Market Frictions, Investor Sophistication and Persistence in Mutual Fund Performance*

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Abstract

If there are diseconomies of scale in asset management, any predictability in mutual fund performance will be arbitraged away by rational investors seeking funds with the highest expected performance (Berk and Green, 2004). In contrast, the performance of US equity mutual funds persists through time. In this paper, we investigate whether market frictions can reconcile the assumptions of investor rationality and diseconomies of scale with the empirical evidence. More specifically, we extend the model of Berk and Green (2004) to account for financial constraints and heterogeneity in investors' reservation returns reflecting the idea that less financially sophisticated investors face higher search costs. In our model, both negative and positive expected fund performance are possible in equilibrium. Moreover, expected fund performance increases with expected managerial ability, which can explain the evidence on performance persistence. The model also implies that performance persistence increases with fund visibility, as fund visibility increases the proportion of unsophisticated investors in the fund. Consistently with this prediction, we report empirical evidence for the US equity fund market that differences in performance are significantly less persistent among hard-to-find funds than otherwise similar funds.

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1 Introduction

Like investors in other retail financial markets, mutual fund investors face non-negligible search costs, entry costs, and switching costs, and are likely to be financially constrained. While the role of market frictions on investor choices has received some attention in the mutual fund literature, the implications of frictions for the determination of mutual fund performance are still not well understood. In this paper, we investigate how market frictions shape investors' investment and disinvestment decisions and the determination of mutual fund performance in equilibrium.

The starting point of our analysis is the model of Berk and Green (BG) (2004), who characterize the competitive provision of capital to mutual funds. In their model, investors learn about managerial ability from past returns and demand shares of all funds with expected risk-adjusted performance net of fees and other costs higher than investors' reservation return, which is assumed to be zero. In the presence of diseconomies of scale, the flows of money into (out of) outperforming (underperforming) funds drive their performance down (up) to zero. In equilibrium, all funds deliver zero net expected performance. Therefore, fund performance is not predictable from fund characteristics or past performance.

BG's influential work has changed the prevalent view on mutual fund performance persistence by showing that lack of predictability in mutual fund performance is consistent with a market populated by competing rational investors, even if fund managers possess skill. However, there exists abundant empirical evidence that underperforming US equity funds continue to underperform in the long term (e.g., Carhart, 1997). The model cannot explain, either, why performance persists for winners in the short term (Bollen and Busse, 2005). Therefore, under the framework of BG, the well documented persistence in mutual fund performance is an anomaly that needs to be explained.

One possible explanation for the discrepancy between the model's implication of performance unpredictability and the empirical evidence on performance persistence is that the assumption of diseconomies of scale in asset management is not a good characterization of the mutual fund industry. However, the available empirical evidence suggests that US equity fund performance decreases with size. Chen et al. (2004) show that, conditional on other fund characteristics, performance decreases with lagged assets under management, especially for funds investing in small-cap growth stocks, suggesting that liquidity is a source of diseconomies of scale portfolio management. Yan et al. (2008) confirm these findings using more direct measures of portfolio liquidity.

An alternative explanation is that market frictions such as search costs, switching costs, and liquidity constraints, distort investor decisions and affect mutual fund equilibrium performance. Understanding the effects of frictions on the determination of equilibrium in the mutual fund market is precisely the purpose of our study. More specifically, we develop a model of performance determination that retains the key features of the model of BG, namely diseconomies of scale and competition among investors, but extends it in several directions. First, we assume that investors' reservation risk-adjusted returns are negative, not zero, for many investors. The idea that mutual fund investors have negative reservation risk-adjusted returns is indeed consistent with the abundant empirical evidence that the average actively managed equity fund underperforms passive benchmarks after fees and trading costs. Negative reservation risk-adjusted returns can arise as a consequence of search costs. For instance, BG assume that the investment alternative to actively managed funds is an index fund. In the presence of search costs, the risk-adjusted return of investing in the index fund net of search costs is negative. Consistently with this view, Hortaçsu and Syverson (2004) attribute the large dispersion of fees across index mutual funds tracking the same index to search costs. Since search costs are likely to vary across investors due to heterogeneity in financial sophistication, in our model we assume that reservation returns are lower for unsophisticated investors.

Second, we assume that investors are financially constrained, i.e., they face a limit on the amount of money they can invest in a mutual fund each period. Moreover, investors face the risk of suffering from liquidity shocks, which would prevent them from investing in a mutual fund. We assume that this risk is higher for unsophisticated investors.

Like in the model of BG, each period investors must choose between an actively managed fund and an index fund, an alternative investment opportunity available to all investors with the same risk as the managed portfolio. We assume that while the fund's current investors can both reinvest their last period's wealth as well as their current endowment in the fund, new investors can only invest their current period's endowment.

Throughout our analysis we take the fund's fee as given. Contractual fee changes are in practice very difficult to change: Fee increases must be approved by both the Board of Directors and the fund's shareholders and decreases must be approved by the Board (Tufano and Sevick, 1997, Christoffersen, 2001). Our assumption of fee exogeneity is a simple way of capturing management companies' limited ability to set fees.

If investors were not financially constrained, any fund's expected risk-adjusted net return would be equal in equilibrium to the reservation return of the most unsophisticated investors among the fund's target investors. Otherwise, there would be excess demand by the most unsophisticated investors for any fund with a higher level of performance. An increase in expected managerial ability would not lead to an increase in the fund's net performance, it would simply result in more flows from unsophisticated investors. In this setup, a fund could only offer a higher expected net performance and attract more sophisticated investors by becoming unavailable to the least sophisticated investors. However, when there is a limit on the amount of money each investor can invest, inflows from the least sophisticated investors do not drive fund performance down to their reservation return, so the fund can still attract more sophisticated investors. In this different setup, more sophisticated investors decide to invest in the fund as long as the fund's expected performance exceeds their reservation return. In equilibrium, any actively managed fund offers an expected risk-adjusted net return at least as high as the reservation return of the most sophisticated investor who decides to invest with the fund. When managerial ability is low, a fund can survive offering a negative risk-adjusted expected net return if there are investors with low enough reservation risk-adjusted returns among the fund's target investors. As managerial ability increases, the fund's equilibrium expected performance increases and the fund attracts more sophisticated investors. A fund can offer a positive expected risk-adjusted net return provided that investors' inflows are not sufficient to drive the fund's performance down to zero. In sum, in our model both negative and positive expected fund performance are possible in equilibrium.[1] Moreover, expected fund performance increases with managerial ability. To the extent that managerial ability is persistent through time, so is realized fund performance.

Therefore, heterogeneity in investors' reservation returns together with financial constraints can rationalize the evidence on fund performance persistence. But the model developed in this paper also delivers a new empirical prediction that has not been tested before in the literature. In particular, the model predicts that performance persistence increases with fund visibility. The intuition for this result is as follows. When a mutual fund family's offerings become more visible, the cost of obtaining information about those funds decreases. This reduction in information costs has the effect of making the funds available to investors who otherwise would not have been aware of their existence or would have not collected information necessary to consider those funds for investment. Such investors are the least sophisticated ones. Therefore, a fund with lower search costs will attract a higher fraction of unsophisticated investors. If managerial ability is low, only a more visible fund, whose target investors are on average less sophisticated, can operate. Moreover, other things equal, a more visible fund captures more assets and, consequently, performs worse. Therefore, a more visible fund is more likely to operate with poorer expected performance and, therefore, is more likely to exhibit persistent underperformance than a less visible fund. On the other hand, the performance of a more visible fund improves faster with managerial ability than that of an otherwise identical less visible fund. The reason is that a more visible fund's current investors are less sophisticated and have less money to invest, so their decision to enter the fund as managerial ability improves is less harmful to fund performance. Moreover, current investors require a lower expected risk-adjusted return in order to decide to reinvest with a more visible fund, so it takes a lower level of managerial ability for all current investors to reinvest with the fund. Once all current investors have decided to reinvest, new investors may enter the fund, but since new investors only have their current endowment to invest, the effect of their entry on fund performance is limited. If we

[1] Note, however, that if positive managerial ability is scarce, positive expected performance, although compatible with equilibrium, will be rarely observed in the data.

further assume the existence of an entry cost to new investors, then increases in managerial ability lead to an even faster rise in fund performance, as new investors invest in the fund only when its expected performance outweights their reservation return plus the entry cost. In sum, other things equal, the expected performance of a more visible fund is lower than that of a less visible fund, but rises faster with managerial ability. In the paper, we show that there exists a range of managerial ability values for which more visible funds exhibit a higher dispersion in expected performance than otherwise identical funds, which implies that differences in realized performance should be more persistent among more visible funds.

We use US mutual fund equity data from the 1996-2010 period to test the model's prediction. We proxy for fund visibility using the size, age and diversity of investment categories of the fund's family. We also use advertising expenditures at the family level to identify funds that target more or less sophisticated investors. Measuring both past and future performance using the four-factor model of Carhart (1997), we find strong evidence of performance persistence over a one-year period, conditional on observable fund characteristics. However, consistently with the model's prediction, the hardest-to-find funds exhibit significantly less persistence in performance than the rest of funds. This is true for both underperformance and outperformance. Funds whose past performance has been in the bottom decile of the distribution in the last twelve months and which belong to the group of hard-to-find funds, do not perform significantly worse than funds with median past performance and outperform the rest of recent losers. Similarly, the performance of hard-to-find recent winners is not significantly better than that of the median fund and is significantly worse than that of other recent winners. In sum, unlike for all the other funds, we find little evidence of performance persistence for funds in the low-visibility group. When past performance is measured using raw returns, we only find evidence of performance differences between the worst recent performers and the median fund. Again, hard-to-find funds exhibit no evidence of performance persistence. In sum, our empirical results lend support to the hypothesis that hard-to-find funds exhibit smaller differences in equilibrium expected performance and, therefore, less persistent performance.

Results are somewhat different when we use advertising expenditures to proxy for fund visibility. While funds with no advertising expenditure exhibit less performance persistence, this result is entirely due to differences among outperforming funds, not underperforming funds.

Finally, we show evidence of differences in performance persistence between between institutional and retail funds that are consistent with our model and with the idea that institutional funds are targeted to more sophisticated investors.

The results of this paper have important consequences for investors, managers and regulators. The analysis suggests that frictions can generate persistent differences in fund performance despite competition among rational investors. Moreover, we show that fund visibility exacerbates persistence, so investors should avoid not just underperforming funds but especially the more visible underperforming funds. For management companies, it is important to know that visibility helps funds attract more assets, but may also increase the fraction of unsophisticated investors in the fund, which has consequences not just for flows but also for fund performance. Finally, the results of the paper suggest that reducing the information costs of complex financial products such as actively managed funds should be accompanied by policies aimed at facilitating comparisons with investment alternatives, such as indexed funds.

The effect of market frictions in general, and search costs in particular, on investor decisions has been previously investigated by the mutual fund literature in the context of studies of mutual fund flows. Sirri and Tufano (1998) are the first to show that search costs affect investor decisions. In particular, they find that the flow-performance relation is less steep for funds associated with higher search costs. Huang et al. (2007) propose a model in which search costs combined with Bayesian learning from past returns lead investors to consider only funds with the highest recent performance since the costs of researching a new fund with less than top recent performance outweight the expected benefits. More recently, Navone (2012) shows that the sensitivity of flows to past performance decreases with past performance but increases with different proxies for fund visibility.

Our paper belongs to a relatively new line of research that investigates the determinants of mutual fund performance persistence in light of Berk and Green's (2004) theory. This line of research includes the studies of Ferreira et al. (2010), Bessler et al. (2010), Reuter and Zitzewitz (2010), and Elton et al. (2011). Ferreira et al. (2010) study differences in performance persistence across countries and find that such differences are associated with differences in the degree of diseconomies of scale and fund competition. Bessler et al. (2010) show that outflows from underperforming funds alone cannot eliminate their performance disadvantage. They do find, however, that outflows from underperforming funds combined with manager replacement can cause reversals in performance. Reuter and Zitzewitz (2010) study the effect of fund flows on performance using a regression discontinuity approach and estimate diseconomies of scale of a magnitude larger than estimated in standard regression but insufficient to eliminate performance persistence. Elton et al. (2011) argue that if there are diseconomies of scale in asset management, then performance should be less persistent among larger funds for which diseconomies of scale are more likely to be important. However, when they divide a sample of equity mutual funds into groups according to assets under management, they find that the degree of performance persistence is similar across all size groups.[2]

Our paper is more closely related to that of Berk and Tonks (2007), who investigate cross-sectional differences in performance persistence for US equity funds. The authors argue that differences in the speed

[2]Elton et al. (2011) also regress performance on past performance, fund size, lagged flows, and other fund characteristics. While they find that lagged flows and size are associated with lower future performance, this association is much weaker than that of past performance with future performance.

of learning across investors cause the composition of a fund's investor base to change with performance, since the first investors to leave or enter a fund are those who update their beliefs the fastest. As a consequence, remaining investors of a fund that has underperformed in the past have a lower flow-to-performance sensitivity, which prevents the fund's assets from shrinking should the fund continue to underperform in the future. Our paper is also related to the work of Glode et al. (2011). These authors study time variation in performance persistence and find evidence that mutual fund performance persistence is strongest following periods of high market returns and vanishes after periods of low market returns. The authors argue that differences in performance persistence across market conditions may be explained by time-varying differences in the participation of unsophisticated investors in the mutual fund market, with a higher fraction of unsophisticated investors leading to larger deviation from the no-predictability equilibrium. Consistently with this hypothesis, the authors report that time-variation in predictability is concentrated among funds catering to retail investors.

Like Berk and Tonks (2007) and Glode et al. (2011), we also attribute differences in performance persistence to investor heterogeneity in their degree of financial sophistication. However, while these authors hypothesize that observed performance persistence is a consequence of investors' failure to respond optimally to differences in expected performance, we show that performance persistence can arise as a consequence of frictions. Of course, in reality performance persistence may be the result of many forces at play. Therefore, we view the theoretical and empirical results of our paper as complementary to those of Berk and Tonks (2007) and Glode et al. (2011).

The rest of the paper is organized as follows. In section 2, we present the theoretical framework of our analysis. In section 3, we describe the data set. In section 4 we present our empirical strategy and the empirical results. Section 5 concludes. The Appendix contains all the proofs.

2 The model

BG consider a fund that can generate returns in excess of a passive benchmark due to its manager's ability. Let R_t denote the fund's return in excess of a passive benchmark before fees and expenses, $R_t = \alpha + \varepsilon_t$, where α reflects managerial ability and ε_t is an idiosyncratic shock that is normally distributed with mean 0 and variance σ^2. Managerial ability, α, is not known to managers or investors, who estimate it using the information contained in past returns. Henceforth, we refer to the fund's risk-adjusted return as the fund's return.

The cost of managing the portfolio is denoted by $C(q)$, where q, is the dollar value of assets under management. $C(q)$ is common knowledge and it satisfies the following properties: $C(0) = 0$, $\lim_{q\to\infty} C'(q) = \infty$ and for all $q \geq 0$, $C(q) \geq 0$, $C'(q) > 0$, $C''(q) > 0$. The last assumption, increasing marginal costs, captures diseconomies in scale in asset trading and is key to the model's implications.

Similarly to BG we model a fund that began operating at time 0 and study the investors' decisions at time t. Since we do not study fund dynamics, our model analyzes a single-period's decision.[3] The fund's net return at time t is defined as $r_t \equiv R_t - \frac{C(q_t)}{q_t} - f$, where q_t is the $t-1$ investment in the fund and f is the fund's fee, which is exogenously given. If the revenues collected by the manager at time t, fq_t, cover the fixed costs of the fund, the fund continues its activity, otherwise the fund closes down. We assume without loss of generality that fixed costs are zero.

We depart from BG in that the fund's potential investors have limited funds to invest and exhibit different degrees of financial sophistication. To model different degrees of sophistication we allow for reservation returns to vary across investors. Like BG, we assume that each investor i has a specific search cost γ_i that reflects her ability to find an alternative fund. For simplicity, we assume that the alternative for all investors is an index fund with zero expected risk-adjusted return. Net of search costs, the reservation expected risk-adjusted return (henceforth reservation return) of the $i-th$ investor is $-\gamma_i$. Therefore, unlike in the model of BG, the investor's reservation return is different from zero and is also different across investors. We assume that there is a continuum of investors in the economy with absolute value of the reservation return γ uniformly distributed over the interval $\left[0, \gamma^{Sup}\right]$, with $\gamma^{Sup} \leq 1$.[4]

The fund has a limited pool of potential investors: all current investors plus investors with higher reservation returns than those of current investors, so the fund's target investors at t have reservation returns in absolute value uniformly distributed over the interval $[0, \gamma_{MAX}]$. Fund visibility is determined by γ_{MAX}. If the fund is more visible, it is available to more unsophisticated investors, so the search costs of the fund's least sophisticated potential investors are higher. We also allow for the possibility that new investors who enter the fund at date t must pay an entry cost K.

The timing of the events is the following:

Date $t-1$:

- Investors enter the fund. We denote by $\overline{\gamma}$ the absolute value of the reservation return of the most sophisticated investor who enters the fund, and by γ_{MAX} the fund's least sophisticated investor's reservation return in absolute value.

Date t:

- The fund's return at date t is realized and current investors obtain its net return.
- After observing the return at date t, the fund's current investors decide whether to reinvest with the fund or withdraw their current investment.

[3] Note that modeling only the decision of investors at time t does not imply that the investors are myopic given the model's assumption that investors maximize the expected risk-adjusted return on their investment.

[4] Therefore, we assume that all investors in the economy have negative reservation returns net of search costs. Alternatively we could allow some investors to have positive reservation returns without altering the conclusions.

- New investors decide whether they want to invest with the fund.
- We assume that each current investor holds an investment in the fund that is worth m dollars at t. Also, each investor is endowed with a wealth of m dollars at date t. However, investor i is exposed at time t to the possibility of a liquidity shock with probability γ_i. Consequently, the expected investment at t by investor i is $m(1-\gamma_i)$. This assumption captures the idea that less sophisticated investors face more severe financial constraints (on average).

Date $t+1$:

- The fund's return at date $t+1$ is realized and the fund's investors obtain its net return.

We study equilibrium at t.

Upon observing the series of net returns and total assets under management from 1 to t, $\{r_s, q_s\}_{s=1}^{s=t}$, investors can infer the series of returns $\{R_s\}_{s=1}^{s=t}$ and update their beliefs about the fund manager's ability through Bayesian updating:

$$\phi_{t+1} = E\left(R_{t+1} \left| R_1, ..., R_t \right.\right).$$

Investor i demands shares of the fund if the fund's expected net return (the fund's performance) exceeds her reservation return $-\gamma_i$. The fund's expected net return in period t equals

$$\begin{aligned} TP_{t+1}(q_{t+1}) &= E\left[r_{t+1}|R_1, ..., R_t\right] \\ &= E\left[R_{t+1} - \frac{C(q_{t+1})}{q_{t+1}} - f \middle| R_1, ..., R_t\right]. \end{aligned}$$

A current investor will either withdraw her date $t-1$ investment from the fund or keep her current investment and invest her date t endowment in the fund depending on whether the fund's expected net return at date t is below or above her reservation return.

An equilibrium at t is an amount of assets under management, q_{t+1}^*, such that investors maximize their expected risk-adjusted return. In an equilibrium in which only current investors enter the fund, the following conditions must hold:

- The fund's expected performance is given by $TP_{t+1}\left(q_{t+1}^*\right) = \phi_{t+1} - \dfrac{C\left(q_{t+1}^*\right)}{q_{t+1}^*} - f$.
- All investors who withdraw their money from the fund have reservation returns higher than $TP_{t+1}\left(q_{t+1}^*\right)$.
- All investors who invest new money in the fund have reservation returns less than or equal to $TP_{t+1}\left(q_{t+1}^*\right)$.

- The equilibrium amount of assets q^*_{t+1} is such that $0 \leq q^*_{t+1} \leq v_t + M$, where $v_t \equiv m\left(\gamma_{MAX} - \overline{\gamma}\right)$ is the value at t of current investors' investment at $t-1$ and M denotes the maximum inflow possible in this period: $m\left(\gamma_{MAX} - \frac{1}{2}\gamma^2_{MAX}\right)$.

To find the cutoff reservation return, $-\gamma^C$, such that all current investors with reservation returns lower than $-\gamma^C$ reinvest with the fund and all current investors with reservation returns higher than $-\gamma^C$ leave the fund, we solve the system:

$$\begin{aligned} TP_{t+1}\left(q^C_{t+1}\right) &= -\gamma^C, \\ q^C_{t+1} &= 2m\left(\gamma_{MAX} - \gamma^C\right) - \frac{m}{2}(\gamma^2_{MAX} - (\gamma^C)^2). \end{aligned}$$

Depending on the value of the solution γ^C, there are three possible alternatives:

Case 1: $\gamma_{MAX} \leq \gamma^C$. Even if all current investors left the fund, so $q_{t+1} = 0$ and $C(q_{t+1}) = 0$, the fund's expected net return would be lower than the reservation return of the fund's most unsophisticated target investor. Therefore, the fund must close down and $q^*_{t+1} = 0$.

Case 2: $\overline{\gamma} \leq \gamma^C < \gamma_{MAX}$. Current investors with reservation returns higher than $-\gamma^C$ exit the fund and those with reservation returns lower than $-\gamma^C$ reinvest with the fund. The fund's expected net return equals $E\left(r_{t+1}\right) = -\gamma^C < 0$ and the fund's assets $q^*_{t+1} = q^C_{t+1}$.

Case 3: $\gamma^C < \overline{\gamma}$. Even if all current investors reinvested with the fund, the fund's expected net return would be higher than the reservation return of the fund's most sophisticated target investor, so some new, more sophisticated investors might want to enter the fund. Therefore, $q^*_{t+1} \geq 2m\left(\gamma_{MAX} - \overline{\gamma}\right) - \frac{m}{2}(\gamma^2_{MAX} - \overline{\gamma}^2)$. In this case, we are interested in knowing whether new investors would pay the cost K to enter the fund.

In an equilibrium in which new investors enter the fund the following conditions must hold:

- The fund's expected return equals $TP_{t+1}\left(q^*_{t+1}\right)$.
- New investors who invest in the fund have reservation returns less than or equal to $TP_{t+1}\left(q^*_{t+1}\right) - K$.
- New investors who decide not to invest in the fund have reservation returns higher than $TP_{t+1}\left(q^*_{t+1}\right) - K$.

To find the cutoff reservation return, $-\gamma^N$, such that all current investors reinvest with the fund, new investors with reservation returns lower than $-\gamma^N$ enter the fund, and new investors with reservation returns higher than $-\gamma^N$ do not invest with the fund, we solve the system:

$$\begin{aligned} TP_{t+1}\left(q_{t+1}^N\right) - K &= -\gamma^N, \\ q_{t+1}^N &= v_t + m\left((\gamma_{MAX} - \gamma^N) - \frac{1}{2}(\gamma_{MAX}^2 - \left(\gamma^N\right)^2)\right). \end{aligned}$$

We now distinguish two cases depending on whether the solution γ^N is higher or smaller than $\overline{\gamma}$. When $\gamma^N \geq \overline{\gamma}$, no new investors want to enter the fund. Even if only current investors reinvested with the fund, the fund's performance would not be enough to convince investors to pay the entry cost. As a result, only current investors invest in the fund and the amount invested in the fund at $t+1$ is $q_{t+1}^* = 2v_t - \frac{m}{2}(\gamma_{MAX}^2 - \overline{\gamma}^2) \equiv \overline{q}_{t+1}$. The expected return in this case is $E\left(r_{t+1}\right) = TP_{t+1}\left(\overline{q}_{t+1}\right)$.

On the other hand, when $\gamma^N < \overline{\gamma}$, new investors enter the fund. The last investor i to enter the fund in the period t will have $\gamma_i = \gamma^N$, and the quantity invested in the fund is $q_{t+1}^* = v_t + m\left((\gamma_{MAX} - \gamma^N) - \frac{1}{2}(\gamma_{MAX}^2 - \left(\gamma^N\right)^2)\right)$. If $\gamma^N < 0$, then all potential investors enter the fund and the quantity invested in the fund is $q_{t+1}^* = v_t + m\gamma_{MAX}\left(1 - \dfrac{\gamma_{MAX}}{2}\right) = v_t + M$. Consequently, the fund's expected net return is $E\left(r_{t+1}\right) = K - \gamma^N$, if $\overline{\gamma} > \gamma^N > 0$ and $E\left(r_{t+1}\right) = TP_{t+1}\left(v_t + M\right)$, if $\gamma^N \leq 0$.

Henceforth, we assume for simplicity that $C\left(q\right) = cq^2$.

Proposition 1 *The expected net return of a fund that targets investors in the interval* $[0, \gamma_{MAX}]$ *equals*

$$E\left(r_{t+1}\left(\phi_{t+1}\right)\right) = \begin{cases} -\gamma^C, & if \quad \Phi_1 \leq \phi_{t+1} < \Phi_2 \\ TP_{t+1}\left(\overline{q}_{t+1}\right), & if \quad \Phi_2 \leq \phi_{t+1} < \Phi_2 + K \\ K - \gamma^N, & if \quad \Phi_2 + K \leq \phi_{t+1} < \Phi_3 + K \\ TP_{t+1}\left(v_t + M\right), & if \quad \Phi_3 + K \leq \phi_{t+1}, \end{cases}$$

where Φ_j, $j = \overline{1,3}$ *are defined in the Appendix and* γ^C, γ^N, *equal:*

$$\begin{aligned} \gamma^C &= \frac{1}{cm}\left(1 + 2cm - A^{1/2}\right), \text{ where} \\ A &\equiv 1 + 2cm\left(2 + \phi - f\right) + c^2m^2\left(2 - \gamma_{MAX}\right)^2 \end{aligned}$$

and

$$\begin{aligned} \gamma^N &= \frac{1}{cm}\left(1 + cm - B^{1/2}\right), \text{ where} \\ B &\equiv 1 + 2cm\left(1 + \phi - f - K\right) + c^2m^2\left(\left(1 - \gamma_{MAX}\right)^2 - \frac{2}{m}v_t\right), \end{aligned}$$

respectively.

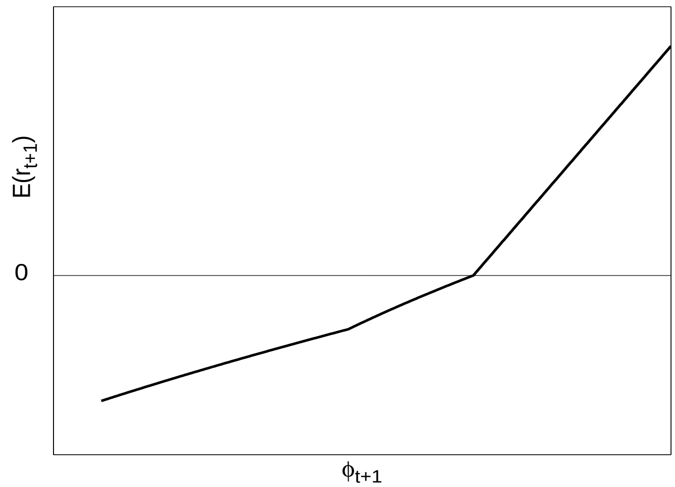

Figure 1: Expected net return as a function of expected managerial skill. Parameter values: $m = 200$, $c = 0.01$, $K = 0$, $\gamma_{MAX} = 0.7$, $f = 0.01$.

Figure 1 shows graphically the fund's expected net return as a function of expected managerial ability holding the fund's fee constant and assuming that there are no entry costs for new investors ($K = 0$). If managerial ability is too low, the fund must close down. As managerial ability increases, the fund starts to operate with the most unsophisticated investors of all its potential investors. Investors' limited capital allows fund performance to increase with managerial ability. If managerial ability is high enough, all current investors reinvest with the fund and new more sophisticated investors start to invest. Because new investors invest only their current endowment, the fund's assets increase less rapidly with increases in managerial ability, so the fund's expected return increases faster. Once all potential investors are in the fund, fund performance increases one-to-one with managerial skill.

Proposition 1 shows that the fund's expected net return in equilibrium can be different from zero. On the one hand, equilibrium expected net returns may be negative in our setup when investors prefer to keep their investment in the fund despite earning a negative return because this return is still higher than their reservation return. On the other hand, positive equilibrium expected net returns can be obtained when managerial ability increases and either entry costs prevent new investors from entering the fund and eroding funds' performance or all potential investors have invested with the fund. Therefore, the interaction of financial constraints and negative reservation returns prevents investors' money flowing freely into and out of the fund and eliminating differential performance. Note that in order to observe dispersion in expected performance in the data, other than that induced by visibility or differences in γ_{MAX} or $\overline{\gamma}$, we need to have dispersion in managerial ability. To the extent that managerial ability persists through time for a given manager, observed differences in fund performance across mutual funds are also persistent.

Note also that the result of Proposition 1, i.e., the fund's expected net return in equilibrium can be different from zero, is not driven by the entry cost K or negative reservation returns. The result is still valid if these two assumptions are relaxed. The necessary conditions to obtain expected net returns different form zero are: heterogeneity of investors' reservation returns and limited capital to invest. Investor heterogeneity ensures that in equilibrium we have expected returns different from zero, but also different for different levels of managerial ability. The assumption that investors are financially constrained, prevents them from having a risk-adjusted expected net return equal to the reservation return of the most unsophisticated investor among the fund's target investors. If the investors were not constrained, there would be excess demand by the most unsophisticated investors for any fund with a higher level of performance. Therefore, an increase in managerial ability would not lead to an increase in the fund's net performance, it would simply attract more flows from unsophisticated investors.

As we can see from Proposition 1, expected net return of a given fund depends on the fund's target of investors, given by γ_{MAX}. Notice that both $\gamma^C$and γ^N increase with γ_{MAX} and this is due to the fact that when the target investors are more sophisticated, there is a larger amount available for reinvestment in the fund, and therefore, the fund performance is eroded to a larger extent by money inflows. As a result, if the fund is less visible it may earn a higher expected net return in equilibrium. However, this does not guarantee that reducing fund visibility always increases expected performance. To see this, let us consider the same fund and two different cases, each one corresponding to a different value of γ_{MAX}. Henceforth, we refer to the first case as the high visibility fund, $\left(\gamma_{MAX}^{High}\right)$, and to the second case as the low visibility fund, $\left(\gamma_{MAX}^{Low}\right)$, with $\gamma_{MAX}^{High} > \gamma_{MAX}^{Low}$. We assume that the total amount currently invested in both cases is the same, v_t. We denote by $\Phi_j^{High}, \Phi_j^{Low}$ the cut-off points for the high and low visibility cases, respectively.

Proposition 2 *There exist K_1 and K_2 as defined in the Appendix such that:*

1. If $K < K_1$, then $E^{Low}\left(r_{t+1}\left(\phi_{t+1}\right)\right) > E^{High}\left(r_{t+1}\left(\phi_{t+1}\right)\right)$, for any ϕ_{t+1}.

2. If $K \in [K_1, K_2]$ then there exist $\phi_1 \in \left(\Phi_2^{High}, \Phi_2^{High} + K\right)$ and $\phi_2 \in \left(\Phi_2^{Low}, \Phi_2^{Low} + K\right), \phi_2 > \Phi_2^{High} + K$ such that $E^{Low}\left(r_{t+1}\left(\phi_j\right)\right) = E^{High}\left(r_{t+1}\left(\phi_j\right)\right), j = 1, 2$. Then, for any $\phi_{t+1} < \phi_1$ and $\phi_{t+1} > \phi_2$, we have that $E^{Low}\left(r_{t+1}\left(\phi_{t+1}\right)\right) > E^{High}\left(r_{t+1}\left(\phi_{t+1}\right)\right)$ and for $\phi_{t+1} \in \left(\phi_1, \phi_2\right)$, $E^{Low}\left(r_{t+1}\left(\phi_{t+1}\right)\right) > E^{High}\left(r_{t+1}\left(\phi_{t+1}\right)\right)$.

3. If $K > K_2$, then there exists $\phi_1 \in \left(\Phi_2^{High}, \Phi_2^{High} + K\right)$ such that $E^{Low}\left(r_{t+1}\left(\phi_1\right)\right) = E^{High}\left(r_{t+1}\left(\phi_1\right)\right)$. Then, for any $\phi_{t+1} < \phi_1$, $E^{Low}\left(r_{t+1}\left(\phi_{t+1}\right)\right) > E^{High}\left(r_{t+1}\left(\phi_{t+1}\right)\right)$ and for $\phi_{t+1} > \phi_1$, $E^{Low}\left(r_{t+1}\left(\phi_{t+1}\right)\right) <$

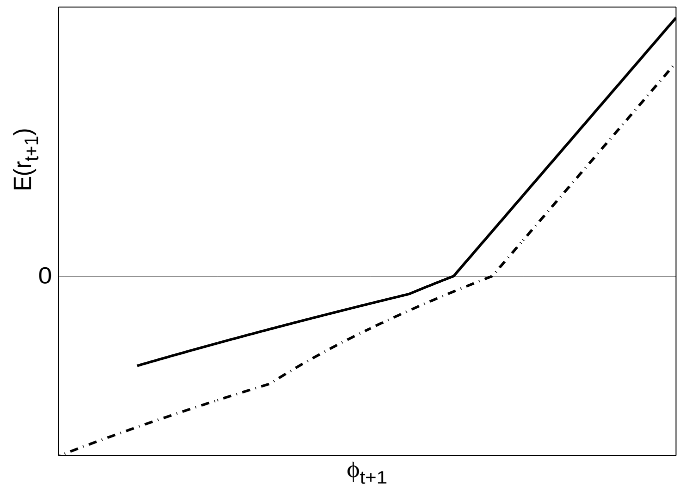

Figure 2: Expected net return as a function of expected managerial skill and fund visibility, no entry costs. The solid (dotted) line corresponds to a low (high) level of visibility, i.e., low (high) γ_{MAX}. Parameter values: $m = 200$, $c = 0.01$, $K = 0$, $\gamma_{MAX}^{High} = 1$, $\gamma_{MAX}^{Low} = 0.5$.

$E^{High}\left(r_{t+1}\left(\phi_{t+1}\right)\right).$

Proposition 2 characterizes the conditions under which a high visibility fund underperforms an otherwise identical low visibility fund. When entry costs are small, $K < K_1$ (see Figure 2 for the case $K = 0$), a more visible fund underperforms an otherwise identical less visible fund for any level of managerial ability. For any given of managerial ability a fund that is visible to the least sophisticated investors captures more investors, which reduces its performance. As can be seen in Figure 2, the performance gap between funds targeted to sophisticated investors and funds targeted to unsophisticated investors narrows as managerial ability increases. This is because it takes a low level of managerial ability for all current investors of the latter to decide to reinvest with the fund: They have lower reservation returns and, because they have less money to invest (on average), their decision to reinvest is not as harmful for fund performance. Once all current investors have decided to reinvest, new investors enter the fund but entry of new investors has a less detrimental effect on fund performance than reinvestment by current investors. Therefore, for low entry costs, differences in expected performance between both funds are more apparent in the lower end of managerial ability. Figure 2 suggests that, holding the distribution of managerial ability constant, there will be more cross-sectional dispersion in fund performance as fund visibility increases. Therefore, differences in fund performance observed in the data should be more persistent among more visible funds.

Figure 3 shows the expected performance of both types of funds when $K \in [K_1, K_2]$. In this case,

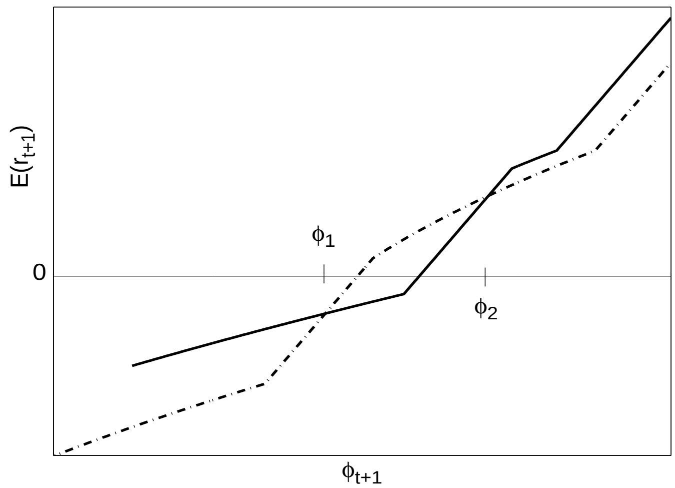

Figure 3: Expected net return as a function of expected managerial skill and fund visibility, positive entry cost. The solid (dotted) line corresponds to a low (high) level of visibility, i.e., low (high) γ_{MAX}. Parameter values: $m = 200$, $c = 0.01$, $K = 0.7$, $\gamma_{MAX}^{High} = 1$, $\gamma_{MAX}^{Low} = 0.5, f = 0.01$.

there exists an interval, (ϕ_1, ϕ_2) in which the more visible fund outperforms the less visible fund. When all current investors have decided to reinvest in the more visible fund, no new investors are willing to enter the fund as long as its expected performance does not exceed the reservation return of the least sophisticated new investor plus the entry cost. In that interval, the fund's expected performance increases one-to-one with managerial ability. The less visible fund, however, continues to retain its current investors' money and attract their $t-$date endowment, so its expected performance increases slowly with ability. The lower bound of the entry cost interval, K_1, guarantees that the expected performance of both types funds cross in the interval $\left(\Phi_2^{High}, \Phi_2^{High} + K\right)$. Existence of the intersection is guaranteed by the fact that unsophisticated investors have less money to invest, which gives more visible funds a performance advantage over less visible funds when current investors have reinvested with both funds and no new investors wish to enter. For higher levels of ability, new investors start to enter the fund. Since new investors in the more visible fund enter for lower levels of ability (because they are not so sophisticated), its expected performance deteriorates sooner as ability improves. In the limit, all possible investors decide to invest. Since the more visible fund attracts a larger set of investors, it is larger and must necessarily underperform.

Finally, when entry costs are very high, i.e., when $K > K_2$, there will be no new investors willing to enter the fund for the range of managerial ability considered. In this case, the more visible fund outperforms the less visible fund for levels of expected managerial ability that are above a minimum level, ϕ_1.

Our model suggests that both negative and positive expected performance are possible in equilibrium in a market with frictions. It also predicts that expected fund performance increases with managerial ability, which explains the evidence that cross-sectional differences in observed performance persist through time. The model also delivers a new prediction: Fund visibility increases cross-sectional dispersion in fund performance, and therefore it increases realized performance persistence. This is a testable empirical prediction and is the basis of the empirical part of the paper.

3 Data

Our main source of data is the CRSP Survivor-Bias-Free US Mutual Fund Database. Since some of the variables employed in the analysis are available only since the early 1990s, we restrict our attention to the 1993-2010 period. We exclude index, non-domestic, non-diversified, and non-equity funds.[5] We aggregate monthly data for different share classes at the fund level. In particular, we compute fund total net assets as the sum of assets of all share classes of the same portfolio, fund age as the number of years since inception of the oldest class, and all other variables (return, expense ratio, 12b-1 fee, front-end and back-end loads) as asset-weighted averages of those variables at the class level. We also compute family age and family assets as the age of the oldest fund in the family and the sum of assets of all funds in the family, respectively. Funds and families are identified using CRSP's crsp_portno and mgmt_cd variables, respectively. When those variables are not available, we use fund name and management company name, instead. To mitigate the effect of documented biases in the CRSP database, we exclude all fund-month observations with total net assets below $15 million and age less than three years (Elton et al., 2011; Evans, 2010). We winsorize fee and return data at 1% of each tail each month.

Throughout the paper, we evaluate mutual fund performance using Carhart's (1997) four-factor model:

$$r_{it} = \alpha_i + \beta_{rm,i} rm_t + \beta_{smb,i} smb_t + \beta_{hml,i} hml_t + \beta_{pr1y,i} pr1y_t + \varepsilon_{it}, \tag{1}$$

where r_{it} is fund i's return in month t in excess of the 30-day risk-free interest rate, as proxied by Ibbotson's one-month Treasury bill rate, and rm_t, smb_t and hml_t denote the return on portfolios that proxy for the market, size, and book-to-market risk factors, respectively. The term $pr1y_t$ is the return

[5] To identify US domestic equity funds, we use the information in CRSP on investment category as follows. For years in which the only objective code available is Wiesenberger's (wbrger_obj_cd), we consider as US domestic equity those funds with the codes: G; G-I; I-G; MCG; GCI; LTG; MCG; SCG; and IEQ. For years 1993-1999, we use the si_obj_cd codes: AGG; GMC; GRI; GRO; ING; SCG. For years 2000-2010, we use the lipper_class_name codes: LCVE; MLVE; EI; EIEI; LCCE; MLCE; LCGE; MLGE; MCVE; MCCE; MCGE; SCVE; SCCE; and SCGE. Index funds are identified by the CRSP's index_fund_flag variable when available and by portfolio name otherwise.

difference between stocks with high and low returns in the previous year and is included to account for passive momentum strategies. We obtain the time series of interest rates, the Fama-French factors and momentum from Kenneth French's website.

To estimate fund i's risk-adjusted performance in month t, we first regress the fund's excess return on the three Fama-French factors and momentum over the previous three years. If less than 36 monthly observations of previous data are available, we require at least 30 observations. We then compute an estimate of fund i's alpha in month t, $\hat{\alpha}_{it}$, as the difference between the fund's excess return in month t and the dot product of the vectors of estimated betas and factor realizations in that month.

We are interested in testing whether past performance predicts future performance over multi-period horizons. To compute risk-adjusted performance over the prior k months in month t, which we denote by $\hat{\alpha}_{i,t-k:t-1}$, we sum monthly estimated alphas from months $t-k$ to month $t-1$. Future performance, denoted by $\hat{\alpha}_{i,t:t+m}$, is computed as the sum of monthly alphas from months t to month $t{+}m$. Throughout the paper, we will focus on annual performance, so we set $k = 12$ and $m = 11$.

We compute flows of money to mutual funds from monthly data on assets under management and returns. In particular, monthly dollar flows in month t are computed as $TNA_t - TNA_{t-1}(1 + r_t)$, where TNA and r denote the fund's total net assets and net return, respectively. Once we have computed monthly dollar flows, we compute annual flows by adding dollar flows over the year. In our regressions, we use annual relative flows defined as total annual flows divided by total net assets at the end of the previous year.

The final dataset contains information on an average number of 1,251 funds and 327 fund families per month. Panels A and B of Table I contain summary statistics of fund characteristics and performance for the 1993-2000 and 2001-2010 sample periods, respectively.

We use the following proxies for fund visibility:

1. Number of different investment categories in which the family offers mutual funds;
2. Family size, as proxied by the natural logarithm of total family assets;
3. Family age, computed as the age of the oldest fund in the family.

These variables have been previously proposed by Huang et al. (2007) as proxies for investor participation costs. Low values of these variables characterize less visible and, therefore, hard-to-find funds. We assume that, because of the higher cost of locating these funds, potential investors include only those who enjoy low search costs due to their higher level of education, financial literacy, intelligence, or access to unbiased advice. We decide to focus on family-level variables for two reasons. First, strategic decisions such as distribution and advertising are taken at the fund family level. As pointed out by Gallaher et al. (2006), "decisions such as advertising budget, what and when to advertise, the types and number of funds to offer, which distribution channels to pursue, service quality, or individual manager appointments primarily originate on the mutual fund family level." Second, evidence on spillover effects within families (Nanda et al., 2004) suggests that funds in the same family may share the same set of potential investors.

For each one of these proxies, we create two dummy variables, denoted by LO and HI, which equal one if fund i belongs to the bottom and top quartiles of the variable's distribution in data the month prior to the evaluation period, respectively.

While sophisticated investors use reliable sources of information, such as analysts' recommendations or their own research, to assess mutual fund performance, it is plausible to think that unsophisticated investors rely more on advertising. Therefore, in addition to the three variables on fund visibility described above, we also use advertising as a proxy for the degree of sophistication of a fund's target investors. More specifically, we obtain data on advertising expenditures at the family level from Kantar Media, which tracks advertising activity in a large variety of media including magazines, newspapers, television, internet, and radio. We are able to collect information on family advertising for about 18% of all fund-month observations in the 1995-2009 period. For each family and month, we compute the average advertising expenditure over the previous 12 months. For this variable, we define the HI subsample as that containing funds the top quartile of the month's distribution. It should be noted, however, that this subsample only has 822 fund-month observations, so results for this subsample should be taken with caution. We set LO equal to one if the fund's family is not contained in the advertising database for that month.

Table 2 compares funds in the LO and HI subsamples on the basis of selected fund characteristics. Less visible funds according to the number of investment categories, family size and family age, are substantially smaller; they charge lower front-end loads, 12b-1 fees, and back-end loads, but higher management fees; and they exhibit better risk-adjusted performance although the difference in performance is not statistically significant. Overall, these characteristics can be regarded as consistent with the idea that funds in less visible families are associated with lower marketing fees and have a more restricted investor base. When we use family advertising to proxy for fund visibility, we still find that funds in the LO subsample are smaller and charge higher management fees. However, these funds also charge higher back-end loads and exhibit worse performance.

4 Empirical strategy and results

4.1 Methodology

To estimate persistence in mutual fund performance, the literature has employed two main alternative methodologies. The more traditional approach consists of sorting funds at the beginning of each evaluation period on the basis of their past performance. Funds are then grouped in quantile portfolios and portfolio returns are computed over the evaluation period. Finally, risk-adjusted performance is measured using the time series of portfolio returns. Failure to find differences in risk-adjusted performance across portfolios is interpreted as lack of persistence in mutual fund performance. This approach has been employed to study performance persistence by Hendricks et al. (1993), Gruber (1996) and Carhart (1997), and Elton et al. (2011), among others. The portfolio-based approach serves two purposes: It tests for persistence in performance and it quantifies the value of investing on the basis of past performance. However, the approach suffers from the same problem as all nonparametric methods, i.e., it requires a large amount of data in multivariate settings. Suppose we wished to test for performance persistence while controlling for the effect of fund size on future performance. We could sort funds on both past performance and size, allocate funds to the resulting performance-size bins, and then compare portfolios that are neutral to size but correspond to different quantiles of past performance. Also, if our goal were to test whether performance persistence changes with size, we could compare portfolios across both past performance and size bins. In both cases, the number of bins grows geometrically with the number of fund characteristics whose effect on performance we wish to measure.

As an alternative, the regression-based approach consists of regressing future performance on past performance and then testing whether the regression coefficient is zero. This approach has been used by Busse et al. (2010), Elton et al. (2011) and Ferreira et al. (2010). By imposing a parametric specification on the functional relation between future performance and past performance and other variables, we can control for the effect of fund characteristics on performance and allow for persistence to vary with those characteristics with less stringent data requirements.

Because we are interested in testing whether the degree of performance persistence changes with fund visibility while controlling for a number of other variables, we choose the regression approach. We start by regressing future performance on past performance. Then, we allow for possible non-linearities and regress future performance on dummy variables corresponding to different deciles of past performance.

4.2 Fund visibility and performance persistence

To evaluate the prevalence of performance persistence in the entire sample, we estimate by pooled OLS the regression equation:

$$\hat{\alpha}_{i,t:t+11} = \delta_{0,t} + \delta_1 \hat{\alpha}_{i,t-12:t-1} + \Delta X'_{i,t-1} + \xi_{i,t:t+11}, \tag{2}$$

where each observation corresponds to one fund-month pair, X is a row vector of control variables, and ε denotes a generic error term. Control variables include: fund size in month $t-1$, defined as the natural logarithm of the fund's assets; relative flows of money into the fund during the year ending in month $t-1$; fund age, defined as the natural logarithm of the fund's age in months; family size in month $t-1$, defined as the natural logarithm of the assets under management of the management company to which the fund belongs; and family age, defined as the natural logarithm of the management company's age in months. We also control for the fund's maximum front-end load, maximum back-end load, expense-ratio, and turnover ratio. Since values of fees and turnover are reported for the entire fiscal year, their value in month $t-1$ is not strictly lagged with respect to future performance unless month $t-1$ is the last month of the fiscal year. To ensure that those variables are known before month t, we use a lag of 12 months for them. We include monthly dummies in the regression and compute standard errors clustered by both fund and month to correct for serial and cross-sectional correlation of residuals, respectively.

The first column in Table 3 reports estimation results for equation (2). The coefficient on past performance is positive and statistically significant at the 1% confidence level, which suggests that past performance persists for periods of at least one year, consistently with previous studies. Both fund size and lagged flows are negatively and significantly associated with performance, consistent with BG's diseconomies of scale hypothesis. Funds belonging to larger management companies are associated with better performance, as documented by Chen et al. (2004). Finally, the fund's back-end load, expense ratio and turnover ratio are negatively related to performance, although the coefficient for turnover ratio is only marginally statistically significant. In sum, these results are consistent with a large body of empirical evidence that future US equity fund performance is predictable from the cross-section of past performance and other fund characteristics.

We then interact the dummy variables LO and HI obtained according to the four proxies of fund visibility with past performance and estimate the regression equation:

$$\begin{aligned}\hat{\alpha}_{i,t:t+11} = \theta_{0,t} + \theta_1\hat{\alpha}_{i,t-12:t-1} + \theta_2\hat{\alpha}_{i,t-12:t-1}LO_{i,t-1} + \theta_3\hat{\alpha}_{i,t-12:t-1}HI_{i,t-1} + \\ +\theta_4 LO_{i,t-1} + \theta_5 HI_{i,t-1} + \Theta X'_{i,t-1} + \upsilon_{i,t:t+11},\end{aligned} \tag{3}$$

where we also include the two dummy variables to allow for the possibility of different means for each group of funds. We are mainly interested in the coefficients θ_2 and θ_3. Columns 2-5 of Table 3 show the estimation results for each of the four proxies. The coefficients of the interaction of performance with the LO dummy (θ_2) are negative in all four cases and statistically significant at the 1% level (family age), 5% level (number of investment categories and family advertising), and 10% level (family size). Estimation results, therefore, suggest that differences in performance are shorter-lived for the least visible funds than for the rest of funds. Moreover, in contrast to other funds, less visible funds exhibit no performance persistence: The regression coefficient on past performance for these funds, $\theta_1 + \theta_4$, is not statistically significant for any of the proxies (unreported). However, we do not find differences in performance persistence between highly visible funds and the rest of funds, which suggests that the relation between visibility and persistence is non-monotonic.

An obvious concern about these results is the possibility that our proxies for visibility capture differences in persistence across funds due to other fund characteristics. As mentioned in the introduction, Elton et al. (2011) test the hypothesis that there should be less performance persistence among larger funds, for which diseconomies of scale are more likely to be important, although they do not find support for that hypothesis. Also, funds in different investment categories may exhibit different degrees of performance persistence due to differences in the nature of the markets in which they operate. To control for both possibilities, we include interactions of performance with fund size and with dummies for investment categories. The estimation results are reported in Table 4. The coefficients on the interactions of size with performance are negative, but not statistically significant except in column 3 (Family Size), where it is only marginally significant. The fact that the interaction of performance with size is not significant provides further support to the finding of Elton et al. (2011) that performance persistence does not decline with fund size. Further, all signs for the interactions of past performance with the *LO* dummies are negative and the coefficients are statistically significant at the 1% level in all cases except for the family advertising proxy (5%).

In sum, the results of Table 3 and 4 are strongly indicative that there exist differences in performance persistence associated with fund visibility and that these differences in persistence cannot be explained by differences in fund size or differences in investment categories.

4.3 Performance persistence for winners and losers

Low persistence among certain types of funds may be the consequence of either recent underperformers improving their performance or recent outperformers delivering lower performance, or both. To disentangle the reason why less visible funds exhibit less persistent differences in performance, we estimate the regression equation:

$$\begin{aligned}\hat{\alpha}_{i,t:t+11} \quad = \quad & \delta_{0,t} + \sum_n \delta_{1,n} dec\_n_{i,t-1} \\ & + \sum_n \delta_{2,n} dec\_n_{i,t-1} LO_{i,t-1} + \sum_n \delta_{3,n} dec\_n_{i,t-1} HI_{i,t-1} \\ & + \delta_4 LO_{i,t-1} + \delta_5 HI_{i,t-1} + \Delta X'_{i,t-1} + \nu_{i,t:t+11}, \qquad (4)\end{aligned}$$

where $dec\_n_{i,t-1}$ is a dummy variable that equals one if fund i's performance is in the n-th decile of all funds' alphas over the prior twelve months. We omit the dummy variables corresponding to the four central performance deciles, i.e., we only include in the regression the dummy variables corresponding to the top three and bottom three performance deciles.

Once equation 4 has been estimated, we test whether the underperformance of funds in the LO subsample is shorter-lived than that of otherwise similar recent underperformers. More specifically, $\delta_{1,1} + \delta_{2,1}$ captures the difference in expected performance between a LO-fund whose past performance belongs to the first decile of the distribution and an otherwise identical LO-fund with past performance in the central deciles. The coefficient $\delta_{1,1}$ captures the difference in expected performance between a fund outside the LO and HI subsamples whose past performance belongs to the first decile of the distribution and an otherwise identical fund with performance in the central deciles. Therefore, a positive value of $\delta_{2,1}$ implies that the performance of underperforming LO-funds converges faster to the median fund's performance than the performance of funds that do not belong to the LO or HI subsamples. Analogously, a negative value of $\delta_{2,10}$ indicates that the performance of outperperforming LO-funds converges faster to the median fund's performance than the performance of funds that do not belong to the LO or HI subsamples.

Similarly, $\delta_{3,1}$ ($\delta_{3,10}$) is positive (negative) if HI-funds in the bottom (top) performance decile converges to that of the median fund faster than that of funds with $LO = HI = 0$.

Column 1 of Table 5 reports estimation results when no interactions with LO and HI are included in the regression equation. The estimated coefficients on the three bottom (top) performance decile dummies are negative (positive) and statistically significant at any significance level. Future performance also appears to increase monotonically with past performance. Differences in performance across deciles are economically significant: Recent top performers outperform otherwise identical funds in the bottom decile by 180 basis points per year.

In columns 2-4 we report estimation results when interactions with LO and HI are included and investor sophistication is determined according to the number of investment categories in which the family offers funds, family size, and family age. The coefficient on the interaction between the bottom decile dummy and LO, $\delta_{2,1}$, is positive and statistically significant, suggesting that hard-to-find underperforming funds exhibit better relative performance than otherwise similar underperforming funds, although the coefficient is only marginally significant for family age. In contrast, none of the coefficients on the interaction of the bottom decile dummy and HI is statistically significant.

However, when we use family advertising to define fund visibility, we find no difference in performance persistence for underperforming funds in the low-visibility subsamples and otherwise similar funds. Moreover, we find that the performance of funds in families with the highest advertising expenditures reverts faster to the median fund's performance following poor recent performance. However, because of the small sample size on fund families' advertising expenditures, this result should be interpreted with caution.

We then ask whether good performance reverts faster for low-visibility funds. The answer is yes: The coefficients on the interaction terms between LO and the top decile dummy, $\delta_{2,10}$, are negative and significant for all four proxies of investor sophistication. None of the interaction terms with the top decile dummy is significant for high-visibility funds.

Therefore, the results of Table 5 suggest that the lower performance persistence documented in Tables 3 and 4 for low-visibility funds is due to these funds' performance improving faster after poor performance and, even more clearly so, to these funds' performance deteriorating faster after good performance. Good relative performance for less visible funds also lives shorter than for other funds.

4.4 Ranking on returns

So far, we have used Carhart's four-factor model to measure fund performance both in the ranking period and in the evaluation period. There is no consensus in the literature on mutual fund performance persistence as to whether the researcher should employ the same model to rank funds and measure subsequent performance. On the one hand, failing to control for a specific positively-priced risk factor in the ranking period contaminates the ranking: Top decile portfolios will contain both funds with true high alpha and funds with a high beta with respect to the omitted risk factor. On the other hand, using the same asset pricing model to sort and estimate performance will also pick up the model bias, as pointed out by Carhart (1997). While the former approach may bias results against finding persistence, the latter may bias results in favor of finding persistence.

To examine whether our conclusions are robust to ranking funds on past returns, we repeat the tests of Table 5 using fund returns measured over the last 12 months to define decile dummies. Table 6 reports the results. The estimated coefficients on the decile dummies when no interactions are included (column 1) are similar to those of Table 5 for the bottom decile dummies. However, the coefficients on the top decile dummies are much lower in absolute value than those obtained when past performance is measured using the four-factor model. In fact, there is no evidence of persistence in outperformance when funds are ranked on past returns. Therefore, funds in the top deciles of past performance are not separated from mid-ranked funds in terms of their subsequent performance.

Consistently with the results of Table 5, the underperformance of bottom-ranked funds in the low-visibility subsample tends to vanish in the subsequent year if the low-visibility subsample is defined according to the number of investment categories, family size, and family age, but not advertising expenditures. However, the coefficients on the interaction of LO with the top decile dummies are not statistically significant. Also, with one exception, none of the coefficients on the interaction of HI with the top decile dummies is statistically significant.

The results of Table 6 suggest that lack of persistence in the underperformance of the least visible funds appears to be robust to model bias. We do not find, however, that more visible funds exhibit less persistence following good performance, simply because there is no evidence of persistence in good performance when funds are ranked according to past fund returns.

4.5 Institutional investors

The prediction that differences in persistence should be associated with differences in investor sophistication could be tested in a more direct way if we could measure the degree of sophistication of a fund's target investors. In Institutional funds are a natural candidate for funds targeted to sophisticated investors. While all investors can invest in funds targeted to retail investors, only qualified investors can invest in institutional funds. Del Guercio and Tkac (2002) document that pension fund sponsors are more likely to use risk-adjusted measures of performance than mutual fund investors when evaluation professional portfolio managers. They also find that pension managers, unlike mutual fund managers, are penalized for poor performance. Both findings are consistent with the idea that pension plan sponsors are more sophisticated than mutual fund investors, most of which are retail investors. Glode et al. (2011) find substantial performance persistence following good markets, but only in the retail segment of the mutual fund market. Huang et al. (2011) show that the sensitivity of fund flows to performance decreases with fund volatility more for institutional funds than for retail funds, which denotes higher sophistication on the part of institutional fund investors in a framework of Bayesian learning from past returns. On the other hand, James and Karceski (2006) find that, despite charging significantly lower management expenses, institutional funds do not outperform retail mutual funds. However, institutional funds with large minimum initial investment requirements outperform both the retail mutual funds and other institutional funds. They attribute differences within the institutional segment to differences in sophistication or agency costs.

To investigate whether differences in performance persistence between low visibility funds and the rest of funds documented in the previous section simply capture differences between retail and institutional investors, we estimate the regression below separately for each type of fund:

$$\hat{\alpha}_{i,t:t+11} \quad = \quad \phi_{0,t} + \sum_{n} \phi_{1,n} dec\_n_{i,t-1} + \Phi X'_{i,t-1} + \omega_{i,t:t+11}.$$

Institutional funds are defined as those containing institutional share classes only. We use the CRSP identifiers for institutional shares, when available, and the fund's or class' name otherwise. Estimation results are reported in Table 7. Results for retail funds (Column 1) are both quantitatively and qualitatively very similar to those in the first column of Table 5. In contrast, coefficients on past performance decile dummies are not statistically significant for institutional funds (Column 2) with the exception of the top performance decile dummy. Therefore, we find less evidence of performance persistence among institutional funds in our data, especially for poor performing funds. This evidence is consistent with that of Busse et al. (2010) who find no evidence performance persistence in institutional investment products using four-factor alphas. It is also consistent with our model's predictions.

However, these results should be taken with caution for two reasons. First, our sample of institutional funds is smaller than the sample of retail funds, which can explain the larger standard errors of Column 2. Second, given data availability, we cannot discard that our sample of institutional funds includes retirement funds offered to retail investors.

5 Conclusions

Why do differences in performance across mutual funds persist through time? To answer this question, we extend the model of Berk and Green (2004) and show that the interaction of investor heterogeneity in reservation returns and a limit on the amount of capital investors can invest in mutual funds can rationalize the empirical evidence on performance persistence.

To test the model's empirical validity, we exploit a prediction of the model that has not been tested before in the literature: Hard-to-find funds should exhibit less dispersion in expected performance and, therefore, less persistence in observed performance differences. Consistently with this prediction, our test results suggest that less visible funds and funds in families that advertise less, exhibit a substantially lower degree of persistence in performance.

The results of the paper highlight the prevalence of frictions in retail financial markets. Previous studies have noted that price competition alone may not be sufficient to eliminate differences in net performance across funds when investors fail to react to differences in expected performance and management companies react strategically (Christoffersen and Musto, 2002; Gil-Bazo and Ruiz-Verdú, 2008; Gil-Bazo and Ruiz-Verdú, 2009). In this paper, we argue that even if investors react rationally to differences in expected performance, market frictions distort their choices with respect to what would be expected in a friction-less market, such as the one described by Berk and Green (2004), and can generate predictability in fund performance.

An important implication of our results is that policies aimed at improving the efficiency of the market for mutual funds should focus on eliminating frictions and, particularly, facilitating product comparisons both within and across asset classes. The fact that funds that are easy to find exhibit a larger degree of persistence in underperformance than the hard-to-find funds suggests that a simple increase in the amount of information available to investors through mandatory disclosures may not be an effective means of improving the efficiency of this market.

6 Appendix

Proof of Proposition 1. The current investors exit or reinvest their wealth depending on whether their reservation return is lower or higher than $-\gamma^C$, where γ^C is such that $TP_{t+1}\left(q^*_{t+1}\right) = -\gamma^C$. The quantity invested in the fund is

$$q^*_{t+1} = m\left(\gamma_{MAX} - \gamma^C\right) + m\left((\gamma_{MAX} - \gamma^C) - \frac{1}{2}(\gamma^2_{MAX} - (\gamma^C)^2)\right),$$

where the first term corresponds to the period $t-1$ investment that is reinvested and the second term corresponds to the period t investment. The equilibrium condition $TP_{t+1}\left(q^*_{t+1}\right) = -\gamma^C$ can be rewritten as

$$\phi - cm\left(2(\gamma_{MAX} - \gamma^C) - \frac{1}{2}(\gamma^2_{MAX} - (\gamma^C)^2)\right) - f = -\gamma^C. \tag{5}$$

Solving for γ^C, we obtain

$$\begin{aligned} \gamma^C &= \frac{1}{cm}\left(1 + 2cm - A^{1/2}\right), \text{ where} \\ A &\equiv 1 + 2cm\left(2 + \phi - f\right) + c^2m^2\left(2 - \gamma_{MAX}\right)^2. \end{aligned}$$

γ^C is a real solution of equation (5) if $A > 0$ and a sufficient condition for $A > 0$ is $2 + \phi > f$, which is a reasonable assumption.

Notice that if $\gamma^C < \overline{\gamma}$ all current investors re-entry and we have also possible entry of new investors. The new investors have to pay the cost K to enter the fund and therefore, their cutoff reservation return, $-\gamma^N$, is obtained from:

$$\begin{aligned} TP_{t+1}\left(q^{**}_{t+1}\right) - K &= -\gamma^N, \\ \text{where } q^{**}_{t+1} &= v_t + m\left((\gamma_{MAX} - \gamma^N) - \frac{1}{2}(\gamma^2_{MAX} - (\gamma^N)^2)\right). \end{aligned}$$

We solve for γ^N from the equilibrium condition

$$\phi - cm\left(2\gamma_{MAX} - \gamma^N - \overline{\gamma} - \frac{1}{2}\left(\gamma^2_{MAX} - (\gamma^N)^2\right)\right) - f - K = -\gamma^N, \tag{6}$$

and obtain

$$
\begin{aligned}
\gamma^N &= \frac{1}{cm}\left(1+cm-B^{1/2}\right), \text{ where} \\
B &\equiv 1+2cm\left(1+\phi-f-K\right)+c^2m^2\left(1+2\overline{\gamma}+\gamma_{MAX}^2-4\gamma_{MAX}\right) \\
&= 1+2cm\left(1+\phi-f-K\right)+c^2m^2\left(\left(1-\gamma_{MAX}\right)^2-\frac{2}{m}v_t\right).
\end{aligned}
$$

γ^N is a real solution of equation (6) if $B \geq 0$. For B to be higher or equal than 0 we need to have $K < \overline{K}\left(\gamma_{MAX}\right) \equiv \frac{1}{2cm}\left(1+2cm\left(1+\phi-f\right)+c^2m^2\left(\left(1-\gamma_{MAX}\right)^2-\frac{2}{m}v_t\right)\right)$. So if $K < \overline{K}\left(\gamma_{MAX}\right)$ there is a solution to equation (6), otherwise there is no real solution (and therefore no new investors enter the fund). When there is a real solution, we distinguish two cases depending on whether the solution γ^N is higher or smaller than $\overline{\gamma}$. When $\gamma^N \geq \overline{\gamma}$, no new investors want to enter the fund because the performance of the fund is lower than the sum of their reservation return and the entry cost. The expected return in this case equals $TP_{t+1}\left(\overline{q}_{t+1}\right) > -\overline{\gamma}$. On the other hand, when $0 \leq \gamma^N < \overline{\gamma}$, new investors enter the fund. Since the last new investor that entered has reservation return $-\gamma^N$, the expected return in this case is $K-\gamma^N$.

Notice also that both γ^C and γ^N increase with γ_{MAX} if $\gamma_{MAX} < 2$.

Consequently, the amount invested in the fund at time $t+1$ is

$$
q_{t+1} = \begin{cases}
0, & if \quad \phi_{t+1} < \Phi_1 \\
m\left(2\left(\gamma_{MAX}-\gamma^C\right)-\frac{1}{2}(\gamma_{MAX}^2-(\gamma^C)^2)\right), & if \quad \Phi_1 \leq \phi_{t+1} < \Phi_2 \\
2v_t-\frac{m}{2}(\gamma_{MAX}^2-\overline{\gamma}^2), & if \quad \Phi_2 \leq \phi_{t+1} < \Phi_2+K \\
v_t+m\left(\left(\gamma_{MAX}-\gamma^N\right)-\frac{1}{2}(\gamma_{MAX}^2-(\gamma^N)^2)\right), & if \quad \Phi_2+K \leq \phi_{t+1} < \Phi_3+K \\
v_t+M, & if \quad \Phi_3+K \leq \phi_{t+1},
\end{cases}
$$

where $\Phi_1 \equiv f-\gamma_{MAX}$, $\Phi_2 \equiv f+2cv_t-\overline{\gamma}-\frac{1}{2}cm\left(\gamma_{MAX}^2-\overline{\gamma}^2\right)$ and $\Phi_3 \equiv f+cv_t+cm\gamma_{MAX}\left(1-\frac{\gamma_{MAX}}{2}\right)$. Notice that if $\phi_{t+1} < \Phi_1$, the fund closes down. As a result the expected return equals to

$$
E\left(r_{t+1}\left(\phi_{t+1}\right)\right) = \begin{cases}
-\gamma^C & if \quad \Phi_1 \leq \phi_{t+1} < \Phi_2 \\
TP_{t+1}\left(\overline{q}_{t+1}\right) & if \quad \Phi_2 \leq \phi_{t+1} < \Phi_2+K \\
K-\gamma^N & if \quad \Phi_2+K \leq \phi_{t+1} < \Phi_3+K \\
TP_{t+1}\left(v_t+M\right) & if \quad \Phi_3+K \leq \phi_{t+1}.
\end{cases}
$$

■

Proof of Proposition 2. Notice that, since $\gamma_{MAX}^{High}-\gamma_{MAX}^{Low} > 0$, we have that $\Phi_1^{Low} > \Phi_1^{High}$, $\Phi_2^{Low} > \Phi_2^{High}$ but $\Phi_3^{Low} < \Phi_3^{High}$.

We search for $\phi_1 \in \left(\Phi_2^{High}, \Phi_2^{High} + K\right)$ such that

$$\begin{aligned} E^{Low}\left(r_{t+1}\right) &= E^{High}\left(r_{t+1}\right) \\ i.e. -\gamma^C &= \phi_1 - cq_{t+1}^* - f. \end{aligned}$$

Notice that $\phi_1 - cq_{t+1}^* - f = \phi_1 - \Phi_2^{High} + \Phi_2^{High} - cv_t - f = \phi_1 - \Phi_2^{High} - \overline{\gamma}^{High}$, and $-\gamma^C = -\left(1 + 2a - A^{1/2}\right)$. We define a by $a \equiv cm$.

Solving for A we obtain $A = \left(2a + a\left(\phi_1 - \Phi_2^{High} - \overline{\gamma}^{High}\right) + 1\right)^2$, if $2a + a\left(\phi_1 - \Phi_2^{High} - \overline{\gamma}^{High}\right) + 1 > 0$ i.e. $\phi_1 > \Phi_2^{High} + \overline{\gamma}^{High} - 2 + \frac{1}{a}$ and this is satisfied for $\phi_1 > \Phi_2^{High}$. Since on the other hand $A = 1 + 2a\left(2 + \phi_1 - f\right) + a^2\left(2 - \gamma_{MAX}^{Low}\right)^2$ we have that

$$\begin{aligned} \left(2a + a\left(\phi_1 - \Phi_2^{High} - \overline{\gamma}^{High}\right) + 1\right)^2 &= 1 + 2a\left(2 + \phi_1 - f\right) + a^2\left(2 - \gamma_{MAX}^{Low}\right)^2 \\ \left(2a + a\left(\phi_1 - \Phi_2^{High} - K - \overline{\gamma}^{High} + K\right) + 1\right)^2 &= 1 + 2a\left(2 + \phi_1 - \left(\Phi_2^{High} + K\right) + \Phi_2^{High} + K - f\right) \\ &\quad + a^2\left(2 - \gamma_{MAX}^{Low}\right)^2 \\ \left(2a + a\left(-x - \overline{\gamma}^{High} + K\right) + 1\right)^2 &= 1 + 2a\left(2 - x + \Phi_2^{High} + K - f\right) + a^2\left(2 - \gamma_{MAX}^{Low}\right)^2, \end{aligned}$$

where by definition $x \equiv \Phi_2^{High} + K - \phi_1$.

We define

$$\begin{aligned} T &\equiv a^2\left(2 - \gamma_{MAX}^{Low}\right)^2 \ \textit{and} \\ \text{and } V &\equiv a\left(4cv_t - \overline{\gamma}^{High} - cv_t\left(\gamma_{MAX}^{High} + \overline{\gamma}^{High}\right)\right) \\ &= av_t\left(4c + \frac{1}{m} + \frac{cv_t}{m}\right) - \gamma_{MAX}^{High}\left(1 + 2cv_t\right). \end{aligned}$$

We obtain two solutions $x_{1,2}^* = \left(2 - \overline{\gamma}^{High} + K \pm \frac{1}{a}\sqrt{T + V}\right)$. If $\gamma_{MAX}^{High} < 2$ and $K > K_1 \equiv \frac{1}{a}\left(\sqrt{T + V} - a\left(2 - \overline{\gamma}^{High}\right)\right)$, the solution $x_1^* = \left(2 - \overline{\gamma}^{High} + K - \frac{1}{a}\sqrt{T + V}\right) \in (0, K)$. Consequently, $\phi_1 = \Phi_2^{High} + K - x_1^* \in \left(\Phi_2^{High}, \Phi_2^{High} + K\right)$.

Notice that $x_2^* = \left(2 - \overline{\gamma}^{High} + K + \frac{1}{a}\sqrt{T + V}\right)$ is always a positive solution but is also higher than K, so it cannot be solution of our problem.

We have shown in Proposition 1 that if $K \geq \overline{K}\left(\gamma_{MAX}^{High}\right) \equiv K_2$ then no new investors will enter the fund that targets the unsophisticated investors. The expected return of this fund increases one to one with ϕ_{t+1}, and since $\Phi_2^{Low} > \Phi_2^{High}$ it implies that $E^{High}\left(r_{t+1}\left(\Phi_2^{Low} + K\right)\right) > E^{Low}\left(r_{t+1}\left(\Phi_2^{Low} + K\right)\right)$ for any $\phi_{t+1} > \phi_1$.

Let us then consider the case when $K < \overline{K}\left(\gamma_{MAX}^{High}\right)$. To prove next that there is $\phi_2 \in \left(\Phi_2^{Low}, \Phi_2^{Low} + K\right)$

such that $E^{Low}(r_{t+1}) = E^{High}(r_{t+1})$ is enough to prove that the following two conditions are true: $E^{High}\left(r_{t+1}\left(\Phi_2^{High}+K\right)\right) > E^{Low}\left(r_{t+1}\left(\Phi_2^{High}+K\right)\right)$ and $E^{High}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right) < E^{Low}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right)$.

We have shown that when $K > K_1$ it exists $\phi_1 \in \left(\Phi_2^{High}, \Phi_2^{High}+K\right)$ such that $E^{Low}(r_{t+1}) = E^{High}(r_{t+1})$ and this implies that $E^{Low}\left(r_{t+1}\left(\Phi_2^{High}+K\right)\right)$ could be either $-\gamma^C$ or $\Phi_2^{High}+K-c\overline{q}_{t+1}-f$. In the first case, it is straightforward that since the return does not change the slope in that interval, $E^{High}\left(r_{t+1}\left(\Phi_2^{High}+K\right)\right) > E^{Low}\left(r_{t+1}\left(\Phi_2^{High}+K\right)\right)$. In the second case, if $E^{Low}\left(r_{t+1}\left(\Phi_2^{High}+K\right)\right) = \Phi_2^{High}+K-c\overline{q}_{t+1}-f$ we have then that

$$\begin{aligned}
E^{High}\left(r_{t+1}\left(\Phi_2^{High}+K\right)\right) &= \Phi_2^{High}+K-c\overline{q}_{t+1}\left(\gamma_{MAX}^{High}\right)-f > \\
E^{Low}\left(r_{t+1}\left(\Phi_2^{High}+K\right)\right) &= \Phi_2^{High}+K-c\overline{q}_{t+1}\left(\gamma_{MAX}^{Low}\right)-f \Leftrightarrow \\
\overline{q}_{t+1}\left(\gamma_{MAX}^{High}\right) &< \overline{q}_{t+1}\left(\gamma_{MAX}^{Low}\right).
\end{aligned}$$

Notice that $\overline{q}_{t+1}(\gamma_{MAX}) = 2v_t - \frac{m}{2}(\gamma_{MAX}^2-\overline{\gamma}^2) = 2v_t - \frac{v_t}{2}(\gamma_{MAX}+\overline{\gamma}) = v_t\left(2-\frac{1}{2}(2\gamma_{MAX}-\frac{v_t}{m})\right)$. Since $\overline{q}_{t+1}(\gamma_{MAX})$ decreases with γ_{MAX} it results that $\overline{q}_{t+1}\left(\gamma_{MAX}^{High}\right) < \overline{q}_{t+1}\left(\gamma_{MAX}^{Low}\right)$.

To prove that $E^{High}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right) < E^{Low}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right)$ we calculate both the expected adjusted returns evaluated in $\Phi_2^{Low}+K$. Notice that in this range both returns equal to $K-\gamma^N$ and γ^N increase with γ_{MAX} if $\gamma_{MAX} < 1$. Since $\gamma_{MAX}^{Low} < \gamma_{MAX}^{High}$ it implies $K-\gamma^{Low,N} > K-\gamma^{High,N}$ and therefore $E^{High}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right) < E^{Low}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right)$. If $K > \overline{K}(\gamma_{MAX})$, the return for the sophisticated equals $E^{Low}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right) = \Phi_2^{Low}+K-c\overline{q}_{t+1}\left(\gamma_{MAX}^{High}\right)-f > K-\gamma^{Low,N}$ and $E^{High}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right) = K-\gamma^{High,N}$, so again $E^{High}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right) < E^{Low}\left(r_{t+1}\left(\Phi_2^{Low}+K\right)\right)$ q.e.d. ■

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Table 1

Summary statistics.

The table shows summary statistics for the sample of US Domestic Equity mutual funds in the 1993-2010 period employed in the paper. N denotes de number of fund-month observations, except in the case of variables measured at the family level, where we only consider a single observation per family and month. $Q1$ and $Q3$ denote the 25th and 75th percentiles, respectively. Total net assets are in millions of USD. Age is the number of years since inception of the fund's oldest class. Family age is the age of the family's oldest fund. Loads, fees, turnover ratio, and returns are asset-weighted averages across all classes in the fund.

Panel A: 1993-2000

Variable	N	Mean	Std. dev.	*Q1*	Median	*Q3*
Total net assets	84287	1333.59	4040.44	93.31	278.9	921.88
Annual flow (in %)	63369	12.24	63.35	-11.43	-0.02	18.18
Age	84144	15.13	14.82	5.42	9.08	17.5
Family total net assets	26998	10981.68	40743.85	228.6	1428.47	5611.1
Family age	26987	25.86	20.68	9.67	16.25	40.5
Front-end load (in %)	37433	3.36	1.96	1.73	3.76	4.75
Back-end load (in %)	28188	1.43	1.37	0.32	1	2.17
Management fee (in %)	37991	0.74	0.24	0.6	0.75	0.9
Expense ratio (in %)	71040	1.21	0.39	0.94	1.16	1.44
12b-1 fee (in %)	22914	0.33	0.25	0.12	0.25	0.5
Turnover ratio (in %)	70452	82.28	64.63	36.2	67	109
Return (in %)	83929	15.17	66.71	-22.03	17.44	51.83
Carhart's 4-factor alpha (in %)	51181	-0.41	26.99	-13.38	-0.73	11.96

Panel A: 2001-2010

Variable	N	Mean	Std. dev.	*Q1*	Median	*Q3*
Total net assets	186114	1256.74	4946.26	80	242.7	838.8
Annual flow (in %)	145663	6.31	58.90	-15.26	-4.73	11.26
Age	185881	14.10	12.87	6.5	10.17	16.08
Family total net assets	43703	20925.18	91580.15	201.1	1265.4	7738.7
Family age	43703	28.74	21.84	12.58	20.67	38.58
Front-end load (in %)	97186	2.62	1.73	1.09	2.65	4.00
Back-end load (in %)	75535	0.76	0.89	0.10	0.43	1.09
Management fee (in %)	171168	0.72	0.25	0.59	0.75	0.89
Expense ratio (in %)	170249	1.23	0.38	0.99	1.21	1.47
12b-1 fee (in %)	127940	0.29	0.23	0.09	0.25	0.44
Turnover ratio (in %)	173993	82.15	64.48	35	66	110
Return (in %)	185859	4.56	65.30	-29.18	11.98	45.30
Carhart's 4-factor alpha (in %)	130793	-2.17	21.14	-12.01	-1.99	7.86

Table 2
Differences across visibility subsamples
The table compares selected fund characteristics across fund subsamples defined according to fund visibility. Risk-adjusted performance is estimated using Carhart's (1997) four-factor model. α denotes performance in the subsequent 12 months. Assets denotes the fund's assets under management. F-load and B-load denote the fund's asset-weighted front-end load and back-end load, respectively. 12b-1 fee and Man. fee denote the fund's 12b-1 and management fee, respectively. High denotes the subsample of funds that belong to the top quartile of the monthly distribution of: the number of investment categories in the family; family size; family age; or family advertising. Low is defined analogously for the bottom quartile, except for family advertising, in which case Low denotes subsample of funds with no reported advertising expenditures. The number of fund-year observations is reported in parentheses.

		Assets	F-load	12b-1 fee	Man. fee	α	B-load
# Inv Cat	Low	525.79	0.74%	0.12%	0.84%	-1.51%	0.12%
		(4360)	(4360)	(3675)	(3318)	(2316)	(4360)
	High	2449.55	1.63%	0.22%	0.64%	-1.66%	0.50%
		(4238)	(4238)	(3806)	(3494)	(2621)	(4238)
	Low-High	-1923.77	-0.89%	-0.10%	0.20%	0.15%	-0,38%
	S.e	88.97	0.04%	0.01%	0.01%	0.20%	0.02%
Family Size	Low	186.12	0.85%	0.14%	0.83%	-1.55%	0.16%
		(5580)	(5580)	(4709)	(4276)	(2915)	(5580)
	High	3387.16	1.71%	0.22%	0.63%	-1.73%	0.49%
		(5493)	(5493)	(4632)	(4422)	(3622)	(5493)
	Low-High	-3201.04	-0.85%	-0.08%	0.20%	0.18%	-0.33%
	S.e.	118.97	0.04%	0.00%	0.01%	0.18%	0.02%
Family Age	Low	385.02	0.69%	0.11%	0.81%	-1.63%	0.11%
		(5648)	(5648)	(4761)	(4455)	(2622)	(5648)
	High	2971.8	2.12%	0.27%	0.63%	-1.8%	0.52%
		(5619)	(5619)	(4739)	(4488)	(3692)	(5619)
	Low-High	-2586.78	-1.43%	-0.15%	0.18%	0.16%	-0.41%
	S.e.	117.58	0.03%	0.00%	0.01%	0.18%	0.01%
Family Adv.	Low	1210.00	1.38%	0.21%	0.74%	-1.91%	0.37%
		(15888)	(15888)	(14414)	(13380)	(9721)	(15888)
	High	2969.95	1.36%	0.19%	0.64%	-1.07%	0.13%
		(822)	(822)	(776)	(731)	(610)	(822)
	Low-High	-1759.95	0.02%	0.02%	0.10%	-0.84%	0.24%
	S.e.	175.65	0.07%	0.01%	0.01%	0.30%	0.03%

Table 3

Performance persistence and fund visibility.

The table reports the estimated coefficients of monthly regressions of fund annual performance on past annual performance and selected fund characteristics in the 1996-2010 period. Risk-adjusted performance is estimated using Carhart's (1997) four-factor model. α denotes performance over the prior 12 months. size denotes the natural logarithm of the fund's assets under management, lagged one year. flow is the net growth in fund's assets during the last 12 months. age is the natural logarithm of the number of months since the inception date of the fund's oldest class, fam_size and fam_age, denote the size the fund's family and the age of the oldest class in the fund's family. F-load and B-load denote the fund's asset-weighted front-end load and back-end load, lagged one year, respectively. turnover denotes the fund's asset-weighted turnover. Regressors include month dummies. HI is a dummy variable that equals one if the fund belongs to the top quartile of the monthly distribution of: the number of investment categories in the family (column 2); family size (column 3); family age (column 4); or family advertising (column 5). LO is defined analogously for the bottom quartile, except in column 4 where it equals one if the fund's family has no reported advertising expenditures. Standard errors are clustered by both fund and month. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

	(1)	(2) #Inv Cat	(3) Family Size	(4) Family Age	(5) Family Adv.
α	0.071***	0.085***	0.088***	0.090***	0.113***
	(0.019)	(0.022)	(0.023)	(0.022)	(0.029)
size	-0.003***	-0.003***	-0.003***	-0.002***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
flow	-0.005**	-0.005**	-0.005**	-0.004**	-0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
age	0.000	0.000	0.000	0.000	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
fam_size	0.001**	0.001**	0.003***	0.001**	0.001
	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
fam_age	-0.000	-0.000	-0.000	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
F-load	0.021	0.026	0.021	0.024	0.032
	(0.034)	(0.034)	(0.034)	(0.034)	(0.038)
B-load	-0.329***	-0.317***	-0.335***	-0.328***	-0.315***
	(0.106)	(0.105)	(0.106)	(0.105)	(0.122)
exp	-0.619**	-0.615**	-0.554**	-0.637**	-0.551*
	(0.275)	(0.275)	(0.277)	(0.275)	(0.295)
turnover	-0.003*	-0.003*	-0.003*	-0.003*	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
α x LO		-0.076**	-0.059*	-0.078***	-0.052**
		(0.031)	(0.031)	(0.030)	(0.026)
α x HI		-0.015	-0.018	-0.021	-0.048
		(0.025)	(0.025)	(0.022)	(0.049)
LO		0.003	0.006**	-0.003	-0.005***
		(0.002)	(0.003)	(0.003)	(0.002)
HI		0.001	-0.004*	-0.001	-0.001
		(0.002)	(0.002)	(0.002)	(0.003)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	108,524	108,524	108,524	108,524	101,098
Adjusted R-squared	0.074	0.075	0.075	0.074	0.076

Table 4

Performance persistence: the role of fund size and investment categories.

The table reports the estimated coefficients of monthly regressions of fund annual performance on past annual performance and selected fund characteristics in the 1996-2010 period. Risk-adjusted performance is estimated using Carhart's (1997) four-factor model. α denotes performance over the prior 12 months. Controls include: size, flow, age, family size, family age, front-end and back-end loads, and portfolio turnover, as defined in Table 3. Regressors include dummy variables for months, investment categories, and interactions of investment categories with performance. HI is a dummy variable that equals one if the fund belongs to the top quartile of the monthly distribution of: the number of investment categories in the family (column 2); family size (column 3); family age (column 4); or family advertising (column 5). LO is defined analogously for the bottom quartile, except in column 4 where it equals one if the fund's family has no reported advertising expenditures. Standard errors are clustered by both fund and month. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

	(1)	(2) #Inv Cat	(3) Family Size	(4) Family Age	(5) Family Adv.
α	0.171***	0.186***	0.181***	0.185***	0.221***
	(0.043)	(0.044)	(0.044)	(0.045)	(0.058)
size	-0.003***	-0.003***	-0.003***	-0.003***	-0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
flow	-0.005**	-0.005**	-0.005**	-0.005**	-0.004**
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
age	0.001	0.001	0.001	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
fam_size	0.001***	0.002***	0.003***	0.001***	0.001*
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)
fam_age	-0.000	-0.000	-0.000	-0.000	-0.001
	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
F-load	0.025	0.029	0.026	0.027	0.036
	(0.034)	(0.034)	(0.034)	(0.034)	(0.038)
B-load	-0.339***	-0.328***	-0.349***	-0.340***	-0.324***
	(0.103)	(0.103)	(0.104)	(0.102)	(0.117)
exp	-0.622**	-0.618**	-0.552**	-0.626**	-0.567**
	(0.260)	(0.260)	(0.263)	(0.259)	(0.277)
turnover	-0.002	-0.002	-0.002	-0.002	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
α x LO		-0.096***	-0.089***	-0.088***	-0.058**
		(0.028)	(0.031)	(0.030)	(0.025)
α x HI		0.005	0.019	-0.004	-0.028
		(0.025)	(0.027)	(0.022)	(0.047)
LO		0.002	0.005*	-0.003	-0.006***
		(0.002)	(0.003)	(0.003)	(0.002)
HI		0.000	-0.003	-0.001	-0.001
		(0.002)	(0.002)	(0.002)	(0.003)
α x size	-0.003	-0.008	-0.016*	-0.007	-0.005
	(0.007)	(0.007)	(0.009)	(0.007)	(0.007)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Inv. Cat. Fixed Effects	Yes	Yes	Yes	Yes	Yes
Inv. Cat. Interactions	Yes	Yes	Yes	Yes	Yes
Observations	108,524	108,524	108,524	108,524	101,098
Adjusted R-squared	0.090	0.091	0.091	0.091	0.094

Table 5

Performance persistence among winners and losers.

The table reports the estimated coefficients of monthly regressions of fund annual performance on past annual performance and selected fund characteristics in the 1996-2010 period. Risk-adjusted performance is estimated using Carhart's (1997) four-factor model. α denotes performance over the prior 12 months. dec_n is a dummy variable that equals one if the fund belongs to the n-th decile of the monthly distribution of past performance. Coefficients for control variables are not reported. Controls include: size, flow, age, family size, family age, front-end and back-end loads, and portfolio turnover, as defined in Table 3. Regressors include month dummies. HI is a dummy variable that equals one if the fund belongs to the top quartile of the monthly distribution of: the number of investment categories in the family (column 2); family size (column 3); family age (column 4); or family advertising (column 5). LO is defined analogously for the bottom quartile, except in column 4 where it equals one if the fund's family has no reported advertising expenditures. Standard errors are clustered by both fund and month. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

	(1)	(2) #Inv Cat	(3) Family Size	(4) Family Age	(5) Family Adv.
dec_1(α)(bottom)	-0.008***	-0.012***	-0.010***	-0.009***	-0.009*
	(0.002)	(0.003)	(0.003)	(0.003)	(0.005)
dec_2(α)	-0.004***	-0.005***	-0.003*	-0.005**	-0.006*
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
dec_3(α)	-0.003***	-0.003***	-0.003**	-0.003***	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
dec_8(α)	0.003***	0.003**	0.003**	0.003**	0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)
dec_9(α)	0.006***	0.006***	0.008***	0.007***	0.008***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)
dec_10(α)(top)	0.010***	0.014***	0.015***	0.014***	0.020***
	(0.003)	(0.004)	(0.004)	(0.003)	(0.006)
dec_1(α) x LO		0.012**	0.010**	0.009*	0.000
		(0.005)	(0.005)	(0.005)	(0.005)
dec_2(α) x LO		0.003	-0.000	0.002	0.003
		(0.003)	(0.003)	(0.003)	(0.003)
dec_3(α) x LO		0.006***	0.003	0.007**	-0.001
		(0.002)	(0.002)	(0.003)	(0.002)
dec_1(α) x HI		0.006	-0.003	-0.001	0.017**
		(0.004)	(0.004)	(0.004)	(0.008)
dec_2(α) x HI		0.002	-0.003	0.001	-0.002
		(0.003)	(0.003)	(0.003)	(0.007)
dec_3(α) x HI		-0.001	-0.001	-0.001	-0.003
		(0.002)	(0.002)	(0.002)	(0.005)
dec_8(α) x LO		-0.004*	-0.004*	-0.004	0.001
		(0.002)	(0.002)	(0.002)	(0.002)
dec_9(α) x LO		-0.001	-0.004	-0.004	-0.003
		(0.003)	(0.003)	(0.003)	(0.003)
dec_10(α) x LO		-0.016***	-0.014***	-0.011**	-0.013**
		(0.005)	(0.005)	(0.005)	(0.005)
dec_8(α) x HI		0.003	0.001	0.002	0.011**
		(0.002)	(0.002)	(0.002)	(0.004)
dec_9(α) x HI		0.003	-0.004	-0.000	0.004
		(0.003)	(0.003)	(0.003)	(0.005)
dec_10(α) x HI		-0.005	-0.008	-0.007	-0.001
		(0.005)	(0.006)	(0.005)	(0.010)
LO		0.004*	0.008***	-0.002	-0.003*
		(0.002)	(0.003)	(0.002)	(0.002)
HI		-0.000	-0.002	-0.001	-0.002
		(0.002)	(0.002)	(0.002)	(0.003)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	108,524	108,524	108,524	108,524	101,098
R-squared	0.076	0.077	0.078	0.077	0.079

Table 6

Performance persistence for recent winners and losers. Fund returns.

The table reports the estimated coefficients of monthly regressions of fund annual performance on past annual performance and selected fund characteristics in the 1996-2010 period. Risk-adjusted performance is estimated using Carhart's (1997) four-factor model. *ret* denotes fund returns in the last 12 months. dec_n is a dummy variable that equals one if the fund belongs to the n-th decile of the monthly distribution of past performance. Coefficients for control variables are not reported. Controls include: size, flow, age, family size, family age, front-end and back-end loads, and portfolio turnover, as defined in Table 3. Regressors include month dummies. HI is a dummy variable that equals one if the fund belongs to the top quartile of the monthly distribution of: the number of investment categories in the family (column 2); family size (column 3); family age (column 4); or family advertising (column 5). LO is defined analogously for the bottom quartile, except in column 4 where it equals one if the fund's family has no reported advertising expenditures. Standard errors are clustered by both fund and month. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

	(1)	(2) #Inv Cat	(3) Family Size	(4) Family Age	(5) Family Adv.
dec_1(ret)	-0.009***	-0.013***	-0.012***	-0.012***	-0.009
	(0.003)	(0.003)	(0.003)	(0.003)	(0.005)
dec_2(ret)	-0.004***	-0.006***	-0.007***	-0.004**	-0.004
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
dec_3(ret)	-0.003**	-0.004**	-0.003**	-0.003*	0.000
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
dec_8(ret)	0.000	-0.000	-0.001	0.001	0.002
	(0.001)	(0.002)	(0.002)	(0.002)	(0.003)
dec_9(ret)	0.002	0.001	0.002	0.003	0.007*
	(0.002)	(0.002)	(0.002)	(0.002)	(0.004)
dec_10(ret)	0.003	0.003	0.003	0.005	0.006
	(0.003)	(0.004)	(0.004)	(0.004)	(0.006)
dec_1(ret) x LO		0.012***	0.010**	0.012***	-0.001
		(0.004)	(0.004)	(0.005)	(0.005)
dec_2(ret) x LO		0.009***	0.008**	0.005*	-0.000
		(0.003)	(0.003)	(0.003)	(0.004)
dec_3(ret) x LO		0.005	0.003	0.005*	-0.003
		(0.003)	(0.003)	(0.003)	(0.003)
dec_1(ret) x HI		0.011**	0.001	0.003	-0.002
		(0.004)	(0.005)	(0.005)	(0.010)
dec_2(ret) x HI		0.003	0.003	-0.004	-0.001
		(0.003)	(0.003)	(0.003)	(0.006)
dec_3(ret) x HI		0.002	0.001	-0.003	-0.001
		(0.002)	(0.002)	(0.002)	(0.005)
dec_8(ret) x LO		0.000	0.002	-0.001	-0.002
		(0.003)	(0.002)	(0.003)	(0.003)
dec_9(ret) x LO		0.000	0.002	-0.003	-0.006
		(0.003)	(0.004)	(0.003)	(0.004)
dec_10(ret) x LO		-0.002	0.001	-0.002	-0.004
		(0.005)	(0.005)	(0.005)	(0.005)
dec_8(ret) x HI		0.002	0.002	-0.003	-0.003
		(0.002)	(0.002)	(0.002)	(0.005)
dec_9(ret) x HI		0.002	-0.004	-0.003	-0.004
		(0.003)	(0.003)	(0.003)	(0.005)
dec_10(ret) x HI		0.002	-0.003	-0.004	-0.000
		(0.006)	(0.005)	(0.004)	(0.010)
LO		0.001	0.004	-0.003	-0.003
		(0.002)	(0.003)	(0.003)	(0.002)
HI		-0.001	-0.004*	0.000	0.001
		(0.002)	(0.002)	(0.002)	(0.003)
Time Fixed Effects	Yes	Yes	Yes	Yes	Yes
Controls	Yes	Yes	Yes	Yes	Yes
Observations	108,524	108,524	108,524	108,524	101,098
Adjusted R-squared	0.073	0.074	0.074	0.074	0.075

Table 7

Performance persistence for recent winners and losers. Retail versus institutional funds.

The table reports the estimated coefficients of monthly regressions of fund annual performance on past annual performance and selected fund characteristics in the 1996-2010 period. Risk-adjusted performance is estimated using Carhart's (1997) four-factor model. *ret* denotes fund returns in the last 12 months. dec_n is a dummy variable that equals one if the fund belongs to the n-th decile of the monthly distribution of past performance. Coefficients for control variables are not reported. Controls include: size, flow, age, family size, family age, front-end and back-end loads, and portfolio turnover, as defined in Table 3. Regressors include month dummies. Column (1) shows results for funds with only retail classes. Column (2) shows results for funds with only institutional classes. Standard errors are clustered by both fund and month. ***, **, and * indicate significance at the 1%, 5%, and 10% levels, respectively

	(1) Retail Funds	(2) Institutional Funds
dec_1(α)(bottom)	-0.011***	-0.009
	(0.003)	(0.007)
dec_2(α)	-0.006***	-0.006
	(0.002)	(0.004)
dec_3(α)	-0.003**	0.002
	(0.001)	(0.003)
dec_8(α)	0.003**	-0.003
	(0.002)	(0.003)
dec_9(α)	0.006***	0.006
	(0.002)	(0.004)
dec_10(α)(top)	0.010***	0.022*
	(0.004)	(0.012)
size	-0.003***	-0.002
	(0.001)	(0.002)
flow	-0.007**	-0.013**
	(0.003)	(0.005)
age	-0.005***	0.003
	(0.002)	(0.004)
fam_size	0.001	0.002
	(0.001)	(0.002)
fam_age	0.003	-0.001
	(0.002)	(0.004)
F-load	0.000	-0.030
	(0.043)	(0.142)
B-load	-0.266*	-0.652
	(0.146)	(1.964)
exp	-0.844**	-0.382
	(0.393)	(0.869)
turnover	-0.005**	0.001
	(0.002)	(0.005)
Time Fixed Effects	Yes	Yes
Observations	55,214	8,554
Adjusted R-squared	0.068	0.107