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

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We develop a unified model of the interactions among investors, fund companies, and fund managers. We show that the interplay between a manager's incentives from her compensation structure and career concerns leads to a nonmonotonic (approximately U-shaped) relation between her risk choices and prior performance relative to her peers. Significantly outperforming (underperforming) managers are less (more) likely to be fired in the future and are also more likely to increase relative risk. *Ceteris paribus*, relative risk declines with the level of employment risk faced by a manager. Using a large sample of mutual fund managers, we find strong support for the hypothesized U-shaped relation between relative risk and prior performance. Our findings also highlight the importance of employment risk as the underlying driver of risk shifting by fund managers. Our theoretical model also generates additional hypotheses that link determinants of the fund flow–performance relation and managers' employment risk to their risk-taking behavior. In support, our empirical analysis shows 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 with younger managers, who face greater employment risk, have more convex U-shaped relative risk–prior performance relations; and managers in larger fund families have lower incentives to engage in risk shifting, thereby leading to a less convex U-shaped relation.

Key words: mutual funds; asset flows; relative risk; ability; career concerns; employment risk

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1. Introduction

We develop a theoretical model to analyze the effects of a fund manager's incentives on her risk-taking behavior. We show that the manager's incentives from her compensation, reputation concerns, and employment risk lead to a nonmonotonic (approximately U-shaped) relation between her risk choices relative to her peers and her prior relative performance. Implicit incentives arising from employment risk play a key role in driving risk shifting by fund managers. We then empirically examine the risk-taking behavior of a large sample of fund managers and find significant support for the predicted U-shaped relation between relative risk and prior performance. We also provide evidence in support of the importance of employment risk as a driver of risk shifting by fund managers. Our theoretical framework generates

additional testable hypotheses that 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 hypotheses, we empirically show that funds with higher expense ratios, funds with older managers, and funds associated with larger fund families have less convex U-shaped relations.

We develop a two-period model of a representative fund manager in an objective category (for example, aggressive growth, income, etc.) with a large number of funds so that a single fund's choices do not affect the benchmark relative to which investors evaluate

the performances of funds. We consider a partial equilibrium framework in which the benchmark is passive and represents an alternate investment opportunity available to investors with a risk that is representative of funds in the objective category.

The incentives of managers depend not only on their objectives but also on the objectives and actions of fund companies who employ them and the investors who provide capital. Our framework, therefore, simultaneously incorporates the actions of the manager, the company, and investors. Because we focus on calendar-year risk-taking behavior, the period and the two subperiods in our model correspond to a year and the first and second halves of the year, respectively. At the beginning of each year, the fund company chooses the fund's fee. The fund manager chooses an observable portfolio (or strategy) for the fund at the beginning of *each half-year*. Investors competitively allocate capital to the fund at the beginning of each year based on their assessment of the manager's ability to generate expected *relative* return, which is the risk-adjusted expected return in excess of the benchmark. The competitive allocation of capital by investors generates a surplus for the fund. We adopt an "incomplete contracting" perspective in which the payoffs of the company and the manager in each year are determined through Nash bargaining over the surplus generated by the competitive allocation of capital by investors. The fund company can replace the fund manager at the end of the first year with another manager of higher perceived ability.

The *relative performance* of the manager in each half-year is the return (before costs and fees) in excess of the benchmark she generates during the half-year. For simplicity, we assume that the manager chooses either a "high relative risk" or a "low relative risk" portfolio strategy in each half-year, where relative risk is the standard deviation of the fund's relative performance. Consistent with the standard trade-off between risk and return, the high relative risk strategy also has a higher expected relative return. The proportions by which the fund's expected relative return is altered by changes in its relative risk are observable to all agents. The ratio of the expected relative return to the relative risk—the "relative" Sharpe Ratio—is higher for the high relative risk strategy. The manager's ability is the *true* risk-adjusted expected relative return she generates, which is the risk-adjusted expected relative return with respect to the hypothetical omniscient agent who knows the manager's ability. All agents have *incomplete* but *symmetric* information about the manager's ability. Investors rationally allocate capital by incorporating their knowledge of the manager's strategy choices.

Consistent with previously documented empirical findings (e.g., Chevalier and Ellison 1997, Sirri and

Tufano 1998, Del Guercio and Tkac 2002), we show that the assets under management are increasing and convex in the manager's average perceived ability and the inflows of new assets into the fund are convex in the fund's relative performance. The manager's payoff in each period that is determined by Nash bargaining with the company is affine in the assets under management. It is, therefore, also increasing and convex in her average perceived ability. We show that there exists a termination threshold such that the manager can be replaced with some termination probability if and only if her average perceived ability is below this threshold. The manager bears personal termination costs from being fired. The manager chooses the fund's portfolio strategy in each period to maximize her expected future payoffs.

Because our empirical analysis focuses on "calendar year" risk-taking behavior, we theoretically examine the relation between the manager's relative risk choices in the second half of each year in response to her performance over the first half to maintain a tight link between the theory and the empirics. To pin down the manager's risk choices in the second year, we extend the model to allow for the manager to receive a terminal payoff at the end of the second year—the payoff from her "outside options"—that is increasing and convex in her average perceived ability.

The manager's relative risk choices in the second half of the first year vary nonmonotonically in an approximately U-shaped manner with her relative performance over the first half. We also show that if there is no employment risk, the manager always chooses high relative risk in the second half regardless of her prior performance. Therefore, implicit incentives arising from employment risk play an important role in driving risk shifting by the manager. Further, factors that increase the *level* of ex ante employment risk faced by the manager increase her propensity to lower relative risk at all levels of prior performance.

The manager's risk choices depend on the interplay between the convexity of her payoffs in her perceived ability and her employment risk. Because the high relative risk strategy has a higher relative Sharpe ratio, the variance of the evolution of the manager's average perceived ability is higher if she chooses the high relative risk strategy. When the manager significantly outperforms her peers over the first half of the year, her probability of being fired in the future is sufficiently low that she prefers to exploit the convexity of her payoff structure by choosing the high relative risk strategy, thereby increasing the variance of the change in her perceived ability. When she significantly underperforms her peers, she is very likely to be fired in the future, so 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 future termination causes the manager to lower relative risk. Because the manager's terminal payoff is increasing and convex in her average perceived ability and she faces no employment risk in the second year, the intuition above immediately implies that she always chooses high relative risk in the second year.

Our theory leads to three testable hypotheses.

(i) There is a U-shaped relation between a manager's relative risk choices and her prior relative performance. (ii) The presence of employment risk plays a key role in driving risk-shifting behavior, implying a U-shaped relation between a manager's choice of relative risk and her probability of future termination. (iii) Any factor that increases the manager's *ex ante* employment risk, *ceteris paribus*, lowers relative risk for all levels of prior performance.

The intuition underlying the U-shaped relation between relative risk and prior performance also suggests additional testable hypotheses that link determinants of the convexity of the fund flow–performance relation and the manager's employment risk to her risk-taking behavior. Factors that 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 outperformer or underperformer 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 that 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 above arguments lead to the following additional testable hypotheses. (iv) 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. (v) Any factor that raises (lowers) the level of employment risk for the manager increases (decreases) the convexity of the U-shaped relative risk–prior relative performance relation.

We empirically investigate our five testable hypotheses using data from Morningstar Mutual Funds Principia on individual fund managers over

the period 1997–2002. We focus on calendar-year risk-taking behavior in which we examine the relationship between managers' relative risk choices in the second half of each year in response to their relative performance over the first half. Consistent with our predictions, we show a statistically and economically significant U-shaped relation between relative risk and prior performance. Consistent with the theory, we also show that funds controlled by younger managers, who face greater levels of employment risk *ex ante*, choose lower relative risk, *ceteris paribus*.

Next, we test the importance of employment risk in driving risk shifting by examining the relation between the future risk taking of managers and their probabilities of future termination. 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 our theory, we show a significant negative relation between the probability of termination and prior relative performance and a U-shaped relation between relative risk and the probability of termination. Therefore, significant underperformers (outperformers) are more (less) likely to be fired and are also more likely to choose high relative risk. Our empirical results are robust when we (i) consider alternate classifications of mutual funds by their investment objectives, (ii) account for the effects of team-managed funds, and (iii) incorporate the possibility that some manager termination events are driven by retirements.

Finally, we empirically investigate the testable hypotheses 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 our hypotheses, 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. We also find some evidence that funds with inexperienced managers who face greater employment risk have more convex U-shaped relations. Finally, consistent with the implications of the theory, funds associated with larger fund companies have less convex U-shaped relations.

Our study contributes to the theoretical and empirical literatures that examine various aspects of the relations among mutual fund flows, fund performance, managerial incentives, and risk-taking behavior. Berk and Green (2004) analyze the determinants of the fund flow–performance relation. Because their primary objective is to explain the observed convexity in the fund flow–performance relation, they do not model the fund manager as an agent distinct from the fund company (who represents the fund company). The effects of the manager's employment risk

on her relative risk choices are, therefore, not the focus of these studies. Further, they predict a monotonic, rather than U-shaped, relation between relative risk and prior performance.¹ Another set of papers (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. (2008) also develop a unified model of fund investors, companies, and managers. As in Berk and Green (2004), their theory predicts a *monotonic* relation between relative risk and prior performance.

Our study also contributes to the empirical literature by showing (i) a U-shaped relation between a manager's relative risk choices and her prior performance, (ii) the importance of employment risk in driving risk shifting by documenting a U-shaped relation between relative risk and the probability of future termination, and (iii) showing the effects of determinants of the convexity of the manager's payoff structure and employment risk on the degree of convexity of the U-shaped relation or 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 managers' risk taking. Brown et al. (1996) find that outperforming managers lower *total* (rather than *relative*) risk relative to underperforming managers.² The predictions of our theory enable us to extend the empirical analyses in these studies by using *nonlinear* specifications

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 nonmonotonic (U-shaped) relation between 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. Hodder and Jackwerth (2007) show that hedge fund managers reduce risk when they have to shut down hedge funds involuntarily but could increase risk if the termination decision is endogenous.

² Busse (2001) finds that outperforming managers increase total risk relative to underperforming managers. Kempf and Ruenzi (2008) show evidence of tournament behavior within mutual fund families. Huang et al. (2011) investigate the effects of risk shifting on fund performance. They find that risk shifting is either an indication of inferior managerial ability or is motivated by agency issues.

to show that *both* outperformers and underperformers increase *relative* risk, whereas intermediate performers lower *relative* risk.

Khorana (1996, 2001) and Chevalier and Ellison (1999) study the effects of manager turnover using empirical specifications that assume a monotonic relation between risk and prior performance. Kempf et al. (2009) empirically show that fund managers who face high employment risk reduce fund risk. Guided by our theory, we empirically show the effects of employment risk on risk taking *controlling* for the predicted nonmonotonic relation between relative risk and prior performance.

We present the model in §2. In §3, we derive the manager's incentive structure. In §4, we derive the main testable implications of the theory. In §5, we present our empirical analysis. Section 6 concludes. We provide proofs of all propositions in the online Appendix A. In the online Appendix B, we present an alternate model in which the manager's portfolio choices are unobservable, but it leads to the same testable implications. We present the results of empirical robustness tests in the online Appendix C. The online appendices are available at <http://www.rmi.gsu.edu/faculty/subramanian.shtml>.

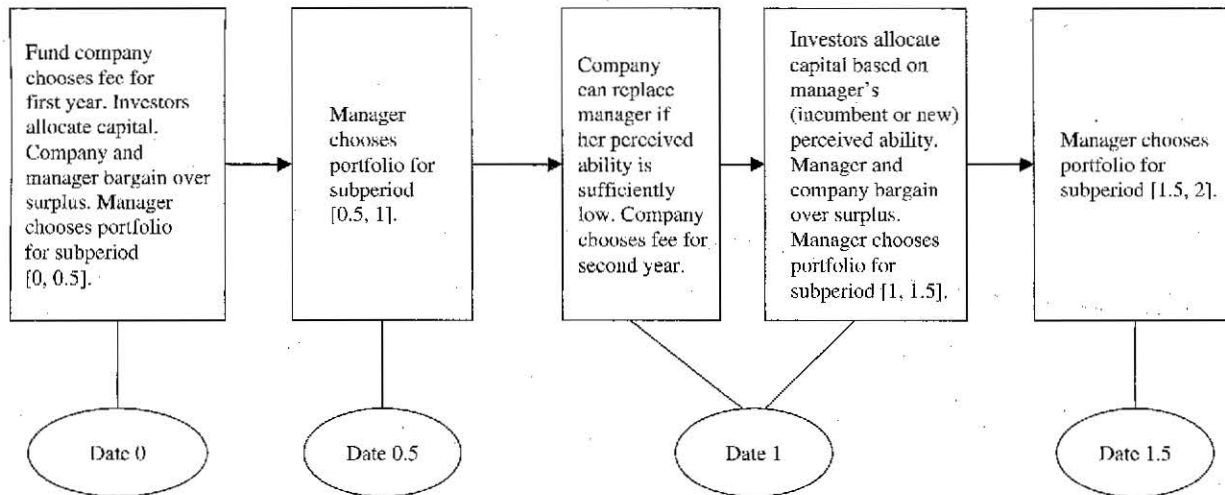
2. The Model

We consider a particular investment objective category (for example, aggressive growth, long-term growth) with a large number of funds so that we can focus on a *representative* fund without loss of generality. The investigation of objective categories with large numbers of funds is consistent with the descriptive statistics of our sample. As in Berk and Green (2004), we consider a partial equilibrium setting in which the benchmark is *passive* and represents an alternate investment opportunity available to investors with a risk that is representative of funds in the objective category.

We model the actions of fund investors, fund companies, and fund managers. There are two periods with dates 0, 1, 2. Each period is divided into equal *subperiods* that are defined by intermediate dates 0.5 and 1.5, respectively. Because we focus on calendar-year risk-taking behavior, we hereafter refer to each period as a “year” and the two subperiods as the first and second halves of the year. Figure 1 shows the model timeline.

The fund company chooses the fund's fee and investors allocate capital to the fund at the beginning of each year, that is, at dates 0 and 1. The fund manager chooses the fund's portfolio at the beginning of each half-year, that is, at dates 0, 0.5, 1, and 1.5. The manager has the ability to generate returns in excess of the benchmark (before costs and fees) in each

Figure 1 Model Timeline



half-year. There is *imperfect*, but *symmetric*, information about the manager's ability. Investors observe the manager's portfolio choices and competitively allocate capital to the fund at dates 0 and 1 based on their assessments of the manager's ability. The competitive allocation of capital by investors generates a surplus for the fund. The manager and the fund company bargain ex post over the surplus generated by investors' capital allocation to determine their respective payoffs in each year. The fund company can replace the fund manager at date 1 if the manager's perceived ability is sufficiently low. In our theoretical and empirical analyses, we focus on the manager's choice of the fund's *relative risk*—the standard deviation of the fund's return in excess of the benchmark—in the second half of each year in response to her *relative performance*—the return in excess of the benchmark—over the first half.

We adopt the perspective of studies in the "incomplete contracting" literature in which explicit contracts between the company and the manager are not enforceable and their respective payoffs are determined through Nash bargaining. As discussed in this literature, explicit contracts may be impossible to enforce because the manager's relative performance, portfolio choices, and reputation may be nonverifiable by a third party such as a court of law.

As a result of Nash bargaining, both the company and the manager receive nonzero proportions of the surplus generated by the competitive allocation of capital by investors. Consequently, the company and the manager both have incentives to increase the surplus. Further, because the company receives a nonzero proportion of the surplus that is determined by the manager's ability, it also has incentives to replace the incumbent manager with another manager of higher perceived ability to increase her

payoff. However, because outside investors earn competitive returns regardless of the manager's ability, they have no incentives to incur the fixed costs associated with replacing the manager. It is, therefore, important to model the company and the manager as distinct agents for the manager to face nonzero employment risk.

We model the publicly observable *relative performance* of the manager *before operating costs and management fees* (which are also publicly observable) in each half-year. The relative performance is defined as the excess return over the benchmark earned by the manager before costs and fees over the half-year. Let $R(t+0.5)$ denote the return over the half-year $[t, t+0.5]$; $t \in \{0, 0.5, 1, 1.5\}$ of the fund (before operating costs and fees) and $R_{\text{benchmark}}(t+0.5)$ be the corresponding return of the benchmark. The relative performance of the manager over the half-year $[t, t+0.5]$; $t \in \{0, 0.5, 1, 1.5\}$ is

$$r(t+0.5) = R(t+0.5) - R_{\text{benchmark}}(t+0.5), \quad t \in \{0, 0.5, 1, 1.5\}. \quad (1)$$

In our subsequent analysis, we directly model the relative performance process $r(\cdot)$ so that our results only depend on this process. As noted earlier, there are a large number of funds in the objective category so that a particular fund's portfolio choices and performance does not affect the passive benchmark.

At each date $t \in \{0, 0.5, 1, 1.5\}$, the manager invests the fund's assets in her choice of portfolio or strategy, which, for simplicity, is either a *high relative risk* strategy or a *low relative risk* strategy. Relative risk is defined as the standard deviation of the fund's relative performance, that is, the standard deviation of the fund's return in excess of the benchmark. We can show that relative risk is also equal to the standard

deviation of the fund's return relative to the average return of all funds in the objective category. In other words, the definition of the fund's relative risk does not depend on whether its return is measured relative to the passive benchmark or with respect to the average return of all funds in the objective category (details available upon request).

The fund's relative performance (before costs and fees) over the half-year $[t, t + 0.5]$ is

$$r(t + 0.5) = lm(t) + \sigma(t)N, \quad t \in \{0, 0.5, 1, 1.5\}, \quad (2)$$

where N is a standard normal random variable. The normal random variables that determine the relative performance over the various half-years are independent. We use the same letter to denote them to avoid cluttering the notation.

In (2), $\sigma(t) = \sigma_{\max}$ and $m(t) = m_{\max}$ if the manager chooses the high relative risk strategy, and $\sigma(t) = \sigma_{\min}$ and $m(t) = m_{\min}$ if the manager chooses the low relative risk strategy. The parameters, $\sigma_{\max}, m_{\max}, \sigma_{\min}, m_{\min}$ are known constants with $\sigma_{\max} > \sigma_{\min}, m_{\max} > m_{\min} > 0$. The manager's strategy (or relative risk) choice is observable, and it is common knowledge that the fund's relative performance is given by (2). However, as discussed earlier, the manager's strategy choice is nonverifiable and, therefore, non-contractible. In the online appendix, we show that our implications are robust to an alternate model in which outside investors cannot observe the manager's portfolio choices.

The expected relative return under the high relative risk strategy differs from the expected relative return under the low relative risk strategy. In other words, because the benchmark with respect to which returns are measured is noisy, relative risk contains a systematic component that affects the expected relative return. The parameter l in (2) is the manager's ability that is *unobservable* to all agents and is given by

$$l = \tilde{E}_t[m(t)^{-1}r(t + 0.5)], \quad (3)$$

where $\tilde{E}_t[\cdot]$ denotes the expectation with respect to the hypothetical omniscient agent who knows the manager's ability. It follows from (3) that

$$l = m_{\max}^{-1} \tilde{E}_t[r_{\max}(t + 0.5)] = m_{\min}^{-1} \tilde{E}_t[r_{\min}(t + 0.5)], \quad t \in \{0, 0.5, 1, 1.5\}, \quad (4)$$

where $r_{\max}(t + 0.5)$ and $r_{\min}(t + 0.5)$ denote the fund's relative performances over the half-year if the manager choose the high and low relative risk strategies, respectively. Hence, the manager's ability is the *true expected relative return* she generates in each half-year *under either strategy* weighted by the risk adjustment factor m_{\max}^{-1} or m_{\min}^{-1} depending on whether she

chooses the high or low relative risk strategy, respectively. In other words, the manager's ability is the true *risk-adjusted* expected relative return she generates.

All agents (including the manager) have a common prior assessment of the manager's ability at date 0 that is normally distributed with mean $\mu(0)$ and variance $s(0)^2$, that is,

$$\text{Prior on } l \sim N(\mu(0), s(0)^2). \quad (5)$$

Outside investors care about the *risk-adjusted* expected relative performance of the fund. Consistent with the above discussion, their valuation of the fund's relative performance under either strategy is

$$E_t[m(t)^{-1}r(t + 0.5)],$$

where $E_t[\cdot]$ denotes the expectation with respect to the information available to all agents at date $t \in \{0, 0.5, 1, 1.5\}$, which comprises the history of the manager's observed relative performance and her portfolio choices. In other words, analogous to the CAPM, outside investors value the fund's relative performance under either strategy as its conditional expectation weighted by the risk-adjustment factor $m(t)^{-1}$. It follows from (2) that

$$\begin{aligned} E_t[m_{\max}^{-1}r_{\max}(t + 0.5)] &= E_t[m_{\min}^{-1}r_{\min}(t + 0.5)] \\ &= E_t(l) = \mu(t). \end{aligned} \quad (6)$$

Hence, investors' valuation of the fund's relative performance under either strategy is equal to the manager's expected ability as perceived by all agents conditional on their information at date $t \in \{0, 1, 2\}$, which we refer to as her *average perceived ability* or *reputation*. The manager's average perceived ability, $\mu(t)$, at any date is, therefore, the expected *risk-adjusted* relative return she generates over the following half-year. Because the expected risk-adjusted relative return equals the manager's average perceived ability regardless of the fund's risk choice, outside investors are indifferent to the fund's relative risk. Our subsequent analysis shows that the manager, in contrast, has incentives to alter the fund's relative risk to influence investors' assessment of her ability and thereby her payoffs. We henceforth drop the subscripts "max" and "min" denoting the fund's relative performances under the two strategies.

By the above discussion, all agents are symmetrically informed and they rationally and correctly incorporate their knowledge of the manager's strategy choices and the parameters $\sigma_{\max}, m_{\max}, \sigma_{\min}, m_{\min}$ in forming posterior assessments of the manager's investment ability based on their observations of her relative performance. Define

$$s(t)^2 = \text{Var}_t[l], \quad t \in \{0, 0.5, 1, 1.5\}, \quad (7)$$

which is the variance of the manager’s ability as perceived by all agents at date $t \in \{0, 0.5, 1, 1.5\}$. The following lemma describes the evolution of the manager’s average perceived ability and its variance.

LEMMA 1 (THE EVOLUTION OF THE MANAGER’S PERCEIVED ABILITY).

(a) *The manager’s average perceived ability evolves as follows:*

$$\mu(t + 0.5) = \frac{\sigma(t)^2\mu(t) + m(t)s(t)^2r(t + 0.5)}{\sigma(t)^2 + m(t)^2s(t)^2}, \quad t \in \{0, 0.5, 1, 1.5\}. \quad (8)$$

The evolution of the manager’s average perceived ability can be rewritten as

$$\begin{aligned} \mu(t + 0.5) &= \mu(t) + \frac{m(t)s(t)^2}{\sqrt{\sigma(t)^2 + m(t)^2s(t)^2}}\widehat{N}, \\ &= \mu(t) + S_\mu(t)\widehat{N}(t), \end{aligned} \quad (9)$$

where \widehat{N} is a standard normal random variable.

(b) *The variance of the manager’s perceived ability evolves as follows:*

$$s(t + 0.5)^2 = \frac{\sigma(t)^2s(t)^2}{\sigma(t)^2 + m(t)^2s(t)^2}. \quad (10)$$

The following lemma provides a necessary and sufficient condition on the parameters $\sigma_{\max}, m_{\max}, \sigma_{\min}, m_{\min}$ that characterize the two strategies, which ensures that the standard deviation of the change in the manager’s average perceived ability in any half-year is higher under the high relative risk strategy.

LEMMA 2 (STANDARD DEVIATION OF CHANGE IN AVERAGE PERCEIVED ABILITY). *The condition*

$$\frac{m_{\max}}{\sigma_{\max}} > \frac{m_{\min}}{\sigma_{\min}} \quad (11)$$

is necessary and sufficient to ensure that the standard deviation, $S_\mu(t)$, of the evolution of the manager’s average perceived ability in half-year $[t, t + 0.5]$ (see (10)) is higher under the high relative risk strategy.

Condition (11) implies that the expected relative return per unit of relative risk is higher for the high relative risk strategy; that is, the high relative risk strategy has a higher “relative” Sharpe ratio. Recall that because the benchmark is noisy, relative risk has a systematic component, so a change in relative risk leads to a change in expected relative return. Condition (11) is required to ensure that the standard deviation of the evolution of the manager’s perceived ability is higher under the high relative risk strategy because the manager’s portfolio choices and the parameters $m_{\min}, m_{\max}, \sigma_{\min}, \sigma_{\max}$ are observable by

outside investors. In the online appendix, we describe an alternate model in which the manager’s portfolio choices are not observed by outside investors. We show there that the standard deviation of the evolution of the manager’s perceived ability is *always* higher under the high relative risk strategy without any additional conditions.

3. Fund Size, Fund Flows, Manager Payoffs, and Employment Risk

We first investigate the relationship between fund investors and the fund company and derive the equilibrium assets under management as well as the fund’s fee in each year. We then analyze the bargaining game between the company and the manager and derive the manager’s payoff in each year. Finally, we characterize the manager’s employment risk by examining the company’s decision to replace her at date 1.

3.1. The Allocation of Capital by Investors and the Assets Under Management

As discussed in the previous section, diversified investors care about the risk-adjusted expected relative return of the fund. As in Berk and Green (2004), 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. To make the timeline of events concrete, the fund’s operating costs are sunk and investors pay management fees *at the beginning* of each year. Because the market for capital provision is perfectly competitive, *in equilibrium*, investors allocate capital to the fund until the *risk-adjusted* expected relative return to investors *net of costs and fees* is zero.

The fund’s operating costs as a function of the assets under management are represented by the increasing and strictly convex function $C(\cdot): [0, \infty) \rightarrow [0, \infty)$, and the marginal operating costs function $C'(\cdot)$ satisfies $C'(0) = 0, C'(\infty) = \infty$. We further assume that $C''(\cdot)$ exists and is strictly negative, that is, $C'(\cdot)$ is strictly concave, which implies that although 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 economies of scale.

PROPOSITION 1 (THE FUND’S FEE AND ASSETS UNDER MANAGEMENT). *In equilibrium, the fund’s fee $f^{\text{opt}}(t)$ and the assets under management $q^{\text{opt}}(t)$ at date $t \in \{0, 1\}$ are given by*

$$q^{\text{opt}}(t) = (C')^{-1}(2\mu(t)1)1_{\mu(t) > 0}, \quad (12)$$

$$f^{\text{opt}}(t) = \left[2\mu(t) - \frac{C(q^{\text{opt}}(t))}{q^{\text{opt}}(t)} \right] 1_{\mu(t) > 0}, \quad (13)$$

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

All our subsequent results only depend on the assets under management being increasing and convex in the manager's average perceived ability. Therefore, to simplify exposition, we henceforth assume that the manager's average perceived ability is positive so that the fund has nonzero assets.³ For tractability, we assume that the operating costs are given by

$$C(q) = kq + gq \log(q), \quad \text{where } g > 0; k \geq 0. \quad (14)$$

From (12), (13), (14), and because $E_t(l) = \mu(t)$, we obtain the following expressions for the equilibrium assets under management $q^{\text{opt}}(t)$ and the fee $f^{\text{opt}}(t)$ at date $t \in \{0, 1, 2\}$:

$$q^{\text{opt}}(t) = \Lambda \exp(((2\mu(t)))/g), \quad \Lambda = e^{(g+k)/g}; \quad (15)$$

$$f^{\text{opt}}(t) = g, \quad t \in \{0, 1\}.$$

From (15), we note that the fund's fee is a constant that does not depend on the manager's perceived ability, which is consistent with a fund's fee not varying significantly over time.⁴ 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. From (14) and (15), the fund's operating costs and fees per unit of assets under management are given by

$$f^{\text{opt}}(t) + C(q^{\text{opt}}(t))/q^{\text{opt}}(t) = 2\mu(t), \quad t \in \{0, 1\}. \quad (16)$$

3.2. The Manager's Payoffs

The manager and the company bargain over the total payoff $Y(t) = f^{\text{opt}}(t)q^{\text{opt}}(t) = gq^{\text{opt}}(t)$ generated by the flow of assets at date $t \in \{0, 1\}$ (recall from (15) that $f^{\text{opt}}(t) = g$ is the fee per unit of assets under management). Their respective payoffs are determined by Nash bargaining. If the bargaining process ends in disagreement, the company and the manager incur personal costs represented by proportions $\delta_F, \delta \in (0, 1]$ of the surplus. Both the company and the manager only incur costs in the current year $[t, t+1)$ upon disagreement. We assume that $\delta + \delta_F > 1$ so that there is a loss in total surplus if the company and the manager cannot reach an agreement. The company and the manager are risk neutral with zero discount rates. The following lemma shows that the manager's payoff at the beginning of each year is affine in the total surplus.

³ This entails little loss of generality as we show later because the manager is replaced with high probability if his average perceived ability falls below a positive threshold.

⁴ The fact that the equilibrium fee is constant in our model is, of course, a consequence of the parametrization (14). We 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.

LEMMA 3. The manager's payoff $P(t)$ at date $t \in \{0, 1\}$ conditional on not being replaced is

$$P(t) = h \exp\left(\frac{2\mu(t)}{g}\right) = h \exp(c\mu(t)), \quad t \in \{0, 1, 2\}, \quad (17)$$

where $h > 0$ and $c = 2/g > 0$ are constants.

The manager's payoff in each year is, therefore, increasing and convex in her average perceived ability at the beginning of the year. Because the company and the manager bargain over the surplus, the company also receives a nonzero proportion of the surplus. Consequently, as we now show, the company has incentives to replace the manager with another manager of higher perceived ability and, therefore, increase its own payoff.

3.3. The Manager's Employment Risk

At date 1, the fund company can replace the manager with another manager of higher perceived ability. The company incurs search costs to find a replacement, and the probability of finding a new manager is $\alpha \in (0, 1)$. If the manager is replaced, she incurs personal costs $\delta > 0$, that is, her future payoffs upon leaving the fund are equal to her future payoffs if she were to continue with the fund less the costs δ . (For example, we could assume that the manager joins another identical fund after incurring search costs δ .)⁵ The following proposition describes the manager's employment risk.

PROPOSITION 2 (THE MANAGER'S EMPLOYMENT RISK). There exists a constant threshold l_b such that the manager is replaced at date 1 with nonzero probability $\alpha \in (0, 1)$ if and only if her average perceived ability $\mu(1) \leq l_b$.

The presence of proportional search costs associated with finding a replacement ensures that it is worthwhile for the fund company to replace the incumbent only if her perceived ability is sufficiently low. We note that α is the probability of the manager being replaced conditional on her average perceived ability $\mu(t)$ being below the threshold l_b . Therefore, the probability that the manager is replaced at date $t+1$ as seen at date t is $\alpha \text{Prob}_t[\mu(t+1) < l_b]$, where $t \in \{0, 1\}$ and Prob_t denotes the conditional probability at date t .

As in "reputation concerns" models, if the manager receives no payoff at the terminal date 2, then she is indifferent to her choices of relative risk in the second year because her payoff in the second year, $P(1)$, only depends on her average perceived ability, $\mu(1)$, at the beginning of the year. To pin down the

⁵ Our results also hold if the manager's personal costs from being replaced at any date are proportional to her payoff at that date if she continues with the fund.

manager's relative risk choices in the second year, we assume that the manager receives a terminal payoff from her "outside options." Note that the manager's payoffs upon disagreement in the bargaining process with the company at date $t \in [0, 1]$ and her payoff from being replaced at date 1 are essentially the payoffs she derives from her outside options at that date. Consistent with these payoffs being increasing and convex in the manager's average perceived ability, we assume that the manager's terminal payoff at date 2 is also increasing and convex in her average perceived ability $\mu(2)$ at date 2, that is,

$$P(2) = D(\mu(2)), \quad (18)$$

where $D(\cdot)$ is an increasing, convex function. The incorporation of a terminal payoff for the manager pins down the manager's risk choices in the second year but does not alter any of the model's main testable implications that relate to the manager's relative risk choices in the second half of the first year in response to her performance over the first half.

4. The Manager's Relative Risk Choices

The manager chooses the fund's relative risk in each half-year to maximize her expected future payoffs; that is, her relative risk choices solve

$$\begin{aligned} & \sup_{\sigma(t) \in [\sigma_{\min}, \sigma_{\max}], t \in [0, 0.5, 1, 1.5]} E[P(0) + P(1) - \delta 1_{\text{fired}=1} 1_{\mu(1) < l_b} + P(2)] \\ &= \sup_{\sigma(t) \in [\sigma_{\min}, \sigma_{\max}], t \in [0, 0.5, 1, 1.5]} E[P(0) + P(1) - \alpha \delta 1_{\mu(1) < l_b} + P(2)]. \end{aligned} \quad (19)$$

The manager's objective (19) incorporates the manager's ability to alter the fund's relative risk in each half-year. The third term inside the expectation reflects the personal costs $\delta > 0$ that the manager incurs if she is fired at date 1 so that her future payoff is lowered from $P(2)$ to $P(2) - \delta$. The indicator functions $1_{\text{fired}=1} 1_{\mu(1) < l_b}$ reflect that the manager is fired with nonzero probability only if her average perceived ability at date 1 is below the threshold l_b .

To maintain a tight link with our empirical analysis, we examine the manager's relative risk choices in the second half of each year in response to her prior performance over the first half. The following proposition describes the manager's relative risk choices in the second half of year 2.

PROPOSITION 3 (RELATIVE RISK OVER HALF-YEAR [1.5, 2]). *Suppose that condition (11) holds. The manager always chooses the high relative risk strategy in the half-year [1.5, 2] regardless of her performance over the first half of the year [1, 1.5].*

The manager's payoff at the end of the second year is increasing and convex in her average perceived ability by (17), and she faces no employment risk. If condition (11) holds, it follows from Lemma 2 that the standard deviation of the evolution of the manager's average perceived ability is higher under the high relative risk strategy. Consequently, it is optimal for the manager to choose high relative risk in the half-year [1.5, 2] regardless of her performance over the first half of the year. If condition (11) does not hold, the standard deviation of the evolution of the manager's average perceived ability is higher under the low relative risk strategy, so it is optimal for the manager to choose low relative risk in the half-year [1.5, 2].

We now derive the manager's optimal relative risk choice over the second half of the first year in response to her performance over the first half.

PROPOSITION 4 (RELATIVE RISK CHOICES OVER HALF-YEAR [0.5, 1]). *Suppose that condition (11) holds. (a) There exist two threshold levels μ_{\min}, μ_{\max} ; $\mu_{\min} \leq \mu_{\max}$ of the manager's average perceived ability, $\mu(0.5)$, at date 0.5 such that the manager chooses low relative risk over the half-year [0.5, 1] if $\mu(0.5) \in (\mu_{\min}, \mu_{\max})$ and high relative risk otherwise. (b) If the manager faces no employment risk ($\alpha \delta = 0$), she chooses high relative risk.*

Proposition 4 implies that the manager's relative risk choice in the second half of the first year [0.5, 1] varies nonmonotonically with her average perceived ability at date 0.5. The nonmonotonic relation between relative risk and average perceived ability follows from the interplay among three factors: (i) the manager's payoff at date 1 is convex in her average perceived ability by (18); (ii) she faces employment risk at date 1 (Proposition 2); and (iii) if condition (11) holds, the standard deviation of the change in her average perceived ability is higher if she chooses the high relative risk strategy (Lemma 2).

Suppose that condition (11) holds so that the standard deviation of the evolution of the manager's perceived ability is higher under the high relative risk strategy. If her average perceived ability at date 0.5 is sufficiently high, her probability of being replaced at date 1 is low. In this case, the manager exploits the convexity of her payoff structure by choosing the high relative risk strategy. If the manager's average perceived ability at date 0.5 is low, the manager has "little to lose" and, therefore, gambles by choosing the high relative risk strategy to increase the probability that her average perceived ability at date 1 will be above the termination threshold l_b (see Proposition 2). At intermediate levels of the manager's average perceived ability, the presence of employment risk makes it optimal for the manager to choose the conservative low relative risk strategy to reduce the probability

that her average perceived ability will fall below the termination threshold l_b .

Proposition 4(b) shows that in the absence of employment risk, the manager always chooses high relative risk because of the convexity of her payoff in her average perceived ability. Hence, employment risk plays a crucial role in driving variations in relative risk choices, or risk shifting.

By (8), the manager's average perceived ability at each date increases with her prior relative performance. Proposition 4 therefore implies that under condition (11), there is a U-shaped relation between the manager's choice of relative risk in the second half of the first year and her performance over the first half. In our two-period model, the manager is "young" in the first year and "old" in the second. In this context, Proposition 3 implies that experienced managers are more likely to choose high relative risk. If condition (11) in Lemma 2 does not hold, the standard deviation of the change in the manager's average perceived ability is higher under the low relative risk strategy. In this case, the relation between relative risk and prior performance is inverted U-shaped. Although we cannot directly verify whether condition (11) holds in the data, our strong empirical support for a U-shaped relation in §4 suggests that condition (11) holds at least on average in the data. The alternate model presented in the online appendix, in which the manager's portfolio choices are not observed by outside investors, unambiguously predicts a U-shaped relation between relative risk and prior performance without any additional conditions.

In the following discussion, we assume that condition (11) holds. By Proposition 2, the conditional probability that the manager will be replaced at date 1 based on the information available at date 0.5 is

$$\begin{aligned} & \text{Conditional Termination Probability} \\ &= \alpha P_{0.5}[\mu(1) \leq l_b], \end{aligned} \quad (20)$$

where the subscript on probability denotes that it is the conditional probability at date 0.5. By (8), the manager's average perceived ability at date 1, $\mu(1)$, declines with her average perceived ability at date 0.5, $\mu(0.5)$. Hence, Proposition 4 directly leads to the following corollary.

COROLLARY 1 (RELATIVE RISK AND PROBABILITY OF FUTURE TERMINATION). *There exist threshold values p_{\min}, p_{\max} ; $p_{\min} \leq p_{\max}$ of the manager's probability of future termination p such that the manager chooses the low (high) relative risk strategy if $p \in (p_{\min}, p_{\max})$ and the high (low) relative risk strategy otherwise.*

The following proposition shows the effects of the degree of convexity of the manager's payoff structure

and her employment risk on the relation between relative risk and prior relative performance.

PROPOSITION 5 (CONVEXITY, EMPLOYMENT RISK, AND RELATIVE RISK CHOICES). *The intermediate interval of values (μ_{\min}, μ_{\max}) of the manager's average perceived ability at date 0.5 for which the manager chooses low relative risk (see Proposition 4) decreases with the degree of convexity c of her payoff structure (see (18)) and increases with the manager's employment risk $\alpha\delta$.*

By the intuition for Proposition 4, the U-shaped relation between relative risk and average perceived ability arises from the interplay between the convexity of the manager's payoff in her average perceived ability and her employment risk. An increase in the degree of convexity of the manager's payoff structure increases the manager's incentives to choose the high relative risk strategy. Consequently, the intermediate range of values of the manager's prior relative performance over which she chooses low relative risk shrinks. An increase in $\alpha\delta$ increases the effects of the manager's "employment risk" on her choice of relative risk, that she chooses low relative risk over a wider range of values of her prior relative performance.

5. Empirical Analysis

5.1. Testable Hypotheses

The results in the previous section lead to the following testable hypotheses.

HYPOTHESIS 1. *There is a U-shaped relation between a manager's (fund's) choice of relative risk and her (its) prior relative performance.*

HYPOTHESIS 2. *Relative risk declines with any factor that raises the level of ex ante employment risk for the manager, ceteris paribus.*

HYPOTHESIS 3. *A fund manager's probability of termination decreases with her prior relative performance. There is a U-shaped relation between future relative risk and the conditional probability of future termination.*

Hypothesis 3 directly examines the importance of employment risk as a driver of risk-shifting behavior.

The intuition underlying the U-shaped relative risk-prior performance relation and Proposition 5 also suggest additional testable hypotheses. 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. The above arguments lead to the following additional testable hypotheses.

HYPOTHESIS 4. 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.

HYPOTHESIS 5. 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.

5.2. 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 data set, we obtain a sample of all the funds that are in existence as of December 1996, 1997, 1998, 1999, 2000, and 2001.⁶ Note that the sample also includes funds (along with their current and past managers) that were liquidated during the years 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.

Following Chevalier and Ellison (1999), we use age as a proxy for a manager’s experience and calculate age from either graduation or birth year. Because we do not have information on the birth or the graduation year for a significant number of managers, the size of the sample is substantially reduced in tests where the manager’s experience is an independent variable. We group managers in two different ways in our tests:

(i) *Investment objectives*: aggressive growth (aggressive growth and small company funds combined), growth, and growth income (growth income and equity income funds combined);

(ii) *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 share class level. The different share classes of the same fund are backed by the same portfolio of assets. Because we are interested in the risk-taking behavior of portfolio managers, we aggregate multiple classes of the same fund to avoid multiple counting.⁷ To build a database at the portfolio level, we weight each observation for the share classes by the total net asset of each class.⁸

Table 1 presents descriptive statistics for the funds in the sample grouped by investment objectives. 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. 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 various fund classifications varies from a low of 16.58% (182/1,098) for the year 2000 to 23.02% (259/1,125) for the year 1999. The overall termination probability is, therefore, almost 20%, which suggests that employment risk is likely to be an important determinant of managerial risk choices.

5.3. Results of Tests

We first test Hypotheses 1 and 2 from §5.1 by examining the relation between future relative risk choices and *prior* performance.

5.3.1. Relationship Between Future Relative Risk Choices and Prior Performance of Fund Managers.

We follow a number of prior studies (Brown et al. 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

⁶ Morningstar stopped reporting detailed data at the manager level in 2002.

⁷ 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.

⁸ Index funds are excluded from the sample.

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

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

Notes. 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. Index funds are excluded from the sample.

the monthly returns in excess of the category median over the half-year (tracking error).

We make two points regarding our relative risk measure. First, standard deviations based on monthly observations can be relatively noisy. Although the estimation error can be reduced by using more frequent observations (we only have monthly data), such observations may still be contaminated by other sources of noise such as market microstructure noise that are smoothed out at more aggregate levels. Second, the risk of a fund's portfolio can change due to active rebalancing by the manager or due to changes in the risks of the individual securities in the portfolio. From a theoretical standpoint, how risk changes occur is not important because the manager ultimately cares about the risk of the overall portfolio. In other words, the manager could achieve her target risk because the risks of individual stocks change and/or by actively rebalancing the portfolio.⁹

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 show

⁹ For these reasons, we believe that tests using mutual funds holding data (for example, see Huang et al. 2011) would support our hypotheses.

specifications where we 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. We denote the standardized performance rank of manager i in the first half of year t as $RK_{i,t}^{(1)}$. 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 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 $SQRK_{i,t}^{(1)}$ as an independent variable. Finally, as in Chevalier and Ellison (1999), we include the logarithm of the manager's age ($\ln \text{MAGE}_{i,t}$) as a proxy for the manager's experience.

We use pooled OLS regressions to test the relation between relative risk over the second half of each year

Table 2 Descriptive Statistics of the Individual Manager Sample

Year	Number of managers	Manager age	Relative risk (%)	
			First semester (monthly)	Second 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

Notes. 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 first semester (second 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).

and performance over the first half. Standard errors of coefficient estimates are corrected for clustering at the fund level. Following Chevalier and Ellison (1999), we include dummy variables for the calendar year and fund segment in all specifications.

Table 4 presents the results of our analysis. For brevity, we only report the results for funds classified by Morningstar categories because the results are similar for funds classified by investment objectives. In all five specifications, the coefficient of prior

Table 3 Descriptive Statistics of Manager Turnover

Panel A: Managers grouped by fund objectives																				
Year	Aggressive growth		Growth		Growth income		Total													
1997	43	(293)	90	(470)	61	(311)	194	(1,074)												
1998	56	(309)	97	(474)	43	(301)	196	(1,084)												
1999	90	(334)	89	(485)	80	(306)	259	(1,125)												
2000	50	(303)	92	(538)	40	(257)	182	(1,098)												
Total	239	(1,239)	368	(1,967)	224	(1,175)	831	(4,381)												
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	(1,074)
1998	21	(123)	30	(139)	25	(85)	34	(228)	19	(90)	10	(77)	22	(164)	15	(73)	20	(105)	196	(1,084)
1999	27	(148)	26	(120)	24	(100)	50	(233)	19	(76)	26	(93)	42	(169)	18	(84)	27	(102)	259	(1,125)
2000	37	(170)	24	(111)	10	(115)	45	(233)	2	(53)	10	(68)	26	(184)	13	(71)	15	(93)	182	(1,098)
Total	111	(553)	99	(492)	79	(381)	193	(958)	49	(297)	54	(292)	116	(666)	55	(321)	75	(421)	831	(4,381)

Notes. 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.

Table 4 Relative Risk Choices over the Second Half of Each Year and Performance over the First Half

Independent variables	(1)	(2)	(3)	(4)	(5)
	Dependent variable: $\sigma_{i,t}^{(2)}$ —Relative risk in the second semester				
$\sigma_{i,t}^{(1)}$	0.50250*** (0.00)		0.49267*** (0.00)	0.45002*** (0.00)	
Ln TNA _{<i>i,t-1</i>}	-0.00049*** (0.00)	-0.00090*** (0.00)	-0.00055*** (0.00)	-0.00016 (0.38)	-0.00027 (0.28)
RK _{<i>i,t</i>} ⁽¹⁾	-0.02223*** (0.00)	-0.06595*** (0.00)	-0.02520*** (0.00)	-0.02324*** (0.00)	-0.05858*** (0.00)
SQRK _{<i>i,t</i>} ⁽¹⁾	0.01937*** (0.00)	0.05820*** (0.00)	0.02185*** (0.00)	0.02021*** (0.00)	0.05206*** (0.00)
Ln MAGE _{<i>i,t</i>}			0.00333*** (0.00)	0.00229** (0.04)	0.00371** (0.02)
EXP _{<i>i,t-1</i>}				0.48727*** (0.00)	0.84495*** (0.00)
TLOAD _{<i>i,t-1</i>}				-0.52149*** (0.00)	-1.02586*** (0.00)
TURNOVER _{<i>i,t-1</i>} (×1,000)				0.00001 (0.40)	0.00002 (0.25)
FLOW _{<i>i,t-1</i>} (% × 1,000)				0.00003 (0.87)	-0.00021 (0.35)
Ln FAGE _{<i>i,t</i>}				0.00057 (0.15)	0.00084 (0.11)
TEAM _{<i>i,t-1</i>}				-0.00076 (0.17)	-0.00169** (0.02)
Segment and year dummies	YES	YES	YES	YES	YES
R ² (%)	53.66	24.73	51.87	50.14	27.24
N	11,655	11,655	5,868	3,247	3,247

Notes. This table analyzes the relationship between the relative risk choices of managers in the second half of a calendar year and their performance over the first half. 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. Funds are classified according to Morningstar categories. The dependent variable is the relative risk over the second half of a year t ($\sigma_{i,t}^{(2)}$). The independent variables include the relative risk over the first half of the year t ($\sigma_{i,t}^{(1)}$) and the logarithm of the fund's total net assets at the end of year $t - 1$ (Ln TNA_{*i,t-1*}). A fund's fractional rank (RK_{*i,t*}⁽¹⁾) represents the percentile performance rank 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 for the year t . To capture nonlinear effects we also include the squared term of a fund's fractional rank (SQRK_{*i,t*}⁽¹⁾). Also included in the regressions is the logarithm of manager's age in year t (Ln MAGE_{*i,t*}), annual expense ratio over the year $t - 1$ (EXP_{*i,t-1*}), total front- and back-end loads over the year $t - 1$ (TLOAD_{*i,t-1*}), turnover ratio over the year $t - 1$ (TURNOVER_{*i,t-1*}), percentage new money into the fund i in year $t - 1$ defined as FLOW_{*i,t-1*} = [(TNA_{*i,t-1*}/(1 + ARET_{*i,t-1*})) - TNA_{*i,t-2*}]/TNA_{*i,t-2*}, where TNA_{*i,t-1*} is the fund i 's total net assets at time $t - 1$, and ARET_{*i,t-1*} is the raw return of fund i in year $t - 1$, and logarithm of fund's age in year t (Ln FAGE_{*i,t*}). TEAM_{*i,t-1*} is a dummy variable that takes the value 1 if the fund is managed by a team in year $t - 1$. The regressions include fund segment and year dummies. The regression coefficients are estimated using pooled OLS regressions. The standard errors of the estimates are corrected for clustering at the fund level (Rogers 1994). p -values are reported in parentheses.

***, **, and * indicate significance at the 1%, 5%, and 10% levels (two-tailed tests), respectively.

performance, RK_{*i,t*}⁽¹⁾ is significantly negative, whereas the coefficient of the squared prior performance rank, SQRK_{*i,t*}⁽¹⁾ 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. In all specifications where prior relative risk, $\sigma_{i,t}^{(1)}$, is included as a control variable, its coefficients are positive and significant, indicating that there is a positive relation between relative risk over the first and second halves

of each year. From Table 2, the mean relative risk in the second half-year is 2.65%. The coefficients of RK_{*i,t*}⁽¹⁾ and SQRK_{*i,t*}⁽¹⁾ in specification (4) suggest that the managers who choose the lowest relative risk choose a level that is 50% (as a proportion of the mean relative risk) lower than the worst performers and 38% lower than the best performers, which indicates that the U-shape is economically significant.

In models (3)–(5), the coefficients of the logarithm of the manager's age are positive and significant. The manager's experience (proxied by age), therefore, increases risk taking over the entire range of prior performance. The positive effect of the manager's experience on level of relative risk taking in the second

part of the year is, therefore, consistent with Hypothesis 2. According to our results, experienced managers are less likely to be replaced and, *ceteris paribus*, are more prone to increase relative risks. In subsequent tests, we will show that more experienced managers have lower termination probabilities.

The specifications in Table 4 include “fund segment” and “year” dummies following earlier related studies such as Chevalier and Ellison (1999). In Tables 4-A and 4-B in the online Appendix C, we show specifications that additionally include manager, fund, or fund family fixed effects. The U-shaped relation is statistically and economically significant as in Table 4. The coefficients of the log of the manager’s age are no longer statistically significant at conventional levels. There are a number of possible (related) reasons for the lowering of statistical significance. First, because the “cross-sectional” dimension of our panel data set is large relative to the “time-series” dimension, the inclusion of manager/fund fixed effects greatly increases “sampling variability” and, therefore, the standard errors of estimated coefficients. Including fixed effects when time-series variation is not significant relative to the cross-sectional variation may result in insignificant coefficients even if the actual relation is significant. Second, because the log of the manager’s age is slowly varying over the time period of the sample, the inclusion of manager fixed effects causes the coefficients of the log of manager age to be poorly identified. Third, in specifications that include the manager’s age, the sample size is significantly lowered. The inclusion of manager/fund/fund family effects, therefore, further reduces statistical power.

We conduct several additional tests to examine the robustness of the results of Table 4. To conserve space, we present the results of many of these tests in Tables 4-C–4-F in the online Appendix C. We describe the findings from these tests here. First, our previous tests controlled for the relative risk in the first semester to mitigate the possibility that the U-shaped relation is driven by funds that persistently deviate more from the benchmark and, thereby, achieve returns in the tails of the distribution of relative performance. To investigate this possibility, we divide the sample into three groups according to their relative risk levels in the first semester (i.e., low, medium, and high relative risk level). We study the risk-shifting behavior of funds in each group (Table 4-C). The evidence is consistent with the results of Table 4. Second, the previous 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, it is not clear how

the incentives and employment risk affect each individual member of a team. To address this issue, we repeat our previous analysis for the subsample of individually managed mutual funds and find similar results (Table 4-D). Third, we repeat our analysis with the full sample (individually managed and team-managed funds) with 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 or the contribution of manager’s experience to the level of risk choice. Fourth,

Table 5 Determinants of Employment Risk

Independent variables	Morningstar categories	
	(1)	(2)
Dependent variable: TERM _{<i>i,t</i>} —Managerial termination dummy		
RK _{<i>i,t-1</i>}	-0.9092*** (0.00)	0.8737*** (0.00)
$\sigma_{i,t-1}$	-4.7674 (0.38)	-4.4900 (0.43)
LnMAGE _{<i>i,t</i>}	-1.3961*** (0.00)	1.5303*** (0.00)
FLOW _{<i>i,t-1</i>}	-0.1735** (0.03)	-0.1813** (0.03)
EXP _{<i>i,t-1</i>}		12.7500 (0.34)
AGE60 _{<i>i,t</i>}		0.1879 (0.44)
Segment and year dummies	YES	YES
Pseudo R ² (%)	1.34	1.57
N	2,291	2,252

Notes. 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 at the fund level. 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). Multiple share classes belonging to the same fund are aggregated at the portfolio level. The dependent variable is a dummy variable that equals 1 when the manager is replaced during a given year (TERM_{*i,t*}). 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 for year $t-1$. We include in the regression the annual expense ratio for year $t-1$ (EXP_{*i,t-1*}), the risk in year $t-1$ ($\sigma_{i,t-1}$) is the standard deviation of the monthly returns in excess of the median monthly return for the fund’s segment in year $t-1$, and the logarithm of the manager’s age in year t (LnMAGE_{*i,t*}). The variable FLOW_{*i,t-1*} is the dollar amount (in billion) of new money into the fund i in year $t-1$ and is defined as FLOW_{*i,t-1*} = (TNA_{*i,t-1*} / (1 + ARET_{*i,t-1*})) - TNA_{*i,t-2*}, where TNA_{*i,t-1*} is the fund i ’s total net assets at the end of year t and ARET_{*i,t*} is the raw return of fund i in year $t-1$. The variable AGE60_{*i,t*} equals one when a manager’s age is above 60, zero otherwise. The last two rows contain the pseudo R² and the number of observations N . *p*-values are reported in parentheses.

***, **, and * indicate significance at the 1%, 5%, and 10% levels (two-tailed tests), respectively.

we test for the U-shaped relation between future relative risk and prior performance using *piecewise linear* specifications instead of a quadratic specification (Table 4-E). We consider both three-segment and five-segment piecewise linear specifications. The results of these tests provide further evidence that the relationship between relative risk and prior performance is, indeed, U-shaped. Finally, we carry out robustness tests using data at the fund-year level (Table 4-F). Hence, multiple observations for various managers belonging to the same fund are grouped into one unique observation. As a proxy for managerial experience we adopt the log of the average managers' age belonging to the same fund ($\ln \text{AvMAGE}_{i,t}$). The results are consistent with our previous evidence and support our Hypotheses 1 and 2.

5.3.2. The Manager's Employment Risk. We now directly test the importance of employment risk in driving risk shifting by fund managers. 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, 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 inflows.

Table 5 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) we also study the effect of past inflows on terminations ($\text{FLOW}_{i,t-1}$). 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 ($\text{AGE60}_{i,t}$). As shown in specification (2), retirement decisions do not appear to drive our results. In fact, the coefficient of the dummy variable is insignificant. Finally, our empirical evidence shows that the fund's expense ratio does not have a significant effect on the manager's termination probability. Overall, the results of Tables 4 and 5 together support our testable Hypotheses 1 and 2 in §5.1.

5.3.3. Relationship Between Relative Risk Choices and the Probability of Termination. The results of Table 4 document a U-shaped relationship between future relative risk choices and prior relative performance. We now test Hypothesis 3 in §5.1 by

Table 6 Relationship Between Future Relative Risk and Termination Probability

Independent variables	Morningstar categories			
	(1)	(2)	(3)	(4)
	Dependent variable: $\sigma_{i,t}$ —Future relative risk			
$\text{P_TERM}_{i,t-1}$	-0.09418*** (0.00)	-0.06893*** (0.01)	-0.11118*** (0.00)	-0.08821*** (0.00)
$\text{SQP_TERM}_{i,t-1}$	0.16152*** (0.01)	0.12102** (0.04)	0.18724*** (0.01)	0.15285*** (0.01)
$\text{FLOW}_{i,t-1}$			-0.00185*** (0.00)	-0.00170*** (0.00)
Segment and year dummies	YES	YES	YES	YES
R^2 (%)	31.53	30.93	31.53	30.93
N	2,291	2,252	2,291	2,252

Notes. This table presents the relationship between future relative risk choices and estimated termination probabilities from Table 5. 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). Multiple share classes belonging to the same fund are aggregated at the portfolio level. 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 at the fund level (Rogers 1994). 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 specifications (1) and (2), the independent variable is the predicted termination probability ($\text{P_TERM}_{i,t-1}$) from the corresponding specification in Table 2. We also include the squared termination probability ($\text{SQP_TERM}_{i,t-1}$). In specifications (3) and (4), as an additional explanatory variable we add the variable $\text{FLOW}_{i,t-1}$ is the dollar amount (in billion) of new money into the fund i in year $t-1$ and is defined as $\text{FLOW}_{i,t-1} = (\text{TNA}_{i,t-1} / (1 + \text{ARET}_{i,t-1})) - \text{TNA}_{i,t-2}$ where $\text{TNA}_{i,t-1}$ is the fund i 's total net assets at time $t-1$, and $\text{ARET}_{i,t-1}$ is the raw return of fund i in period $t-1$. The last two rows contain the R^2 and the number of observations N . p -values are reported in parentheses.

***, **, and * indicate significance at the 1%, 5%, and 10% levels (two-tailed tests), respectively.

Table 7 Determinants of Risk Shifting

Independent variables	(1)	(2)	(3)	(4)
$\sigma_{i,t}^{(1)}$	0.47807*** (0.00)	0.48727*** (0.00)	0.48388*** (0.00)	0.45213*** (0.00)
$\ln TNA_{i,t-1}$	-0.00037*** (0.00)	-0.00031** (0.02)	-0.00020 (0.13)	-0.00020 (0.25)
$RK_{i,t}^{(1)}$	-0.09604*** (0.00)	-0.02855*** (0.00)	-0.03800*** (0.00)	-0.07960 (0.37)
$SQRK_{i,t}^{(1)}$	0.08893*** (0.00)	0.02463*** (0.00)	0.03392*** (0.00)	0.06770 (0.40)
$FAMILY_{i,t-1}$		-0.00887*** (0.00)	-0.00813*** (0.00)	-0.00664** (0.02)
$EXP_{i,t-1}$			-0.17664 (0.31)	0.07064 (0.80)
$\ln MAGE_{i,t}$				0.01033* (0.08)
$RK_{i,t}^{(1)} * FAMILY_{i,t-1}$		0.02787*** (0.00)	0.02459*** (0.01)	0.01848* (0.08)
$SQRK_{i,t}^{(1)} * FAMILY_{i,t-1}$		-0.02120*** (0.00)	-0.01812** (0.04)	-0.01280 (0.17)
$RK_{i,t}^{(1)} * EXP_{i,t-1}$	1.27709*** (0.00)		1.35208** (0.05)	0.54117 (0.58)
$SQRK_{i,t}^{(1)} * EXP_{i,t-1}$	-1.35035*** (0.00)		-1.23561** (0.04)	-0.59064 (0.48)
$RK_{i,t}^{(1)} * \ln MAGE_{i,t}$	0.01495*** (0.01)			-0.02953 (0.21)
$SQRK_{i,t}^{(1)} * \ln MAGE_{i,t}$	-0.01358* (0.07)			0.02565 (0.22)
Segment and year dummies	YES	YES	YES	YES
R^2 (%)	50.76	55.02	54.49	51.12
N	4,903	7,996	5,991	2,962

Notes. The table analyzes the effects of determinants of the fund flow–performance relation and employment risk on the relationship between the future risk choices and prior performance of managers. 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. Funds are classified according to their Morningstar category. The regression coefficients are estimated using pooled OLS regressions. The standard errors of the estimates are corrected for clustering at the fund level (Rogers 1994). The dependent variable is the relative risk over the second semester of year t ($\sigma_{i,t}^{(2)}$). The independent variables include the relative risk over the first semester of the year t ($\sigma_{i,t}^{(1)}$) and the logarithm of the fund total net assets in the previous year ($\ln TNA_{i,t-1}$). A fund's fractional rank ($RK_{i,t}^{(1)}$) represents the percentile performance rank of the fund 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 for the year t . To capture nonlinear effects we also include the squared term of a fund's fractional rank ($SQRK_{i,t}^{(1)}$). Also included in the regressions are the annual expense ratio for year $t-1$ ($EXP_{i,t-1}$), the logarithm of manager's age in year t ($\ln MAGE_{i,t}$), and a dummy variable that takes the value of one if the fund family has total assets under management above the median family size for year $t-1$ ($FAMILY_{i,t-1}$). The last two rows contain the R^2 and the number of observations N . p -values are reported in parentheses.

***, **, and * indicate significance at the 1%, 5%, and 10% levels (two-tailed tests), respectively.

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 5, 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 Morningstar categories are reported in Table 6. In all 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. Combined with the results of Table 5, these findings imply that outperforming (underperforming) managers are less (more) likely to be fired and also choose higher relative risk.

In summary, Table 6 supports Hypothesis 3 and shows the importance of employment risk in driving risk taking by fund managers.

5.3.4. Determinants of Risk Shifting. We now empirically investigate Hypotheses 4 and 5 in §5.1 that relate determinants of the convexity of the fund flow–performance relation and employment risk to a manager’s risk-taking behavior.

We run tests very similar to those of previous studies such as Chevalier and Ellison (1997) and Sirri and Tufano (1998) to analyze 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. Using both quadratic and piecewise linear specifications, we confirm that the relation is convex. Further, the degree of convexity of the fund flow–performance relation decreases with the fund’s expense ratio. Because the results are consistent with those reported in previous literature, we do not report them for brevity.

Gervais et al. (2005) show that funds associated with larger fund companies have less convex fund flow–performance relations. Their results also suggest that managers of such funds have less incentive to engage in risk shifting to influence investors’ perception of their abilities. Both the above effects predict a less convex U-shaped relation between relative risk and prior performance. Consequently, our theory predicts that fund company size has a negative effect on the convexity of the U-shaped relation.

Table 7 examines how the key factors that affect the convexity of the fund flow–performance relation and employment risk—the expense ratio, the size of the fund family, and the manager’s age—affect the degree of convexity of the U-shaped relative risk–prior performance relation. First, we note that, in general, the coefficient of prior performance, $RK_{i,t}^{(1)}$, is significantly negative, whereas the coefficient of the squared prior performance rank, $SQRK_{i,t}^{(1)}$, is significantly positive. The U-shaped relation between relative risk and prior performance is, therefore, quite robust to the specifications used in these tables.

In specification (1), 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. In specifications (2) and (3), we see that family size has a negative effect on the convexity of the U-shaped relation between relative risk and prior performance, which is consistent with our prediction. Furthermore, the expense ratio continues to have a

negative effect on the convexity of the U-shaped relation. In specification (4), some coefficients become statistically insignificant perhaps because of the significant reduction in the size of the sample when the manager’s age is included as an independent variable.

6. 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 leads to a 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 nonmonotonic relation.

Our empirical tests confirm the existence of a U-shaped relation between future relative risk and prior relative performance. Consistent with the theory, we also show that older managers, who face lower employment risk, choose higher relative risk, *ceteris paribus*. We also document, for the first time, a U-shaped relation between a manager’s likelihood of choosing high relative risk and her probability of future termination. Therefore, we empirically establish the importance of employment risk as a driver of risk shifting by fund managers. Finally, we show empirical support for the additional testable hypotheses suggested by our theory that link determinants of the convexity of the fund flow–performance relation and employment risk to the degree of convexity of the U-shaped relative risk–prior performance relation.

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