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MUTUAL FUND TOURNAMENT: RISK TAKING INCENTIVES INDUCED BY RANKING OBJECTIVES

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Mutual fund tournament: Risk taking incentives induced by ranking objectives*

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Abstract

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. However, emphasis was 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 analyze the game played by two risk-neutral fund managers with ranking objectives. We derive conditions on the set of possible strategies under which the aggregate amount of risk undertaken in the late period is larger than in the first period. In the second part of the paper, we provide evidence that *(i)* funds have risk incentives generated by ranking objectives, *(ii)* risk induced by ranking objectives is mainly idiosyncratic, and *(iii)* risk incentives generated by ranking objectives are stronger for funds ranked in the top decile after the first part of the year.

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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), Kosky 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 Morningstar Inc., the financial publisher. The average return of the category was 18.7 percent, Morningstar said."

Furthermore, empirical studies also suggest that ranking is a measure of relative performance investors take into account (see Massa (1997)). Therefore, since managers receive asset-based compensation (see Khorana (1996)) and investors take ranking into account when choosing funds[2], 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 their expected return while in the second period, the

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

[2] 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).

riskiness of the investment strategy chosen by managers depends on their ranking, the interim loser taking more risk than the interim winner. This results holds even if managers' compensation depends also on their performance relative to some market return. We also derive conditions on the set of possible strategies under which the aggregate amount of risk undertaken in the second period is larger than in the first period.

A direct consequence of this last result is that if managers have ranking based objectives then the aggregate amount of risk undertaken by two funds well ahead of the market after the first period may increase in the second period.

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 empirically whether fund managers have ranking objectives. To perform such a test, we construct an interim performance measure which captures both the interim ranking and the distance to the top fund. For any fund (not ranked first at interim stage), the larger this performance measure, the better the ranking and/or the smaller the distance to the top fund. If managers have ranking objectives, the better their interim performance, the higher their incentive to participate in a winner-takes-all contest, hence the larger their risk-taking incentives. We find evidence of significant positive relation between the interim performance measure and the change of risk in the last part of the year for funds ranked in the top half. Moreover, this relation is significantly stronger for funds in the top decile than for other top half funds. These results suggest that a top 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

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market return (here, the S&P500 index) as a benchmark. As in the other studies, we find that funds ahead of the benchmark decrease risk in the last part of the year. But 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. In other words, we do not find any evidence that risk-taking incentives are generated by compensations convex in excess return.

The organization of this paper is as follows. Section 2 reviews the related literature. Section 3 presents the model. Section 4 derives the equilibrium when mangers have ranking-based objectives. Section 5 presents the empirical results. Section 6 concludes.

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 Kosky 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". 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. Kosky 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.

Closely related theoretical papers studying relative performance evaluation in financial markets are those of Huddart (1999), Hvide (1999), and Palomino (1999) 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 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 four 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 in our context. Conversely, in our model, players face an end of the game and only receive a payoff at the end of the game. Third, we do not assume a perfect correlation of returns if the two managers undertake the same level of risk. Hence, in our model, managers face a trade-off between expected return and variance while in Cabral's model, agents face a trade-off between expected return and co-variance. 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.[3] There is a continuum of investment strategies

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[3]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

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and the return of each strategy is normally distributed. 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 borrowing 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.

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

The better performing manager receives a strictly positive compensation normalized to one and the worse performing manager gets nothing. If the two managers perform equally well, they both receive a compensation of $1/2$.

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. 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.

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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.

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 his return and that of his competitor. The possibility to influence the covariance of the return provides the following type of behaviors. The best reply of an interim loser to the portfolio chosen by the interim winner in the second period is to "differentiate himself" from the interim winner. That is, in the second period, the interim loser chooses a portfolio with return uncorrelated to that of the interim winner. Conversely, the best reply of an interim winner is to choose the same portfolio as the interim loser. Hence, when studying the strategic choice of correlations in returns by managers, the main issue is of herding incentives generated by ranking based objectives. Here, by concentrating on the variance as a strategic variable, we focus on risk incentives generated by ranking objectives.

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.

4   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

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

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

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

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

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_w^* and v_l^* are decreasing and increasing 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 *In the first period, both managers choose $\hat{v}$.*

Proof: 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 $\hat{v}$. $\square$

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 performance in the first period. The following proposition derives conditions on the set of possible strategies under which the total amount of risk undertaken in the last part of the year is larger than in the first part.

Proposition 3 *If for all $d > 0$, $|m'(\hat{v}-d)| \geq |m'(\hat{v}+d)|$, then the total amount of risk in the second period is larger than in the first period independently of Δ (i.e., $v_{1,2}+v_{2,2} > v_{1,1}+v_{2,1}$)*

Proof: From the proof of Proposition 1, we know that in the period 2 subgame Nash Equilibrium, $m'(v_l^*) = -m'(v_w^*)$. Proposition 3 follows directly. $\square$

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Note that the proposition holds if $m(.)$ is symmetric with respect to $\hat{v}$, and holds independently of the observed difference in performance after the first period (Δ).

An extension

The model presented so far 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.

We now extend the previous model to the case in which managers' compensation depends *both* on their ranking and their performance relative to an exogenous benchmark. Denote $R_{b,t}$ the realized benchmark return in period t. We assume that the compensation of manager i is as follows:

$$\hat{C}_i = \alpha \sum_{t=1}^{2} (R_{i,t} - R_{b,t}) + \beta C_i \tag{7}$$

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

If managers' compensation is given by $\hat{C}$, then it is increasing both in ranking and in performance relative to some exogenous benchmark.

Let F be the distribution function of a random variable normally distributed with mean zero and variance equal to one, respectively. Then, in period 2 the objective of the interim loser is to maximize

$$H_l(v_l, v_w, \Delta) = \alpha m(v_l) - \beta F[G(v_w, v_l, \Delta)] \tag{8}$$

(where $G(v_w, v_l, \Delta)$ is given by (2)) while the objective of the interim winner is to maximize

$$H_w(v_w, v_l, \Delta) = \alpha m(v_w) + \beta F[G(v_w, v_l, \Delta)] \tag{9}$$

The following proposition establishes that Propositions 1 and 2 still hold under the new compensation scheme.

Proposition 4 *Assume that managers' compensation is given by (7). Then*

(i) *If $\Delta \neq 0$, then $v_w^* < \hat{v} < v_l^*$ in the second period.*

(ii) *In the first period, both managers choose $\hat{v}$.*

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Proof: See Appendix.

Proposition 4 states that the existence of a premium for being ranked first generates risk-taking incentives in the last period for a manager not ranked first at interim stage.

5   Empirical results

The objective of this section is to test whether managers respond to ranking objectives. 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. As a function of the realized return, the compensation C has the following shape:

$$\mathrm{C}_{i,t} = f(R_{i,t} - R_t^M) + B.I_{R_{i,t}=R_t^T}$$

where $R_{i,t}$, R_t^M and R_t^T represent the return realized by fund i in year t, the market return in year t, and the return realized by the top performer in year t, respectively, f is an increasing function and B represents the managerial income generated by the flow into the fund ranked first while $I_{\{\}}$ is the indicator function.

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

$$E(C_{i,t}|\mathrm{Info}_{i,t}^{int}) = E[f(R_{i,t} - R_t^M)|\mathrm{info}_{i,t}^{int}] + B.\mathrm{Prob}(R_{i,t} = R_t^T|\mathrm{Info}_{i,t}^{int})$$

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

The interim ranking performance should be positively related to the probability of the fund being ranked first at the end of the year. It implies that the better the interim ranking performance, the larger the weight of the ranking objective in the expected compensation. Therefore, funds with higher interim ranking performance are expected to take relatively more risk in the last part of the year. Our goal is to test this ranking performance-risk relation.

5.1 Performance measures

Let $R_{i,t}(1)$ and $N_{i,t}$ denote fund i's return and ranking (according to its return), respectively, in the first semester of year t. We consider the following performance measures.

- $FRAC_{i,t}$: Represents the fraction of funds below fund i after the first semester of year t, i.e.,

$$FRAC_{i,t} = 1 - \frac{N_{i,t} - 1}{N_t}$$

  where N_t is the number of the active funds in year t.

- $COMP_{i,t}$: Composite index taking into account ranking and distribution of returns above $R_{i,t}(1)$. Let

$$D_{i,t} = \frac{1}{N_t} \sum_{j \neq i} (R_{j,t}(1) - R_{i,t}(1)) I_{\{R_{j,t}(1) > Ri,t(1)\}}$$

  Then

$$COMP_{i,t} = \frac{1}{1 + D_{i,t}}$$

- $EXCESS_{i,t}$: Return of fund i in excess of the market return (S&P500) in the first semester of year t, i.e.,

$$EXCESS_{i,t} = R_{i,t}(1) - R_t^M(1),$$

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

While $EXCESS$ represents the standard relative performance measure with respect to an exogenous market return benchmark, $FRAC$ and $COMP$ are relative performance measures with respect to a direct competitor. $FRAC$ represents the normalized ranking of the fund after the first semester going down from 1 for the top fund to $\frac{1}{N_t}$ for the bottom fund. $COMP$ takes into account both the ranking of fund i and the distribution of performances of funds that have outperformed fund i in the first semester. $COMP$ is relatively large when the fund is ranked high and/or there is not much difference between fund performances after the first semester. $COMP$ is small if the fund is ranked low and/or

performances are widely dispersed. We use $COMP$ to capture the idea that if managers have tournament incentives, then both their ranking and the distance to the top fund matter.

5.2 Data

The data used in this paper come from Morningstar Incorporated. The main data source is Morningstar Mutual Funds OnDisc of January 1995, which includes monthly returns of US mutual funds up to December 1994. This data set contains only funds that were still in operation as of January 1995. In order to mitigate the problem of the survivorship bias, we also purchased from Morningstar the returns data of the funds which ceased to exist since the beginning of 1989. Similar to Brown, Harlow, and Starks (1996) we restrict our attention to growth-oriented funds. Our final sample consists of 798 growth funds which were active in the period January 1989 through December 1994. Since we are mainly interested in testing the impact of ranking objectives on fund choice of risk, in each year, we restrict our attention to the funds that are above the median after the first semester. There are two main reasons for which we concentrate on top half funds. First, almost all these funds outperform the market return after the first semester. Hence, risk-incentives are not driven by the willingness to catch up with the market return. Second, it seems reasonable to assume that only these funds compete for the top end-of-the-year rankings.

5.3 Results

Following Koski and Pontiff (1999), we analyze changes in total, systematic and idiosyncratic risks between the first and the second half of the year.

5.3.1 Total risk

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

We define the total risk undertaken by fund i over semester l as the standard deviation

of fund i's monthly returns, i.e.,

$$STD_i(l,t) = \sqrt{\frac{1}{5}\sum_{m=1}^{6}(R_{i,m}(l,t) - \bar{R}_i(l,t))^2} \tag{10}$$

First, we test whether ranking objectives matter and if they are more important for top performing funds than for others. We run the following regression:

$$\Delta STD_{i,t} = \alpha_1 STD(1)_{i,t} + \alpha_2 EXCESS_{i,t} + \alpha_3 RANK_{i,t} + (\alpha_4 + \alpha_5 RANK_{i,t}) * Dec(1)$$
$$+ \sum_t \delta_t YearDum_t + \varepsilon_{i,t} \tag{11}$$

where $\Delta STD_{i,t} \equiv STD(2)_{i,t} - STD(1)_{i,t}$ is the change in the measure of fund i's total risk between the first and second semesters of year t, $RANK_{i,t}$ is one of the two ranking measures ($FRAC_{i,t}$ or $COMP_{i,t}$), $Dec(1)$ is a dummy equal to 1 if the fund belongs to the top decile according to its performance in the first semester, and $YearDum_t$ is a dummy variable equal to 1 in year t. Following Koski and Pontiff (1999), we 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 $STD(1)$. Note that we also include the top decile dummy in the regression to make the intercept different for the top decile and the rest of the funds. Year dummies $YearDum_t$ are included in order to control for the year-specific effects.

Table 1 shows ordinary least squares (OLS) estimates with heteroscedasticity-consistent standard errors. When $RANK = FRAC$, results are not significant. Conversely, they are highly significant when $RANK = COMP$. The difference of results between the two regressions does not come as a surprise since the probability of catching up with the top fund depends on both the interim ranking *and* the distance to the top fund. The variable $COMP$ takes both components into account while $FRAC$ only considers the first one.

We find that α_3 and α_5 are significantly positive at the 5% level. This means that interim ranking influences subsequent change in risk. Furthermoore, α_5 significantly positive means that the influence of the intermediate ranking is significantly stronger for top decile funds than for the others. In other words, ranking objectives are more important for funds with

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a top decile interim performance than for others.

To investigate the shape of the performance-risk relation in more detail when $RANK = COMP$, we run a piecewise linear regression where the slope coefficient for the ranking-related performance measure is different for each of the deciles:

$$\Delta STD_{i,t} = \alpha_1 STD(1)_{i,t} + \alpha_2 EXCESS_{i,t} + \sum_{j=1}^{5} (\alpha_{3,j} + \alpha_{4,j} COMP_{i,t}) * Dec(j)$$
$$+ \sum_t \delta_t YearDum_t + \varepsilon_{i,t} \tag{12}$$

where $Dec(j)$ is a dummy equal to 1 if the fund belongs to the j-th decile according to its performance in the first semester. Table 2 provides the results. We find that α_2 is significantly negative at the 10% level. This is consistent with the results of Brown, Harlow, and Starks (1996), Chevalier and Ellison (1997), and Koski and Pontiff (1999): funds that have outperformed in the first part of the year the benchmark against which they are evaluated decrease their level of risk in the last part of the year. We also find that $\alpha_{4,1}$, $\alpha_{4,3}$ and $\alpha_{4,4}$ are significantly positive at the 5% level and, for all $j = 2, \ldots, 5$, we reject the hypothesis that $\alpha_{4,1} = \alpha_{4,j}$ at the 5% level. These results confirm those obtained in Regression (11): ranking objectives generate risk-taking incentives and these incentives are stronger for top funds than for others.

It can be argued that there is an alternative explanation for our results: the allocation of money into funds is a convex function of $EXCESS$, hence generating a compensation convex in $EXCESS$ and risk incentives for managers. To test for such a possibility, we relax the constraint that $EXCESS$ has a linear impact on ΔSTD, and assume that the relation is decile dependent. We consider the following regressions.

$$\Delta STD_{i,t} = \alpha_1 STD(1)_{i,t} + \alpha_2 EXCESS_{i,t} + \alpha_3 RANK_{i,t}$$
$$+ (\alpha_4 + \alpha_5 EXCESS_{i,t} + \alpha_6 RANK_{i,t}) * Dec(1) \tag{13}$$
$$+ \sum_t \delta_t YearDum_t + \varepsilon_{i,t}$$

$$\Delta STD_{i,t} = \alpha_1 STD(1)_{i,t} + \sum_{j=1}^{5} (\alpha_{2,j} + \alpha_{3,j} EXCESS_{i,t} + \alpha_{4,j} COMP_{i,t}) * Dec(j)$$
$$+ \sum_t \delta_t YearDum_t + \varepsilon_{i,t} \tag{14}$$

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Results are given in Tables 3 and 4. For either regression, we do not find any evidence that the impact of the excess return in the first part of the year on the change of risk level differs for top performing managers and for other managers. In particular, the change of risk level in the last part of the year does not appear to be convex in the excess return realized in the first part of the year.

Hence, we can conclude that there is no evidence that managers' compensation is convex in excess returns while there is evidence that top interim performers have strong risk incentives generated by ranking objectives.

5.3.2 Systematic and idiosyncratic risks

In order to investigate in more details the risk taking behavior of fund managers, we decompose the total risk STD into systematic and idiosyncratic risks.

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 $IDIO_{i,t}$ 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:

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

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

For both measures of risk, we run the most detailed type of regressions, i.e.,

$$\Delta RISK_{i,t} = \alpha_1 RISK(1)_{i,t} + \sum_{j=1}^{5} \left(\alpha_{2,j} + \alpha_{3,j} EXCESS_{i,t} + \alpha_{4,j} COMP_{i,t} \right) * Dec(j)$$
$$+ \sum_t \delta_t YearDum_t + \varepsilon_{i,t}$$
$$(15)$$

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

Results for the systematic risk and idiosyncratic risk are given in Tables 5 and 6, respectively. Results are qualitatively similar to those obtained for the total risk although only

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marginally significant in case of systematic risk. Conversely, the results for idiosyncratic risk are highly significant. It implies that funds have ranking objectives which generate mainly idiosyncratic risk-taking incentives. Furthermore, these ranking objectives are more important for top decile funds than for others.

5.3.3 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 Starks, 1996) or the mean return (as Kosky and Pontiff, 1999) as benchmarks to compute excess returns. Our results also hold if we consider different splittings of the calendar year. More precisely, we checked that our results 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).

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. The interim loser increases risk while the interim winner decreases risk. Furthermore, we have derived conditions on the set of possible strategies under which the aggregate amount of risk undertaken in the last period is larger than in the first period.

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 idiosyncratic risk. Furthermore, ranking objectives are significantly more important for funds with a top decile interim performance than for the others.

Finally, 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" manager's incentives, hence aligning their incentives with those of investors.

7   Appendix

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

$$\Delta + m(v_w^*) - m(v_l^*)) = 2(v_l^* + v_w^*)m'(v_w^*) \tag{16}$$

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

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

$$2(v_l^* + v_w^*)m''(v_w^*) + m'(v_w^*) < 0 \tag{18}$$

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

respectively.

Conditions (16) and (17) imply that

$$m'(v_l^*) = -m'(v_w^*) \tag{20}$$

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

If $m'(v_w^*) > 0$ then $m(v_w^*) > m(v_l^*)$. This ensures a probability of winning the contest strictly larger than $1/2$ for the intermediate winner. Conversely, if $m'(v_w^*) < 0$ then $m(v_w^*) < m(v_l^*)$ and the probability that the intermediate winner wins the contest is less than $1/2$. This implies that there exist a deviation v_w' such that $m(v_w') > m(v_l^*)$ which ensures a probability of winning strictly larger than $1/2$. 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 (16) and (17), we deduce that

$$d\Delta + m'(v_w)dv_w - m'(v_l)dv_l = 2(dv_w + dv_l)m'(v_w) + 2(v_w + v_l)m''(v_w)dv_w \tag{21}$$

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

This implies that

$$m''(v_w)dv_w = m''(v_l)dv_l \tag{23}$$

In turn, this implies that dv_l and dv_w are of opposite signs. Furthermore, from (20), (21) and (23), we obtain that

$$d\Delta = dv_w \left(2(v_l + v_w)m''(v_w) - \frac{m''(v_w)}{m''(v_l)}m'(v_w) \right) \tag{24}$$

Hence, v_w and v_l are decreasing and increasing in Δ, respectively. $\square$

Proof of proposition 4:

Proof of (i). From (8), we deduce that the FOC of compensation maximization for the interim loser is

$$\alpha m'(v_l) + \beta f[G(v_w, v_l, \Delta)]\frac{2(v_w + v_l)m'(v_l) + \Delta + m(v_w) - m(v_l)}{2(v_w + v_l)3/2} = 0 \tag{25}$$

and from (9), we deduce that the FOC of compensation maximization for the interim winner is

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

From (25) and (26), we deduce that in equilibrium, it must be the case that

$$m'(v_l) \left(\alpha - \frac{\beta f[G(v_w, v_l, \Delta)]}{(v_w + v_l)1/2} \right) = m'(v_w) \left(\alpha + \frac{\beta f[G(v_w, v_l, \Delta)]}{(v_w + v_l)1/2} \right) \tag{27}$$

Given that $m(.)$ is strictly concave, (27) 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 (25), this implies that $\Delta + m(v_w) - m(v_l) < 0$. However, in such a case the LHS of (26) is strictly negative. Hence, this cannot be an equilibrium. Therefore, in equilibrium, $m'(v_l) < 0 < m'(v_w)$ which implies that $v_w < \hat{v} < v_l$.

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

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Table 1: OLS Regression for Changes in total risk within a year (ΔSTD) as a function of interim performance. Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively.

	$RANK = FRAC$	$RANK = COMP$
$STD(1)$	-0.562***	-0.560***
	(0.032)	(0.032)
$EXCESS$	-0.027	-0.075**
	(0.025)	(0.033)
$RANK$	0.007*	0.362***
	(0.004)	(0.131)
$RANK * Dec(1)$	0.020	1.976**
	(0.024)	(0.929)
R^2	0.325	0.328

Table 2: OLS Regression for Changes in total risk within a year (ΔSTD) as a function of interim performance with $RANK = COMP$. Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last four columns present F-statistics on a test of differences: $\alpha_{4,i} = \alpha_{4,j}$ $(i = 1, \ldots, 4; \; j = i + 1, \ldots, 5)$.

	Coefficient	F(decile 1)	F(decile 2)	F(decile 3)	F(decile 4)
$STD(1)$	-0.559***				
	(0.032)				
$EXCESS$	-0.113***				
	(0.041)				
$RANK * Dec(1)$	3.281***				
	(1.184)				
$RANK * Dec(2)$	0.744*	6.36**			
	(0.420)				
$RANK * Dec(3)$	0.906***	5.41**	0.25		
	(0.317)				
$RANK * Dec(4)$	0.868***	5.50**	0.17	0.03	
	(0.251)				
$RANK * Dec(5)$	0.479**	7.16***	0.68	3.56*	5.46**
	(0.232)				
R^2	0.333				

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Table 3: OLS Regression for Changes in total risk within a year (ΔSTD) as a function of interim performance. Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively.

	$RANK = FRAC$	$RANK = COMP$
$STD(1)$	-0.560***	-0.559***
	(0.031)	(0.031)
$EXCESS$	0.028	-0.058
	(0.041)	(0.051)
$EXCESS * Dec(1)$	-0.050*	-0.012
	(0.030)	(0.027)
$RANK$	-0.001	0.303
	(0.007)	(0.187)
$RANK * Dec(1)$	0.025	1.865*
	(0.025)	(0.967)
R^2	0.326	0.328

Table 4: OLS Regression for Changes in total risk within a year (ΔSTD) as a function of interim performance with $RANK = COMP$. Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last four columns present F-statistics on a test of differences: $\alpha_{3,i} = \alpha_{3,j}$ and $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1, \ldots, 4$; $j = i+1, \ldots, 5$).

	coefficient	F(decile 1)	F(decile 2)	F(decile 3)	F(decile 4)
$STD(1)$	-0.557***				
	(0.032)				
$EXCESS*Dec(1)$	-0.108**				
	(0.046)				
$EXCESS*Dec(2)$	-0.099	0.08			
	(0.065)				
$EXCESS*Dec(3)$	-0.119	0.05	0.19		
	(0.078)				
$EXCESS*Dec(4)$	-0.121	0.06	0.23	0.00	
	(0.080)				
$EXCESS*Dec(5)$	-0.065	0.60	0.42	0.91	1.11
	(0.083)				
$RANK*Dec(1)$	3.137**				
	(1.342)				
$RANK*Dec(2)$	0.709	4.99**			
	(0.486)				
$RANK*Dec(3)$	0.808**	4.20**	0.07		
	(0.366)				
$RANK*Dec(4)$	0.801***	4.19**	0.07	0.00	
	(0.293)				
$RANK*Dec(5)$	0.486*	5.25**	0.40	1.62	3.22*
	(0.276)				
R^2	0.334				

Table 5: OLS Regression for Changes in systematic risk within a year ($\Delta BETA$) as a function of interim performance with $RANK = COMP$. Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; $***$, $**$ and $*$ indicate significance at the 1%, 5% and 10% level, respectively. The last four columns present F-statistics on a test of differences: $\alpha_{3,i} = \alpha_{3,j}$ and $\alpha_{4,i} = \alpha_{4,j}$ $(i = 1, \ldots, 4; j = i + 1, \ldots, 5)$.

	Coefficient	F(decile 1)	F(decile 2)	F(decile 3)	F(decile 4)
$BETA(1)$	-0.775***				
	(0.038)				
$EXCESS * Dec(1)$	-1.468				
	(1.453)				
$EXCESS * Dec(2)$	-2.118	0.49			
	(2.065)				
$EXCESS * Dec(3)$	-1.371	0.00	0.37		
	(2.491)				
$EXCESS * Dec(4)$	-2.513	0.47	0.09	0.63	
	(2.622)				
$EXCESS * Dec(5)$	-1.195	0.03	0.46	0.01	0.85
	(2.663)				
$RANK * Dec(1)$	69.610*				
	(40.346)				
$RANK * Dec(2)$	7.655	3.84**			
	(15.218)				
$RANK * Dec(3)$	16.581	2.51	0.63		
	(11.841)				
$RANK * Dec(4)$	18.449*	2.31	1.12	0.05	
	(9.534)				
$RANK * Dec(5)$	9.824	3.11*	0.04	0.72	2.41
	(9.083)				
R^2	0.616				

Table 6: OLS Regression for Changes in unsystematic risk within a year ($\Delta IDIO$) as a function of interim performance with $RANK = COMP$. Note: heteroscedasticity-consistent (White) standard errors are reported in parentheses; ∗∗∗, ∗∗ and ∗ indicate significance at the 1%, 5% and 10% level, respectively. The last four columns present F-statistics on a test of differences: $\alpha_{3,i} = \alpha_{3,j}$ and $\alpha_{4,i} = \alpha_{4,j}$ ($i = 1, \ldots, 4;\ j = i+1, \ldots, 5$).

	Coefficient	F(decile 1)	F(decile 2)	F(decile 3)	F(decile 4)
$IDIO(1)$	-0.586***				
	(0.028)				
$EXCESS * Dec(1)$	-0.129***				
	(0.039)				
$EXCESS * Dec(2)$	-0.143**	0.25			
	(0.056)				
$EXCESS * Dec(3)$	-0.137**	0.04	0.03		
	(0.036)				
$EXCESS * Dec(4)$	-0.125*	0.01	0.20	0.07	
	(0.070)				
$EXCESS * Dec(5)$	-0.103	0.45	1.23	0.70	0.27
	(0.068)				
$RANK * Dec(1)$	4.203***				
	(1.027)				
$RANK * Dec(2)$	1.028**	16.29***			
	(0.420)				
$RANK * Dec(3)$	0.996***	14.11***	0.01		
	(0.342)				
$RANK * Dec(4)$	0.579**	18.23***	2.32	2.65	
	(0.268)				
$RANK * Dec(5)$	0.689***	16.75***	1.37	1.55	0.46
	(0.232)				
R^2	0.500				

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