking and end-of-the-year rankings, Table 2 provides for growth-and-income funds the ranking after the first semester of the top ten performers over the calendar year.

[Insert Table 2]

As expected, funds highly ranked in the middle of the year are most likely to top the annual rankings. In 9 years out of 19, the top or second interim performer became the winner at the end of the year. However, in several years, funds ranked as low as 151 topped the annual rankings. Thus, the contest for the top annual ranking is not limited to a few best performers in the middle of the year, and even funds ranked relatively low at the interim stage still have a reasonable chance to win the annual tournament.

5.2 Tested hypothesis

Our conjecture is that, when selecting funds, investors take into account *both* the excess return realized by the fund and its ranking. Therefore, managers receiving an asset based compensation have both ranking and excess return incentives. Hence, we want to test some of the predictions of Proposition 3.

For a given category of funds k (i.e., $k =$ growth-and-income, growth or aggressive-growth), let $R_{i,t}^{k}$, R_{t}^{kb} and R_{t}^{kT} represent the return realized by fund i in year t, the benchmark return in year t, and the return realized by the top performer in year t, respectively.

Assume that the objective function of manager i from category k is

$$\mathrm{C}_{i,t}^{k} = a(R_{i,t}^{k} - R_{t}^{kb}) + B^{k} I_{R_{i,t}^{k} = R_{t}^{kT}} \tag{12}$$

where $I_{\{\}}$ is the indicator function.

From (12), we deduce that managers' compensation is increasing in benchmark adjusted return $(R_{i,t}^k - R_t^{kb})$ and the manager ranked first in his category k receives an extra income B^k. Therefore scheme (12) provides the same incentives as scheme (9).

In such a situation, after having observed the interim performance of his competitors, the objective of manager i is to maximize

$$E(C_{i,t}^k|\text{Info}_{i,t}^{int,k}) = aE[R_{i,t}^k - R_t^{kb}|\text{info}_{i,t}^{int,k}] + B^k\text{Prob}(R_{i,t}^k = R_t^{kT}|\text{Info}_{i,t}^{int,k})$$

where $\text{Info}_{i,t}^{int,k}$ is the information about interim performance at interim stage in category k.

In each category k, let $R_{i,t}^k(j)$ and $R_t^{kT}(j)$ denote the returns realized by fund i and the top interim performer of year t, respectively, over part j $(j = 1, 2)$ of year t. In the context of the model of the previous sections, define the interim winner of year t in category k as the top interim performer (i.e., the fund with return $R_t^{kT}(1)$) and an interim loser of year t as a fund with an interim performance smaller than $R_t^{kT}(1)$.

Let $\Delta_{i,t}^{kT} = R_t^{kT}(1) - R_{i,t}^k(1)$ and $\Delta_{ij,t}^k = R_{i,t}^k(1) - R_{j,t}^k(1)$. Given that the information at interim stage is about interim relative performance,

$$\text{Prob}(R_{i,t}^k = R_t^{kT}|\text{Info}_{i,t}^{int,k}) = \text{Prob}\left[R_{i,t}^k(2) > \text{Max}_{j\neq i}(\Delta_{ij,t}^k + R_{j,t}^k(2))\right]$$

The right-hand side of this equation can be rewritten as

$$\text{Prob}\left\{R_{i,t}^k(2) > \text{Max}\left[\Delta_{i,t}^{kT} + R_t^{kT}(2), \text{Max}_{\{j|j\neq i, R_{j,t}^k(1)<R_t^{kT}(1)\}}(\Delta_{ij,t}^k + R_{j,t}^k(2))\right]\right\} \tag{13}$$

In order the rewrite the objective function of manager i from category k so as to test the prediction of Proposition 3, we assume that expression (13) can be approximated by

$$\text{Prob}\left\{R_{i,t}^k(2) > \text{Max}_{\{j|j\neq i, R_{j,t}^k(1)<R_t^{kT}(1)\}}(\Delta_{ij,t}^k + R_{j,t}^k(2))\right\}\text{Prob}\left(R_{i,t}^k(2) > \Delta_{i,t}^{kT} + R_t^{kT}(2)\right)$$

Now, let

$$\beta_i^k = \text{Prob}\left\{R_{i,t}^k(2) > \text{Max}_{\{j|j\neq i, R_{j,t}^k(1)<R_t^{kT}(1)\}}(\Delta_{ij,t}^k + R_{j,t}^k(2))\right\}.$$

In such a case, in category k, the objective of manager i in the second part of the year is to maximize

$$aE[R^k_{i,t} - R^{kb}_t|\text{info}^{int,k}_{i,t}] + B^k\beta^k_i \text{Prob}\left(R^k_{i,t}(2) > \Delta^{kT}_{i,t} + R^{kT}_t(2)\right)$$

This is the same maximization program as that of the interim loser in the second period when the compensation scheme is given by (9) with $\beta = \beta^k_i$. Therefore, we can test the predictions of Proposition 3.

Given that β^k_i represents the probability for manager i of outperforming all the other funds except the top interim performer, β^k_i should be increasing with the interim performance of manager i. Hence, the predictions of Proposition 3 are the following:

- For a given β^k_i, risk taking incentives for an interim loser are increasing in $\Delta^{kT}_{i,t}$. (Proposition 3, part *(iii)*)
- Given $\Delta^{kT}_{i,t}$, risk taking incentives for an interim loser are increasing with β^k_i. (Proposition 3, part *(iv)*)

To test those predictions, we proceed as follows. Let

$$DIST^k_{i,t} = \frac{1}{1 + R^{kT}_t(1) - R^k_{i,t}(1)} = \frac{1}{1 + \Delta^{kT}_{i,t}}$$

In category k, $DIST^k_{i,t}$ represents a normalized measure of the difference in performances between the top interim performer and fund i after the first semester of year t. $DIST^k_{i,t}$ is equal to one if fund i is the top interim performer and $DIST^k_{i,t}$ declines toward zero as the interim performance of fund i decreases.

Let $EXCESS^k_{i,t}$ denote the return of fund i in excess of the market return (S&P500) in the first semester of year t, i.e.,

$$EXCESS^k_{i,t} = R^k_{i,t}(1) - R^M_t(1),$$

where $R^M_t(1)$ represents the return of the S&P500 index over the first semester of year t.

Note that this implies that for all categories, we use the same benchmark. As explained in more details below, our results hold if we use category specific benchmarks.

Let $R^k_{i,m}(l,t)$ be the return of fund i in the m-th month of the l-th semester of year t. Then, $\bar{R}^k_{i,t}(l) = \sum_{m=1}^{6} R^k_{i,m}(l,t)$ represents the average monthly performance of fund i over semester l of year t.

We define the total risk undertaken by fund i over semester l of year t as the standard deviation of fund i's monthly returns, i.e.,

$$STD(l)^k_{i,t} = \sqrt{\frac{1}{5}\sum_{m=1}^{6}(R^k_{i,m}(l,t) - \bar{R}^k_i(l,t))^2} \tag{14}$$

For each year and for each category, we split the set of funds into ten groups according to their interim performance, top decile interim performers being in Group 1 and worst decile performers being in Group 10. Then, we run the following regression.

$$\begin{aligned}\Delta STD^k_{i,t} = \alpha_1 STD(1)^k_{i,t} + \textstyle\sum_{j=1}^{10} \left(\alpha^k_{2,j} + \alpha_{3,j} EXCESS^k_{i,t} + \alpha_{4,j} DIST^k_{i,t}\right) * Dec(j) \\ + \textstyle\sum_t \delta_t YearDum_t + \varepsilon^k_{i,t}\end{aligned} \tag{15}$$

where $\Delta STD^k_{i,t} \equiv STD(2)^k_{i,t} - STD(1)^k_{i,t}$ is the change in the measure of fund i's total risk between the first and second semester of year t, and $Dec(j)$ is a dummy equal to 1 if the fund belongs to the j-th decile according to its performance in the first semester. Note that we assume that slope coefficients ($\alpha_{3,j}$ and $\alpha_{4,j}$, $j = 1, \ldots, 10$) are the same across categories, while decile specific constant terms ($\alpha^k_{2,j}$) are category specific.

$YearDum_t$ is a dummy variable equal to 1 in year t. Year dummies are included in order to control for the year-specific effects.

Following Koski and Pontiff (1999), we also include the risk level for the first semester in our regression to control for the measurement error. Since we have a noisy measure of risk based on 6 monthly observations, we expect mean reversion in the noise component of our estimate from the first to the second semester which should be captured by $STD(1)$.

Proposition 3, part *(iii)* predicts that if interim losers in the j-th decile have ranking objectives then $\alpha_{4,j}$ is negative. Proposition 3, part *(iv)* predicts that if interim losers in the j-th and the j'-th decile with $(j < j')$ have ranking objectives then $\alpha_{4,j} \leq \alpha_{4,j'}$.

5.3 Results

The results of regression (15) are given in Tables 3.a and 3.b. We observe that $\alpha_{4,j}$ $(j = 1, \ldots, 6)$ is significantly negative at the 1% Level. Furthermore, $\alpha_{4,1}$ is significantly smaller than $\alpha_{4,3}$ and $\alpha_{4,5}$ at the 5% level, significantly smaller than $\alpha_{4,4}$ at the 10% level and significantly smaller than $\alpha_{4,j}$ $(j = 6, \ldots, 10)$ at the 1% level. Hence, the predictions of Proposition 3 are verified for funds in the top decile at interim stage. This result provides evidence that risk undertaken top interim performers (i.e., funds in the top decile at interim stage) in the last part of the year is (partly) generated by ranking objectives.

From Table 3.b, we observe that risk-taking incentives in the last part of the year are also driven by excess return, since for all $j = 1, \ldots 5$, $\alpha_{3,j}$ is significantly positive. However, risk-taking incentives are driven by excess returns in a *linear* way and *not* in a convex way since $\alpha_{3,1}$ is not significantly different from $\alpha_{3,2}$, $\alpha_{3,3}$, $\alpha_{3,5}$, $\alpha_{3,8}$ and $\alpha_{3,9}$. Therefore, there is no evidence that that risk taking incentives in the last part of the year are generated by an objective function convex in benchmark-adjusted return.

Following Koski and Pontiff (1999), we also analyze changes in systematic and idiosyncratic risks between the first and the second half of the year. The systematic risk ($BETA$) is measured as the beta coefficient in a market model regression of fund return in excess of the risk-free rate on the S&P500 return in excess of the risk free rate.

The idiosyncratic risk ($IDIO$) is defined as the standard deviation of the residual terms from a market model regression of fund return in excess of the risk free rate on the S&P500 return in excess of the risk free rate.

$$IDIO_i^k(l,t) = \sqrt{\frac{1}{5}\sum_{m=1}^{6}\left(e_{i,m}^k(l,t)\right)^2}$$

where $e_{i,m}^k(l,t)$ is the market model residual.

For both measures of risk, we run the following regression.

$$\Delta RISK_{i,t}^k = \alpha_1 RISK(1)_{i,t} + \sum_{j=1}^{10}\left(\alpha_{2,j}^k + \alpha_{3,j} EXCESS_{i,t}^k + \alpha_{4,j} RISK_{i,t}^k\right) * Dec(j) + \sum_t \delta_t YearDum_t + \varepsilon_{i,t}^k \quad (16)$$

where $RISK = BETA, IDIO$ and $\Delta RISK_{i,t}^k$ is the change in $RISK$ for fund i in category k between the first and the second semester of year t.

Results for $BETA$ are given in Tables 4.a and 4.b. For all $j = 1, \ldots, 8$, $\alpha_{4,j}$ is significantly negative at the 1% level. Furthermore $\alpha_{4,1}$ is significantly smaller than $\alpha_{4,3}$ and $\alpha_{4,5}$ at the 5% level, significantly smaller than $\alpha_{4,4}$ at the 10% level and significantly smaller than $\alpha_{4,j}$ $(j = 6, \ldots, 10)$ at the 1% level.

Results for $IDIO$ are given in Tables 5.a and 5.b. $\alpha_{4,j}$ $(j = 1, \ldots, 10,\ j \neq 3)$ is not significantly different from zero.

These results suggest that for top decile managers, the risk induced by ranking objectives is mainly systematic.

5.4 An alternative performance measure

The previous regressions have tested the empirical predictions of Proposition 3. However, one can argue that the model developed in Section 3 and 4 is not realistic since it considers only two competing funds. If there are more than two competing funds, then each fund should take into account the differences between his performance and the interim performance of all the other competing funds when choosing his strategy in the last part of the year. (The necessary conditions of a Nash equilibrium with N competing funds are derived in Appendix.)

Therefore, we construct a performance measure (hereafter $DISTN$) which takes into account the interim relative performance with respect to other funds.

Let

$$D_{i,t}^k = \frac{1}{N_t} \sum_{j \neq i} (R_{j,t}^k(1) - R_{i,t}^k(1)) I_{\{R_{j,t}^k(1) > R^k i,t(1)\}} = \frac{1}{N_t} \sum_{j \neq i} \Delta_{ji,t}^k I_{\{\Delta_{ji,t}^k > 0\}}$$

and

$$DISTN_{i,t}^k = \frac{1}{1 + D_{i,t}^k}$$

$DISTN$ takes into account the distribution of performances of funds that have outperformed fund i in the first semester. $DISTN_{i,t}^k$ is equal to one if fund i is ranked first in his category at interim stage and decreases as the ranking of fund i worsens.

Results for regression (15) with $DISTN$ substituting $DIST$ are given in tables 6.a and 6.b. We observe that $\alpha_{4,1}$ is significantly negative at the 1% level and is significantly smaller than $\alpha_{4,j}$ $(j = 2, \ldots, 10)$ at the 1% level. These results provide additional evidence that top decile managers have ranking objectives in the last part of the year.

5.5 Robustness

We checked the robustness of our results in several ways. Qualitatively, our results hold if

- We use the median return in the category (as Brown, Harlow and Stark, 1996) or the mean return in the category (as Kosky and Pontiff, 1999) as benchmarks to compute excess returns. Note that in such cases, the benchmarks are category specific.
- We consider different splittings of the calendar year. More precisely, we checked that our result hold if we consider the period from January to May as the first period (and June to December as the second) or if we consider January to July as the first period (and August to December as the second).
- We consider different quantile specification. More precisely, our result holds if we consider the top 96% performers in each category and split funds in eight or twelve groups according to their performance. In both cases, risk undertaken by funds in the best performing group at interim stage is partly generated by ranking objectives in the last part of the year.

6 Conclusion

The nature of the competition in the money management industry generates relative performance objectives for managers. In this paper, we have studied how ranking objectives (as in a tournament) influence portfolio decision of mutual fund manager. In a two-period setting, we have shown how interim ranking influences the riskiness of the investment strategy chosen by managers in the last period: interim losers increase risk in the last part of the year.

Then, we have provided evidence that fund managers have ranking objectives which generate risk taking incentives and risk induced by ranking objectives takes mainly the form of systematic risk. Furthermore, ranking objectives are significantly more important for funds with a top decile interim performance than for the others.

From these results, we can advise investors not to select mutual funds on the basis of their ranking in performance but rather on the extent of the difference in performances. Such a fund picking strategy "linearizes" managers' incentives, hence aligning their incentives with those of investors.

7 Appendix

Proof of Proposition 1: Conditions (3) and (4) are equivalent to

$$\Delta + m(v_w^*) - m(v_l^*) = 2(v_l^* + v_w^*)m'(v_w^*) \tag{17}$$

$$\Delta + m(v_w^*) - m(v_l^*) = -2(v_l^* + v_w^*)m'(v_l^*) \tag{18}$$

respectively. This implies that conditions (5) and (6) are equivalent to

$$2(v_l^* + v_w^*)m''(v_w^*) + m'(v_w^*) < 0 \tag{19}$$

$$2(v_l^* + v_w^*)m''(v_l^*) + m'(v_l^*) < 0 \tag{20}$$

respectively.

Conditions (17) and (18) imply that

$$m'(v_l^*) = -m'(v_w^*) \tag{21}$$

Hence, $v_l - \hat{v}$ and $v_w - \hat{v}$ are of opposite signs.

Assume that $m'(v_w^*) < 0$. From (17), this implies that $m(v_w^*) > m(v_l^*)$. It follows that the interim winner can increase his probability of winning the contest by choosing $v = v_l^*$. Therefore, there exists a deviation that increases the probability of winning the contest. Hence, there cannot be an equilibrium with $m'(v^*) < 0$. Therefore, in equilibrium $v_w^* < \hat{v} < v_l^*$. The proof that v_w^* and v_l^* are increasing and decreasing in Δ, respectively, follows directly from $m'(v_l^*) = -m'(v_w^*)$ and the strict concavity of $m(.)$.

From conditions (17) and (18), we deduce that

$$d\Delta + m'(v_w)dv_w - m'(v_l)dv_l = 2(dv_w + dv_l)m'(v_w) + 2(v_w + v_l)m''(v_w)dv_w \tag{22}$$

$$d\Delta + m'(v_w)dv_w - m'(v_l)dv_l = -2(dv_w + dv_l)m'(v_l) - 2(v_w + v_l)m''(v_l)dv_l \tag{23}$$

This implies that

$$m''(v_w)dv_w = m''(v_l)dv_l \tag{24}$$

In turn, this implies that dv_l and dv_w are of opposite signs. Furthermore, from (21), (22) and (24), we obtain that

$$d\Delta = dv_w \left(2(v_l + v_w)m''(v_w) - \frac{m''(v_w)}{m''(v_l)}m'(v_w)\right) \tag{25}$$

Hence, v_w and v_l are decreasing and increasing in Δ, respectively. □

Proof of Proposition 2: From the proof of Proposition 1, we know that a manager who is leading after the first period has a probability strictly larger than 1/2 of winning the contest. Now, if manager 1 choose $v_1 = \hat{v}$ in the first period, then for any $v_2 \neq \hat{v}$ chosen by manager 2, $\text{Prob}(\Delta_{2,1} > 0) < 1/2$ while if manager 2 chooses $v_2 \neq \hat{v}$ in the first period, then $\text{Prob}(\Delta_{2,1} > 0) = 1/2$. Hence, $\hat{v}$ is a best reply to $\hat{v}$.□

Proof of proposition 3:

Proof of (i). From (10), we deduce that the FOC of compensation maximization for the interim loser is

$$\alpha m'(v_l) + \beta f[G(v_w, v_l, \Delta)]\frac{2(v_w + v_l)m'(v_l) + \Delta + m(v_w) - m(v_l)}{2(v_w + v_l)^{3/2}} = 0 \tag{26}$$

and from (11), we deduce that the FOC of compensation maximization for the interim winner is

$$\alpha m'(v_w) + \beta f[G(v_w, v_l, \Delta)]\frac{2(v_w + v_l)m'(v_w) - (\Delta + m(v_w) - m(v_l))}{2(v_w + v_l)^{3/2}} = 0 \tag{27}$$

From (26) and (27), we deduce that in equilibrium, it must be the case that

$$m'(v_l) = -m'(v_l) \tag{28}$$

Given that $m(.)$ is strictly concave, (28) implies that, in equilibrium, $m'(v_l)$ and $m'(v_w)$ are of opposite signs. Assume that $m'(v_l) > 0 > m'(v_w)$. From (27), this implies that $m(v_w) < m(v_l)$. The rest of the proof is identical to the proof of Proposition 1.

Proof of (ii). Identical to the proof of Proposition 2.

Proof of (iii) When α goes to zero, i.e., when theta becomes large, the FOC of compensation maximization for the interim loser converges to (18) while FOC of compensation maximization for the interim winner converges to (17). Then, proceeding as in by proof of Proposition 1 and by continuity, there exists $\bar{\theta}$ such that if $\theta > \bar{\theta}$, then we have the desired result.

Proof of (iv). Denote $H(v_l^* \beta)$ the LHS of equation (26). In equilibrium, $H(v_l^* \beta) \equiv 0$. The second order condition for maximization implies that $\partial H / \partial V_l^* < 0$. Given that $m'(v_l^*) < 0$, it implies that $\partial H / \partial \beta > 0$. Therefore, $dv_l^* / d\beta > 0$. Since in equilibrium $m'(v_l^*) = -m'(v_w^*)$, it follows that $dv_l^* / d\beta < 0$. □

Proof of Proposition 5: Consider any equilibrium that satisfies conditions *(i)* and *(ii)*. Given, the equilibrium strategy of the interim loser (i.e., the probability q_l with which he chooses α'), the interim winner is indifferent between the two pure strategies. This implies that

$$\begin{aligned} &q_l \text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha', \alpha_{al} = \alpha'\right) + (1 - q_l) \text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha', \alpha_{al} = \alpha''\right) = \\ &q_l \text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha'', \alpha_{al} = \alpha'\right) + (1 - q_l) \text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha'', \alpha_{al} = \alpha''\right) \end{aligned} \tag{29}$$

Given that

$$\text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha', \alpha_{al} = \alpha'\right) = \text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha'', \alpha_{al} = \alpha''\right) = 0$$

It follows that

$$q_l = \frac{\text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha', \alpha_{al} = \alpha''\right)}{\text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha', \alpha_{al} = \alpha''\right) + \text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha'', \alpha_{al} = \alpha'\right)}$$

Proceeding similarly, we find that

$$q_w = \frac{\text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha'', \alpha_{al} = \alpha'\right)}{\text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha', \alpha_{al} = \alpha''\right) + \text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha'', \alpha_{al} = \alpha'\right)}$$

Therefore $q_w > q_l$ is equivalent to

$$\text{Prob}\left(R_{2l} - R_{2w} > \Delta | \alpha_{aw} = \alpha'', \alpha_{al} = \alpha'\right) > \text{Prob}\left(R_{2l} - R_{2w} > \delta | \alpha_{aw} = \alpha', \alpha_{al} = \alpha''\right)$$

This is equivalent to

$$F\left(\frac{\Delta - (\alpha' - \alpha'')(m_a - m_b)}{\sqrt{(\alpha' - \alpha'')^2 (v_a + v_b)}}\right) < F\left(\frac{\Delta - (\alpha'' - \alpha')(m_a - m_b)}{\sqrt{(\alpha' - \alpha'')^2 (v_a + v_b)}}\right)$$

where F is the distribution function of a random variable normally distributed with mean zero and variance equal to 1. Given that $\alpha' > \alpha''$, this last inequality always holds. □

Proof of Proposition 6: Proceeding as in the previous section, one shows that the objective of interim loser is to maximize

$$H(\alpha_{al}, \alpha_{bl}, \alpha aw, \alpha_{bw}, \Delta) = \frac{-\Delta + (\alpha_{al} - \alpha_{aw})(m_a - 1) + (\alpha_{bl} - \alpha_{bw})(m_b - 1)}{\sqrt{(\alpha_{aw} - \alpha_{al})^2 v_a + (\alpha_{bw} - \alpha_{al})^2 v_b}}$$

with respect to α_{al} and α_{bl} under the constraint that $\alpha_{al} + \alpha_{bl} \leq 1$. First, we show that there cannot be an interior solution to this problem. To see this, assume that the interim loser chooses $\alpha_{bl} \in (0, 1)$.

$$\frac{\partial H}{\partial \alpha_{al}} = \frac{(m_a - 1)(\alpha_{bw} - \alpha_{bl})^2 v_b - v_a(\alpha_{al} - \alpha_{aw})\left[(\alpha_{bl} - \alpha_{bw})(m_b - 1) - \Delta\right]}{\left((\alpha_{aw} - \alpha_{al})^2 v_a + (\alpha_{bw} - \alpha_{al})^2 v_b\right)^{3/2}}$$

Therefore if $\alpha_{bl} < \alpha_{bw}$, for any α_{al}, $\partial H / \partial \alpha_{al} > 0$. It implies that the interim loser chooses $\alpha_{al} = 1 - \alpha_{bl}$. Now if $\alpha_{bl} > \alpha_{bw}$, then it implies that $\alpha_{al} < \alpha_{aw}$ (since $\alpha_{aw} + \alpha_{bw} = 1$, by assumption.)

$$\frac{\partial H}{\partial \alpha_{bl}} = \frac{(m_b - 1)(\alpha_{aw} - \alpha_{al})^2 v_a - v_b(\alpha_{bl} - \alpha_{bw})\left[(\alpha_{al} - \alpha_{aw})(m_a - 1) - \Delta\right]}{\left((\alpha_{aw} - \alpha_{al})^2 v_a + (\alpha_{bw} - \alpha_{al})^2 v_b\right)^{3/2}}$$

If $\alpha_{al} < \alpha_{aw}$, then for any α_{al}, $\partial H / \partial \alpha_{bl} > 0$. It implies that the interim loser chooses $\alpha_{bl} = 1 - \alpha_{al}$. Therefore, we always have $\alpha_{aw} + \alpha_{al} = 1$.

This implies that the problem of the interim loser is to choose α_{al} to as to maximize

$$K(\alpha_{al}, \alpha_{aw}, \Delta) = \frac{-\Delta + (\alpha_{al} - \alpha_{aw})(m_a - m_b)}{\sqrt{(\alpha_{aw} - \alpha_{al})^2 (v_a + v_b)}}$$

under the constraint that $\alpha_{al} \in [0, 1]$. It is straightforward that this is equivalent to maximizing $|\alpha_{al} - \alpha_{aw}|$. Therefore, if $\alpha_{aw} < 1/2$, the interim loser chooses $\alpha_{al} = 1$ while if $\alpha_{aw} > 1/2$, the interim loser chooses $\alpha_{bl} = 1$. □

Proof of Proposition 7: As already, mentioned, the best reply of the interim is to play the same strategy as the interim winner. Furthermore, from Propositions 6,we know that $(\alpha_{al}, \alpha_{bl}) = (1, 0)$ is a best reply to $(\alpha_{aw}, \alpha_{bw})$ with $\alpha_{aw} > 1/2$ and $\alpha_{aw} + \alpha_{bw} = 1$; and $(\alpha_{al}, \alpha_{bl}) = (0, 1)$ is a best reply to $(\alpha_{aw}, \alpha_{bw})$ with $\alpha_{aw} < 1/2$ and $\alpha_{aw} + \alpha_{bw} = 1$. This implies that there exists an equilibrium in which manager j chooses $(\alpha_{aj}, \alpha_{bj}) = (1, 0)$ with probability q_j and $(\alpha_{aj}, \alpha_{bj}) = (0, 1)$ with probability $1 - q_j$ $(j = w, l)$. Proposition 5 implies that $q_w > q_l$ □

7.1 Necessary conditions for a Nash Equilibrium with $N > 2$ competing funds.

Assume that there are $N > 2$ competing funds and that the compensation of fund i is as follows

$$\begin{aligned} C_i &= B \quad \text{if } R_{i,1} + R_{i,2} > R_{j,1} + R_{j,2} \ (i \neq j) \\ C_i &= 0 \quad \text{otherwise} \end{aligned} \tag{30}$$

Let $\Delta_{ij} = R_{i,1} - R_{j,1}$. The objective of fund i in period 2 is to maximize

$$\text{Prob}\,(R_{2,i} > \max_{j \neq i} R_{2,j} - \Delta_{ij})$$

Given that returns are uncorrelated, this is equivalent to maximizing

$$\prod_{j \neq i} \text{Prob}\,(R_{2,i} > R_{2,j} - \Delta_{ij})$$

Given that returns are normally distributed, the first order condition of expected compensation maximizations are

$$\sum_{j \neq i} \frac{\partial G}{\partial v_i}(v_i^*, v_j^*, \Delta_{ij}) f[G(v_i^*, v_j^*, \Delta_{ij})] = 0 \quad i = 1, \ldots, N$$

Year	Aggressive Growth	Growth	Growth and income
1976	33	119	75
1977	34	123	80
1978	35	127	85
1979	36	130	90
1980	36	131	92
1981	39	138	94
1982	44	143	99
1983	49	159	101
1984	62	180	110
1985	74	202	121
1986	85	234	143
1987	106	269	169
1988	131	313	211
1989	140	334	239
1990	148	354	249
1991	160	389	284
1992	184	423	312
1993	215	518	344
1994	298	634	412

Table 1: Dataset: Number of funds for each category for each year.

Year	Number of Funds	n = 1	2	3	4	5	6	7	8	9	10
		Interim ranking of the fund ranked n-th at the end of the year									
1976	75	2	1	6	5	3	33	12	10	25	31
1977	80	1	4	2	18	7	17	3	23	14	11
1978	85	2	1	5	6	7	3	28	11	4	22
1979	90	1	39	2	3	9	24	30	6	51	5
1980	92	30	3	17	18	1	20	15	8	49	2
1981	94	50	1	14	2	4	11	19	3	7	9
1982	99	6	5	13	22	11	12	16	30	25	24
1983	101	2	10	1	34	3	7	15	20	35	9
1984	110	6	19	20	9	5	8	1	2	15	17
1985	121	25	20	22	16	5	6	3	8	2	21
1986	143	1	4	40	38	3	7	2	5	6	45
1987	169	3	125	15	4	41	33	42	64	14	10
1988	211	1	30	5	7	6	3	2	18	37	24
1989	239	2	4	12	22	20	6	11	9	5	35
1990	249	22	4	3	113	76	157	129	23	24	6
1991	284	24	38	1	2	4	29	9	85	51	12
1992	312	151	1	3	5	10	13	45	14	34	2
1993	344	1	16	2	8	9	61	24	141	46	29
1994	412	3	7	9	13	2	22	1	63	29	109

Table 2: Growth and income funds: Interim ranking of funds in the Top 10 at the end of the year.

Table 3a: OLS Regression for Changes in total risk within a year (ΔSTD) as a function of interim performance.

$$\Delta STD^k_{i,t} = \alpha_1 STD(1)^k_{i,t} + \sum_{j=1}^{10} \left(\alpha^k_{2,j} + \alpha_{3,j} EXCESS^k_{i,t} + \alpha_{4,j} DIST^k_{i,t}\right) * Dec(j) + \sum_t \delta_t YearDum_t + \varepsilon^k_{i,t}$$

Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last nine columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1, \ldots, 9$; $j = i+1, \ldots, 10$).

	coefficient	F(1)	F(2)	F(3)	F(4)	F(5)	F(6)	F(7)	F(8)	F(9)
$DIST * Dec(1)$	-6.47***									
	(1.40)									
$DIST * Dec(2)$	-4.62***	1.27								
	(1.05)									
$DIST * Dec(3)$	-2.99***	4.69**	1.57							
	(1.00)									
$DIST * Dec(4)$	-3.69***	3.23*	0.58	0.34						
	(0.89)									
$DIST * Dec(5)$	-2.78***	5.60**	2.18	0.03	0.65					
	(0.92)									
$DIST * Dec(6)$	-2.60***	6.65***	2.96*	0.12	1.09	0.03				
	(0.81)									
$DIST * Dec(7)$	-1.75**	10.44***	6.50**	1.31	3.86**	1.06	0.85			
	(0.71)									
$DIST * Dec(8)$	-1.12*	13.64***	9.96***	3.10*	7.08***	2.89*	2.74*	0.60		
	(0.65)									
$DIST * Dec(9)$	0.44	22.13***	19.82***	9.90***	17.26***	10.20***	10.82***	6.64***	3.56*	
	(0.71)									
$DIST * Dec(10)$	-0.57	16.08***	12.58***	4.86**	9.71***	4.72**	4.72**	1.90	0.44	1.36
	(0.70)									
R^2	0.70									

Table 3b: OLS Regression for Changes in total risk within a year (ΔSTD) as a function of interim performance.

$$\Delta STD_{i,t}^{k} = \alpha_1 STD(1)_{i,t}^{k} + \sum_{j=1}^{10} \left(\alpha_{2,j}^{k} + \alpha_{3,j} EXCESS_{i,t}^{k} + \alpha_{4,j} DIST_{i,t}^{k} \right) * Dec(j) + \sum_t \delta_t YearDum_t + \varepsilon_{i,t}^{k}$$

Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last nine columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1, \ldots, 9$; $j = i+1, \ldots, 10$).

	coefficient	F(1)	F(2)	F(3)	F(4)	F(5)	F(6)	F(7)	F(8)	F(9)
$STD(1)$	-0.471***									
	(0.017)									
$EXCESS * Dec(1)$	0.062***									
	(0.011)									
$EXCESS * Dec(2)$	0.055***	0.16								
	(0.013)									
$EXCESS * Dec(3)$	0.045***	0.78	0.27							
	(0.016)									
$EXCESS * Dec(4)$	0.033**	2.76*	1.53	0.39						
	(0.014)									
$EXCESS * Dec(5)$	0.040**	1.22	0.56	0.05	0.13					
	(0.016)									
$EXCESS * Dec(6)$	0.021	4.66**	3.08*	1.28	0.32	0.75				
	(0.015)									
$EXCESS * Dec(7)$	0.015	6.64***	4.60**	2.16	0.84	1.41	0.10			
	(0.015)									
$EXCESS * Dec(8)$	0.031**	2.70	1.55	0.43	0.00	0.16	0.24	0.68		
	(0.015)									
$EXCESS * Dec(9)$	0.034**	2.11	1.15	0.26	0.01	0.07	0.38	0.90	0.02	
	(0.015)									
$EXCESS * Dec(10)$	0.020	3.56*	2.35	1.04	0.27	0.62	0.00	0.06*	0.21	0.33
	(0.018)									
R^2	0.70									

Table 4a: OLS Regression for Changes in systematic risk within a year ($\Delta BETA$) as a function of interim performance.

$$\Delta BETA^k_{i,t} = \alpha_1 BETA^k(1)_{i,t} + \sum_{j=1}^{10}\left(\alpha^k_{2,j} + \alpha_{3,j}EXCESS^k_{i,t} + \alpha_{4,j}DIST^k_{i,t}\right) * Dec(j)$$
$$+\sum_t \delta_t YearDum_t + \varepsilon^k_{i,t}$$

Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last nine columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1,\dots,9$; $j = i+1,\dots,10$).

	coefficient	F(1)	F(2)	F(3)	F(4)	F(5)	F(6)	F(7)	F(8)	F(9)
$DIST * Dec(1)$	-1.68***									
	(0.26)									
$DIST * Dec(2)$	-1.31***	1.18								
	(0.25)									
$DIST * Dec(3)$	-0.93***	5.56**	1.63							
	(0.22)									
$DIST * Dec(4)$	-1.14***	3.19*	0.38	0.64						
	(0.20)									
$DIST * Dec(5)$	-0.87***	6.09**	2.05	0.05	1.00					
	(0.24)									
$DIST * Dec(6)$	-0.74***	10.75***	4.70**	0.69	3.42*	0.28				
	(0.17)									
$DIST * Dec(7)$	-0.57***	14.53***	7.58***	2.28	6.54**	1.39	0.70			
	(0.17)									
$DIST * Dec(8)$	-0.57***	14.77***	7.74***	2.35	6.74***	1.43	0.73	0.00		
	(0.17)									
$DIST * Dec(9)$	-0.14	27.97***	18.81***	10.78***	20.31***	8.18***	8.97***	4.35**	4.45**	
	(0.17)									
$DIST * Dec(10)$	0.10	35.59***	25.90***	17.19***	29.05***	13.62***	16.16***	9.82***	10.03***	1.36
	(0.18)									
R^2	0.63									

Table 4b: OLS Regression for Changes in systematic risk within a year ($\Delta BETA$) as a function of interim performance.

$$\Delta BETA^k_{i,t} = \alpha_1 BETA(1)^k_{i,t} + \sum_{j=1}^{10} \left(\alpha^k_{2,j} + \alpha_{3,j} EXCESS^k_{i,t} + \alpha_{4,j} DIST^k_{i,t} \right) * Dec(j) + \sum_t \delta_t YearDum_t + \varepsilon^k_{i,t}$$

Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last nine columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1, \ldots, 9$; $j = i+1, \ldots, 10$).

	coefficient	F(1)	F(2)	F(3)	F(4)	F(5)	F(6)	F(7)	F(8)	F(9)
$BETA(1)$	-0.767***									
	(0.014)									
$EXCESS * Dec(1)$	0.019***									
	(0.003)									
$EXCESS * Dec(2)$	0.019***	0.00								
	(0.003)									
$EXCESS * Dec(3)$	0.013***	1.60	1.46							
	(0.004)									
$EXCESS * Dec(4)$	0.013***	1.35	1.27	0.00						
	(0.004)									
$EXCESS * Dec(5)$	0.011***	3.20*	2.97*	0.23	0.21					
	(0.004)									
$EXCESS * Dec(6)$	0.003	13.18***	12.28***	4.29**	3.83*	2.59				
	(0.003)									
$EXCESS * Dec(7)$	-0.002	22.04***	20.80***	9.46***	8.52***	6.97***	1.27			
	(0.003)									
$EXCESS * Dec(8)$	-0.001	20.93***	19.61***	8.44***	7.56***	6.05**	0.79	0.07		
	(0.003)									
$EXCESS * Dec(9)$	-0.003	26.65***	24.92***	11.56***	10.34***	8.74***	1.99	0.05	0.27	
	(0.003)									
$EXCESS * Dec(10)$	-0.004	25.21***	23.46***	11.71***	10.50***	9.06***	2.57	0.29	0.65	0.12
	(0.004)									
R^2	0.63									

Table 5a: OLS Regression for Changes in idiosyncratic risk within a year ($\Delta IDIO$) as a function of interim performance.

$$\Delta IDIO^k_{i,t} = \alpha_1 IDIO(1)^k_{i,t} + \sum_{j=1}^{1} 0 \left(\alpha^k_{2,j} + \alpha_{3,j} EXCESS^k_{i,t} + \alpha_{4,j} DIST^k_{i,t} \right) * Dec(j)$$
$$+ \sum_t \delta_t YearDum_t + \varepsilon^k_{i,t}$$

Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last nine columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1, \ldots, 9$; $j = i+1, \ldots, 10$).

	coefficient	F(1)	F(2)	F(3)	F(4)	F(5)	F(6)	F(7)	F(8)	F(9)
$DIST * Dec(1)$	-1.50									
	(1.11)									
$DIST * Dec(2)$	0.19	2.00								
	(1.60)									
$DIST * Dec(3)$	-1.22**	0.06	3.84**							
	(0.52)									
$DIST * Dec(4)$	0.36	2.51	0.05	5.50**						
	(0.55)									
$DIST * Dec(5)$	0.15	2.04	0.00	4.56**	0.10					
	(0.51)									
$DIST * Dec(6)$	-0.96	0.20	2.15	0.13	3.17**	2.45				
	(0.63)									
$DIST * Dec(7)$	-0.25	1.12	0.37	2.06	0.79	0.39	0.92			
	(0.57)									
$DIST * Dec(8)$	0.23	2.26	0.00	5.33**	0.04	0.02	2.94*	0.58		
	(0.49)									
$DIST * Dec(9)$	0.74	3.78*	0.63	9.82***	0.35	0.93	6.06**	2.45	0.75	
	(0.48)									
$DIST * Dec(10)$	-0.64	0.53	1.26	0.73	2.06	1.44	0.19	0.31	1.87	4.77**
	(0.55)									
R^2	0.47									

Table 5b: OLS Regression for Changes in idiosyncratic risk within a year ($\Delta IDIO$) as a function of interim performance.

$$\Delta IDIO_{i,t}^{k} = \alpha_1 IDIO(1)_{i,t}^{k} + \sum_{j=1}^{10} \left(\alpha_{2,j}^{k} + \alpha_{3,j} EXCESS_{i,t}^{k} + \alpha_{4,j} DIST_{i,t}^{k}\right) * Dec(j) + \sum_t \delta_t YearDum_t + \varepsilon_{i,t}^{k}$$

Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last nine columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1, \ldots, 9$; $j = i+1, \ldots, 10$).

	coefficient	F(1)	F(2)	F(3)	F(4)	F(5)	F(6)	F(7)	F(8)	F(9)
$IDIO(1)$	-0.625***									
	(0.016)									
$EXCESS * Dec(1)$	0.034***									
	(0.008)									
$EXCESS * Dec(2)$	0.033***	0.00								
	(0.008)									
$EXCESS * Dec(3)$	0.014	2.85*	2.67							
	(0.009)									
$EXCESS * Dec(4)$	0.012	3.37*	3.21*	0.03						
	(0.009)									
$EXCESS * Dec(5)$	0.004	5.15**	5.02**	0.57	0.36					
	(0.011)									
$EXCESS * Dec(6)$	-0.018*	15.48***	15.13***	5.73**	5.11**	2.42				
	(0.011)									
$EXCESS * Dec(7)$	-0.015	13.64***	13.48***	4.84**	4.27**	1.89	0.03			
	(0.011)									
$EXCESS * Dec(8)$	-0.020*	17.06***	16.61***	6.69***	6.02**	3.00**	0.03	0.13		
	(0.010)									
$EXCESS * Dec(9)$	-0.029***	28.14***	27.29***	12.64***	11.71***	6.47**	0.71	1.12	0.45	
	(0.009)									
$EXCESS * Dec(10)$	-0.040***	33.22***	32.33***	17.07***	15.95***	9.88***	2.37	3.01*	1.92	0.67
	(0.010)									
R^2	0.47									

Table 6a: OLS Regression for Changes in total risk within a year (ΔSTD) as a function of interim performance.

$$\Delta STD^k_{i,t} = \alpha_1 STD(1)^k_{i,t} + \sum_{j=1}^{10}\left(\alpha^k_{2,j} + \alpha_{3,j} EXCESS^k_{i,t} + \alpha_{4,j} DISTN^k_{i,t}\right) * Dec(j) + \sum_t \delta_t YearDum_t + \varepsilon_{i,t}$$

Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last nine columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1, \ldots, 9$; $j = i+1, \ldots, 10$).

	coefficient	F(1)	F(2)	F(3)	F(4)	F(5)	F(6)	F(7)	F(8)	F(9)
$DISTN * Dec(1)$	-2.68***									
	(0.47)									
$DISTN * Dec(2)$	-0.89**	8.63***								
	(0.43)									
$DISTN * Dec(3)$	-0.70	9.78***	0.10							
	(0.48)									
$DISTN * Dec(4)$	-0.96**	7.59***	0.01	0.19						
	(0.47)									
$DISTN * Dec(5)$	-0.51	9.91***	0.35	0.09	0.50					
	(0.57)									
$DISTN * Dec(6)$	-0.75	7.60***	0.04	0.01	0.11	0.13				
	(0.59)									
$DISTN * Dec(7)$	0.12	14.92***	2.16	1.42	2.63	0.80	1.55			
	(0.62)									
$DISTN * Dec(8)$	0.56	12.28***	2.64	2.02	3.07*	1.45	2.22	0.25		
	(0.86)									
$DISTN * Dec(9)$	3.46***	23.83***	12.50***	11.68***	13.56***	10.82***	12.38***	7.86***	5.09**	
	(1.23)									
$DISTN * Dec(10)$	4.66**	11.00***	6.38**	6.04**	6.76***	5.74**	6.38***	4.56**	3.59*	0.28
	(2.22)									
R^2	0.70									

Table 6b: OLS Regression for Changes in total risk within a year (ΔSTD) as a function of interim performance.

$$\Delta STD_{i,t}^k = \alpha_1 STD(1)_{i,t}^k + \sum_{j=1}^{10}\left(\alpha_{2,j}^k + \alpha_{3,j} EXCESS_{i,t}^k + \alpha_{4,j} DISTN_{i,t}^k\right) * Dec(j) + \sum_t \delta_t YearDum_t + \varepsilon_{i,t}^k$$

Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last nine columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ $(i = 1, \ldots, 9;$ $j = i+1, \ldots, 10)$.

	coefficient	F(1)	F(2)	F(3)	F(4)	F(5)	F(6)	F(7)	F(8)	F(9)
$STD(1)$	-0.465***									
	(0.017)									
$EXCESS * Dec(1)$	0.067***									
	(0.011)									
$EXCESS * Dec(2)$	0.063***	0.05								
	(0.013)									
$EXCESS * Dec(3)$	0.049***	0.99	0.59							
	(0.015)									
$EXCESS * Dec(4)$	0.044***	2.01	1.30	0.07						
	(0.013)									
$EXCESS * Dec(5)$	0.050***	0.73	0.42	0.00	0.10					
	(0.017)									
$EXCESS * Dec(6)$	0.032**	3.90**	2.90*	0.72	0.42	0.74				
	(0.012)									
$EXCESS * Dec(7)$	0.022	7.30***	5.62**	1.97	1.55	1.90	0.28			
	(0.014)									
$EXCESS * Dec(8)$	0.033**	3.93**	2.85*	0.63	0.34	0.65	0.01	0.39		
	(0.014)									
$EXCESS * Dec(9)$	0.021	6.54**	5.11**	1.84	1.44	1.79	0.27	0.00	0.38	
	(0.015)									
$EXCESS * Dec(10)$	0.004	6.75***	5.75**	2.96*	2.54	2.88*	1.15	0.50	1.34	0.46
	(0.023)									
R^2	0.70									

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