

Fund Flows, Performance, Managerial Career Concerns, and Risk-Taking*

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Abstract

We develop a framework in which we simultaneously model the interactions among investors, fund companies (represented by fund advisors), and managers. In this framework, we show that the interplay between a manager's incentives arising from her compensation structure and career concerns leads to a non-monotonic (approximately U-shaped) relation between her risk choices and prior performance relative to her peers. We empirically analyze the risk-taking behavior of a large sample of fund managers and find significant support for the predicted U-shaped relative risk-prior performance relation. Reputation concerns and employment risk plays a crucial role in driving the non-monotonic relation; significant out performers (under performers) are less (more) likely to be fired in the future, and are also more likely to increase relative risk. We also show empirical support for the additional testable implications of the theory that link determinants of the fund flow-performance relation and managerial career concerns to risk-taking behavior. Funds with higher expense ratios have less convex fund flow-performance relations and less convex U-shaped relative risk-prior performance relations. Funds with younger managers, who face greater employment risk, have more convex U-shaped relative risk-prior performance relations.

Key Words: Mutual Funds, Asset Flows, Relative Risk, Ability, Career Concerns, Employment Risk

JEL Classifications: G10, C61, D81,

I. Introduction

We theoretically and empirically analyze the effects of incentives arising from compensation structures and career concerns on the risk-taking behavior of fund managers. The incentives of fund managers endogenously depend not only on their objectives, but also the objectives and actions of the fund companies who employ them and fund investors who provide capital. In our framework, therefore, we simultaneously model the actions of the fund manager, the fund company and fund investors. The fund manager dynamically chooses the fund's relative risk in response to her endogenously determined incentive structure (payoff and employment risk). The fund advisor optimally chooses the fund's fee and decides whether to continue with or replace the manager. Fund investors allocate capital to the fund based on the fund's fee, its operating costs, and their assessments of the manager's ability.

In this framework, we show that the interplay between a manager's incentives from her compensation, reputation concerns, and employment risk leads to a non-monotonic (approximately U-shaped) relation between her risk choices relative to her peers and her prior relative performance. Implicit incentives arising from reputation concerns and employment risk play a key role in driving risk shifting by fund managers. We empirically examine the risk-taking behavior of a large sample of fund managers and show significant support for the predicted U-shaped relation between relative risk and prior relative performance as well as for the importance of incentives arising from career concerns in driving risk-shifting by fund managers. Our theory also leads to additional novel implications, which link determinants of the convexity of the fund flow-performance relation and managers' employment risk to their risk-taking behavior. *Ceteris paribus*, factors that decrease the convexity of the fund flow-performance relation and/or the manager's employment risk *decrease* the convexity of the U-shaped relative risk-prior performance relation. Consistent with these predictions, we empirically show that funds with higher expense ratios have less convex fund flow-performance relations and less convex U-shaped relative risk-prior performance relations. Funds with older managers with lower employment risk also have less convex relative risk-prior performance relations.

In our multi-period model, the focus is on a representative fund manager in an objective category (for example, aggressive growth, income) with a large number of funds. We model the *relative performance* of the manager in each period, which is the return (before costs and fees) in excess of the benchmark she generates during the period. In each period, the manager invests the fund's capital in a portfolio or strategy of her choice. The fund's relative performance over the period (before costs and fees) is affected by the manager's ability. There is *incomplete*, but *symmetric* information about a manager's investment ability. The manager, fund company and investors update their assessments of the manager's ability in a Bayesian manner on the basis of the manager's observed relative performance. Investors dynamically allocate capital to the fund on the basis of their assessment of the manager's ability. As in studies in the "incomplete contracting" literature (for example, Stole and Zwiebel, 1996), explicit contracts are not enforceable, and the manager's compensation in each period is determined through *ex post* bargaining with the *fund advisor* (who represents the fund company) over the surplus that she generates.

In each period, the market for capital provision is perfectly competitive and there are decreasing returns to scale in fund management. The fund optimally sets its fee in each period rationally anticipating the flow of capital from investors. We show that the assets under management are increasing and convex in the manager's average perceived ability and are increasing in the manager's experience. The inflows of new assets into the fund over any period are convex in the fund's relative performance as reported in previous empirical research (Chevalier and Ellison 1997, Sirri and Tufano 1998, Del Guercio and Tkac, 2002). Further, the convexity of the flow-performance relation decreases with the fund's expense ratio and with the manager's experience.

We analyze the bargaining game between the advisor and the manager and show that the manager's payoff at each date is increasing and convex in her average perceived ability or *reputation*. If the fund advisor incurs costs in replacing the manager with another of higher perceived ability, there exists a *termination threshold* such that the incumbent manager can be replaced with some nonzero *termination probability* if and only if her average perceived ability is below this threshold. The manager bears personal *termination costs* from being fired.

In each period, the manager chooses the fund's portfolio strategy to maximize her discounted expected end-of-period payoff. The expected change in the manager's (fund's) relative performance under any portfolio is proportional to her ability. The relative risk (variance of excess returns) takes values in a stochastically varying interval that is known to the manager and the advisor. Outside investors only know the average relative risk of the manager's available portfolios. The realized interval of possible relative risk choices in each period, the distribution from which it is drawn, and the manager's actual relative risk choice are all unknown to investors. As in studies such as Morris (1995), Scheinkman and Xiong (2003) and Dumas et al (2007), therefore, there is *asymmetric information* about the model for the evolution of the manager's relative performance.

In the above unified framework in which the objectives and actions of fund investors, advisors and managers are simultaneously incorporated, we show that the manager's relative risk choices vary non-monotonically in an approximately U-shaped manner with her prior average relative performance. We also show that, if there is no employment risk, the manager's relative risk choices do not vary with prior performance. Therefore, implicit incentives that arise from employment risk play an important role in driving variations of relative risk with prior performance, that is, *risk-shifting*.

The intuition underlying these results is that the manager's risk choices depend on the interplay between the convexity of her payoff in her perceived ability or reputation and her employment risk. The fact that the manager's actual risk choices are unobservable to investors creates incentives for the manager to affect the level of noise in their perception of her ability by altering the fund's relative risk. When she significantly outperforms the benchmark, her probability of being fired in the future is sufficiently low that she prefers to exploit the convexity of her payoff structure by choosing high relative risk, thereby increasing the noise in investors' perception of her ability. On the other hand, when she significantly under performs the benchmark, she is almost certain to be fired in the future so that she "gambles" by increasing relative risk thereby increasing the probability that her perceived ability improves enough to exceed the termination threshold. At intermediate performance levels, the risk of termination in the future causes the manager to choose lower relative risk, on average, compared with her choices at the two extremes of average relative performance. Further, the manager's

employment risk declines over time because her ability improves (learning by doing). Hence, she chooses higher relative risk as she becomes more experienced.

Factors which increase the degree of convexity of the fund flow-performance relation increase the convexity of the manager's payoff structure. As a result, the manager's propensity to choose higher relative risk increases at all levels of prior performance. However, the *marginal* propensity to increase relative risk is greater when the manager is either a significant out-performer or under performer compared with the scenario in which she is an intermediate performer. Hence, the U-shaped relation between relative risk and prior performance becomes "steeper" or more convex. On the other hand, factors which increase the manager's employment risk increase her propensity to *lower* relative risk. Her marginal propensity to lower relative risk is, however, greater when she is an intermediate performer compared with the two extremes of prior performance leading again to a more convex or steeper U-shaped relative risk-prior performance relation.

The predictions of the theory reconcile a number of empirical findings on the relations among mutual fund flows, performance, managerial turnover and risk-taking in a *single* unified framework. Our analysis also leads to new testable implications that have (to the best of our knowledge) not been examined in previous empirical literature---(i) the U-shaped relation between relative risk and prior performance, (ii) the importance of career concerns and employment risk in driving this U-shaped relation, and (iii) the effects of managers' compensation and employment risk incentives on the degree of convexity of the U-shaped relation. In our empirical analysis, we test these predictions by examining the relative risk choices of a large sample of U.S. equity mutual fund managers in different objective categories.

Our empirical investigation makes use of data from Morningstar Mutual Funds Principia on individual fund managers over the period 1997-2002. We show a *statistically and economically* significant U-shaped relation between *relative* risk and prior performance. Managers with average prior performance choose a relative risk level that is more than 20 percent (as a proportion of the mean relative risk) *lower* than the worst performing managers and 15 percent lower than the best performing managers. The U-shaped relation is robust to alternative classifications of mutual funds by their investment objectives.

Next, we directly test the importance of employment risk in driving managerial risk-shifting by examining the relation between the *future* risk-taking of fund managers and their employment risk, which is represented by their probabilities of termination in the future. We estimate the probability of future termination of a fund manager at any date, and then examine the relation between the likelihood of choosing high relative risk and the probability of termination. As predicted by the theory, we show a significant negative relation between the probability of termination and prior relative performance, and a U-shaped relation between relative risk choices and the probability of termination. Therefore, significant under performers (out performers) are more (less) likely to be fired in the future, and are also more likely to choose high relative risk.

Finally, we empirically investigate the additional testable implications of the theory that relate the convexity of the fund flow-performance relation, the manager's employment risk, and the convexity of the U-shaped relative risk-prior performance relation. Consistent with the theoretical predictions, we show that funds with higher expense ratios have less convex fund flow-performance relations and less convex U-shaped relative risk-prior performance relations. Funds controlled by younger managers, who face greater employment risk, have more convex relative risk-prior performance relations.

Our study contributes to the theoretical and empirical literature that examines various aspects of the relations among mutual fund flows, fund performance, managerial incentives and risk-taking behavior. Lynch and Musto (2003) and Berk and Green (2004) analyze the determinants of the flow-performance relation. As their primary objective is to explain the observed convexity in the fund flow-performance relation, the fund manager is not explicitly modeled as an active economic agent distinct from the fund advisor (who represents the fund company). The effects of the manager's employment risk (which arises from the incentives of the fund advisor to replace the manager) on her relative risk choices is, therefore, not the focus of these studies. In particular, they do not predict a U-shaped relation between relative risk and prior performance that arises from the interaction between the manager's compensation and employment risk incentives.¹ Another set of papers

¹ Das and Sundaram (2002) and Ou-Yang (2003) analyze the effects of various compensation schemes on fund managers' equilibrium portfolio choices. These studies also do not predict a *non-monotonic* (U-shaped) relation between relative risk

(for example, Heinkel and Stoughton, 1994, Carpenter, 2000) investigates the effects of fund managers' incentives on their risk-taking behavior abstracting from the investors-fund company relation. These studies also do not predict a U-shaped relative risk-prior performance relation.

Gervais et al (2005) develop a model of the actions of investors, fund companies and managers to highlight the advantages enjoyed by fund families in monitoring fund managers. We differ from their study in that we focus on investigating the risk-taking decisions of fund managers in response to their incentives, but abstract from issues related to the sizes of the fund families that employ the managers. Dangi et al (2007) also develop a model of fund investors, companies, and managers. Their theory too does not predict a U-shaped relation between relative risk and prior performance. We complement these studies by predicting (and showing empirical support for) a U-shaped relation between relative risk and prior performance. We also analyze how incentives arising from compensation structures and career concerns affect the degree of convexity of the U-shaped relation, or the *intensity* of risk-shifting.

This study contributes to the empirical literature by showing (i) a U-shaped relation between a fund manager's relative risk choices and her prior performance, (ii) the importance of employment risk in driving risk-shifting by fund managers by documenting a U-shaped relation between relative risk and the probability of future termination, and (iii) the effects of the convexity of the fund flow-performance relation and managerial employment risk on the *degree of convexity* of the U-shaped relation (alternately, the *intensity* of risk-shifting).

Brown et al (1996) and Chevalier and Ellison (1997) empirically analyze the effects of convexity in the fund flow-performance relation on fund managers' risk-taking. They abstract from the *sources* of convexity in the fund flow-performance relation and the effects of managerial career concerns, especially, employment risk. Brown et al (1996) find that out performing managers to lower *total* (rather than *relative*) risk relative to under performing managers.² Building on our theory, we significantly extend the empirical analyses in these studies by using *non-linear* specifications to show that *both* out performers and under performers increase *relative* risk,

and prior performance. Further, we examine the effect of career concerns on managers' risk choices in a unified framework in which the interactions among investors, companies and managers are incorporated.

² Busse (2001), however, finds that out performing managers increase total risk relative to under performing managers.

while intermediate performers lower *relative* risk. In addition, we show the effects of the managers' compensation and employment risk incentives on their risk-shifting behavior.

Khorana (1996, 2001) and Chevalier and Ellison (1999) study the effects of managerial turnover, but do not focus on the effects of convexity in the fund flow-performance relation on managers' risk-shifting behavior. We complement their empirical analyses by investigating the effects of the determinants of *both* the convexity of the fund flow-performance relation (therefore, the manager's compensation structure) *and* career concerns on the manager's risk-taking behavior.

In summary, this study contributes to the literature by theoretically and empirically analyzing the determinants of the risk-taking behavior of fund managers. Our theory leads to novel implications for the effects of incentives arising from compensation structures and career concerns on managerial risk-taking, which find significant support in our empirical analysis. The empirical results suggest that the different components of managers' incentive structures have economically significant effects on their risk-taking behavior.

II. A Simple Framework

We begin by deriving the main implications of our study using a simple one-period reduced-form model. The framework serves to illustrate the intuition underlying the results. We present a more formal model in Section III. We focus on a particular investment objective category (for example, aggressive growth, value, long-term growth) with a large number of funds so that a particular fund's performance does not affect the benchmark. Hence, without loss of generality, we focus on a *representative* fund. There are two dates 0 and 1. The manager of the fund has an ability to generate returns (before costs and fees) in excess of the benchmark. The manager and outside investors have imperfect, but symmetric, information about the manager's ability. In this reduced-form framework, we directly model the manager's ability as perceived by all agents in the economy (including the manager). The manager's average perceived ability at date 0 is $\mu(0)$.

At each date $t \in \{0,1\}$, the fund's assets under management are an increasing, strictly convex function $\Lambda(\cdot)$ of the manager's average perceived ability at that date. The manager receives a constant proportion $g \in (0,1)$ of the assets under management as compensation. The manager also faces employment risk. There is

an exogenous threshold l_b such that the manager is replaced by the fund advisor with probability $\alpha \in (0,1)$ if and only if his average perceived ability is below the threshold. If the manager is replaced, he faces personal costs that are a proportion $\delta \in (0,1)$ of his compensation.

At date zero, the manager can either choose a “high relative risk” or “low relative risk” strategy. The manager’s average perceived ability evolves as follows over the period under each strategy:

$$(1) \quad \begin{aligned} \mu_{s_{\max}}(1) &= \mu(0) + s_{\max} N \text{ under the high relative risk strategy} \\ \mu_{s_{\min}}(1) &= \mu(0) + s_{\min} N \text{ under the low relative risk strategy} \end{aligned}$$

where N is a standard normal random variable and $s_{\max} > s_{\min}$. The subscripts on the manager’s average perceived ability at date 1 denote its dependence on the manager’s choice of strategy. Hence, the variance of the evolution of the manager’s average perceived ability is higher under the high relative risk strategy. The manager is risk-neutral with a zero discount rate and chooses either the high relative risk or low relative risk strategy at date 0 to maximize her expected end-of-period payoff incorporating the possibility of being fired at the end of period. Specifically, the manager’s objective function is as follows:

$$\sup_{s \in \{s_{\min}, s_{\max}\}} E[1_{\text{fired}=0} g\Lambda(\mu_s(1)) + 1_{\text{fired}=1} (1 - \delta) g\Lambda(\mu_s(1))] = \sup_{s \in \{s_{\min}, s_{\max}\}} E[g\Lambda(\mu_s(1)) - 1_{\mu_s(1) < l_b} \alpha \delta g\Lambda(\mu_s(1))]$$

In the above, $1_{\text{fired}=1}$ ($1_{\text{fired}=0}$) denotes the event that the manager is replaced (not replaced) at date 1. The term $\alpha \delta$ captures the level of employment risk faced by the manager; if it equals zero the manager faces no employment risk. It follows that the manager chooses the high relative risk strategy if and only if

$$(2) \quad E[g\Lambda(\mu_{s_{\max}}(1)) - g\Lambda(\mu_{s_{\min}}(1))] > \alpha \delta E[1_{\mu_{s_{\max}}(1) < l_b} g\Lambda(\mu_{s_{\max}}(1)) - 1_{\mu_{s_{\min}}(1) < l_b} g\Lambda(\mu_{s_{\min}}(1))]$$

The manager’s compensation (provided she is not replaced) is convex in her average perceived ability because it is proportional to the assets under management. In the absence of employment risk, the right hand side of (2) is zero, while the left hand side is positive because the high relative risk strategy second degree stochastically dominates the low relative risk strategy by (1). Now consider the case where the manager’s employment risk is nonzero. When her average perceived ability at date 0 is high, the manager’s probability of

termination at date 1 is small so that the effect of employment risk is small relative to the effect of the convexity of the manager's compensation. The manager, therefore, chooses high relative risk in this region. When the manager's average perceived ability at date 0 is very low, her average perceived ability at date 1 is almost certain to be lower than the threshold l_b . Therefore, in this region too, the left hand side of (2) exceeds the right hand side so that the manager chooses high relative risk. That is, the manager has little to lose and, therefore, gambles by increasing relative risk. In the intermediate region of average perceived abilities, the right hand side of (2) could exceed the left hand side, that is, the manager chooses low relative risk to decrease her probability of termination at date 1.

If the manager's average perceived ability increases with her prior relative performance (we demonstrate this in our formal model), the above intuition leads to the following predictions:

Prediction 1: There is an (approximately) U-shaped relation between a manager's (fund's) choice of relative risk and her prior relative performance.

Prediction 2: Employment risk plays a key role in driving risk-shifting by fund managers. There is a U-shaped relation between a manager's choice of relative risk at any date and her probability of future termination.

The intuition underlying the above predictions suggests that, *ceteris paribus*, an increase in the convexity of the manager's payoff structure increases her propensity to raise relative risk at all levels of prior performance. Her marginal propensity to increase relative risk is, however, greater at extremes of prior performance, thereby leading to a more convex or "steeper" U-shaped relation between relative risk and prior performance. On the other hand, an increase in the manager's employment risk increases her propensity to lower relative risk at all levels of prior performance. Her marginal propensity to lower relative risk is, however, greater at intermediate levels of prior performance, thereby again leading to a more convex or "steeper" U-shaped relation. We, therefore, obtain the following additional testable predictions that link the convexity of the fund flow-performance relation (therefore, the manager's compensation structure) and the manager's employment risk to the convexity of the U-shaped relation between relative risk and prior performance.

Prediction 3: Any factor that increases the convexity of the fund flow-performance relation and, therefore, the manager's payoff structure increases the convexity of the U-shaped relative risk-prior performance relation.

Prediction 4: Any factor that increases the manager's employment risk is associated with a more convex U-shaped relation between relative risk and prior performance.

III. The Model

We now present a more formal model in which the relation between the fund's assets under management and the manager's average perceived ability or reputation, the manager's compensation structure, and her employment risk, which were *exogenously assumed* in the simple, reduced-form framework of Section II, are derived *endogenously*. We model the actions of fund investors, fund companies (represented by fund advisors), and fund managers. As in the framework of Section II, we focus on a *representative* fund. The time horizon is infinite with dates $(0,1,2,\dots)$, which are the epochs where investors observe the fund's performance and make capital allocation decisions. The representative manager begins managing the fund at date zero.

A. The Manager's Relative Performance and Ability

The key state variable in the model is the publicly observable *relative performance* of the manager *before operating costs and management fees* (which are also publicly observable) over any period. This is defined as the excess return over the benchmark earned by the manager before costs and fees over the period. At any date t , the manager has an *unobservable* ability $l_t \in R$ to generate excess returns over the period $[t, t + 1]$. As we describe shortly, the manager's investment ability varies stochastically over time. Managers differ in their investment abilities.

Let $R_l(t + 1)$ and $R_{benchmark}(t + 1)$ be the returns over the period $[t, t + 1]$ of the fund (before operating costs and fees) and the benchmark, respectively (the subscripts indicate dependence on the manager's ability). The *relative performance* of the manager over the period $[t, t + 1]$ (before operating costs and fees) is

$$(3) \quad r_l(t) = R_l(t) - R_{benchmark}(t)$$

B. The Actions of Investors, the Advisor, and the Manager

At the beginning of each period $[t, t + 1]$, the fund company (represented by the advisor) chooses the fund's fee and decides whether to continue with the incumbent manager or replace her. After the fund advisor makes her decisions, investors *competitively* allocate capital to the fund based on their assessments of the current manager's ability. The competitive allocation of capital by investors generates a surplus for the fund. The fund advisor and manager then bargain over this surplus to determine their respective payoffs for the period $[t, t + 1]$ (note that the manager who is bargaining could either be the incumbent or the new manager if the incumbent is fired). The fund manager then chooses a portfolio (or strategy) in which she invests the fund's capital. Since we are only concerned with the sequence of these events, we assume they all occur at date t .

The manager's compensation in each period is determined by *ex post* bargaining with the advisor over the surplus that is generated through the flow of assets under management. We, therefore, adopt the perspective of studies in the "incomplete contracting" literature (for example, Stole and Zwiebel 1996) in which explicit contracts are not enforceable and agents' payoffs are determined through Nash bargaining. As discussed in this literature, explicit contracts between the advisor and the manager may be impossible to enforce because the manager's relative performance and reputation may be *non-verifiable*, the possibility of *hold-up* by either party, and/or the impossibility of enforcing long-term contractual agreements. In our framework, the manager has bargaining power because she affects the assets under management through her perceived ability or reputation, and the advisor incurs costs if she leaves the fund.

C. The Manager's Available Strategy Choices

At each date t , the manager invests the fund's assets in her choice of portfolio or strategy. The mean of the manager's relative performance (before costs and fees) over the period $[t, t + 1]$ under any portfolio is proportional to her ability. The variance of the relative performance over the period $[t, t + 1]$ (the fund's *relative risk*) lies in the interval $[\sigma_{\min}(t)^2, \sigma_{\max}(t)^2] \equiv [s(t)^2 - \varepsilon(t)^2, s(t)^2 + \varepsilon(t)^2]$ where $s(t)$ and $\varepsilon(t) < s(t)$ are random variables. $s(\cdot)^2$ is uniformly bounded above and below away from zero, is independently and identically distributed across time, and has mean σ^2 . The process $\varepsilon(\cdot)$ is independently distributed across

time.³ We also assume that $s(t)^2 - \varepsilon(t)^2$ is uniformly bounded below away from zero for all s, t . Hence, the interval of possible relative risk choices $[\sigma_{\min}(t)^2, \sigma_{\max}(t)^2]$ is uniformly bounded above and below away from zero for all t .

The average relative risk σ^2 of the manager's available portfolios could be viewed as the base relative risk of the fund with the interval $[\sigma_{\min}(t)^2, \sigma_{\max}(t)^2]$ representing stochastically varying fluctuations about the base relative risk level. The stochastic variation of the interval $[\sigma_{\min}(t)^2, \sigma_{\max}(t)^2]$ of possible relative risk choices reflects the fact that the risks of available investment opportunities and the risk of the benchmark could vary randomly over time. The parameters $\sigma_{\max}(t)$, $\sigma_{\min}(t)$ and σ could vary across funds.

For simplicity, we assume that the manager either chooses the maximum relative risk $\sigma_{\max}(t)^2$ or the minimum relative risk $\sigma_{\min}(t)^2$ at each date t .⁴ All our results qualitatively hold in the more general scenario in which the manager could choose any relative risk in the interval $[\sigma_{\min}(t)^2, \sigma_{\max}(t)^2]$. If the manager chooses a portfolio that has relative risk $\sigma(t)^2 \in \{\sigma_{\min}(t)^2, \sigma_{\max}(t)^2\}$, then the relative performance (before costs and fees) over the period $[t, t+1]$ is:

$$(4) \quad r_t(t+1) = l(t) + \sigma(t)N,$$

where N is a standard normal random variable. The expected relative performance (before costs and fees) is, therefore, proportional to the manager's ability. The subscript on the relative performance (before costs and fees) denotes its dependence on the manager's ability.

There is *asymmetric information* regarding the manager's available strategy choices. The parameters $\sigma_{\max}(t)$, $\sigma_{\min}(t)$, and the manager's actual choice of relative risk are observable only to the manager and the

³ Note that the distribution of $\varepsilon(t)^2$ depends on $s(t)$ because its support lies in $[0, s(t)^2]$.

⁴ Note that, because σ^2 is the mean of the random variable $s(t)^2$, the *realization* of the stochastic interval of possible relative risk choices $[\sigma_{\min}(t)^2, \sigma_{\max}(t)^2]$ at date t could lie to the left of, right of, or contain the base relative risk σ^2 .

advisor. Outside investors know the base relative risk σ^2 of the fund from widely and easily available information such as Morningstar ratings, fund prospectuses, etc. However, they do not observe $\sigma_{\max}(t), \sigma_{\min}(t)$ and also do not know the distributions from which they are drawn. Investors' lack of information about the manager's available portfolio choices arises from the fact that they delegate their portfolio decisions to fund managers because managers have an advantage in terms of information processing costs and/or ability. Investors have diversified holdings in several different funds and cannot monitor frequent changes in each fund's actual portfolio. They also do not have the same information as the manager of the risks of the several hundred securities that are in (or could potentially enter) each fund's portfolio.

As in studies such as Scheinkman and Xiong (2003) and Dumas et al (2007), therefore, there are *asymmetric beliefs* regarding the *underlying model* for the evolution of the manager's relative performance.⁵ While the advisor and manager know that the manager's relative performance evolves as in (4), investors believe that the manager's relative performance evolves as

$$(5) \quad r_l(t+1) = l(t) + \sigma N$$

Because σ^2 is the average relative risk of the manager's available strategies at each date, investors' belief about the fund's relative risk in each period is not systematically greater or less than the actual relative risk (see footnote 5). Further, since the processes $\sigma_{\min}(\cdot), \sigma_{\max}(\cdot)$ are (i) stochastic and unobservable to investors, (ii) their distributions are unknown, (iii) the process $s(\cdot)$ is i.i.d. across time, (iv) the process $\varepsilon(\cdot)$ is independently distributed across time, and (v) the manager's ability is also unknown, investors cannot statistically reject the model (5) based on observations of the manager's relative performance history (see Bensoussan, 1992).

All agents update their assessments of the manager's ability based on observations of the manager's relative performance. Because there is asymmetric information regarding the model for the evolution of the manager's relative performance, investors' assessments of the manager's ability over time differ from the

⁵ As argued by Morris (1995), the presence of heterogeneous beliefs about the model for the evolution of an economic variable is consistent with the presence of asymmetric information in a world with rational agents.

manager's and advisor's assessments. As we show in the next section, this creates incentives for the manager to affect the level of noise in investors' perception of her ability by increasing relative risk when she either outperforms or underperforms the benchmark, and lowering relative risk when she is an intermediate performer, thereby leading to the U-shaped relation between relative risk and prior performance that we empirically document in Section V.⁶

D. Learning about the Manager's Ability

All agents have a *symmetric* prior on the manager's initial ability $l(0)$ that is normally distributed with mean $\mu_{initial} > 0$ and variance $\sigma_{initial}^2$. The manager's and advisor's common information set at date t , which is denoted by F_t^M , is represented by the manager's relative performance and relative risk choice history $\{r_t(s); \sigma^*(s); s < t\}$ where $\sigma^*(s) \in \{\sigma_{\min}(s), \sigma_{\max}(s)\}$. The manager and advisor dynamically update their assessment of the manager's ability based on their information F_t^M . By Section 6.2 of Oksendal (2001), their *posterior* assessments of the manager's ability at any date is normally distributed with variance

$$(6) \quad \sigma_m(t)^2 = \left(1/\sigma_{initial}^2 + \sum_{s=0}^{t-1} 1/\sigma^*(s)^2 \right)^{-1}$$

The mean $\mu_m()$ of the posterior assessment satisfies:

$$(7) \quad \mu_m(t+1) - \mu_m(t) = \frac{\sigma_m(t)^2 \sigma^*(t)}{\sigma_m(t)^2 + \sigma^*(t)^2} N,$$

where N is a standard normal random variable.

The investors' information, which is represented by F_t^I , contains the manager's observable relative performance history $\{r_t(s); s < t\}$ and the base relative risk σ^2 . They use the model (5) for the manager's relative

⁶ On the other hand, in the hypothetical scenario in which investors can perfectly observe or infer the manager's actual risk choices, we can show that the relation between relative risk and prior performance is *inverted U-shaped* (details available). The strong empirical evidence of a U-shaped relative risk-prior performance relation (that we show in Section V), therefore, supports the hypothesis that the manager's actual risk choices are not perfectly observed or inferred by investors.

performance process to update their assessments of the manager's ability. Hence, the manager's average ability and its variance as perceived by investors at date t are (see Section 6.2 of Oksendal, 2001)

$$(8) \quad \mu_i(t) = \frac{\sigma^2 \mu_{initial} + \sigma_{initial}^2 t \left(\frac{1}{t} \sum_{s=1}^t r_l(s) \right)}{\sigma_{initial}^2 t + \sigma^2}$$

$$\mu_i(t+1) = \frac{\sigma^2 \mu_i(t) + \sigma_i(t)^2 r_l(t+1)}{\sigma_i(t)^2 + \sigma^2}$$

$$(9) \quad \sigma_i(t)^2 = \frac{\sigma_{initial}^2 \sigma^2}{\sigma_{initial}^2 t + \sigma^2}$$

For subsequent reference, we denote the *average excess return* (before operating costs and fees) in each period earned by the manager from date zero by $S_l(t)$, that is,

$$(10) \quad S_l(t) = \frac{1}{t} \sum_{u=1}^t r_l(u)$$

We refer to $S_l(\cdot)$ as the manager's *average relative performance* (before operating costs and fees).

Hereafter, for expositional convenience, we refer to the manager's "average ability as perceived by investors" as the manager's "average perceived ability". For notational simplicity, we denote the manager's relative performance and average relative performance (before costs and fees) at date t simply by $r(t)$ and $S(t)$, respectively, dropping the subscripts denoting their dependence on the manager's ability.

IV. Fund Size, Flows, Manager's Incentives, and Risk Choices

We first investigate the relationship between fund investors and the fund company (represented by the fund advisor) and derive the equilibrium assets under management as well as the fund's fee. We then analyze the bargaining game between the advisor and the manager, and derive the manager's payoff structure. Finally, we characterize the manager's employment risk by examining the advisor's incentives to replace the manager.

A. The Allocation of Capital by Investors and the Assets under Management

The fund's relative risk is *unsystematic*. As in Berk and Green (2004), diversified investors, who are *relative risk-neutral*, supply capital with infinite elasticity to funds with positive excess expected returns and withdraw capital from funds with negative excess expected returns. There are decreasing returns to scale in fund management so that the fund's operating costs are increasing and convex in the assets under management. Since the market for capital provision is perfectly competitive, *in equilibrium*, investors allocate capital to the fund until the expected excess return to investors *net of costs and fees* is zero (see Berk and Green, 2004).

The fund's operating costs as a function of the assets under management are represented by the increasing and strictly convex function $C(\cdot):[0,\infty)\rightarrow[0,\infty)$. The marginal operating costs function $C'(\cdot)$ satisfies $C'(0)=0, C'(\infty)=\infty$ implying that $C'(\cdot)$ is a *surjective* mapping from $[0,\infty)\rightarrow[0,\infty)$. In addition, we assume that $C'''(\cdot)$ exists and is strictly negative, that is, $C'(\cdot)$ is strictly concave. This assumption implies that, while the fund's marginal operating costs increase with the fund's size, their *rate of increase* declines with the fund's size. The decline of the marginal operating costs with the fund's size could, for example, arise from the beneficial effects of economies of scale. The operating costs function $C(\cdot)$ is common knowledge.

Proposition 1 *In equilibrium, the fund's fee $f^{opt}(t)$ and the assets under management $q^{opt}(t)$ are given by*

$$(11) \quad \begin{aligned} q^{opt}(t) &= (C')^{-1}(\mu_i(t)) \mathbb{1}_{\mu_i(t)>0} \\ f^{opt}(t) &= \left[\mu_i(t) - \frac{C(q^{opt}(t))}{q^{opt}(t)} \right] \mathbb{1}_{\mu_i(t)>0} \end{aligned}$$

$q^{opt}(t)$ is increasing and convex for $\mu_i(t) \in (0, \infty)$.

To simplify the exposition, we henceforth assume that the manager's average perceived ability is positive so that the fund has nonzero assets. This entails little loss of generality as we show later that the manager is replaced with high probability if his average perceived ability falls below a positive threshold. All our subsequent results depend only on the monotonicity and convexity of the assets under management in the manager's average perceived ability. For tractability, we henceforth assume that the operating costs are given by

$$(12) \quad C(q) = kq + gq \log(q), \text{ where } g > 0; k \geq 0$$

From (11), (12), and the fact that $E_t^I(l(t)) = \mu_i(t)$, we obtain the following expressions for the equilibrium assets under management $q^{opt}(t)$ and the fee $f^{opt}(t)$:

$$(13) \quad \begin{aligned} q^{opt}(t) &= A \exp[(\mu_i(t))/g]; \quad A = e^{-(g+k)/g} \\ f^{opt}(t) &= g \end{aligned}$$

From (13), we note that the fund's fee is, in fact, a constant that does not depend on the manager's perceived ability. This result is consistent with the fact that a fund's fee does not vary significantly over time.⁷ Hence, as in Berk and Green (2004), fund flows and the assets under management are the primary mechanism through which managers are compensated for their skills. As expected, from (12) and (13), the fund's operating costs and fees per unit of assets under management are given by

$$(14) \quad f^{opt}(t) + C(q^{opt}(t))/q^{opt}(t) = \mu_i(t)$$

Note that operating costs and fees are incurred *at the beginning* of each period. From (14), the relative performance *net of costs and fees* (the fund's *realized relative performance*) in any period $[t, t+1]$ is

$$(15) \quad r_{net}(t+1) = r(t+1) - \mu_i(t)$$

By (11), (13), (14) and (15), the growth rate of the fund's total assets and inflow of new assets into the fund over the period $[t, t+1]$ are, respectively,

$$(16) \quad \begin{aligned} \text{Growth Rate}_{[t,t+1]} &= \frac{q^{opt}(t+1) - q^{opt}(t)}{q^{opt}(t)} = \exp\left[\frac{(\mu_i(t+1) - \mu_i(t))}{g}\right] \\ \text{New Assets}_{[t,t+1]} &= \exp\left[\frac{(\mu_i(t+1) - \mu_i(t))}{g}\right] - [R(t+1) - f^{opt}(t) - C(q^{opt}(t))/q^{opt}(t)] \\ &= \exp\left[\frac{(\mu_i(t+1) - \mu_i(t))}{g}\right] - r_{net}(t+1) - R_{benchmark}(t+1) \end{aligned}$$

⁷ The fact that the equilibrium fee is constant in our model is, of course, a consequence of the parametrization (10). One can, however, show that for a more general operating costs function satisfying our assumptions, the dynamic variation of the fund's fee is relatively small compared with the dynamic variation of the assets under management.

In the second equation in (16), the expression $[R(t+1) - f^{opt}(t) - C(q^{opt}(t))/q^{opt}(t)]$ is the return on the fund net of costs and fees. The last equality follows from (15) and the definition of $r(t+1)$ in (3). By (8) and (15)

$$(17) \quad \mu_i(t+1) - \mu_i(t) = \frac{\sigma_i(t)^2 r_i(t+1) - \mu_i(t)\sigma_i(t)^2}{\sigma_i(t)^2 + \sigma^2} + \zeta = \frac{\sigma_i(t)^2 r_{net}(t+1)}{\sigma_i(t)^2 + \sigma^2} + \zeta$$

Equations (7) and (13)-(17) lead to the following implications:

Implication 1: *In any period, the fund's growth rate, the percentage inflow of new assets and (controlling for the beginning-of-period assets) the dollar inflow of new assets, are all convex in the fund's realized relative performance over the period.*

Implication 2: *The degree of convexity of the relation between fund inflows and realized relative performance declines with the fund's fees and with the manager's experience.*

The convexity of the fund flow-performance relation is extensively documented in previous research (Chevalier and Ellison 1997, Sirri and Tufano 1998). The prediction of a negative relation between the fund's fees and the convexity of the fund flow-performance relation is consistent with Berk and Green (2004) and supported by our empirical analysis in Section V. If managers of older funds are also more experienced, the prediction that the convexity of the fund flow-performance relation declines with the manager's experience is consistent with the empirical evidence in Chevalier and Ellison (1997) who document that older funds have less convex fund flow-performance relations. In our dataset of individual fund managers, however, the relationship between the manager's experience and the convexity of the fund flow-performance relation is negative, but not statistically significant at standard confidence levels.

B. Bargaining between the Fund Advisor and the Fund Manager

The manager and the advisor bargain over the total payoff $R(t) = f^{opt}(t)q^{opt}(t) = gq^{opt}(t)$ generated by the flow of assets (recall from 14 that $f^{opt}(t) = g$ is the fee per unit of assets under management). If the bargaining process ends in disagreement, the manager leaves the fund, and the advisor and the manager incur personal costs represented by proportions $\delta_F, \delta \in (0,1]$ of the surplus. Both the advisor and the manager only

incur costs in the current period $[t, t + 1)$ upon disagreement.⁸ We assume that $\delta + \delta_F > 1$ so that there is a loss in total surplus if the advisor and the manager cannot reach an agreement. The fund advisor is risk-neutral, but the fund manager is risk-averse with CRRA preferences described by the power utility function $x^\gamma; \gamma \in (0, 1]$. We adopt Nash bargaining as the solution concept. Convexity assumptions in the theory of bargaining require randomization to ensure the existence of equilibrium (see Section 8.2 of Myerson 1992).

Proposition 2 *Let $P(t)$ be the expected utility payoff (after randomization) the manager derives from her compensation at date t conditional on not being replaced by the advisor. Then*

$$(18) \quad P(t) = h \exp\left(\frac{\gamma}{g}(\mu_i(t))\right) = h \exp(c[(\mu_i(t))])$$

where $h > 0$ is a constant and $1 - \gamma$ is the manager's relative risk aversion. Hence, the manager's expected utility payoff is increasing and convex in her average perceived ability.

C. The Manager's Employment Risk

At any date t , the fund advisor may replace the manager with another manager. The risk-neutral fund advisor makes her replacement decision to maximize her income for the period $[t, t + 1)$. The advisor bears personal costs proportional to her payoff to find a replacement, and the probability of finding a new manager in any period is $\alpha \in (0, 1)$. The manager incurs proportional personal costs $\delta < 1$ if she is replaced. Let $p(\mu')$ be the probability (which is common knowledge) that investors' assessment of the new manager's ability has mean μ' respectively. The following result describes the manager's employment risk.

Proposition 3 *At any date t , there exists a constant threshold l_b such that the incumbent manager is replaced with nonzero probability $\alpha \in (0, 1)$ if and only if her average perceived ability $\mu_i(t) \leq l_b$.*

⁸ For instance, we can assume that the manager obtains an identical job in the next period and the advisor replaces the manager with an identical one in the next period.

The presence of proportional search costs associated with finding a replacement ensures that it is worthwhile for the fund advisor to replace the incumbent only if her perceived ability is sufficiently low.⁹ Proposition 3 leads to the following empirical implication, which is consistent with the evidence in Khorana (1996) and Chevalier and Ellison (1999) and the evidence we document in Section V.

Implication 3: *The probability of a fund manager getting fired increases with under performance.*

D. The Manager's Relative Risk Choices

We now derive the fund manager's relative risk choices in response to her endogenously determined incentive structure described by Propositions 1, 2, and 3. For tractability, as in several prior learning models (for example, Jovanovic and Nyarko, 1996, Prendergast and Stole 1996, Berk and Green 2004), we consider the scenario where, at each date t , the risk-averse fund manager cares about the total expected utility that she derives from her payoff at date $t + \Delta$.¹⁰ The manager's objective, therefore, is:

$$(19) \quad \sup_{\sigma(t) \in \{\sigma_{\min}(t), \sigma_{\max}(t)\}} E_t^M [[P_{\sigma(t)}(t+1) - \delta 1_{\mu_t(t+\Delta) \leq l_b(t+\Delta)} 1_{\text{fired}=1} P_{\sigma(t)}(t+1)]]$$

The subscripts on the manager's payoff at date $t + 1$ indicate its dependence on the manager's relative risk choice during the period $[t, t + 1]$. The following result describes the manager's optimal relative risk choices.

Proposition 4 *At each date t , there exist thresholds levels of the prior average relative performance (given by 11) $S_{\text{low}}(t), S_{\text{high}}(t)$ with $-\infty < S_{\text{low}}(t) \leq S_{\text{high}}(t) < \infty$ such that, if $S(t) \leq S_{\text{low}}(t)$ or $S(t) \geq S_{\text{high}}(t)$, the manager chooses relative risk $\sigma_{\max}(t)$. If $S(t) \in (S_{\text{low}}(t), S_{\text{high}}(t))$, the manager chooses relative risk $\sigma_{\min}(t)$.*

(b) *A necessary condition for the existence of a nonempty interval $(S_{\text{low}}(t), S_{\text{high}}(t))$ is*

⁹ We allow for the possibility that a manager, who is fired from one fund, can begin managing a new fund. In this case, the market continues to update its assessment of her ability based on her performance with the new fund.

¹⁰ Allowing for the manager to have a long-term objective function makes the model analytically intractable due to path dependencies introduced by the presence of learning and the possibility of termination. We have, however, analyzed this model by numerically computing the solution of the recursive dynamic programming equation for the manager's value function and, therefore, her relative risk choices. All our simulations reveal that the testable implications of our analysis are qualitatively unchanged. This is not surprising since the intuition underlying the results remains unaltered.

$$(20) \quad \left[\frac{1}{2} c^2 \left(\frac{\sigma_{\text{initial}}^2}{\sigma_{\text{initial}}^2 (t+1) + \sigma_0^2} \right)^2 (\sigma_{\text{max}}(t)^2 - \sigma_{\text{min}}(t)^2) \right] < \ln\left(\frac{1}{1-\alpha\delta}\right)$$

Proposition 4 leads to the following implication.

Implication 4: *The manager's relative risk choices vary non-monotonically in a U-shaped manner with her prior average relative performance.*

The result in part b) implies that a manager facing no employment risk ($\alpha\delta = 0$) always chooses the high relative risk. Hence, our analysis implies that employment risk plays a crucial role in driving *variations* in relative risk choices or *risk-shifting*. As discussed in Section II, the interplay between the convexity of the manager's payoff structure and her employment risk leads to the following implications regarding the interactions among the shape of the fund flow-performance relation, the manager's career concerns, and her risk-shifting behavior.

Implication 5: *Ceteris paribus, a more convex fund flow-performance relation is associated with a more convex U-shaped relation between relative risk and prior average relative performance.*

Implication 6: *Ceteris paribus, a higher level of employment risk is associated with a more convex U-shaped relation between relative risk and prior average relative performance.*

Implications 1-6 reconcile a large body of previous empirical evidence on the relations among fund flows, performance, manager turnover, and risk-taking in a unified framework. They also lead to new, testable implications that have not been examined in previous empirical research--the U-shaped relation between relative risk and prior performance, and the effects of determinants of the degree of convexity of the fund flow-performance relation and managerial employment risk on the degree of convexity of the U-shaped relation. We empirically analyze these implications in the next section.

V. Empirical Analysis

A. Testable Implications

The results of Sections II-IV lead to the following testable predictions:

1. There is an (approximately) U-shaped relation between a manager's (fund's) choice of relative risk and her prior relative performance.
2. A fund manager's probability of termination in the future decreases with her prior relative performance. There is a U-shaped relation between future relative risk and the probability of future termination.
3. Any factor that increases (decreases) the convexity of the fund flow-performance relation also increases (decreases) the convexity of the U-shaped relative risk-prior relative performance relation.
4. Any factor that raises (lowers) the level of employment risk for the manager, *ceteris paribus*, increases (decreases) the convexity of the U-shaped relative risk-prior relative performance relation.

B. Data Description

Because our testable hypotheses relate to the actions of fund managers, our empirical analysis is at the individual manager level. The data we use are from January 1997, 1998, 1999, 2000, 2001 and 2002 Morningstar Mutual Funds Principia. From this dataset, we obtain a sample of all the funds that are in existence as of December 1996, 1997, 1998, 1999, 2000, and 2001. Note that the sample also includes funds (along with their current and past managers) that were liquidated during the period 1997-2002 thereby mitigating survivorship bias. For each fund in this sample, Morningstar provides biographical information and starting and ending dates for *all* managers who were associated with the fund, that is *current as well as past* fund managers. We obtain the biographical information on all managers who were associated with a fund from January 1996 until December 2001. *For each manager*, we collect the monthly returns of the fund(s) she manages over the time horizon considered. The observations, thus, are at the individual manager level.

We proxy a manager's experience by her age as in Chevalier and Ellison (1999) and calculate age from either graduation or birth year. Unfortunately, for a significant number of managers, we do not have information on the birth year or the graduation year so we cannot compute experience for these managers. In our tests where the manager's experience is an independent variable, therefore, the size of the sample is reduced. For robustness, we group managers in two different ways in our tests:

- (i) By *investment objectives*: aggressive growth (aggressive growth and small company funds combined), growth, and growth income (growth income and equity income funds combined));
- (ii) By *Morningstar categories* (large growth, mid-cap growth, small growth, large blend, mid-cap blend, small blend, large value, mid-cap value, and small value).

Morningstar reports funds' data at the class share level. The different share classes of the same fund only differ with respect to their fee structure or their minimum investment requirements, but are backed by the same portfolio of assets. Since we are interested in the risk-taking behavior of portfolio managers, we aggregate multiple classes of the same fund to avoid multiple counting.¹¹ To build a database at the portfolio level we weight each observation for the share classes by the total net asset of each class.¹²

Table 1 presents descriptive statistics for the funds in the sample grouped by investment objectives. The number of funds increases significantly over time in all categories. The average annual returns in the three categories reflect the overall performance of the market. In 2000 and 2001, returns are low in all three categories possibly due to the bursting of the technology bubble. Table 2 presents descriptive statistics for the managers. There is substantial variation in the ages of managers in our sample with the average age being approximately 45 years. The relative risk choices of the managers (the standard deviation of monthly returns in excess of the median return of funds with the same objective) appear to be consistent with the objectives of the funds. The relative risks are highest for aggressive growth funds and lowest for growth and income funds. It also appears that the average relative risk over the first half of each calendar year is higher than in the second half.

Table 3 presents descriptive statistics of manager turnover in our sample. As in Chevalier and Ellison (1999), we characterize a manager turnover event as one where a manager is associated with a fund in a particular year, but is not associated with it in the following year, and *either* manages a fund with fewer assets *or* does not appear in the sample. The unconditional average probability of termination in any year across the

¹¹ In order to determine which share classes belong to the same portfolio we use a matching algorithm based on names, and then we check the results with the asset turnover data. Multiple share classes belonging to the same portfolio have the same asset turnover ratio.

¹² Index funds are excluded from the sample.

various fund classifications varies from a low of 16.58 percent (182/1,098) for the year 2000 to 23.02 percent (259/1,125) for the year 1999. The overall termination probability is, therefore, almost twenty percent. An unconditional termination probability of twenty percent every year suggests that employment risk is likely to be an important determinant of managerial risk choices.

C. Results of Tests

We first test hypothesis 1 in Section VA by examining the relation between future relative risk choices and prior performance. In these tests, we also investigate the effects of variables such as the fund's fees and the manager's experience, which potentially affect the fund-flow performance relation and employment risk. We then analyze the determinants of the fund flow-performance relation and employment risk and, thereby, test hypotheses 3 and 4 in Section VA. Finally, we test hypothesis 2 in Section VA, which relates a manager's relative risk choices to her probability of future termination.

Relationship between Future Relative Risk Choices and Prior Performance of Fund Managers

We follow a number of prior studies (Brown, Harlow, and Starks, 1996, Chevalier and Ellison, 1997) by examining calendar-year risk-taking behavior. The dependent variable in these tests is, therefore, each manager's relative risk choice over the second half of each calendar year. The relative risk is the standard deviation of the monthly returns in excess of the category median over the period (tracking error).¹³ We denote the relative risk over the second half of the year for manager i in year t as $\sigma_{i,t}^{(2)}$. We also control for the relative risk in the first half of the calendar year, which is denoted as $\sigma_{i,t}^{(1)}$. In these tests, multiple share classes associated with the same fund are aggregated at the portfolio level (All our results hold if we treat individual share classes as independent observations.).

The main independent variable is the manager's standardized performance rank over the first half of each year denoted as $RK_{i,t}^{(1)}$ (see Sirri and Tufano, 1998). We compute the standardized rank by first determining the actual rank of the manager relative to other managers in the same fund segment and then

¹³ The tracking error, as a measure of managerial risk-taking, is also used in Chen and Pennacchi (2002) and Chevalier and Ellison (1997).

dividing the rank by the number of managers in the segment. The standardized rank, therefore, takes values in (0,1] with the top performer getting a rank of one. To test for a U-shaped relation, we also include the square of the standardized performance rank $SQRK^{(1)}_{i,t}$ as an independent variable. We include interaction terms with the fund's expense ratio over the previous year ($EXP_{i,t-1}$) and the logarithm of the manager's age ($LnMAGE_{i,t}$). The results are unchanged when we use the contemporaneous expense ratio ($EXP_{i,t}$) instead of the lagged expense ratio ($EXP_{i,t-1}$).

We use pooled OLS regressions to test the relation between future relative risk and prior performance. Standard errors of coefficient estimates are corrected for clustering at the fund level (see Rogers, 1993).^{14,15} We also include dummy variables for the calendar year and fund segment. The reported P-value for every coefficient corresponds to a two-tailed test of the null hypothesis that the coefficient is zero.

Table 4 presents the results of our analysis. Panel A displays the results when funds are grouped by investment objectives. In all four specifications, the coefficient of prior performance, $RK^{(1)}_{i,t}$, is significantly negative, while the coefficient of the squared prior performance rank, $SQRK^{(1)}_{i,t}$, is significantly positive suggesting the presence of a U-shaped relation between future relative risk and prior performance. An examination of the coefficients reveals that the minimum of the U-shape occurs in the interior of the range of performance ranks. Hence, the relation between future relative risk and prior performance is, in fact, U-shaped over the observed range of manager performance. The coefficient on the prior relative risk, $\sigma^{(1)}_{i,t}$, is positive and significant indicating that there is a positive relation between future and prior relative risk.

From the coefficients in specification (1), we note that the manager with a prior performance rank of 0.5 chooses relative risk that is 0.50 percent ($= -0.01830*0.5 + 0.01655*0.25$) *lower* than the worst-performing manager with a prior performance rank of 0 and 0.33 percent ($= -0.01830*[0.5 - 1] + 0.01655*[0.25 - 1]$) *lower* than the best-performing manager with a prior performance rank of 1. These numbers clearly show the existence of a U-shaped relation between relative risk and prior performance, that is, out-performers and under

¹⁴ Petersen (2006) shows that when residuals are correlated across firms clustered standard errors are more reliable than Fama-MacBeth standard errors.

¹⁵ The results are unchanged when the clustering correction is carried out at the managerial level.

performers *both* choose higher relative risk than intermediate performers. Similarly, from specification (1) in Panel B of Table 4, we note that the manager with a prior performance rank 0.5 chooses relative risk that is 0.60 percent ($= -0.02223*0.5 + 0.01937*0.25$) *lower* than the worst-performing manager and 0.34 percent ($= -0.02223*[0.5 - 1] + 0.01937*[0.25 - 1]$) *lower* than the best performing manager. From Table 2, the mean relative risk in the second semester is 2.65%. The results of Panels A and B show that the managers with average prior performance choose a relative risk level that is more than 20 percent (as a proportion of the mean relative risk) *lower* than the worst performing managers and 15 percent lower than the best performing managers, which indicates that the U-shape is also economically significant.¹⁶

The coefficients of the interaction between the squared prior performance rank and the expense ratio and the interaction between the squared prior performance rank and the manager's age are negative and significant. The fund's expense ratio and the manager's experience (proxied by age), therefore, both *lower* the degree of convexity of the U-shaped relation. That is, funds with higher fees or funds managed by more experienced managers have "flatter" U-shaped relations between future relative risk and prior performance.

From Table 3, the median expense ratio in the sample is 1.19 percent and the first (third) quartile is 0.92 percent (1.5 percent). From the coefficients of the interaction terms with the expense ratio in specification (2) of Table 4, we see that the managers with prior performance rank 0.5 of funds with expense ratio 0.92 percent choose a relative risk level that is 0.18 percent ($=1.10219*(0.015 - 0.0092)*0.5-0.97628*(0.015 - 0.0092)*0.25$) *higher* than the corresponding managers of funds with expense ratio 1.5 percent. Further, the managers with prior performance rank 0.5 of funds with expense ratio 1.5 percent choose a relative risk level that is 0.33 percent lower than the worst performing managers and 0.20 percent lower than the best performing managers of funds with the same expense ratio. On the other hand, the managers with prior performance rank 0.5 of funds with expense ratio 0.92 percent choose a relative risk level that is 0.51 percent lower than the worst performing managers and 0.31 percent lower than the best performing managers of funds with the same expense ratio. These numbers clearly show that funds with lower expense ratios have "steeper" or "more convex" U-

¹⁶ Similar computations for the other model specifications show the economic significance of the U-shaped relation.

shaped relations between relative risk and prior performance. Moreover, the difference in convexity is economically significant relative to the average relative risk (2.65%) of all funds.

From Table 3, the median manager age in the sample is 44 years and the first (third) quartile is 38 years (53 years). From the coefficients of the interaction terms with the logarithm of manager age in specification (3) of Table 4, we see that the managers of age 38 with prior performance rank 0.5 choose a relative risk level that is 0.53 percent $(-0.01442*0.5*(LN(53) - LN(38)) - 0.01764*0.5*(LN(53) - LN(38)))$ lower than the corresponding managers of age 53. Further, the managers of age 38 with prior performance rank 0.5 choose a relative risk level that is 0.50 percent lower than the worst performing managers and 0.33 percent lower than the best performing managers of the same age. On the other hand, the managers of age 53 with prior performance rank 0.5 choose a relative risk level that is 0.40 percent lower than the worst performing managers and 0.13 percent lower than the best performing managers of the same age. These numbers clearly show that funds with younger managers have “steeper” or “more convex” U-shaped relative risk-prior performance relations and the difference in convexity is economically significant relative to the average relative risk of all funds.

In our subsequent tests, we show that the fund’s expense ratio decreases the convexity of the fund flow-performance relation without affecting employment risk, while more experienced managers have lower termination probabilities. The negative effects of the fund’s expense ratio and the manager’s experience on the convexity of the U-shaped relative risk-prior performance relation are, therefore, consistent with hypotheses 3 and 4 in Section IIA. Panel B reports the results when funds are grouped by Morningstar categories. All the implications of Panel A hold. There is a U-shaped relation between future relative risk and prior performance. The fund’s expense ratio and the manager’s experience lower the convexity of the U-shaped relation.

The aforementioned tests do not differentiate funds according to their organizational structure (individual manager or team) and we treat multiple managers for a single fund as separate observations. In a team-managed mutual fund is not clear how the incentives and employment risk affect each individual member of a team, hence, we believe that restricting our analysis to individually-managed mutual funds might provide additional robustness to our evidence and show whether our previous results are driven by the organizational form of mutual funds. In Table 4 Panel C, we focus only on the sub sample of individually-managed mutual

funds and we repeat the tournament behavior analysis. The results indicate that the relative risk-prior performance relation is still U-shaped and fund's expense ratio and the manager's experience both lower the degree of convexity of the U-shaped relation. Therefore, it appears that our previous results are not affected by the funds' organizational form. In results not reported for brevity, we repeated our analysis with the full sample (individually-managed and team-managed funds) and we included a team dummy variable and its interactions with the other major explanatory variables. In all the tests the coefficients of the team dummy variable and its interactions are not significant and do not affect the shape of the relative risk-prior performance relation.

The Fund Flow-Performance Relation

Table 5 presents the results of our analysis of the relation between the dollar inflows of new assets into a fund and its prior performance. We consider dollar flows because they directly determine the manager's compensation. The analysis in Table 5 is carried out using share class observations since mutual fund investors allocate their funds at the share class level and not at the aggregated portfolio level. The dependent variable in these tests is the dollar inflow of new assets with the inflows assumed to occur at the beginning of the year.

$$\text{FLOW}_{i,t} = ((\text{TNA}_{i,t} / (1 + \text{ARET}_{i,t})) - \text{TNA}_{i,t-1}) .$$

$\text{TNA}_{i,t}$ is the fund i 's total net assets at time t , and $\text{ARET}_{i,t}$ is the raw return of fund i in period t .¹⁷

Table 5 Panel A, uses a quadratic specification where the main independent variables are the performance rank of the fund and the squared performance rank over the previous year, $\text{RK}_{i,t-1}$, $\text{SQRK}_{i,t-1}$, respectively. We include interactions with the expense ratio and manager age as defined in Table 4. We control for the fund's size over the previous year, $\text{LnTNA}_{i,t-1}$, fund's expense ratio over the previous year, $\text{EXP}_{i,t-1}$, standard deviation of monthly returns over the previous year, $\text{STD}_{i,t-1}$, and the new dollar inflows into the entire segment for the year, FLOW_SEG_t . We test a quadratic specification of the fund flow-performance relation described as follows:

$$\text{Dollar Inflows} = \alpha + \beta_1(\text{Prior Performance}) + \beta_2(\text{Prior Performance})^2 + \text{Interaction Terms}$$

¹⁷ The results are unchanged when we compute inflows assuming that they occur at the end of the year.

Through the interaction terms, we examine the effects of the fund's fees, and the manager's age on the degree of convexity of the fund flow-performance relation.

In the first specification of Table 5 Panel A, the coefficient of the squared prior performance rank, $SQRK_{i,t-1}$, is positive and significant suggesting that the flow-performance relation is convex. The coefficient of the interaction between fees and the squared prior performance rank is negative and significant indicating that funds with higher expense ratios have a less convex fund flow-performance relation.¹⁸ When we include interactions with the manager's age (experience) in specification (2), the coefficient of the interaction term between the expense ratio and squared prior performance rank is negative and significant. The coefficient of the interaction between manager's age and the squared prior performance rank is negative but not significant. This could be due to the fact that the size of the sample is reduced dramatically when we include the manager's age as an independent variable, due to missing information on managers' ages in the sample. Specifications (3) and (3) in Table 5 present the results of the analysis with funds grouped by Morningstar categories. We see that the implications of the results with funds grouped by investment objectives continue to hold.

In Table 5, Panels B and C we carry out similar tests with a *piecewise linear* specification of the fund flow-performance relation (with two intervals) instead of a quadratic specification. The main implications remain unchanged. The relation between fund flows and performance is convex. The degree of convexity of the fund flow-performance relation decreases with the fund's expense ratio.¹⁹ The manager's experience does not have a significant effect on the convexity of the fund flow-performance relation.

The Manager's Employment Risk

We now examine the determinants of the manager's employment risk. We estimate the probability of future termination for a fund manager using a procedure similar to that in Chevalier and Ellison (1999). At the beginning of each year, we estimate the probability that the manager is terminated by the end of the year, that is,

¹⁸ The results are unchanged when we use the contemporaneous expense ratio ($EXP_{i,t}$) instead of the lagged expense ratio ($EXP_{i,t-1}$).

¹⁹ The documented negative impact of expense ratios on the convexity of the flow-performance relationship is consistent with the evidence shown in Huang, Wei, and Yan (2006).

the manager is not associated with the fund in the *following* year, and either manages a fund with fewer assets, or disappears from the sample altogether. We use LOGIT analysis (with standard errors corrected for clustering at the fund level) to estimate this probability as a function of the manager's prior relative performance. We control for the prior relative risk choice of the manager, $\sigma_{i,t-1}$, the manager's experience (proxied by her age), and previous fund's inflows.

Table 6 reports the results of our analysis. In all the specifications, there is a significant negative relation between the probability of termination and prior performance and a negative relation between the probability of termination and the manager's experience. Following Khorana (1996) and Hu, Hall and Harvey (2000), in specification (3) we also study the effect of past inflows on terminations ($FLOW_{i,t-1}$). Our results document that past inflows are an important determinant of managerial replacement decisions. To account for the possibility that some of our managerial departures may be motivated by retirements and not terminations, we include a dummy variable for managers with an age equal or above sixty ($AGE60_{i,t}$). As shown in specifications (2) and (3), retirement decisions do not appear to drive our results. In fact, the coefficients of the dummy variable are both insignificant. Finally, our empirical evidence shows that the fund's expense ratio does not have a significant effect on the manager's termination probability.

The results of Tables 4, 5, and 6 together support our testable hypotheses 3 and 4 in Section IIA. Consistent with hypothesis 3, the fund's fees decrease the convexity of the fund flow-performance relation and also decrease the convexity of the U-shaped relative risk-prior performance relation. Consistent with hypothesis 4, more experienced managers face lower employment risk, and experience lowers the degree of convexity of the U-shaped relation between their relative risk choices and prior performance.

Relationship between Future Relative Risk Choices and the Probability of Future Termination

The results of Table 4 document a U-shaped relationship between future relative risk choices and prior relative performance. We now test hypothesis 2 in Section IIA by investigating the relationship between a fund manager's relative risk choices and her probability of termination from the fund in the future.

For each specification in Table 6, we infer the manager's probability of termination, $P_TERM_{i,t-1}$, and then examine the relation between her *future* relative risk choice and her probability of termination. The results of the analysis when managers are grouped by investment objectives or Morningstar categories are reported in Table 7. In all the four specifications, we find a negative and significant coefficient on $P_TERM_{i,t-1}$ and a positive and significant coefficient on $SQP_TERM_{i,t-1}$ suggesting that there is a significant U-shaped relationship between the likelihood of choosing high relative risk in the future and the termination probability. An examination of the coefficients of $P_TERM_{i,t-1}$ and $SQP_TERM_{i,t-1}$ reveals that the minimum of the U-shape occurs in the interior of the possible range [0,1] of termination probabilities. For example, from specification (1), the minimum of the U-shape occurs at a termination probability approximately equal to $\frac{0.23}{2*0.79} = 0.15$. Similar calculations for the other specifications show that the relation between future relative risk and termination probability is, indeed, U-shaped. Combined with the results of Table 6, these findings, therefore, imply that outperforming (under performing) managers are less (more) likely to be fired, and are also choose higher relative risk. In summary, the results of Table 7 support hypothesis 2 and show the importance of employment risk in driving risk-taking by fund managers.

A potential concern with our empirical measurement of manager turnover is that we could also be capturing “positive” termination events such as promotions, transfers to more successful funds, etc. Such concerns can, however, be significantly mitigated. First, positive career outcomes are usually a result of good performance. As Table 6 shows, however, the probability of termination in our sample declines significantly with prior performance and with experience. It is, therefore, likely that the termination events that we capture are largely negative career events.

Second, the incorporation of positive career outcomes does not alter the key implications of the theory. For concreteness, suppose that the manager can be promoted (either within the fund company or to a higher position in another company) if her average perceived ability exceeds a threshold, and promotion is represented by a discontinuous increase in her compensation. The possibility of promotion essentially implies that the manager effectively holds an additional call option on her average perceived ability. As is well known, the

presence of a call option encourages risk-taking. In the absence of employment risk, the convexity of the manager's compensation in her average perceived ability along with the call option due to the possibility of promotion implies that the manager always chooses high relative risk. In the presence of employment risk, therefore, a significantly out performing manager chooses high relative risk. The intuition described earlier for the "left tail" of the U-shaped relation continues to be valid in this setting too, that is, an under performing manager "gambles" by choosing high relative risk. In the intermediate region, the manager lowers relative risk as a result of the tradeoff between the negative effects of employment risk with the positive effects of the convexity in her compensation structure and the possibility of promotion.

The incorporation of positive career outcomes, therefore, does not alter the prediction of a U-shaped relation between relative risk and prior relative performance (Implication 4). Further, the intuition described earlier for the effects of determinants of the convexity of the manager's payoff structure and/or her employment risk on the degree of convexity of the U-shaped relation continue to hold. Implications 5 and 6 are, therefore, also unaltered.

V. Conclusions

We theoretically and empirically examine the effect of incentives arising from compensation structures and career concerns on the risk-taking behavior of fund managers. We show that the interplay between a manager's incentives lead to a non-monotonic (approximately U-shaped) relation between her risk choices and prior performance relative to her peers. Implicit incentives arising from employment risk play a key role in driving this non-monotonic relation. The results of our analysis reconcile a large body of empirical evidence on the interactions among the performance of mutual funds, their assets and capital flows, the incentives and career concerns of fund managers, and their risk-taking behavior. Our unified model of the relations among investors, funds, and managers also leads to additional testable implications for the effects of determinants of the fund flow-performance relation and fund managers' career concerns on the degree of convexity of the U-shaped relative risk-prior performance relation.

Consistent with our predictions, our empirical tests confirm the existence of a U-shaped relation between future relative risk and prior relative performance and a positive relation between relative risk and

experience. We also find a significant negative relation between a manager's termination probability and her prior relative performance and experience, and document, for the first time, a U-shaped relation between a manager's likelihood of choosing high relative risk and her probability of termination. Therefore, we empirically establish the importance of employment risk as a driving force behind risk-shifting by fund managers. Consistent with the implications of the theory, we also show that funds with higher expense ratios have less convex fund flow-performance relations and less convex U-shaped relations between relative risk and prior performance. Funds managed by older, more experienced, managers, who face lower employment risk, also have less convex U-shaped relative risk-prior performance relations.

Appendix

Proof of Proposition 1

If investors invest capital $q(t)$ in the fund, then their expected end-of-period payoff *before costs and fees* is $q(t)E_t^I[1 + R(t+1)]$ (see equation (3)) where $E_t^I[.]$ denotes expectation conditional on investors' information F_t^I . Let $f(t)$ denote the fund's fee per unit of assets under management for the period $[t, t+1]$, which is chosen by the fund at date t (we later analyze the fund's optimal choice of fee). The expected end-of-period payoff to investors *net of costs and fees* is

$$(A1) \quad v_{net}(t) = q(t)E_t^I(1 + R(t+1)) - f(t)q(t) - C(q(t)).$$

The expected end-of-period payoff under the benchmark is

$$(A2) \quad v_{benchmark}(t) = q(t)E_t^I(1 + R_{benchmark}(t+1))$$

For a total investment $q(t)$, therefore, it follows from (3), (A1), and (A2) that the *expected excess return* (net of costs and fees) to investors from investing in the fund is

$$\frac{v_{net}(t) - v_{benchmark}(t)}{q(t)} = E_t^I(r(t+1)) - f(t) - \frac{C(q(t))}{q(t)} = E_t^I(r_{net}(t+1)),$$

where $r_{net}(t+1)$ denotes the excess return for the period $[t, t+1]$ net of costs and fees.

Investors' expectation of the excess returns *net of costs and fees* might be positive or negative "off equilibrium" due to the relative magnitudes of the expected excess return *before costs and fees* (that depends on the manager's perceived ability) and the fund's operating costs and fees. Perfect competition in the allocation of capital by investors, however, ensures that, *in equilibrium*, investors' expected excess return net of costs and

fees is equal to zero, that is, investors “compete away” their additional rents (see Berk and Green, 2004). In other words, the fund captures the surplus generated by the ability of its manager. Hence, *for a given fee* $f(t)$, the *equilibrium* assets under management $q^*(f(t);t)$ (the additional argument explicitly indicates the dependence of the assets under management on the fee) satisfy

$$(A3) \quad \begin{aligned} E_t^I(r(t+1)) &= f(t) + \frac{C(q^*(f(t);t))}{q^*(f(t);t)}; \text{ if } E_t^I(r(t+1)) \geq f(t); \\ q^*(f(t);t) &= 0 \text{ if } E_t^I(r(t+1)) < f(t) \end{aligned}$$

(A3) implies that the equilibrium assets under management solve the first equation provided the manager’s expected excess return before costs and fees (therefore, the manager’s perceived ability; see (4)) is high enough to ensure that the fund’s assets under management are nonzero; otherwise the fund is liquidated.

The fund optimally chooses its fee rationally anticipating the allocation of capital by investors in response to the fee to maximize its total payoff. Hence, the *optimal* fee $f^{opt}(t)$ charged by the fund satisfies:

$$(A4) \quad f^{opt}(t) = \arg \max_{f(t) > 0} f(t)q^*(f(t);t)$$

where $q^*(f(t);t)$ satisfies (A3). The corresponding assets under management are, therefore, given by $q^*(f^{opt}(t);t) = q^{opt}(t)$.

From (4), we see that $E_t^I(r(t+1)) = E_t^I(l(t)) = \mu_i(t)$. It follows from (A3) that the assets under management are zero if $f(t) \geq \mu_i(t)$. Without loss of generality, we can, therefore, restrict consideration to scenarios in which $0 < f(t) < \mu_i(t)$. By (A3), the equilibrium assets under management $q^*(f(t);t)$ for a given fee $f(t) \in (0, \mu_i(t))$ satisfy the following:

$$(A5) \quad f(t) = \mu_i(t) - \frac{C(q^*(f(t);t))}{q^*(f(t);t)}.$$

Next, since $C(0) = 0$ and $C(\cdot)$ is strictly convex, $C(q) < qC'(q)$ for any $q > 0$ (this follows from the mean value theorem and the fact that $C'(\cdot)$ is increasing because $C(\cdot)$ is strictly convex). Therefore,

$$\frac{d}{dq}(C(q)/q) = \frac{qC'(q) - C(q)}{q^2} > 0,$$

so that $C(q)/q$ is strictly increasing. Further, because $C(q)/q < C'(q)$ and $C'(0) = 0$, it follows that $\lim_{q \rightarrow 0} C(q)/q = 0$. Finally, as $C'(\infty) = \infty$, it follows from an application of L’Hospital’s rule that $\lim_{q \rightarrow \infty} C(q)/q = \infty$. Hence, $C(q)/q$ maps $q \in [0, \infty)$ onto $[0, \infty)$. It then follows from (A5), and the fact that

$C(q)/q$ maps $q \in [0, \infty)$ onto $[0, \infty)$, that there is a one-one correspondence between the fee $f(t)$ and the assets under management. Therefore, we can re-express the fund's problem as one of maximizing its payoff by choosing the assets under management where the fee is determined by the condition that $E_t^I(r_{net}(t+1)) = 0$ for each possible choice of the assets under management, where $r_{net}(t+1)$ is determined by (A1) and (A2). In other words, the fund seeks to solve

$$(A6) \quad q^{opt}(t) = \arg \max_q q[\mu_i(t) - C(q)/q] = \arg \max_q [q\mu_i(t) - C(q)] = (C')^{-1}(\mu_i(t))$$

Note that $(C')^{-1}(\cdot)$ exists because $C'(\cdot)$ is a surjective mapping from $[0, \infty) \rightarrow [0, \infty)$ by assumption. From (A5) and (A6), the equilibrium assets under management $q^{opt}(t)$ and the fee $f^{opt}(t)$ are given by (11).

Setting $x = \mu_i(t)\Delta$, we note that $\frac{dq^{opt}}{dx} = \frac{1}{C''(q^{opt})} > 0$ because $C(\cdot)$ is strictly convex by assumption.

Next, we see that $\frac{d^2 q^{opt}}{dx^2} = -\frac{C'''(q^{opt})}{C''(q^{opt})} \left(\frac{dq^{opt}}{dx} \right)^2 > 0$ since $C'''(\cdot) < 0$ by assumption. Hence, the equilibrium

assets under management are increasing and strictly convex in the manager's average perceived ability. Q.E.D.

Proof of Proposition 2

Let Π be the space of Borel probability measures on $[0,1]$ that represents the set of randomized bargaining strategies. If $\pi \in \Pi$ is a bargaining strategy, then the probability that the manager receives a proportion $y \in [0,1]$ of the total surplus is $d\pi(y)$. If the bargaining process ends in disagreement, the fund manager and advisor obtain proportions $1 - \delta, 1 - \delta_F$ respectively of the surplus for the period. Let $\Pi_{\delta, \delta_F} \subset \Pi$ denote the set of probability measures with support in the interval $[1 - \delta, \delta_F]$ that is non-empty since $\delta + \delta_F > 1$. By the theory of Nash bargaining (see Ch. 8 of Myerson 1992), the equilibrium of the bargaining game is given by $\pi^* \in \Pi_{\delta, \delta_F}$ that solves

$$(A7) \quad \pi^* = \arg \max_{\pi \in \Pi_{\delta, \delta_F}} \left(\int_0^1 R(t)^\gamma (y^\gamma - (1 - \delta)^\gamma) d\pi(y) \right) \left(\int_0^1 R(t)[(1 - y) - (1 - \delta_F)] d\pi(y) \right) = \\ R(t)^{\gamma+1} \arg \max_{\pi \in \Pi_{\delta, \delta_F}} \left(\int_0^1 (y^\gamma - (1 - \delta)^\gamma) d\pi(y) \right) \left(\int_0^1 [(1 - y) - (1 - \delta_F)] d\pi(y) \right)$$

The first term in the product on the right hand side above represents the expected utility payoff (after randomization) to the manager in excess of her disagreement payoff, and the second term represents the payoff to the risk-neutral fund advisor in excess of the disagreement payoff. Notice that the maximization problem in (A7) does not depend on the surplus $R(t)$ that is bargained over. This is a direct consequence of the

homotheticity of the manager's and advisor's preferences. The existence of a solution to (A7) is guaranteed using arguments that are described in detail in Chapter 8 of Myerson (1992). It follows from (A7) that the manager's expected utility payoff (after randomization) in equilibrium is $lR(t)^\gamma$ where $l = \int_0^1 y^\gamma d\pi^*(y)$. The functional form (18) for the manager's utility payoff then follows from the fact that the surplus $R(t) = f^{opt}(t)q^{opt}(t)$ where $f^{opt}(t), q^{opt}(t)$ are given by (13). Q.E.D.

Proof of Proposition 3

By the proof of Proposition 2, the advisor's income for the period $[t, t+1)$ if the incumbent manager is not replaced is $Q_{incumbent}(t) = jR_{incumbent}(t)$ where $j > 0$ is a constant, and the subscripts indicate the dependence of the total surplus, and the advisor's payoff, on the incumbent manager. From (A7), the fund advisor's payoff if the incumbent were to continue managing the fund is given by

$$Q_{incumbent}(t) = \lambda \exp(v[(\mu_i(t))])$$

where $\lambda > 0$ and $v > 0$ are constants. If the incumbent is replaced by the new manager, the fund advisor's payoff if the new manager's average perceived ability is μ' is given by

$$(A8) \quad Q_{\mu'}(t) = \lambda \exp(v[(\mu')])$$

Suppose that the fund advisor bears proportional search costs in finding a new manager. It is worthwhile for the advisor to replace the incumbent if and only if

$$(A9) \quad \sum_{\mu'} [Q_{\mu'}(t) - Q_{incumbent}(t)] p(\mu') \geq \psi Q_{incumbent}(t)$$

where the right hand side of (A9) represents the advisor's search costs. It follows from (A9) that it is profitable for the advisor to replace the incumbent if and only if

$$(A10) \quad \sum_{\mu', \sigma'} (\exp[v(\mu' - \mu_i(t))] - 1) p(\mu') \geq \psi$$

It follows from (A10) that the incumbent manager faces a nonzero probability $\alpha \in (0,1)$ of being replaced if and only if $\mu_i(t)$ is below a constant threshold l_b . Q.E.D.

Proof of Proposition 4

By (4), (18), and the fact that $E_t^M(l(t)) = \mu_m(t)$ by definition, we can show that the manager's conditional expected end-of-period utility at date t if she chooses relative risk $\sigma(t) \in \{\sigma_{\min}(t), \sigma_{\max}(t)\}$ is

$$(A11) \quad U(t) = he^{c[\mu_i(t)] + (\mu_m(t) - \mu_i(t))c\eta(t) + \frac{1}{2}c^2\eta(t)^2\bar{\sigma}(t)^2} \left[1 - \alpha\delta N \left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}(t)} - c\eta(t)\bar{\sigma}(t) \right) \right]$$

In the above, $\bar{\sigma}(t) = \sqrt{\sigma(t)^2 + \sigma_m(t)^2}$ and $\eta(t) = \frac{\sigma_i(t)^2}{\sigma_i(t)^2 + \sigma^2}$. It follows from (A11) that the manager chooses high relative risk $\sigma_{\max}(t)$ if and only if

$$(A12) \quad e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\max}(t)^2} - e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\min}(t)^2} \geq \alpha\delta \left[\begin{array}{l} e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\max}(t)^2} N \left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}_{\max}(t)} - c\eta(t)\bar{\sigma}_{\max}(t) \right) \\ - e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\min}(t)^2} N \left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}_{\min}(t)} - c\eta(t)\bar{\sigma}_{\min}(t) \right) \end{array} \right]$$

where $\bar{\sigma}_{\max}(t) = \sqrt{\sigma_{\max}(t)^2 + \sigma_m(t)^2}$; $\bar{\sigma}_{\min}(t) = \sqrt{\sigma_{\min}(t)^2 + \sigma_m(t)^2}$. The proof proceeds by showing that the expression on the right hand side above goes to zero as $\mu_i(t) \rightarrow -\infty$, to

$$\alpha\delta \left[e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\max}(t)^2} - e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\min}(t)^2} \right] \leq e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\max}(t)^2} - e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\min}(t)^2}$$

as $\mu_i(t) \rightarrow \infty$ and has at most one local maximum. Therefore, it can intersect the straight line $\left[e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\max}(t)^2} - e^{\frac{1}{2}c^2\eta(t)^2\bar{\sigma}_{\min}(t)^2} \right]$ at most twice. The first two statements follow from the fact that, for $x \in \{\max, \min\}$

$$\lim_{\mu_i(t) \rightarrow -\infty} N \left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}_x(t)} - c\eta(t)\bar{\sigma}_x(t) \right) = 1$$

$$\lim_{\mu_i(t) \rightarrow \infty} N \left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}_x(t)} - c\eta(t)\bar{\sigma}_x(t) \right) = 0$$

The third statement will follow if we show that the derivative of the expression on the right hand side of (A12) with respect to $\mu_i(t)$ has at most two zeroes (we could check that one of these corresponds to a local maximum and the other to a local minimum). It can be shown that this derivative has zeroes at values of $\mu_i(t)$ that solve the equation

$$\exp\left[\frac{1}{2}\left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}_{\max}(t)} - c\eta(t)\bar{\sigma}_{\max}(t)\right)^2 - \frac{1}{2}\left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}_{\min}(t)} - c\eta(t)\bar{\sigma}_{\min}(t)\right)^2\right] = \frac{\bar{\sigma}_{\min}(t)}{\bar{\sigma}_{\max}(t)} e^{\left[\frac{1}{2}c^2\eta(t)^2(\sigma_{\max}(t)^2 - \sigma_{\min}(t)^2)\right]},$$

or, taking the logarithms of both sides above,

$$\frac{1}{2}\left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}_{\max}(t)} - c\eta(t)\bar{\sigma}_{\max}(t)\right)^2 - \frac{1}{2}\left(\frac{l_b - \mu_i(t) - \eta(t)(\mu_m(t) - \mu_i(t))}{\eta(t)\bar{\sigma}_{\min}(t)} - c\eta(t)\bar{\sigma}_{\min}(t)\right)^2 = \log\left(\frac{\bar{\sigma}_{\min}(t)}{\bar{\sigma}_{\max}(t)}\right) + \left[\frac{1}{2}c^2\eta(t)^2(\sigma_{\max}(t)^2 - \sigma_{\min}(t)^2)\right]$$

The left hand side above is a parabola that goes to $-\infty$ as $\mu_i(t) \rightarrow \pm\infty$ because $\bar{\sigma}_{\max}(t) > \bar{\sigma}_{\min}(t)$. Therefore, the equation has at most two zeroes as a function of $\mu_i(t)$. It then follows from (8) and (10) that there exist thresholds $S_{low}(t), S_{high}(t)$ of the manager's prior average relative performance such that the manager chooses relative risk $\sigma_{\max}(t)$ for $S(t) > S_{high}(t)$ and $S(t) < S_{low}(t)$.

b) From the proof of part (a), there exists an intermediate region where choosing low relative risk is optimal if and only if there are values of $\mu_i(t)$ for which the right-hand side of (A12) exceeds the left-hand side. The maximum possible value of the expression on the right hand side of (A12) is lower than

$$(\alpha\delta)e^{\frac{1}{2}\bar{\sigma}_{\max}(t)^2c^2\eta(t)^2}. \text{ If } \left[\frac{1}{2}(\sigma_{\max}(t)^2 - \sigma_{\min}(t)^2)c^2\eta(t)^2\right] > \log\left(\frac{1}{1-\alpha\delta}\right), \text{ then}$$

$$(A13) \quad (\alpha\delta)e^{\frac{1}{2}\bar{\sigma}_{\max}(t)^2c(t)^2} < e^{\frac{1}{2}\bar{\sigma}_{\max}(t)^2c(t)^2} - e^{\frac{1}{2}\bar{\sigma}_{\min}(t)^2c(t)^2}.$$

Therefore, from (A13), the condition $\left[\frac{1}{2}(\sigma_{\max}(t)^2 - \sigma_{\min}(t)^2)c^2\eta(t)^2\right] < \log\left(\frac{1}{1-\alpha\delta}\right)$ is necessary for the existence of an intermediate interval where issuing the conservative forecast is optimal.

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Table 1: Selected Characteristics of the Equity Fund Sample: 1997-2002 Morningstar Mutual Fund Principia

The sample includes open-end U.S. equity funds that have an objective of aggressive growth, growth, or growth and income, as provided by Morningstar Mutual Funds Principia January 1997-2002. Multiple share classes belonging to the same fund are aggregated at the portfolio level. *Returns* are annualized from monthly returns. To be included in the table, a fund has to exist for a whole year and have monthly returns and year-end total assets information available. In subsequent analyses, samples might be different due to different data requirements.

Year	Number of Funds	End of Year Total Assets (\$ Million)	Average Return (Annual)	Average Expense Ratio (Annual)
Panel A: Aggressive Growth (Total Number of Funds: 2,249)				
1997	373	669.30	20.50%	1.41%
1998	443	545.84	2.84%	1.39%
1999	455	674.82	40.24%	1.38%
2000	472	738.90	1.23%	1.38%
2001	506	561.27	-2.76%	1.36%
Overall Average		636.40	11.79%	1.38%
Panel B: Growth (Total Number of Funds: 4,628)				
1997	651	944.48	25.27%	1.31%
1998	775	1,077.78	19.56%	1.30%
1999	913	1,261.24	29.88%	1.29%
2000	1,038	1,200.56	-2.16%	1.29%
2001	1,251	881.25	-12.78%	1.25%
Overall Average		1,069.64	8.63%	1.28%
Panel C: Growth and Income (Total Number of Funds: 2,294)				
1997	413	1,636.94	28.21%	1.08%
1998	454	1,903.46	17.16%	1.07%
1999	471	2,121.97	13.38%	1.09%
2000	487	1,920.14	-0.02%	1.13%
2001	469	1,802.62	-7.79%	1.11%
Overall Average		1,883.27	9.65%	1.10%
Panel D: All Investment Objectives				
Total Sample	9,171	1,166.91	9.65%	1.26%

Table 2: Descriptive Statistics of the Individual Manager Sample

This table presents descriptive statistics of our sample of individual fund managers obtained from Morningstar Mutual Funds Principia January 1997-2002. Multiple share classes belonging to the same fund are aggregated at the portfolio level. The variable Age is calculated either from the year of birth of the manager (if it is available) or inferred from the graduation year of the manager. *Relative Risk* for the 1st semester (2nd semester) is the standard deviation of monthly excess returns earned by the manager (relative to objective median in that month) over the first six months of a year (last six months of a year).

Year	Number of Managers	Manager Age	Relative Risk 1 st semester (Monthly)	Relative Risk 2 nd semester (Monthly)
Panel A: Aggressive Growth (Total Number of Managers: 4,028)				
1997	611	43.9	2.79%	2.08%
1998	786	44.7	2.00%	3.13%
1999	840	44.3	3.56%	3.40%
2000	863	45.6	7.08%	4.12%
2001	928	46.1	4.07%	2.95%
Overall Average		44.9	4.01%	3.19%
Panel B: Growth (Total Number of Managers: 8,005)				
1997	1,043	44.8	2.00%	2.02%
1998	1,240	45.1	1.78%	2.69%
1999	1,617	45.0	3.02%	2.75%
2000	1,890	45.4	5.65%	3.49%
2001	2,215	45.7	3.62%	2.89%
Overall Average		45.3	3.47%	2.86%
Panel C: Growth and Income (Total Number of Managers: 3,950)				
1997	669	45.1	1.22%	1.29%
1998	750	45.5	1.13%	1.80%
1999	809	44.9	2.15%	1.67%
2000	868	45.9	3.03%	1.99%
2001	854	46.8	2.29%	1.68%
Overall Average		45.6	2.02%	1.70%
Panel D: All Investment Objectives				
Total Sample	15,983	45.2	3.25%	2.65%

Table 3: Descriptive Statistics of Manager Turnover

This table presents descriptive statistics on manager turnover in our sample. In each year, we present the number of terminations and the total number of manager-year observations (in parentheses). Multiple share classes belonging to the same fund are aggregated at the portfolio level

Panel A. Managers Grouped by Fund Objectives

Year	Aggressive Growth	Growth	Growth Income	Total
1997	43 (293)	90 (470)	61 (311)	194 (1074)
1998	56 (309)	97 (474)	43 (301)	196 (1084)
1999	90 (334)	89 (485)	80 (306)	259 (1125)
2000	50 (303)	92 (538)	40 (257)	182 (1098)
Total	239 (1239)	368 (1967)	224 (1175)	831 (4381)

Panel B. Managers Grouped by Morningstar Categories

Year	Large Growth	Medium Growth	Small Growth	Large Blend	Medium Blend	Small Blend	Large Value	Medium Value	Small Value	Total
1997	26 (112)	19 (122)	20 (81)	64 (264)	9 (78)	8 (54)	26 (149)	9 (93)	13 (121)	194 (1074)
1998	21 (123)	30 (139)	25 (85)	34 (228)	19 (90)	10 (77)	22 (164)	15 (73)	20 (105)	196 (1084)
1999	27 (148)	26 (120)	24 (100)	50 (233)	19 (76)	26 (93)	42 (169)	18 (84)	27 (102)	259 (1125)
2000	37 (170)	24 (111)	10 (115)	45 (233)	2 (53)	10 (68)	26 (184)	13 (71)	15 (93)	182 (1098)
Total	111 (553)	99 (492)	79 (381)	193 (958)	49 (297)	54 (292)	116 (666)	55 (321)	75 (421)	831 (4381)

Table 4: The Relation between the Manager’s Future Relative Risk Choices and Prior Performance

The table analyses the relationship between the future risk choices and prior performance of managers at the calendar-year level. The sample includes managers of non-index U.S. Equity Mutual Funds contained in the Morningstar Mutual Funds Principia January 1997-2002. Multiple share classes belonging to the same fund are aggregated at the portfolio level. In Panel A the funds are classified according to their investment objectives (Growth, Growth & Income, and Income). In Panel B the funds are classified according to their Morningstar categories (Large Growth, Medium Growth, Small Growth, Large Blend, Medium Blend, Small Blend, Large Value, Medium Value, and Small Value). In Panel C, we consider the sub-sample of funds managed by individual managers and not by teams. The regression coefficients are estimated using pooled OLS regressions with year and fund segment dummies. The standard errors of the estimates are corrected for clustering (Rogers, 1993). The dependent variable is the relative risk over the second semester of a year ($\sigma_{i,t}^{(2)}$). The relative risk is computed as the standard deviation of the monthly returns in excess of the median monthly return for the fund’s segment over the second semester of the year. The independent variables include the relative risk over the first semester of the year ($\sigma_{i,t}^{(1)}$), and the logarithm of the fund total net assets in the previous year ($\text{LnTNA}_{i,t-1}$). A fund’s fractional rank ($\text{RK}_{i,t}^{(1)}$) and its squared term ($\text{SQRK}_{i,t}^{(1)}$), represents its percentile performance relative to other funds with the same investment objective in the same period, and ranges from 0 to 1. Fractional ranks are defined on the basis of raw returns over the first semester within a fund segment. Also included in the regressions are the annual expense ratio ($\text{EXP}_{i,t}$) and the logarithm of manager’s age ($\text{LnMAGE}_{i,t}$). ***, **, and * indicate significance at the one, five, and ten percent level (two-tailed tests), respectively. The last two rows contain the number of observations N and the R^2 . P-values are reported in parentheses.

Panel A - Funds Grouped by Investment Objectives

Dependent Variable : $\sigma_{i,t}^{(2)}$ – Relative Risk in the 2 nd Semester				
Independent Variables	(1)	(2)	(3)	(3)
$\sigma_{i,t}^{(1)}$	0.48521 *** (0.00)	0.47556 *** (0.00)	0.47675 *** (0.00)	0.45633 *** (0.00)
$\text{LnTNA}_{i,t-1}$	-0.00053 *** (0.00)	-0.00030 *** (0.00)	-0.00071 *** (0.00)	-0.00042 *** (0.00)
$\text{RK}_{i,t}^{(1)}$	-0.01830 *** (0.00)	-0.02843 *** (0.00)	-0.07066 *** (0.00)	-0.09467 *** (0.00)
$\text{SQRK}_{i,t}^{(1)}$	0.01655 *** (0.00)	0.02525 *** (0.00)	0.08076 *** (0.01)	0.10260 *** (0.00)
$\text{RK}_{i,t}^{(1)} * \text{EXP}_{i,t-1}$		1.10219 *** (0.00)		1.30241 *** (0.00)
$\text{SQRK}_{i,t}^{(1)} * \text{EXP}_{i,t-1}$		-0.97628 *** (0.00)		-1.18877 *** (0.01)
$\text{RK}_{i,t}^{(1)} * \text{LnMAGE}_{i,t}$			0.01442 *** (0.01)	0.01660 *** (0.01)
$\text{SQRK}_{i,t}^{(1)} * \text{LnMAGE}_{i,t}$			-0.01764 ** (0.02)	-0.01966 *** (0.01)
Segment and Year Dummies	YES	YES	YES	YES
R^2 (%)	57.88	57.81	55.86	55.31
N	11,655	8,915	5,868	4,903

Panel B - Funds Grouped by Morningstar Categories

Dependent Variable : $\sigma_{i,t}^{(2)}$ – Relative Risk in the 2nd Semester

Independent Variables	(1)	(2)	(3)	(3)
$\sigma_{i,t}^{(1)}$	0.50250 *** (0.00)	0.49761 *** (0.00)	0.49330 *** (0.00)	0.47807 *** (0.00)
LnTNA _{i,t-1}	-0.00049 *** (0.00)	-0.00035 ** (0.00)	-0.00055 *** (0.00)	-0.00037 *** (0.00)
RK _{i,t} ⁽¹⁾	-0.02223 *** (0.00)	-0.02919 *** (0.00)	-0.08164 *** (0.00)	-0.09604 *** (0.00)
SQRK _{i,t} ⁽¹⁾	0.01937 *** (0.00)	0.02764 *** (0.00)	0.07571 *** (0.00)	0.08893 *** (0.00)
RK _{i,t} ⁽¹⁾ * EXP _{i,t-1}		0.96870 *** (0.00)		1.27709 *** (0.00)
SQRK _{i,t} ⁽¹⁾ * EXP _{i,t-1}		-0.99566 *** (0.00)		-1.35035 *** (0.00)
RK _{i,t} ⁽¹⁾ * LnMAGE _{i,t}			0.01480 *** (0.00)	0.01495 *** (0.01)
SQRK _{i,t} ⁽¹⁾ * LnMAGE _{i,t}			-0.01413 ** (0.04)	-0.01358 * (0.07)
Segment and Year Dummies	YES	YES	YES	YES
R ² (%)	53.66	53.12	51.84	50.76
N	11,655	8,915	5,868	4,903

Panel C – Individually Managed Funds Grouped by Investment Objectives and Morningstar Categories

Dependent Variable : $\sigma_{i,t}^{(2)}$ – Relative Risk in the 2 nd Semester		
	Investment Objectives	Morningstar Categories
Independent Variables	(1)	(2)
$\sigma_{i,t}^{(1)}$	0.41341 *** (0.00)	0.42723 *** (0.00)
$\text{LnTNA}_{i,t-1}$	-0.00053 *** (0.00)	-0.00036 ** (0.02)
$\text{RK}_{i,t}^{(1)}$	-0.11842 *** (0.00)	-0.11352 *** (0.00)
$\text{SQRK}_{i,t}^{(1)}$	0.14849 *** (0.00)	0.10158 * (0.06)
$\text{RK}_{i,t}^{(1)} * \text{EXP}_{i,t-1}$	1.46692 *** (0.00)	1.43253 *** (0.00)
$\text{SQRK}_{i,t}^{(1)} * \text{EXP}_{i,t-1}$	-4.29229 *** (0.01)	-1.58176 *** (0.00)
$\text{RK}_{i,t}^{(1)} * \text{LnMAGE}_{i,t}$	0.02758 *** (0.00)	0.01565 (0.15)
$\text{SQRK}_{i,t}^{(1)} * \text{LnMAGE}_{i,t}$	-0.02661 *** (0.00)	-0.01309 (0.17)
Segment and Year Dummies	YES	YES
R^2 (%)	52.98	53.13
N	1,979	1,979

Table 5: Determinants of the Fund Flow-Performance Relation

The sample includes U.S. Equity Mutual Funds contained in the Morningstar Mutual Funds Principia January 1997-2002. The funds are classified according to their investment objectives (Growth, Growth & Income, and Income) or their Morningstar categories (Large Growth, Medium Growth, Small Growth, Large Blend, Medium Blend, Small Blend, Large Value, Medium Value, and Small Value). The regression coefficients are estimated using pooled OLS regressions with year and fund segment dummies. The standard errors of the estimates are corrected for clustering (Rogers, 1993). The dependent variable $FLOW_{i,t}$ is the dollar amount (in million) of new money into the fund i in year t and is defined as $FLOW_{i,t} = (TNA_{i,t} / (1 + ARET_{i,t})) - TNA_{i,t-1}$ where $TNA_{i,t}$ is the fund i 's total net assets at time t , and $ARET_{i,t}$ is the raw return of fund i in period t . The independent variables include the logarithm of fund i 's total net assets in the prior period ($LnTNA_{i,t-1}$), the annual expense ratio ($EXP_{i,t-1}$), the standard deviation of monthly raw returns for fund i during the previous period ($STD_{i,t-1}$), the growth rate of net new money for all funds in the same segment in the current period ($FLOW_SEG_t$), the log of manager's age ($LnMAGE_{i,t}$), and a measures of fractional performance of fund i , in the preceding year. A fund's fractional rank ($RK_{i,t-1}$) represents its percentile performance relative to other funds with the same investment objective in the same period, and ranges from 0 to 1. In this table, fractional ranks are defined on the basis of a fund's one-year raw returns within a fund segment. We also use the squared fractional rank ($SQRK_{i,t-1}$). ***, **, and * indicate significance at the one, five, and ten percent level (two-tailed tests), respectively. The last two rows contain the number of observations N and the R^2 . P-values are reported in parentheses.

Dependent Variable : $FLOW_{i,t}$ - Dollar Inflow of New Assets into the Fund

Independent Variables	Investment Objectives		Morningstar Categories	
	(1)	(2)	(3)	(3)
$LnTNA_{i,t-1}$	7.90740 (0.12)	-0.62020 (0.93)	6.19970 (0.22)	-2.18441 (0.76)
$EXP_{i,t-1}$	9709.91 *** (0.00)	9530.54 ** (0.02)	7079.03 *** (0.00)	8100.81 *** (0.01)
$STD_{i,t-1}$	657.137 *** (0.00)	683.895 ** (0.02)	192.769 (0.35)	61.7965 (0.85)
$FLOW_SEG_t$ (x 000's)	0.96730 *** (0.00)	1.20650 *** (0.00)	2.08810 *** (0.00)	2.56840 *** (0.00)
$LnMAGE_{i,t}$		27.25941 (0.80)		-6.85122 (0.93)
$RK_{i,t-1}$	163.128 (0.48)	-412.641 (0.82)	22.1957 (0.93)	-227.568 (0.87)
$SQRK_{i,t-1}$	567.632 ** (0.04)	2363.09 (0.22)	564.843 ** (0.04)	1684.54 (0.29)
$RK_{i,t-1} * EXP_{i,t-1}$	-1917.10 (0.88)	19469.5 (0.45)	2259.51 (0.86)	3345.48 (0.87)
$SQRK_{i,t-1} * EXP_{i,t-1}$	-25752.5 * (0.09)	-59820.9 * (0.07)	-25593.7 * (0.08)	-33717.9 * (0.09)
$RK_{i,t-1} * LnMAGE_{i,t}$		93.4860 (0.83)		81.2570 (0.82)
$SQRK_{i,t-1} * LnMAGE_{i,t}$		-348.726 (0.43)		-269.262 (0.48)
Segment and Year Dummies	YES	YES	YES	YES
R^2 (%)	5.37	6.06	5.72	5.91
N	11,073	6,387	11,073	6,387

Panel B – Piecewise Linear Specification - Funds Grouped by Investment Objectives

In addition to the variables presented in the previous panel of Table 5, in the piecewise linear specification the performance measure is separated into two variables: $PERF_L_{i,t-1} = \text{Min}(RK_{i,t-1}, 0.5)$ and $PERF_H_{i,t-1} = \text{Min}(0.5, RK_{i,t-1} - PERF_L_{i,t-1})$. The coefficients of the piecewise decomposition of fractional ranks represent the slope of the flow-performance relationship over their range of sensitivity. ***, **, and * indicate significance of the regression coefficients at the one, five, and ten percent level (two-tailed tests), respectively. ††† ; ††; † Indicate respectively the 1% , 5%, and 10% level of significance for the test of equality between estimated coefficients (two-tailed test).

Dependent Variable : $FLOW_{i,t}$ - Dollar Inflow of New Assets into the Fund			
Independent Variables	β	(1)	(2)
$LnTNA_{i,t-1}$	β_1	7.79480 (0.13)	-0.70592 (0.92)
$EXP_{i,t-1}$	β_2	10761.6 *** (0.00)	12459.8 *** (0.00)
$STD_{i,t-1}$	β_3	677.919 *** (0.00)	702.403 ** (0.02)
$FLOW_SEG_t$ (x 000's)	β_4	0.96760 *** (0.00)	1.21130 *** (0.00)
$LnMAGE_{i,t}$	β_5		58.8000 (0.53)
$PERF_L_{i,t-1}$	β_6	460.940 *** (0.00)	1095.27 (0.22)
$PERF_H_{i,t-1}$	β_7	1000.57 *** (0.00)	2749.98 ** (0.02)
Test: $\beta_6 = \beta_7$		(0.05) ††	(0.34)
$PERF_L_{i,t-1} * EXP_{i,t-1}$	β_8	-14924.1 ** (0.02)	-13098.8 (0.24)
$PERF_H_{i,t-1} * EXP_{i,t-1}$	β_9	-40302.6 *** (0.01)	-66299.1 *** (0.01)
Test: $\beta_8 = \beta_9$		(0.09) †	(0.09) †
$PERF_L_{i,t-1} * LnMAGE_{i,t}$	β_{10}		-148.240 (0.52)
$PERF_H_{i,t-1} * LnMAGE_{i,t}$	β_{11}		-351.581 (0.18)
Test: $\beta_{10} = \beta_{11}$			(0.61)
Segment and Year Dummies		YES	YES
R^2 (%)		5.35	5.09
N		11,073	6,387

Panel C - Piecewise Linear Specification - Funds Grouped by Morningstar Categories

Dependent Variable : FLOW _{it} - Dollar Inflow of New Assets into the Fund			
Independent Variables	β	(1)	(2)
LnTNA _{i,t-1}	β_1	6.1618 (0.23)	-2.13487 (0.77)
EXP _{i,t-1}	β_2	7466.74 *** (0.00)	7804.00 *** (0.01)
STD _{i,t-1}	β_3	207.586 (0.31)	64.8290 (0.84)
FLOW_SEG _t (x 000's)	β_4	2.08620 *** (0.00)	2.56210 *** (0.00)
LnMAGE _{it}	β_5		5.04618 (0.95)
PERF_L _{i,t-1}	β_6	272.394 ** (0.05)	518.145 (0.51)
PERF_H _{i,t-1}	β_7	898.202 *** (0.00)	2387.97 ** (0.03)
Test: $\beta_6 = \beta_7$		(0.07) †	(0.24)
PERF_L _{i,t-1} * EXP _{i,t-1}	β_8	-7890.65 (0.29)	-6618.12 (0.59)
PERF_H _{i,t-1} * EXP _{i,t-1}	β_9	-38482.7 *** (0.01)	-54055.9 ** (0.03)
Test: $\beta_8 = \beta_9$		(0.13)	(0.18)
PERF_L _{i,t-1} * LnMAGE _{it}	β_{10}		-55.9821 (0.78)
PERF_H _{i,t-1} * LnMAGE _{it}	β_{11}		-318.764 (0.21)
Test: $\beta_{10} = \beta_{11}$			(0.48)
Segment and Year Dummies		YES	YES
R ² (%)		5.73	5.97
N		11,073	6,387

Table 6: Determinants of Employment Risk

This table reports the results of estimating, at the beginning of any year, the probability of termination of the manager over the next year using LOGIT regressions with year and segment dummies. The standard errors of the estimates are corrected for clustering. Funds are classified according to their investment objectives (Growth, Growth & Income, and Income) or their Morningstar categories (Large Growth, Medium Growth, Small Growth, Large Blend, Medium Blend, Small Blend, Large Value, Medium Value, and Small Value). Multiple share classes belonging to the same fund are aggregated at the portfolio level. The dependent variable is a dummy variable that equals one when the manager is replaced during a given year. A fund's fractional rank ($RK_{i,t-1}$) represents its percentile performance relative to other funds in the same segment, and ranges from 0 to 1 where 0 indicates the bottom performer. In the table, fractional ranks are defined on the basis of a fund's one-year raw returns within a fund segment. We include in the regression the annual expense ratio ($EXP_{i,t}$), the previous risk ($\sigma_{i,t-1}$) is the standard deviation of the monthly returns in excess of the median monthly return for the fund's segment, and the logarithm of the manager's age ($LnMAGE_{i,t}$). The variable $FLOW_{i,t}$ is the dollar amount (in billion) of new money into the fund i in year t and is defined as $FLOW_{i,t} = (TNA_{i,t} / (1 + ARET_{i,t})) - TNA_{i,t-1}$ where $TNA_{i,t}$ is the fund i 's total net assets at time t , and $ARET_{i,t}$ is the raw return of fund i in period t . The variable $AGE60_{i,t}$ equals one when a manager's age is above 60, zero otherwise. ***, **, and * indicate significance at the one, five, and ten percent level (two-tailed tests), respectively. The last two rows contain the number of observations N and the Pseudo- R^2 . P-values are reported in parentheses.

Dependent Variable : $TERM_{i,t}$ – Managerial Termination Dummy				
Independent Variables	Investment Objectives		Morningstar Categories	
	(1)	(2)	(3)	(3)
$RK_{i,t-1}$	-0.6970 *** (0.00)	-0.6699 *** (0.00)	-0.9092 *** (0.00)	-0.8737 *** (0.00)
$\sigma_{i,t-1}$	-7.3649 (0.14)	-5.9050 (0.26)	-4.7674 (0.38)	-4.4900 (0.43)
$LnMAGE_{i,t}$	-1.3450 *** (0.00)	-1.4932 *** (0.00)	-1.3961 *** (0.00)	-1.5303 *** (0.00)
$FLOW_{i,t-1}$	-0.1734 ** (0.03)	-0.1806 ** (0.03)	-0.1735 ** (0.03)	0.1813 ** (0.03)
$EXP_{i,t}$		9.5992 (0.48)		12.7500 (0.34)
$AGE60_{i,t}$		0.2217 (0.36)		0.1879 (0.44)
Segment and Year Dummies	YES	YES	YES	YES
Pseudo R^2 (%)	1.36	1.29	1.34	1.57
N	2,291	2,252	2,291	2,252

Table 7: Relationship between Future Relative Risk and Termination Probability

This table presents the relationship between future relative risk choices and estimated termination probabilities from Table 6. Funds are classified according to their investment objectives (Growth, Growth & Income, and Income) or their Morningstar categories (Large Growth, Medium Growth, Small Growth, Large Blend, Medium Blend, Small Blend, Large Value, Medium Value, and Small Value). The regression coefficients are estimated using pooled OLS regressions with year and fund segment dummies. The standard errors of the estimates are corrected for clustering (Rogers, 1993). Multiple share classes belonging to the same fund are aggregated at the portfolio level. The dependent variable ($\sigma_{i,t}$) is the standard deviation of the monthly returns in excess of the median monthly return for the fund's segment during the current year. In each specification, the independent variable is the predicted termination probability ($P_TERM_{i,t-1}$) from the corresponding specification in Table 6. We also include the squared termination probability ($SQP_TERM_{i,t-1}$). ***, **, and * indicate significance at the one, five, and ten percent level (two-tailed tests), respectively. The last two rows contain the number of observations N and the R^2 . P-values are reported in parentheses.

Dependent Variable : $\sigma_{i,t}$ – Future Relative Risk				
Independent Variables	Investment Objectives		Morningstar Categories	
	(1)	(2)	(3)	(3)
P_TERM _{i,t-1}	-0.22976 *** (0.00)	-0.16362 *** (0.00)	-0.09418 *** (0.00)	-0.06893 *** (0.01)
SQP_TERM _{i,t-1}	0.39080 *** (0.00)	0.28190 *** (0.00)	0.16152 *** (0.01)	0.12102 ** (0.04)
Segment and Year Dummies	YES	YES	YES	YES
R ² (%)	32.70	31.15	31.53	30.93
N	2,291	2,252	2,291	2,252