Monetary Policy and the Flow-performance Relationship of Mutual Funds

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Abstract

I determine how monetary policy affects the response of investor flows to prior mutual fund performance. Using the Federal funds rate as a proxy for the risk-free rate, I demonstrate that the tightening of the Federal Reserve's monetary policy stance generally leads to less flows into US equity mutual funds, but this occurs to a greater extent in the lower end of the performance distribution than in the higher end. To explain this result, I develop a model of portfolio allocation with costly information and show that this empirical finding comes from two effects of increasing the risk-free rate. First, investment in the fund declines for all levels of past fund returns due to shareholders' portfolio reallocation towards safe assets. Second, investors acquire less private information about the fund, which makes their flows more dependent on observable past returns. The latter effect counteracts the first one for the best-performing funds while intensifying the decrease in flows for the worst performers. I further test the validity of the proposed mechanism by providing empirical support for another prediction of the model concerning the difference in the dependence of flows on monetary policy between high-information-cost funds and low-information-cost funds.

Keywords: Monetary policy, Mutual funds, Flow-performance relationship of mutual funds, Costly private information acquisition
JEL Classification: G11, G23, E44

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1 Introduction

Mutual funds have enjoyed rising popularity as an investment vehicle in recent years. Together with the industry's expansion in size, mutual fund holdings of financial assets have steadily grown, transforming them into an important source of funding for both firms and governments.[1] This increasing share of the business of financial intermediation has sustained the interest of academics and policymakers alike in understanding shareholder flows in and out of mutual funds, especially that it has been found that investor flows can have potentially negative effects on the asset markets funds invest in (Coval and Stafford, 2007; Mitchell, Pedersen, and Pulvino, 2007).

A generally accepted view is that mutual fund flows chase past performance (Edelen and Warner, 1999; Huang, Wei, and Yan, 2007; Spiegel and Zhang, 2013). That is, shareholders exit funds that have poor prior returns and they invest more in funds that did well in the previous period. Aside from this positive relation between flows and lagged performance, the literature has likewise found that unsatisfactory returns induce outflows that are disproportionately less than the inflows superior returns attract (Ippolito, 1992; Sirri and Tufano, 1998; Del Guercio and Tkac, 2002). The determinants of such heterogeneity across the performance spectrum have been and continue to be widely analyzed[2] due to the confirmed link between the asymmetry in the response of flows to previous returns and the risk-taking incentives of mutual fund managers (Chevalier and Ellison, 1997).[3]

The goal of this paper is to bring to the forefront another factor that affects the shape of the flow-performance relationship: the monetary policy stance of the central bank. In this study, I empirically establish that when short-term rates decline, shareholder flows increase more for the worst-performing funds than for the best performers. In other words, poor fund returns are penalized less when monetary policy is loosened. I use the effective Federal funds rate as a proxy for the risk-free interest rate and find that a 1% increase in the Federal funds rate reduces shareholder flows into the best-performing funds by 0.19% of total assets. The effect on the worst performers is a decrease of 0.26%, with the difference between the two

[1]Mutual fund assets under management ballooned from just 4.5 trillion USD in 1997 (See https://www.iciglobal.org/pubs/fact_books/1998_factbook; date accessed: April 30, 2018) to about 19 trillion USD in 2016 (Investment Company Institute, 2017).

[2]Additional papers on the topic include Berk and Green (2004); Fant and O'Neal (2000); Del Guercio and Tkac (2002); Huang et al. (2007); Ferreira, Keswani, Miguel, and Ramos (2012); Huang, Wei, and Yan (2012); and Franzoni and Schmalz (2017).

[3]In particular, because fund manager compensation is usually a percentage of total assets under management, the tendency of investors to reward high performance to a greater extent than they punish low performance may motivate managers to invest in riskier securities.

performance groups being statistically significant. These numbers translate to an average outflow of 2.07 million USD in the higher end of the performance distribution and 2.37 million USD in the lower end. I verify that these results are robust to the inclusion of macroeconomic variables and their forecasts, which are correlated with the Federal funds rate, as additional regressors.

I proceed by proposing a theoretical explanation for these empirical results. The main argument is that the dependence of the reaction of investors flows to monetary policy on the level of past returns is driven by the effect of the risk-free rate on shareholders' incentives to acquire costly private information about the fund. I consider a two-period model with risk-averse, borrowing-constrained investors that seek to maximize payoffs at time-2 by choosing a portfolio composed of a riskless asset and a risky mutual fund at time-1. Taking into account that information about the manager's ability to generate returns is in reality asymmetric between a fund manager and her investors, I assume that time-invariant manager skill is unknown to investors. Nevertheless, fund performance is persistent, implying that the fund payoff in period 1, which is a noisy public signal of manager ability, can be used to more precisely estimate the period-2 payoff.

Aside from this public signal, investors can choose to acquire supplemental information about the fund (e.g., in the form of carefully studying a fund's prospectus and its historical performance). In particular, shareholders can decide to observe a perfect private signal of manager skill before the realization of the period-1 payoff, albeit at a cost. Solving the model yields that there is less private information acquisition if the risk-free rate is increased, as a higher return from holding the riskless asset disincentivizes investment both in the mutual fund and in the information technology.

The model additionally demonstrates that the effect of less private information is that it decreases fund investment for low period-1 payoffs, while it increases the shareholders' holdings of the fund for high period-1 payoffs. Without the private signal, investors only have the first-period payoff to infer ability from, so poor past performance leads to minimum (zero) investment, while an excellent period-1 payoff encourages investors to hit their borrowing limit and obtain the maximum ownership of the fund possible. With private information, investment in the fund for these two cases is not as extreme because low past performance can sometimes come from a fund manager with high ability and vice versa.

The main empirical prediction of the model, that a higher risk-free rate diminishes investment in the mutual fund but more so in the lower end of the performance distribution, is derived from two effects, which I call the *yield effect* and the *information effect*. A better payoff for the riskless asset not only makes the mutual fund less attractive as an investment option (yield effect) but it also curtails the incentives to obtain private information (information effect). Whereas the yield effect results in depressed holdings in the fund for all levels of performance, less information makes investors rely more on the public signal, which further decreases investment for bad performance while counteracting the yield effect for good performance.

To empirically identify the costly information channel of the effect of monetary policy on fund flows, I additionally test a cross-sectional implication of the model in the last part of the paper. The theoretical analysis predicts that when private information is more expensive to acquire, the information effect becomes more pronounced. Increasing the riskless rate makes the difference between the flows of a high-information-cost fund and a low-information-cost fund more positive when period-1 payoff is very satisfactory.

Because young funds only have a short time series of past returns to learn manager ability from, I use the age of a fund as a proxy for information costs and show that for young funds (i.e., high-cost funds), the decline in flows for superior performance is in fact 0.13% less than for old funds. That is, for every percent increase in the effective Federal funds rate, the impact of high information costs on young funds is an inflow of almost half a million USD if the fund is one of last month's winners. The findings do not change when I use the 1-year Tresury yield as an alternative proxy for the risk-free rate, when I add return volatility as an independent variable in the regression, or when I control for prior belief of manager ability (as proxied by past long-term return and prior fund family performance).

As its principal contribution, this study is the first to highlight monetary policy as a factor influencing the asymmetry of the flow-performance relationship, in addition to fund age (Chevalier and Ellison, 1997; Berk and Green, 2004), information costs (Sirri and Tufano, 1998; Huang et al., 2007), aggregate flows to the mutual fund industry (Fant and O'Neal, 2000), clientele characteristics (Del Guercio and Tkac, 2002), the level of development of the country where the fund is headquartered (Ferreira et al., 2012), the volatility of past returns (Huang et al., 2012), and the excess return of the market factor (Franzoni and Schmalz, 2017). Furthermore, this paper joins previous studies in investigating how the central bank's monetary policy stance can be a determinant of mutual fund flows (Feroli, Kashyap, Schoenholtz, and Shin, 2014; Banegas, Montes-Rojas, and Siga, 2016; Hau and Lai, 2016). While their authors mainly examine the risk-free rate's effect on aggregate flows, this paper, on the other hand, emphasizes its consequences for the shape of fund-level flows as a function of prior performance.

The model presented herein is likewise related to prior research that considers the impact of monetary policy on investors' portfolio decisions. The literature has until now suggested that a low policy rate leads to portfolio reallocation toward risky securities due (1) to lower-yielding safe assets (Fishburn and Porter, 1976; Rajan, 2005) and (2) to reduced risk perceptions brought about by low asset price volatility (Gambacorta, 2009; Adrian and Shin, 2010; Borio and Zhu, 2012). This study introduces costly private information acquisition as an additional channel through which the risk-free interest rate can influence portfolio choice.

The remainder of the paper is organized as follows. Section 2 describes the data sources and the definitions of the variables used in the analysis in the succeeding sections. The baseline empirical results pertaining to the effect of monetary policy on fund flows are detailed in Section 3. I propose an explanation for these findings by developing and solving a model of portfolio allocation with costly information in Section 4. To verify the validity of the mechanism in the previous section, Section 5 tests an additional implication of the model and performs further robustness checks. Section 6 concludes.

2 Description of the data

The first part of this study aims to empirically assess the effects of monetary policy on shareholder flows into US open-end equity mutual funds for different levels of past fund performance. The data principally come from the Center for Research in Security Prices (CRSP) Survivorship Bias Free Mutual Fund Database. From this source, I obtain information on mutual fund classes' monthly returns, monthly total net assets, expense ratios, fees, investor clientele, and age. Each mutual fund class is designated to a mutual fund and, consequently, to a mutual fund family using the Mutual Fund Links database of the Wharton Research Data Services (WRDS). The values of the macroeconomic variables used in this study, which include the Federal funds rate, the gross domestic product (GDP), the consumer price index (CPI), and the unemployment rate, all originate from the FRED website of the Federal Reserve Bank of St. Louis.[4] The median forecasts of one-step ahead GDP growth rate, unemployment rate, and inflation rate are from the Survey of Professional Forecasters.

[4]See https://fred.stlouisfed.org.

2.1 Mutual funds

The sample of US funds consists of 4,002 US open-end equity mutual funds that were active at least once between January 1994 and December 2011. To build this sample, I start from the class-level information in the CRSP Mutual Fund Database and aggregate each variable to come up with the fund-level variables. For most variables, I do so by weighting each class by its fraction of the fund's total net assets at the start of each month. I exclude small (i.e., those that had monthly total net assets less than 5 million USD) and very young funds (i.e., those that were active for less than 36 months). The summary statistics for the fund-level variables are in Table I.

[Table I around here]

Fund performance is defined here as the Carhart 4-factor alpha Alpha_{im}:

$$\text{Alpha}_{im} = \frac{1}{6}\sum_{m'=m-5}^{m}\left[R^e_{im'} - \hat{\beta}^{\text{MKT}}_{im'}\text{MKT}_{m'} - \hat{\beta}^{\text{SMB}}_{im'}\text{SMB}_{m'} - \hat{\beta}^{\text{HML}}_{im'}\text{HML}_{m'} - \hat{\beta}^{\text{MOM}}_{im'}\text{MOM}_{m'}\right],$$

where $R^e_{im'}$ is the excess return of fund i in month m', $\text{MKT}_{m'}$, $\text{SMB}_{m'}$, and $\text{HML}_{m'}$ are the three Fama-French factors, and $\text{MOM}_{m'}$ the momentum factor. These factors are available at Kenneth French's website.[5] The betas are estimated using a rolling window of 36 months. The volatility of excess returns is the standard deviation of the past year's monthly excess returns. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{im-1} - \text{ACQ}_{im},$$

where TNA_{im} is the total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Per-unit flow, which is the main dependent variable in this study, is defined as flow divided by the total net assets at the start of the month. Class age is the number of months since the inception date of each class, while fund age is the age of the oldest class of the fund. The maximum front load is the maximum percentage charge for purchasing shares of a fund. Maximum exit fees are the sum of the maxima of the redemption fee and the CDSC (contingent deferred sales charge) load, which are two fees (in percentage terms) for redeeming shares. I also have dummies for whether a fund is an index fund, for whether a class is mainly used for saving up for retirement, and for whether it caters mainly to institutional investors.

[5] See http://mba.tuck.dartmouth.edu/pages/faculty/ken.french/data_library.html.

2.2 Macroeconomic variables

As a determinant of the monetary policy stance of the Federal Reserve, I use the Federal funds rate, which is the overnight rate at which depositary institutions lend and borrow the balances they hold at the central bank to each other. The main variable of interest is the effective Federal funds rate, which is the volume-weighted median rate of overnight Federal funds transactions. In some model specifications, I substitute the 1-year Treasury constant maturity rate for the Federal funds rate to prove that the findings are robust to the proxy for the risk-free rate. In any case, one should not expect any differences in the empirical results as the two alternatives are very highly correlated (see Figure 1).

[Figure 1 around here]

The effective Federal funds rate closely tracks the target Federal funds rate set by the Federal Reserve. This decision of the central bank is, however, influenced by the contemporaneous state of the economy. For example, the Federal Reserve may raise the interest rate to curb inflation or it may lower rates to stimulate economic activity during recessions. To better identify the effect on mutual fund flows that is derived from the Federal funds rate and cleanly separate it from the impact of economic conditions, I include in the regressions the quarterly values of three macroeconomic variables: the inflation rate, the GDP growth rate, and the unemployment rate. The inflation rate is the annualized percentage change in the Consumer Price Index, the GDP growth rate is the annualized percentage change in the Gross Domestic Product, while the unemployment rate is the rate of civilian unemployment.

It is also a possibility that the Federal Reserve adjusts the tightness of the monetary policy regime as a reaction to an expected change in inflation or in GDP growth. That is, the determination of the target Federal funds rate may have a forward-looking dimension. This is why I further incorporate the forecasts of the three macroeconomic variables in the empirical analysis, where the one-quarter ahead forecasts are the median forecasts from the Survey of Professional Forecasters.

Figure 2 plots the macroeconomic variables and their forecasts with the Federal funds rate. It does seem from the figure that the Federal funds rate evolves systematically with the inflation rate, the GDP growth rate, and the unemployment rate. For instance, a forecasted increase in prices of consumer goods in the next quarter is related to a tighter monetary policy stance by the Federal Reserve. Moreover, the Federal funds rate comoves negatively with the level and the forecast of the unemployment rate. And as expected, steep drops in the expected GDP growth rate coincide with drastic interest rate cuts.

[Figure 2 around here]

3 Baseline empirical results

I start the empirical exercise by running a regression of monthly per-unit flows on the Federal funds rate, fund performance, and their interaction term. Specifically, the model I use is the following:

$$\begin{aligned}\text{Flow}_{im} =& \beta_0 + \beta_L \text{I}_{im-1}(\text{Low performance}) + \beta_M \text{I}_{im-1}(\text{Medium performance}) \\ &+ \beta_F \text{FedFunds}_{m-1} + \beta_{LF} \text{I}_{im-1}(\text{Low performance}) \times \text{FedFunds}_{m-1} \\ &+ \beta_{MF} \text{I}_{im-1}(\text{Medium performance}) \times \text{FedFunds}_{m-1} + \gamma' X_{im} + \varepsilon_{im}, \end{aligned} \tag{1}$$

where Flow_{im} is the per-unit flow of fund i in month m, FedFunds_m is the end-of-month effective Federal funds rate, I_{im}(Low performance) is a variable that takes a value of 1 if i is in the bottom quintile of performance at the end of month m, I_{im}(Medium performance) is a dummy for funds that are in the middle three quintiles, X_{im} is a vector of fund characteristics, and ε_{im} is the error term. The dummy I_{im}(High performance) for funds with the highest performance is omitted, which means that the effect of the Federal funds rate on the funds with the best risk-adjusted returns is measured by β_F. The fund controls are the log of total net assets, the volatility of excess returns, lagged flows, the log of age, the expense ratio, the maximum front load, the maximum exit fees, the dummy for institutional funds, the dummy for retirement funds, and the dummy for index funds.

If the hypothesis is true, I should obtain that (1) the estimate for β_F is negative, as increasing the risk-free rate reduces flows even to the best-performing funds, and that (2) the estimate for β_{LF} is also less than zero since the model suggests that this decline is more severe for the worst performers. Table II summarizes the regression results. Here, the standard errors are two-way clustered at the fund and the month levels.

[Table II around here]

From Columns 2 and 3, one notices that even though the estimates for β_{LF} are negative and statistically significant, it seems that the Federal funds rate does not affect the flows to funds in the highest performance quintile. The estimates for β_F is not different from zero and on top of that, has the opposite sign. Recall, however, that flows are calculated here as total dollar flows as a proportion of total net assets. It may well be that the estimate for β_F in Column 2 is positive because funds tend to be smaller under tight monetary conditions. That is, it may be the case that the denominator in the definition of monthly per-unit flows is less when interest rates are high, which may then cancel the negative effect of a greater risk-free rate on monthly net flow (i.e., the numerator). Indeed, in adding the interaction term of the log of total net assets and the Federal funds rate (see Columns 4 and 5), one achieves the predicted sign of β_F.

The regression estimates imply that a 1% increase in the Federal funds rate lessens shareholder flows into the best-performing funds by 0.19% of total assets. The impact on the funds in the bottom quintile of risk-adjusted returns is a decrease of 0.26%, with the difference between the two groups being statistically significant. Given that the average size of top performers is 1.09 billion USD and that of the worst performers is 910.82 million USD, these numbers translate to an average outflow of 2.07 million USD in the higher end of the performance distribution and 2.37 million USD in the lower end.

One may be concerned that these findings are driven not by the Federal funds rate, but by the prevailing state of the economy that determines the Federal Reserve's target short-term rate. For example, the central bank may opt to tighten monetary policy when the economy is experiencing fast growth in order to contain inflation. In a boom, asset returns are generally high and if a fund has bad performance when everyone else is doing well, it may mean that fund manager ability is in reality very low. The findings in Table II can thus be interpreted as investors exiting more from funds with poor risk-adjusted returns when the economy is growing.

To address this issue, I control for the effect of the general conditions of the economy by additionally including three macroeconomic variables in the analysis, namely, the prior quarter's inflation rate, GDP growth rate, and unemployment rate. In the regressions, I likewise consider these three new variables and their interactions with fund performance in order to ascertain that the previous results on flows can in fact be attributed to the Federal funds rate. Panel A of Table II displays the coefficient estimates when the macroeconomic variables are interacted with the performance percentile. From Columns 1 and 2, one can see that the estimates for β_F and β_{LF} are all less than zero and statistically significant even when the new controls are added.

Interestingly, I obtain that a greater GDP growth rate makes flows more dependent on performance. Further interacting the macroeconomic variables with the performance dummies (see Columns 1 and 2 of Panel B) provides empirical evidence for the alternative explanation discussed earlier. It appears that a higher GDP growth rate indeed leads to more flows, but less so for the worst performers.

Because monetary policy might not just be a response to the realized values of the macroeconomic variables but also to their forecasts, Columns 3 and 4 of both Panels A and B present the outcome when the regressions are rerun using the one-quarter-ahead forecasts in the prior quarter. Even when both the levels and the forecasts, together with their interactions with performance, are appended to the list of regressors, I again get that all the estimates for β_{LF} are negative and statistically significant (see Columns 5 and 6 of both panels). Those for β_F are similarly less than zero, but are however only significant in Panel A. Nonetheless, Table III still demonstrates that the finding of the baseline specification, which is that flows to poorly-performing funds are more negatively affected by the Federal fund rate than the flows to the best performers, withstands the inclusion of various determinants of contemporaneous and expected market conditions.

[Table III around here]

4 Theory for the baseline empirical results

In this part of the paper, I present a model of portfolio allocation and costly private information acquisition that can offer an explanation for the findings of the previous section. The theoretical set-up is a modified version of that of Huang et al. (2007) (henceforth, HWY), who seek to link the asymmetric flow-performance relationship to the participation cost of mutual fund shareholders. The most important difference of the current model from that of HWY is that the model in this section considers the risk-free rate as another state variable that affects investors' optimal choices, while HWY normalize this quantity to zero.

4.1 Model set-up

The economy consists of three dates, $t = 0, 1, 2$, and two periods. There are two types of agents, namely, risk-averse investors and a mutual fund manager. There is a measure-1 continuum of investors who all have initial wealth of 1, which they allocate at $t = 1$ between a risk-free asset and the mutual fund. Every unit invested in the riskless asset yields a payoff of $R_F \geq 1$ at $t = 2$. Investors are likewise allowed to borrow at the risk-free rate $R_F - 1$.

Mutual fund shares are risky. The fund's publicly-observable one-period per-unit payoff R_t at $t = 1, 2$ is persistent and can be expressed as

$$R_t = R + \frac{1}{\sqrt{\alpha_T}}\varepsilon_t, \tag{2}$$

where R is time-invariant manager ability, the noise ε_t is independently and identically distributed across time with a standard normal distribution, and $\alpha_T > 0$.[6] As in HWY, R can be viewed as the skill of the manager to generate returns in excess of a benchmark. I assume that R is unknown to investors but that they do have a common prior belief concerning manager ability; that is, it is common knowledge that R is normally distributed with mean $\mu > R_F$ and variance $1/\alpha_0$. Specifically, R can be represented as

$$R = \mu + \frac{1}{\sqrt{\alpha_0}}\varepsilon_0, \tag{3}$$

where ε_0 is a noise term with a standard normal distribution.

Investors are Bayesian updaters who, while constructing their portfolios at $t = 1$, use the first-period per-unit payoff R_1 to more precisely estimate R. The public signal is however not the only source of information available to investors. Shareholders can additionally choose to acquire information by reading news about the fund, by studying the historical composition of its portfolio (and, hence, its investment strategies), and by finding out how it is rated by investment research companies. At the end of the first period and right before R_1 is made public, investors can decide to observe a private signal that is revealed together with R_1. An investor who chooses to do so (i.e., the investor is *informed*) learns R with certainty, but this comes at a cost that is paid at $t = 1$. The investor-level information cost c_i is heterogeneous across investors and is uniformly distributed over $[0, \bar{c}]$. After the realization of R_1, an informed investor's posterior distribution of the payoff R_2 is therefore

$$R_2 | R_1, R \sim \mathrm{N}(R, 1/\alpha_T), \tag{4}$$

[6] The persistence of mutual fund manager skill has been studied extensively. Empirical evidence on whether fund returns persist through time or not is mixed (Grinblatt and Titman, 1992; Hendricks, Patel, and Zeckhauser, 1993; Brown and Goetzmann, 1995; Malkiel, 1995; Gruber, 1996; Carhart, 1997; Wermers, 2003; Bollen and Busse, 2004; Berk and Tonks, 2007).

while that of an *uninformed* investor (i.e., one who does not invest in private information acquisition) is

$$R_2|R_1 \sim \mathrm{N}(\mu_R, \sigma^2_{R_2|R_1}), \tag{5}$$

where

$$\mu_R = \mathrm{E}[R_2|R_1] = \mu + \frac{\alpha_T}{\alpha_0 + \alpha_T}(R_1 - \mu) \text{ and } \sigma^2_{R_2|R_1} = \mathrm{Var}[R_2|R_1] = \frac{1}{\alpha_T} + \frac{1}{\alpha_0 + \alpha_T}. \tag{6}$$

Investors have exponential utility over terminal wealth at $t = 2$; that is, the utility function of investor i is $U(W_{2i}) = -\exp(-\rho W_{2i})$, where W_{2i} is the value of i's portfolio at $t = 2$ and $\rho > 0$ is the coefficient of risk aversion common to all investors. Similar to HWY, I impose a short-sale constraint on mutual fund shares as open-end funds cannot be sold short in real life. In addition, I assume that, because of credit risk, investors can borrow at most $\bar{B} \geq 0$ to invest in the mutual fund, that is, portfolio holdings of the fund cannot exceed $1 + \bar{B}$. The model timeline is displayed in Figure 3.

[Figure 3 around here]

4.2 Investment choice

The aim of the model is to show how the risk-free rate affects private information acquisition and, consequently, flows into the fund at $t = 1$. Just like in HWY, investor i has two decisions at $t = 1$. First, she determines whether to pay c_i to observe R simultaneously with the costless public signal R_1. Afterwards, she chooses how much of her wealth to allocate between the risk-free asset and the mutual fund subsequent to the realization of her signals.

Solving the model backwards, I start by separately characterizing the optimal portfolio decisions of an informed and an uninformed investor as a function of their signals. Observing a high R_1 or a high R improves the conditional mean of R_2, which then increases the optimal investment in the fund. The lemma below summarizes the results.

Lemma 1. *The mutual fund investment I_1^U of an uninformed investor at $t = 1$ after observ-*

ing R_1 is given by

$$I_1^U(R_1, R_F) = \begin{cases} 0 & \text{if } R_1 < \underline{R}_1^U \\ \dfrac{\mu_R - R_F}{\rho\sigma^2_{R_2|R_1}} & \text{if } \underline{R}_1^U \leq R_1 \leq \bar{R}_1^U \\ 1 + \bar{B} & \text{if } \bar{R}_1^U < R_1 \end{cases}, \tag{7}$$

where

$$\underline{R}_1^U = R_F - \frac{\alpha_0}{\alpha_T}(\mu - R_F) \text{ and } \bar{R}_1^U = \underline{R}_1^U + \left(1 + \frac{\alpha_0}{\alpha_T}\right)\rho(1+\bar{B})\sigma^2_{R_2|R_1}, \tag{8}$$

and μ_R and $\sigma^2_{R_2|R_1}$ are as defined in Equation 6. On the other hand, the mutual fund investment I_1^I of an informed investor at $t = 1$ after observing R_1 and R is given by

$$I_1^I(R_1, R, R_F) = I_1^I(R, R_F) = \begin{cases} 0 & \text{if } R < R_F \\ \dfrac{\alpha_T}{\rho}(R - R_F) & \text{if } R_F \leq R \leq \bar{R}_1^I \\ 1 + \bar{B} & \text{if } \bar{R}_1^I < R \end{cases}, \tag{9}$$

where

$$\bar{R}_1^I = R_F + \frac{1}{\alpha_T}\rho(1 + \bar{B}). \tag{10}$$

Proof. See Appendix. □

Notice that the informed investors' decision does not depend on R_1, as they already know managerial ability with certainty. Moreover, because the investors' utility function is exponential and fund payoffs are normally distributed, mutual fund investment for both investor types is linear and increasing for intermediate values of their respective signals. On the other hand, for very low values of the signals, the updated expected value of the period-2 payoff is low enough such that investors would want to short sell the mutual fund if they could. For these signal realizations, the short-sale constraint binds and optimal investment is zero. Conversely, high values of R_1 and R lead to a high conditional mean of the period-2 payoff and consequently to more investment in the mutual fund. For very high signal realizations, the borrowing constraint binds and optimal investment is equal to $1 + \bar{B}$.

To understand how private information influences mutual fund investment, the next lemma presents the average investment of informed and uninformed investors as a function of past returns.

Lemma 2. *Given R_1 and R_F, the average investment $\tilde{I}_1^U$ of all uninformed investors at $t = 1$ is equal to $I_1^U(R_1, R_F)$, while that of all informed investors is*

$$\tilde{I}_1^I(R_1, R_F) = \frac{\alpha_T \sigma_R}{\rho}\left[F\left(z_R\right) - F\left(z_R - \frac{\rho}{\alpha_T \sigma_R}(1 + \bar{B})\right)\right], \tag{11}$$

where

$$\sigma_R^2 = Var[R|R_1] = \frac{1}{\alpha_0 + \alpha_T},\ z_R = \frac{\mu_R - R_F}{\sigma_R}, \tag{12}$$

and the function $F(z)$ is positive and strictly increasing in z. In addition, $\tilde{I}_1^I(R_1, R_F)$ is positive and strictly increasing in R_1, with $\lim_{R_1 \to -\infty} \tilde{I}_1^I = 0$ and $\lim_{R_1 \to \infty} \tilde{I}_1^I = 1 + \bar{B}$.

Proof. See Appendix. □

The definition of F can be found in the lemma's proof. Just like the average fund investment of uninformed investors, that of informed investors is increasing in R_1. Because uninformed investors have zero investment for very low values of R_1 and maximum investment for high values of R_1, Lemma 2 readily leads to the corollary below.[7]

Corollary 1. $\tilde{I}_1^I(R_1, R_F) > \tilde{I}_1^U(R_1, R_F) = 0$ *for* $R_1 < \underline{R}_1^U$ *and* $\tilde{I}_1^I(R_1, R_F) < \tilde{I}_1^U(R_1, R_F) = 1 + \bar{B}$ *for* $\bar{R}_1^U < R_1$.

The average informed investor invests more than the average uninformed investor when past returns are low because there is always a positive mass of informed investors who, despite observing a low R_1, receive high private signals. Similarly, for high R_1, the average informed investor places less portfolio weight on the mutual fund as compared to the average uninformed investor since some of the informed investors privately observe low values of R. These results are illustrated in Figure 4a.

[Figure 4 around here]

In other words, Corollary 1 states that, in comparison to a more informed investor, having less private information about the mutual fund results in *underinvestment* for very low past returns and *overinvestment* for very high past returns. Fund investment of uninformed

[7] The model of Berk and Green (2004) yields a similar result.

investors are, in a sense, more dependent on R_1 since the public signal is the only piece of information they possess to learn managerial ability from.

This result is an important point of departure of the model in this section from that of HWY. In their study, less information increases the conditional variance of the second-period payoff, which then decreases a risk-averse investor's portfolio allocation in the mutual fund for *all* levels of past returns. The current model likewise features underinvestment of uninformed investors due to risk aversion, but only for low values of R_1. Overinvestment in the best-performing funds emerges from two ingredients in the present set-up, namely, (1) the borrowing constraint and (2) the absence of the requirement that one has to be informed to invest in the mutual fund. Figure 4b shows the average investment of uninformed and informed investors when there is no borrowing limit. That is, the plots are the limits of $\tilde{I}_1^I$ and $\tilde{I}_1^U$ as $\bar{B}$ approaches infinity. As one can see, allowing for infinite holdings of the mutual fund reverts the implication of the model to that of HWY.[8] Moreover, if there were an information prerequisite for investment in the fund, less information would also lead to less portfolio allocation in the risky asset. I argue that this condition is restrictive; intuitively, very high past returns should encourage investment in the mutual fund even without private information.

4.3 Information choice and total investment

After establishing the optimal fund investment of informed and uninformed investors as a function of their signals, I next consider the investors' costly information decision. The following lemma characterizes the expected utilities of being uninformed and being informed, which investors compare to decide whether to observe a private signal of managerial ability before the first period returns are realized. Here, I assume that investors borrow at $t = 1$ to pay the information cost c_i and that this loan does not affect the borrowing limit $\bar{B}$. That is, an informed investor's maximum portfolio allocation in the mutual fund is still $1 + \bar{B}$.[9]

Lemma 3. *Investor i's expected utilities* $E[U_i^I]$ *and* $E[U_i^U]$ *of, respectively, being informed*

[8] See Appendix for the proof that the average investment of informed investors is always greater than that of the uninformed when there is no borrowing constraint.

[9] This assumption is made for tractability. Requiring that the sum of c_i and the investment in the mutual fund be less than or equal to $1 + \bar{B}$ results in c_i interacting with the investment choice, which greatly complicates the analysis. One can justify this assumption by saying that the loan that funds private information acquisition is less risky than the one extended to finance investment in the mutual fund.

and being uninformed can be expressed as

$$
\begin{aligned}
E[U_i^U] &= -exp\left(-\rho R_F\right) H\left(R_F, a^U\right) \;\; and \\
E[U_i^I] &= -exp\left(-\rho R_F(1-c_i)\right) H\left(R_F, a^I\right),
\end{aligned} \tag{13}
$$

where $a^U = 1 + \alpha_0/\alpha_T$ *and* $a^I = \sqrt{1+\alpha_0/\alpha_T}$*, and the positive function* H *is increasing in* a*.*

Proof. See Appendix. □

The definition of H is in the proof of Lemma 3. The functions $H(R_F, a^U)$ and $H(R_F, a^I)$ are just $\mathrm{E}[\exp(-\rho I_1^U(R_2 - R_F))]$ and $\mathrm{E}[\exp(-\rho I_1^I(R_2 - R_F))]$, respectively, where I_1^U and I_I^U are as defined in Lemma 1. One can thus view H as the expected *additional* utility derived from optimally investing in the risky asset after observing the first-period return.

Since $H\left(R_F, a^I\right) < H\left(R_F, a^U\right)$, private information increases investors' expected utility if c_i is equal to zero. This is the case because the private signal results in a more precise prediction of the second-period payoff, which a risk-averse investor prefers. The lower conditional variance of R_2 however comes with a cost c_i, which can offset the benefits of more information if c_i is sufficiently high. As a consequence of Lemma 3, Corollary 2 asserts that there is a cutoff level of the information cost, below which investors acquire information and above which they do not.

Corollary 2. *Investor* i *pays information cost* c_i *if* $c_i \leq c^*(R_F)$*, where*

$$
c^*(R_F) = \frac{1}{\rho R_F} ln\left(\frac{H(R_F, a^U)}{H(R_F, a^I)}\right). \tag{14}
$$

Knowing the optimal decisions of investors (as described in Corollary 2 and Lemma 1), I can now obtain the total assets of the mutual fund after R_1 is made public. Because c_i is uniformly distributed on $[0, \bar{c}]$, there is a mass $\min\{c^*/\bar{c}, 1\}$ of informed investors and $1-\min\{c^*/\bar{c}, 1\}$ of uninformed investors in the economy. Moreover, the aggregate investment of each type of investor is just the average investment multiplied by the mass. This leads to Lemma 4, which expresses the total investment in the mutual fund as a function of c^*, $\tilde{I}_1^U$, and $\tilde{I}_1^I$.

Lemma 4. *The total investment I_1 at $t = 1$ as a function of R_1 and R_F is*

$$I_1(R_1, R_F) = \min\left\{\frac{c^*(R_F)}{\bar{c}}, 1\right\} \tilde{I}_1^I(R_1, R_F) + \left(1 - \min\left\{\frac{c^*(R_F)}{\bar{c}}, 1\right\}\right) \tilde{I}_1^U(R_1, R_F). \quad (15)$$

Figure 5 shows the total assets in the mutual fund using the same parameter values as in Figure 4a. The investors' total investment in the fund is a linear combination of the average investment of uninformed and informed investors. This implies that I_1 is higher for low past returns and lower for high past returns if there are more investors who choose to observe the private signal. In particular, aggregate fund investment is less dependent on past returns if the average investor is more informed.

[Figure 5 around here]

4.4 Effects of the risk-free rate

I continue the theoretical exercise by demonstrating how time-1 mutual fund assets, as a function of the first-period return, are influenced by the risk-free rate. To do so, I perform a sensitivity analysis to determine how R_F affects the two decisions investors make, specifically, how much to allocate in the fund and whether to invest in private information acquisition or not.

A higher risk-free rate makes the riskless asset a more attractive investment vehicle than the mutual fund. The average portfolio allocation in the fund is therefore decreasing in R_F for uninformed and informed investors alike. This result is formalized in Proposition 1, and illustrated in Figures 6a and 6b.

Proposition 1. *$\tilde{I}_1^U(R_1, R_F)$ and $\tilde{I}_1^U(R_1, R_F)$ are both decreasing in R_F.*

Proof. See Appendix. □

[Figure 6 around here]

Proceeding to the information choice of investors, one can see from the definition of c^* in Corollary 2 that the risk-free rate can influence the cutoff level of information costs by way of three channels. First, a higher R_F increases the opportunity cost of investing in private information, which then lowers c^*. Raising the risk-free rate makes borrowing to finance c_i more expensive and consequently discourages investor i to acquire a private signal of managerial ability. The second and third channels of how R_F can impact the threshold level of information costs are through $H(R_F, a^I)$ and $H(R_F, a^U)$. The lemma below specifies how H changes with the riskless rate.

Lemma 5. *$H(R_F, a)$ is increasing in R_F, with $\lim_{R_F \to -\infty} H = 0$ and $\lim_{R_F \to \infty} H = 1$.*

Proof. See Appendix. □

The function H increases with the risk-free rate because a higher R_F encourages the tilting of the portfolio away from the fund, which then makes the expected utility of both informed and uninformed investors closer to their expected utility if they only hold the risk-free asset.

Raising the risk-free rate increases $H(R_F, a^I)$ because the option to invest in the mutual fund while being informed is less valuable. Investors prefer private information less and the cost cutoff is hence lowered. However, a higher R_F also increases $H(R_F, a^U)$, which produces the opposite outcome. That is, a greater value for $H(R_F, a^U)$ disfavors being uninformed, which raises c^* as a consequence. Despite these conflicting results, I demonstrate in the following proposition that if the risk-adjusted return of the fund is low enough, the last channel is offset by the second and the net effect of increasing the risk-free rate is that the average investor becomes less informed. This is the case because a very high risk-adjusted return means that a higher R_F will minimally change the portfolio holdings of an informed investor, indicating that the impact of the second channel is very small.

Proposition 2. *If $\dfrac{\mu - 1}{\rho \sigma_{R_1}^2} < \dfrac{1 + \bar{B}}{2}$, then $c^*(R_F)$ is decreasing in R_F for $R_F \in [1, \mu)$.*

Proof. See Appendix. □

Given these two propositions, I now establish the overall effect of an increase in the risk-free rate on fund assets at the start of period 2 by taking the partial derivative of I_1 in Lemma 4 with respect to R_F. Assuming that $c^*(1) < \bar{c}$, which implies that $c^*(R_F) < \bar{c}$ and that there is always a positive mass of uninformed investors in the economy, I obtain that

$$\frac{\partial I_1}{\partial R_F} = \underbrace{\frac{c^*}{\bar{c}}\frac{\partial \tilde{I}_1^I}{\partial R_F} + \left(1 - \frac{c^*}{\bar{c}}\right)\frac{\partial \tilde{I}_1^U}{\partial R_F}}_{\text{Yield effect}} + \underbrace{\frac{1}{\bar{c}}\frac{\partial c^*}{\partial R_F}\left(\tilde{I}_1^I - \tilde{I}_1^U\right)}_{\text{Information effect}}. \tag{16}$$

The first two terms, which are negative by Proposition 1, represent the *yield effect* of a change in the risk-free rate; a higher return for the riskless asset leads to a lower portfolio weight on the mutual fund. This is illustrated as a downward shift from the dashed black line to the gray line in Figure 7a. On the other hand, the last term in Equation 16 exhibits the *information effect*, which is positive for high values of R_1 and negative for low values of R_1. An increase in the risk-free rate decreases private information acquisition (Proposition 2) and moves the curve of total investment closer to that of uninformed investors' average investment. This is depicted as the counterclockwise "rotation" of the gray line towards the black solid line in Figure 7a. In other words, the information effect reinforces the yield effect for the worst-performing funds, while the former mitigates the latter for the best performers. The decrease in fund assets following a rise in the risk-free interest rate is therefore greater the lower the past returns are.

[Figure 7 around here]

4.5 Model predictions

I proceed by demonstrating that the implications of the model concur with the findings in Section 3. I define period-1 flows f_1 as new money invested in the fund in the first period. Suppose that the mutual fund has assets $I_0 > 0$ at $t = 0$. I have that

$$f_1(R_1, R_F) = \frac{I_1(R_1, R_F) - I_0 R_1}{I_0}. \tag{17}$$

Taking the partial derivative of f_1 with respect to R_F,

$$\frac{\partial f_1}{\partial R_F} = \frac{1}{I_0}\frac{\partial I_1}{\partial R_F}. \tag{18}$$

Consistent with the baseline empirical results in the Section 3, Equation 18 indicates that, conditional on keeping the same level of I_0, an increase in R_F generally lowers flows into the fund, with the decrease being more pronounced for low values of R_1. This model implication, which is similar to the one on the impact of the risk-free rate on total time-1 investment, is illustrated in Figure 7b. The individual effects of the yield and information channels are highlighted in the plot, similar to what is done in Figure 7a.

Aside from a hypothesis regarding the shape of the flow-performance relationship across time, the model likewise offers predictions concerning the cross-sectional variation in the dependence of f_1 to the risk-free rate. As in HWY, the maximum *investor-level* information cost $\bar{c}_j$ can be viewed as a measure of *fund-level* information costs for fund j. That is, funds that are harder to get information about (e.g., newly opened ones) have higher values of $\bar{c}_j$.

Consider two funds with the same total assets at $t = 0$ but different levels of $\bar{c}_j$: a high-cost fund H with $\bar{c}_H > c^*(1)$ and a low-cost fund L with $\bar{c}_L < c^*(\mu)$. That is, for all values of the risk-free rate, fund H always has a positive mass of uninformed investors, while fund L has a sufficiently low fund-level information cost that all its investors choose to acquire private information. One can think of fund H as a young fund that only has a short time series of past returns to learn manager ability from, whereas fund L is a mature fund with an already long track record.

I am interested in the difference f_1^{H-L} between the flows of the two funds, where

$$\begin{aligned} f_1^{H-L}(R_1, R_F) =& f_1^H(R_1, R_F) - f_1^L(R_1, R_F) \\ =& \frac{1}{I_0}\left(1 - \frac{c^*(R_F)}{\bar{c}_H}\right)\left(\tilde{I}_1^U(R_1, R_F) - \tilde{I}_1^I(R_1, R_F)\right). \end{aligned} \tag{19}$$

Note that f_1^{H-L} is negative for low past returns and positive for high past returns, since the more uninformed investors there are, the more dependent flows are to the public signal. I analyze how this flow difference changes with the risk-free rate for extreme values of past returns. That is, I consider the case where $R_1 < \underline{R}_1^U$ or $R_1 > \bar{R}_1^U$. In this range, $\partial \tilde{I}_1^U / \partial R_F = 0$, as uninformed investors who observe very high or very low returns do not change their investment decision (i.e., either to have $I_1^U = 0$ or $I_1^U = 1 + \bar{B}$) after a small increase in R_F. The partial derivative of f_1^{H-L} with respect to the risk-free rate becomes

$$\frac{\partial f_1^{H-L}}{\partial R_F} = \frac{1}{I_0}\Bigg[\underbrace{-\left(1 - \frac{c^*}{\bar{c}_H}\right)\frac{\partial \tilde{I}_1^I}{\partial R_F}}_{\text{Yield effect}}\underbrace{-\frac{1}{\bar{c}_H}\frac{\partial c^*}{\partial R_F}\left(\tilde{I}_1^U - \tilde{I}_1^I\right)}_{\text{Information effect}}\Bigg]. \tag{20}$$

The first term in the square brackets, which is the difference between the yield effects for funds H and L, is positive. The yield channel functions less for fund H than for fund L because a proportion $1 - c^*/\bar{c}_H$ of fund H's investors do not react to R_F while all of fund L's investors do. Aside from this downward shift, there is also a "rotation" of the curve of f_1^{H-L}, which is attributable to the information effect for fund H. The second term in the square brackets in Equation 20 is positive for $R_1 > \bar{R}_1^U$ and negative for $R_1 < \underline{R}_1^U$, as a higher risk-free rate discourages information acquisition of fund H's investors. This then makes f_1^{H-L} more positive for high R_1 and less positive (or more negative) for low R_1. Taken altogether, the model predicts that, controling for I_0, a higher risk-free rate results in a general increase in the difference between the flows of high-cost funds and low-cost funds. Furthermore, this change in f_1^{H-L} is less for the worst performers in comparison to funds with superior returns. These implications are depicted in Figure 8.

[Figure 8 around here]

4.6 Comment on the borrowing constraint

I close this section by discussing the significance of the borrowing limit $\bar{B}$ for the main results. Suppose there is no constraint on the amount investors could borrow (i.e., as $\bar{B}$ goes to infinity). From Section 4.2, having more uninformed investors means less investment in the mutual fund for any level of past returns. A higher risk-free rate lowers private information acquisition (Proposition 2), which then leads to a decrease in flows for all R_1 (see Figure 9a). Because all the terms in Equation 16 are negative, there are no obvious differences in $\partial I_1/\partial R_F$ across performance levels. Furthermore, Equation 20 without a borrowing constraint is

$$\frac{\partial f_1^{H-L}}{\partial R_F} = \frac{\alpha_T}{I_0 \rho}\left[\left(1 - \frac{c^*}{\bar{c}_H}\right)(\Phi(z_R) - \nu) + \frac{\sigma_R}{\bar{c}_H}\frac{\partial c^*}{\partial R_F}(F(z_R) - \nu z_R)\right], \tag{21}$$

where $\nu = (\alpha_0 + \alpha_T)(\alpha_0 + 2\alpha_T)^{-1}$. As z_R approaches infinity, $\partial f_1^{H-L}/\partial R_F$ goes to negative infinity. This suggests that the difference between the flows of high-cost and low-cost funds is decreasing in R_F for highly-performing funds (see Figure 9b), which is the opposite empirical prediction when $\bar{B}$ is finite. The imposition of a borrowing constraint, though a non-standard assumption, is necessary for the model to explain the relationships that have been detailed in Section 3.

[Figure 9 around here]

5 Additional empirical results and robustness checks

To more cleanly attribute the findings of Section 3 to investors being less informed when the risk-free rate is raised, I continue by empirically testing the second implication of the model developed in Section 4, which concerns the differential negative impact of the risk-free rate on flows of funds with high and low information costs. Funds that have not been in existence for a long time have shorter histories of returns and company filings from which to retrieve information about manager ability. This implies that the investor may need to study the other funds that belong to the same fund family or to access expensive expert advice in order to evaluate a young fund's prospects. I therefore choose fund age as a proxy for fund information costs in the analysis in this section.

Every month, I rank all funds according to age, and call funds belonging to the bottom quartile "young" and the others "old." The last two columns of Table I show the means of the fund-level variables for the two groups of funds. On average, young funds have been in existence for a little less than five years, while the mean age of old funds is 17 years. As expected, old funds are also bigger; they have, on average, five times more assets than young funds. Even though these two groups are significantly different along most dimensions, the succeeding regressions include these fund characteristics as additional independent variables to control for their potential confounding effects on fund flows.

5.1 Effect of fund age

I run a regression of per-unit flows on the triple interaction of last month's Federal funds rate, the lagged performance dummies, and the dummy for young funds. The model I use is:

$$\begin{aligned}
\text{Flow}_{im} =& \delta_0 + \delta_Y \text{I}_{im-1}(\text{Young}) + \delta_L \text{I}_{im-1}(\text{Low performance}) \\
&+ \delta_{YL} \text{I}_{im-1}(\text{Young}) \times \text{I}_{im-1}(\text{Low performance}) \\
&+ \delta_F \text{FedFunds}_{m-1} + \delta_{YF} \text{I}_{im-1}(\text{Young}) \times \text{FedFunds}_{m-1} \\
&+ \delta_{LF} \text{I}_{im-1}(\text{Low performance}) \times \text{FedFunds}_{m-1} \\
&+ \delta_{YLF} \text{I}_{im-1}(\text{Young}) \times \text{I}_{im-1}(\text{Low performance}) \times \text{FedFunds}_{m-1} \\
&+ \eta' Z_{im} + \xi_{im},
\end{aligned} \tag{22}$$

where I_{im}(Young) takes a value of 1 if fund i is in the bottom quartile of age in month m and ξ_{im} is the error term. The interactions of $\mathrm{FedFunds}_{m-1}$, I_{im-1}(Young), and I_{im-1}(Medium performance) are incorporated in the model but suppressed in Equation 22 to economize on space. Again, performance in the highest quintile is the omitted category. Motivated by the results in Section 3, I also include in the vector Z_{im} of controls the following variables: (1) the interaction of the log of total net assets with the Federal funds rate, and (2) the interaction terms of the six macroeconomic variables (i.e., the levels and the forecasts) with the fund performance percentile.

The coefficient estimates, with their corresponding standard errors that are two-way clustered at the fund and the month levels, are presented in Table IV. The second column has the results when the Federal funds rate and its interactions are excluded from the regression. The positive estimate for δ_Y and the negative estimate for δ_{YL} is consistent with Corollary 1. That is, less information leads to flows being more responsive to the tails of the performance distribution, which is also documented by Chevalier and Ellison (1997) and by Huang et al. (2012).

[Table IV around here]

Columns 3 and 4 display the findings when the interactions of $\mathrm{FedFunds}_{m-1}$ are introduced. Since the estimate for δ_F is negative and statistically significant, there is evidence that flows to old funds generally decline with the Federal funds rate. But because the estimate for δ_{LF} is not significantly different from zero, it seems that this effect is a parallel downward shift of flows across all levels of performance. Moreover, if the risk-free rate is increased, a positive estimate for δ_{YF} suggests that the difference between the flows of young and old funds becomes more positive for the top performers, while a negative estimate for δ_{YLF} means that this effect is dampened if risk-adjusted returns are poor. These conclusions confirm those of the sensitivity analysis of the difference f_1^{H-L} between the flows of high-cost and low-cost funds in the discussion of the implications of the model in Section 4.5.

For old funds, the drop in flows as a response to a 1% increase in the Federal funds rate is 0.22% for unsatisfactory performance and 0.17% for superior performance. For young funds, these values are 0.23% and 0.04%, respectively. Given that the average size of young funds is 353.23 million USD in the highest performance quintile, the impact of high information costs on young funds is an inflow of almost half a million USD (for every percent increase in the effective Federal funds rate) if the fund is one of last month's winners.

5.2 Further robustness checks

I close this section by discussing some robustness checks I perform to rule out other explanations that could drive the discussed results. As in Dell'Ariccia, Laeven, and Suarez (2017), I verify whether the findings are robust to the definition of the risk-free rate. One may argue that the Federal funds rate is not the riskless borrowing and lending rate available to mutual fund investors, so I rerun the model in Equation 22 employing the 1-year Treasury yield as the risk-free interest rate. It has already been commented that the two definitions for the short-term rate almost perfectly track each other during the sample period (see Figure 1), so it does not come as a surprise that, as seen in Table V, the results survive this robustness check.

[Table V around here]

Next, it may be the case that the there are more flows to highly-performing young funds when the interest rate is raised because young funds have more volatile (i.e., riskier) returns in comparison to old funds. The difference of 0.001 in the return volatility of young and old funds (see Table I) is statistically significant at the one-percent level. The empirical findings may have been obtained due to changes in risk aversion that are correlated with the monetary policy stance of the Federal Reserve. If the appetite for risk decreases with the real interest rate (Bekaert, Hoerova, and Lo Duca, 2013), then fund investors are expected to already hold only the least risky mutual funds when the risk-free rate is high. More pronounced inflows for young funds if prior performance is very good could be a consequence of new shareholders finally starting to invest in the riskier funds when returns hurdle some threshold.

I hence take the interaction terms of return volatility with the fund performance dummies and the Federal funds rate, and include them as controls in the regression model in Equation 22. The results in Table VI indicate that the estimates for δ_{YF} and δ_{YLF} are still significant, of the desired sign, and of a similar magnitude as in Table IV even when the standard deviation of past excess returns is taken into account. In addition, the positive estimates for the coefficient of the interaction of return volatility with the Federal funds rate hint that the alternative channel is at work, but it still fails to explain all of the variation in flows between young and old funds.

[Table VI around here]

Finally, one can conjecture that the difference in reactions of the shareholders of young and old funds to rate changes is derived from having dissimilar prior beliefs of managerial skill. In other words, investors may think that managers of funds that have existed longer have higher *ex-ante* ability because the fund would have already closed if the opposite were true. Using the notation of the model in Section 4, it may well be the case that the μ of old funds is greater than that of young funds and that this drives the empirical findings. Higher interest rates may encourage the shift towards safe assets, which may crowd out investment in funds whose managers are believed to have little skill even before prior performance is observed. Similar to the argument for risky funds during more restrictive monetary policy regimes, the empirical results in Section 5.1 may have come from formerly disregarded funds attracting more new investors due to their excellent past returns.

Accordingly, I attempt to control for the prior belief of manager skill in two ways. First, I compute for a measure of performance previous to observing the past month's average 4-Factor Carhart alpha. Since lagged performance in month m is the average of the raw alphas from $m-6$ to $m-1$, *ex-ante* manager ability $\text{Alpha}_{im}^{\text{12m}}$ at the beginning of m is computed as the 12-month average of raw alphas from $m-18$ to $m-7$:

$$\begin{aligned}\text{Alpha}_{im}^{\text{12m}} = \frac{1}{12}\sum_{m'=m-18}^{m-7}\Big[R^e_{im'} - \hat{\beta}_{im'}^{\text{MKT}}\text{MKT}_{m'} - \hat{\beta}_{im'}^{\text{SMB}}\text{SMB}_{m'} \\ - \hat{\beta}_{im'}^{\text{HML}}\text{HML}_{m'} - \hat{\beta}_{im'}^{\text{MOM}}\text{MOM}_{m'}\Big].\end{aligned}$$

Each month, I rank funds according to $\text{Alpha}_{im}^{\text{12m}}$ and assign each fund to a decile. I then include manager ability decile by month fixed effects, together with fund fixed effects, in the regression model of Equation 22 to take the prior belief of manager skill into account in the analysis. The outcome of this step is displayed in Panel A of Table VII. As one can see, the estimates for δ_{YF} and for δ_{YLF} are very similar to those of the baseline specification.

[Table VII around here]

Second, I use the funds' mutual fund family designation to control for the manager's *ex-ante* capacity to generate risk-adjusted returns. Elton, Gruber, and Green (2007) demonstrate that fund returns are very correlated within fund families due to common exposures to individual stocks and to specific industries. Moreover, fund managers are chosen at the fund family level, which may imply that when a new fund opens, the best estimate for its future performance is the average performance of the mutual fund family.

I thus elect to check whether the baseline results continue to hold if fund family by month fixed effects are introduced to Equation 22. Panel B of Table VII has the estimates of the resulting regression coefficients with their standard errors, which are two-way clustered at the fund family and the month levels, in parentheses. The estimates for δ_{YF} and for δ_{YLF} are still, respectively, significantly positive and significantly negative, downplaying the possibility that the original findings are principally driven by the difference in prior belief of managerial skill between young and old funds.[10]

6 Concluding remarks

This study has determined how mutual fund flows respond to the monetary policy stance of the central bank. Using the effective Federal funds rate as the risk-free rate, I have established that a 1% increase in the short-term rate lessens shareholder flows into the best-performing funds by 0.19% of total assets. The effect on the worst performers is, on the other hand, a decrease of 0.26%, with the difference between the two groups being statistically significant.

I have additionally provided a theoretical framework that can explain these findings. In the model, the main driver of the relationship between the risk-free rate and shareholder flows is found to be the decrease in investors' information acquisition when the returns of safe assets are higher. Fund shareholders invest less in information collection when the risk-free rate is increased. This then depresses their holdings of the mutual fund across the whole performance distribution, but more so in the leftmost tail.

To pin down the costly information channel of the impact of monetary policy on fund investor flows in the data, I have likewise derived a cross-sectional prediction of the model. I have demonstrated that the aforementioned reaction of flows varies across funds with different information costs. In particular, the difference between the flows of high-information-cost funds and low-information-cost funds is more positive for very satisfactory performance when rates are raised. This implication has been tested by employing the age of a fund as a proxy for information costs and it has been confirmed that the decline in flows for superior performance is in fact 0.14% less than for old funds.

[10] It is worth nothing at this point that most of the proxies for fund information costs used by Huang et al. (2007) and by Sirri and Tufano (1998) (e.g., family size, family star status) are at the fund-family level. In contrast, the empirical strategy of this paper utilizes a fund-level proxy for information costs (i.e., fund age) whose effect on flows survives even when family-level fixed effects are added.

This study highlights a previously overlooked effect of monetary policy on a rapidly growing sector of the financial system. Inasmuch as shareholder flows can have potentially distortionary consequences for the asset markets mutual funds invest in, central banks may find it beneficial to use the findings of this paper to guide them in their interest rate decisions.

Finally, this study hints at another potential dimension of the risk-taking channel of monetary policy for investment funds. A number of empirical papers confirm that low interest rate environments drive fixed-income fund managers to tilt their portfolios towards riskier assets (Choi and Kronlund, 2017; Di Maggio and Kacperczyk, 2017), a result that the authors attribute to managers' searching for yield (Fishburn and Porter, 1976; Rajan, 2005). In contrast to their explanations that center on the agent in the principal-agent relationship inherent to the asset management industry, the findings presented in this study demonstrate how the tightness of monetary policy changes the investment behavior of the principal, which, in theory, may then affect the incentives of the agent to assume more risk (Chevalier and Ellison, 1997).

7 Appendix: Proofs

Proof of Lemma 1. It is a known result that if an investor has exponential utility with risk aversion parameter ρ and if the return of the risky asset is normally distributed with mean μ and variance σ^2, the proportion ω_R of wealth invested in the risky asset is given by $\omega_R = \dfrac{\mu - r}{\rho\sigma^2}$, where r is the risk-free rate. Using (4) and (5), one obtains the second line of (7) and (9). The first line of (7) and (9) results from the binding short-selling constraint (i.e., $I_1^I \geq 0$ and $I_1^U \geq 0$), while the third line comes from the binding borrowing constraint (i.e., $I_1^I \leq 1 + \bar{B}$ and $I_1^U \leq 1 + \bar{B}$). $\square$

Proof of Lemma 2. The investment decision of uninformed investors is dependent only on the public signal R_1, which means that all of them invest $I_1^U(R_1)$ in the mutual fund and, as a result, that $\tilde{I}_1^U(R_1) = I_1^U(R_1)$. For informed investors, it is the case that $\tilde{I}_1^I(R_1) = \mathrm{E}[I_1^I(R)|R_1]$. Agents' beliefs must be correct, which implies that $R|R_1$ is a normally distributed variable with mean $\mathrm{E}[R|R_1] = \mu_R$ and variance $\sigma_R^2 = \mathrm{Var}[R|R_1] = (\alpha_0 + \alpha_T)^{-1}$. Hence,

$$\begin{aligned}
\tilde{I}_1^I(R_1) =& \mathrm{E}[I_1^I(R)|R_1] = \int_{R_F}^{\bar{R}_1^I} \frac{\alpha_T}{\rho}\left(R - R_F\right)\frac{1}{\sigma_R}\phi\left(\frac{R-\mu_R}{\sigma_R}\right) dR \\
&+ \int_{\bar{R}_1^I}^{\infty} \left(1+\bar{B}\right)\frac{1}{\sigma_R}\phi\left(\frac{R-\mu_R}{\sigma_R}\right) dR \\
=& \frac{\alpha_T\sigma_R}{\rho}\left[F\left(z_R\right) - F\left(z_R - \frac{\rho}{\alpha_T\sigma_R}(1+\bar{B})\right)\right],
\end{aligned}$$

where $z_R = (\mu_R - R_F)/\sigma_R$, $F(x) = \phi(x) + x\Phi(x)$ for $x \in (-\infty, \infty)$, and ϕ and Φ are the pdf and the cdf, respectively, of a standard normal variable. The function F is positive and strictly increasing everywhere since $\lim_{x\to-\infty} F(x) = 0$ and $F'(x) = \Phi(x) > 0$.

Because F is strictly increasing, $\tilde{I}_1^I(R_1) > 0$. The first derivative of $\tilde{I}_1^I(R_1)$ is

$$\tilde{I}_1^{I\prime}(R_1) = \frac{\alpha_T^2}{\rho(\alpha_0+\alpha_T)}\left[\Phi\left(z_R\right) - \Phi\left(z_R - \frac{\rho}{\alpha_T\sigma_R}(1+\bar{B})\right)\right] > 0,$$

which means that $\tilde{I}_1^I(R_1)$ is itself strictly increasing. Finally, it is straightforward to see that $\lim_{R_1\to-\infty}\tilde{I}_1^I(R_1) = 0$ and $\lim_{R_1\to\infty}\tilde{I}_1^I(R_1) = 1 + \bar{B}$. $\square$

Proof that $\tilde{I}_1^I > \tilde{I}_1^U$ when there is no borrowing constraint. As $\bar{B}$ goes to ∞, $\tilde{I}_1^I \to \alpha_T\sigma_R F(z_R)/\rho$.

Since F is positive everywhere, $\lim_{\bar{B}\to\infty} \tilde{I}_1^I > \lim_{\bar{B}\to\infty} \tilde{I}_1^U = 0$ for $R_1 \leq \underline{R}_1^U$. For the remaining values of R_1, the difference between $\tilde{I}_1^I$ and $\tilde{I}_1^U$ without a borrowing constraint is

$$\lim_{\bar{B}\to\infty} \tilde{I}_1^I - \lim_{\bar{B}\to\infty} \tilde{I}_1^U = \frac{\alpha_T \sigma_R}{\rho} \left(F(z_R) - \frac{\alpha_0 + \alpha_T}{\alpha_0 + 2\alpha_T} z_R \right) = \frac{\alpha_T \sigma_R}{\rho} Q(z_R).$$

The function Q is convex since $Q''(z_R) = \phi(z_R) > 0$. The minimum value of Q is achieved at $\underline{z}_R < \infty$, where

$$Q'(\underline{z}_R) = \Phi(\underline{z}_R) - \frac{\alpha_0 + \alpha_T}{\alpha_0 + 2\alpha_T} = 0,$$

which means that the minimum value of Q is $Q(\underline{z}_R) = \phi(\underline{z}_R) > 0$. This implies that Q is positive everywhere and, hence, that $\lim_{\bar{B}\to\infty} \tilde{I}_1^I > \lim_{\bar{B}\to\infty} \tilde{I}_1^U$ also for $R_1 > \underline{R}_1^U$. □

Proof of Lemma 3. If investor i is uninformed, her terminal wealth at $t = 2$ is equal to $W_{2i}^U = \omega_R^U R_2 + (1 - \omega_R^U) R_F$, where $\omega_R^U \in [0, 1 + \bar{B}]$ is the investment at $t = 1$ in the mutual fund. This implies that

$$\begin{aligned}
\mathrm{E}[U_i^U | R_1] &= -\exp(-\rho R_F) \exp\left[-\rho \omega_R^U (\mu_R - R_F) + \frac{\rho^2}{2} \left(\omega_R^U\right)^2 \sigma_{R_2|R_1}^2 \right] \\
&= \begin{cases} -\exp(-\rho R_F) \ \text{ if } R_1 < \underline{R}_1^U \\ -\exp(-\rho R_F) \sqrt{2\pi} \phi \left(\dfrac{\mu_R - R_F}{\sigma_{R_2|R_1}} \right) \ \text{ if } \underline{R}_1^U \leq R_1 \leq \bar{R}_1^U \\ -\exp\left[-\rho R_F - \rho(1 + \bar{B}) \left(\mu_R - R_F - \dfrac{\rho(1+\bar{B})}{2} \sigma_{R_2|R_1}^2 \right) \right] \ \text{ if } \bar{R}_1^U < R_1 \end{cases}.
\end{aligned}$$

Taking the expectation of $\mathrm{E}[U_i^U | R_1]$ over all possible values of R_1, I then have that

$$\begin{aligned}
&\mathrm{E}[U_i^U] = \mathrm{E}[\mathrm{E}[U_i^U | R_1]] \\
&= -\exp(-\rho R_F) \left\{ \Pr[R_1 < \underline{R}_1^U] + \int_{\underline{R}_1^U}^{\bar{R}_1^U} \sqrt{2\pi} \phi \left(\frac{\mu_R - R_F}{\sigma_{R_2|R_1}} \right) \frac{1}{\sigma_{R_1}} \phi \left(\frac{R_1 - \mu}{\sigma_{R_1}} \right) dR_1 \right. \\
&\quad \left. + \int_{\bar{R}_1^U}^{\infty} \exp\left[-\rho(1 + \bar{B}) \left(\mu_R - R_F - \frac{\rho(1 + \bar{B})}{2} \sigma_{R_2|R_1}^2 \right) \right] \frac{1}{\sigma_{R_1}} \phi \left(\frac{R_1 - \mu}{\sigma_{R_1}} \right) dR_1 \right\} \\
&= -\exp(-\rho R_F) \hat{H}(z^*, a^U, \sigma_{R_1}),
\end{aligned}$$

where $a^U = 1 + \alpha_0/\alpha_T$, $z^* = (\mu - R_F)/\sigma_{R_1}$, and $\sigma_{R_1}^2 = \mathrm{Var}[R_1] = 1/\alpha_0 + 1/\alpha_T$, . Here,

$$\hat{H}(z, a, \sigma) = \Phi(-az) + \frac{\sqrt{2\pi(a^2 - 1)}}{a} \phi(z) \left[\Phi\left(\sqrt{a^2 - 1} z \right) - \Phi\left(\sqrt{a^2 - 1} \eta(z, \sigma) \right) \right]$$

$$+\exp\left(-\lambda(z,\sigma)\right)\Phi(a\eta(z,\sigma)),$$

where $\eta(z,\sigma) = z - \rho\sigma(1+\bar{B})$, and $\lambda(z,\sigma) = \rho\sigma(1+\bar{B})\left(z - \frac{1}{2}\rho\sigma(1+\bar{B})\right)$.

On the other hand, if the investor is informed, her terminal wealth is $W_{2i}^I = \omega_R^I R_2 + (1 - \omega_R^I - c_i)R_F$. Her expected utility as a function of R is therefore

$$\begin{aligned}
\mathrm{E}[U_i^I|R] &= -\exp\left(-\rho R_F(1-c_i)\right)\exp\left[-\rho\omega_R^I(R-R_F) + \frac{\rho^2}{2}\left(\omega_R^I\right)^2\frac{1}{\alpha_T}\right] \\
&= \begin{cases} -\exp\left(-\rho R_F(1-c_i)\right) \text{ if } R < R_F \\ -\exp\left(-\rho R_F(1-c_i)\right)\sqrt{2\pi}\phi\left(\sqrt{\alpha_T}(R-R_F)\right) \text{ if } R_F \le R \le \bar{R}_1^I \\ -\exp\left[-\rho R_F(1-c_i) - \rho(1+\bar{B})\left(R - R_F - \frac{\rho(1+\bar{B})}{2\alpha_T}\right)\right] \text{ if } \bar{R}_1^I < R \end{cases}.
\end{aligned}$$

Remembering that $R|R_1 \sim \mathrm{N}(\mu_R, \sigma_R)$, the expected utility of an informed investor given R_1 is

$$\begin{aligned}
\mathrm{E}[U_i^I|R_1] &= \mathrm{E}[\mathrm{E}[U_i^I|R]|R_1] = -\exp\left(-\rho R_F(1-c_i)\right)\{\Pr[R<R_F] \\
&+ \int_{R_F}^{\bar{R}_1^I}\sqrt{2\pi}\phi\left(\sqrt{\alpha_T}(R-R_F)\right)\frac{1}{\sigma_R}\phi\left(\frac{R-\mu_R}{\sigma_R}\right)dR \\
&+ \int_{\bar{R}_1^I}^{\infty}\exp\left[-\rho(1+\bar{B})\left(R - R_F - \frac{\rho(1+\bar{B})}{2\alpha_T}\right)\right]\frac{1}{\sigma_R}\phi\left(\frac{R-\mu_R}{\sigma_R}\right)dR\Bigg\} \\
&= -\exp\left(-\rho R_F\right)\hat{H}(z', a', \sigma_{R_2|R_1}),
\end{aligned}$$

where $z' = (\mu_R - R_F)/\sigma_{R_2|R_1}$ and $a' = \sqrt{2 + \alpha_0/\alpha_T}$. Calculating the expected utility of an informed investor before observing R_1, I obtain that

$$\mathrm{E}[U_i^I] = \mathrm{E}[\mathrm{E}[U_i^I|R_1]] = -\exp\left(-\rho R_F(1-c_i)\right)\hat{H}(z^*, a^I, \sigma_{R_1}),$$

where $a^I = \sqrt{1+\alpha_0/\alpha_T}$.

The first part of the lemma is proved by letting $H(R_F, a) = \hat{H}(z^*, a, \sigma_{R_1})$. The function H is positive because $z^* > \eta(z^*, \sigma_{R_1})$. Finally, the partial derivative of H with respect to a is

$$\frac{\partial}{\partial a}H(R_F,a) = \sqrt{2\pi}\frac{1}{a^2\sqrt{a^2-1}}\phi(z^*)\left[\Phi\left(\sqrt{a^2-1}z^*\right) - \Phi\left(\sqrt{a^2-1}\eta^*\right)\right], \tag{23}$$

which is positive because Φ is strictly increasing. □

Proof of Proposition 1. The threshold values $\underline{R}_1^U$ and $\bar{R}_1^U$ of $\tilde{I}_1^U$, defined in Lemma 1, are increasing in R_F. Since the function in the strictly increasing part of $\tilde{I}_1^U$ is decreasing in R_F, one obtains that $\partial\tilde{I}_1^U/\partial R_F \leq 0$. Similarly, the partial derivative of $\tilde{I}_1^I$ with respect to R_F is

$$\frac{\partial}{\partial R_F}\tilde{I}(R_1, R_F) = -\frac{\alpha_T}{\rho}\left[\Phi\left(z_R\right) - \Phi\left(z_R - \frac{\rho}{\alpha_T\sigma_R}(1+\bar{B})\right)\right],$$

which is also negative because Φ is strictly increasing. $\square$

Proof of Lemma 5. Taking the partial derivative of H with respect to R_F,

$$\begin{aligned}\frac{\partial H}{\partial R_F} = \frac{1}{\sigma_{R_1}}\Bigg\{&\frac{\sqrt{2\pi}}{a}\phi(z^*)\left[F\left(\sqrt{a^2-1}z^*\right) - F\left(\sqrt{a^2-1}\eta^*\right)\right] \\ &-\exp(-\lambda^*)\sigma_{R_1}\rho(1+\bar{B})\left[\frac{\sqrt{2\pi(a^2-1)}}{a}\Phi\left(\sqrt{a^2-1}\eta^*\right)\phi(\eta^*) - \Phi(a\eta^*)\right]\Bigg\},\end{aligned} \tag{24}$$

where F is as in Lemma 2, $\eta^* = \eta(z^*, \sigma_{R_1})$, and $\lambda^* = \lambda(z^*, \sigma_{R_1})$. To figure out the sign of (24), I start by determining the sign of the expression in the second set of square brackets. Let

$$G(x) = \frac{\sqrt{2\pi(a^2-1)}}{a}\Phi\left(\sqrt{a^2-1}x\right)\phi(x) - \Phi(ax).$$

The derivative of G with respect to x is

$$G'(x) = -\frac{2\pi}{a}\phi(x)F\left(\sqrt{a^2-1}x\right),$$

which is negative because F is everywhere positive (Lemma 2). Since G is strictly decreasing and $\lim_{x\to-\infty} G(x) = 0$, G is negative for all x. This, together with the result that F is strictly increasing (Lemma 2), means that $\partial H/\partial R_F$ is positive. $\square$

Proof of Proposition 2. Let $H^I = H(R_F, a^I)$ and $H^U = H(R_F, a^U)$. The derivative of c^* with respect to R_F is

$$\frac{\partial c^*}{\partial R_F} = -\frac{1}{R_F}c^* + \frac{1}{\rho R_F}\left[\frac{1}{H^U}\frac{\partial H^U}{\partial R_F} - \frac{1}{H^I}\frac{\partial H^I}{\partial R_F}\right] \tag{25}$$

Let $D(R_F, a) = \partial H(R_F, a)/\partial R_F$ (i.e., equation (24)) and consider the function $V(R_F, a) =$

$D(R_F, a)/H(R_F, a)$, with $a \geq 1$. Taking the partial derivative of V with respect to a,

$$\frac{\partial V}{\partial a} = \frac{1}{H^2}\left[H\frac{\partial D}{\partial a} - D\frac{\partial H}{\partial a}\right], \tag{26}$$

where the function parameters are suppressed for brevity. It can be shown that

$$\frac{\partial D}{\partial a} = \frac{1}{\sigma_{R_1}}\left[z^*\frac{\partial H}{\partial a} - A\right],$$

where $\partial H/\partial a$ is as in (23) and

$$A = \frac{\sqrt{2\pi}}{a^2}\phi(z^*)\left[\phi\left(\sqrt{a^2-1}z^*\right) - \phi\left(\sqrt{a^2-1}\eta^*\right)\right].$$

Notice that $A > 0$ since the assumption that $\dfrac{\mu - 1}{\rho\sigma_{R_1}^2} < \dfrac{1+\bar{B}}{2}$ implies that $z^* < -\eta^*$ for all $R_F \in [1, \mu)$. Equation (26) is now

$$\frac{\partial V}{\partial a} = \frac{1}{H^2}\left[\left(\frac{1}{\sigma_{R_1}}z^*H - D\right)\frac{\partial H}{\partial a} - \frac{1}{\sigma_{R_1}}AH\right]. \tag{27}$$

To determine the sign of $\partial V/\partial a$, I focus on the expression in parentheses in (27). After some calculations, it becomes

$$\frac{1}{\sigma_{R_1}}z^*H - D = \frac{1}{a\sigma_{R_1}}\phi(z^*)\left(J(\eta^*) - J(-z^*)\right), \tag{28}$$

where $J(x) = F(ax)/\phi(x)$ and F is as defined in Lemma 2. I ascertain the sign of (28) by computing for the derivative of J with respect to x:

$$J'(x) = \frac{1}{\phi(x)}\left[a\Phi(ax) + xF(ax)\right] = \frac{1}{\phi(x)}K(x).$$

The derivative of K is equal to $(a^2-1)\phi(ax) + 2F(ax)$, which is positive because $a \geq 1$ and F is positive everywhere (Lemma 2). Additionally using the fact that $\lim_{x\to-\infty} K(x) = 0$, I have that $K(x) > 0$ for all x, which means that $J'(x) > 0$ (i.e., J is increasing in x). Because $\eta^* < -z^*$, (28) is negative. Equation (27) is likewise negative (i.e., V is decreasing in a), as $\partial H/\partial a$ and H are both positive (Lemma 3). Furthermore, $a^I < a^U$ implies that $V(R_F, a^U) < V(R_F, a^I)$. Finally, the expression in brackets in (25) is negative, leading to the conclusion that $c^{*'}(R_F) < 0$. $\square$

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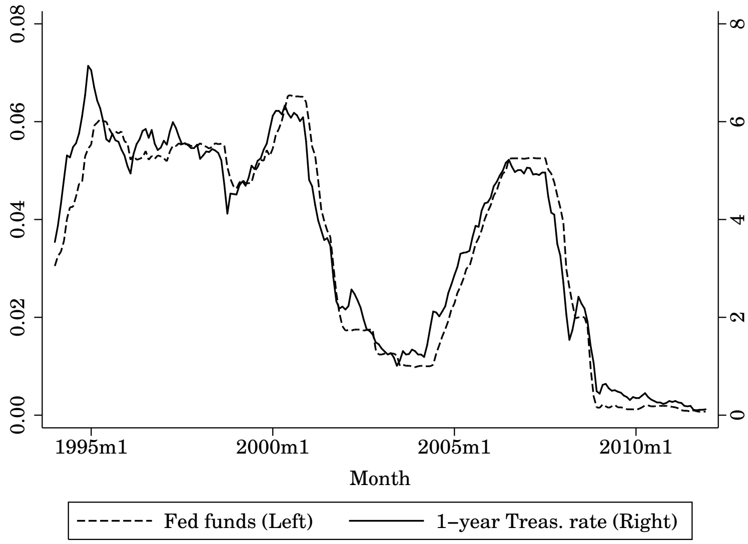


Figure 1

FEDERAL FUNDS RATE AND 1-YEAR TREASURY RATE

The figure above plots the end-of-month effective Federal funds rate with the end-of-month 1-year Treasury constant maturity rate from January 1994 to December 2011.

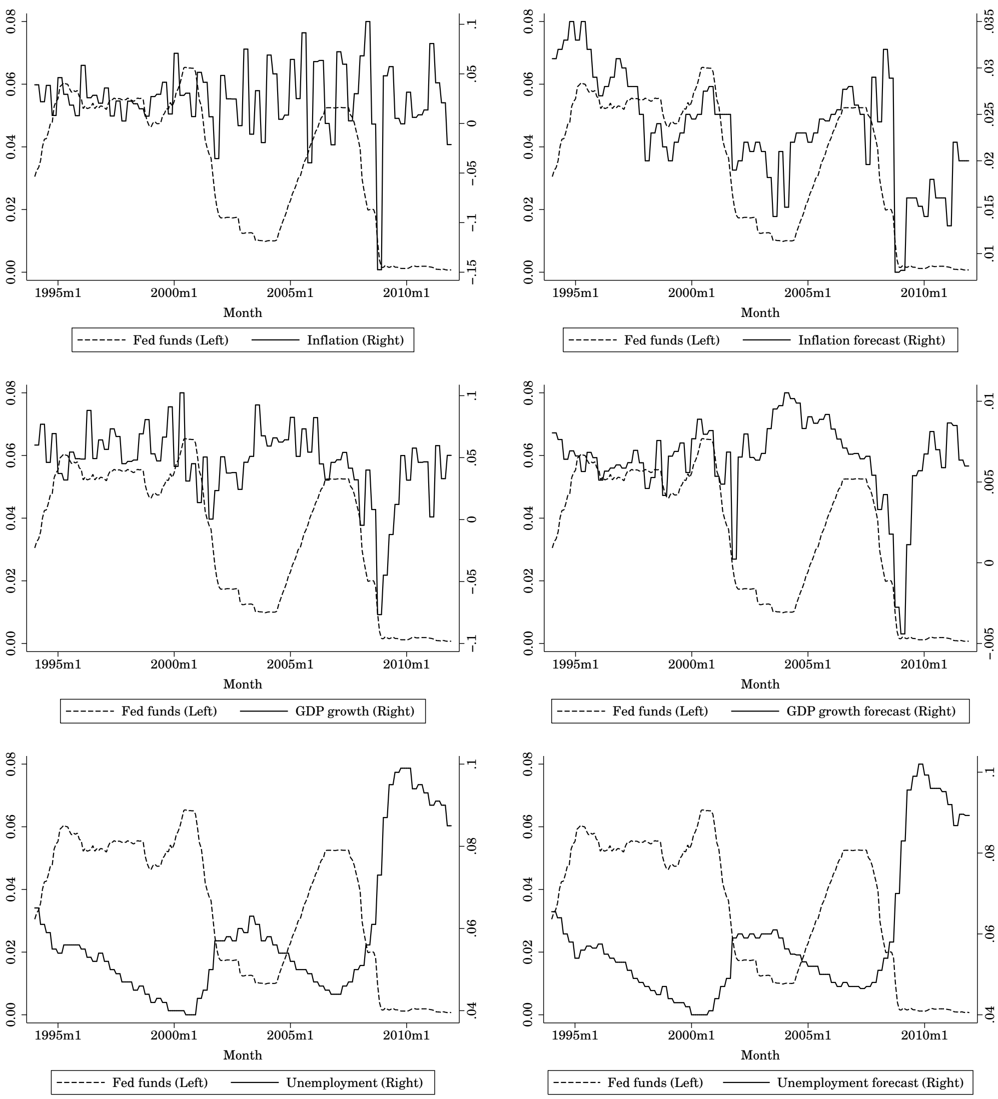


Figure 2

Federal funds rate and other macroeconomic variables

The six panels show the plot of the end-of-month effective Federal funds rate juxtaposed with the quarterly values of six other macroeconomic variables from January 1994 to December 2011. Inflation rate is the annualized percentage change in the Consumer Price Index, while GDP growth rate is the annualized percentage change in the Gross Domestic Product. Unemployment rate is the rate of civilian unemployment. The forecasts are the median one-step ahead forecasts from the Survey of Professional Forecasters.

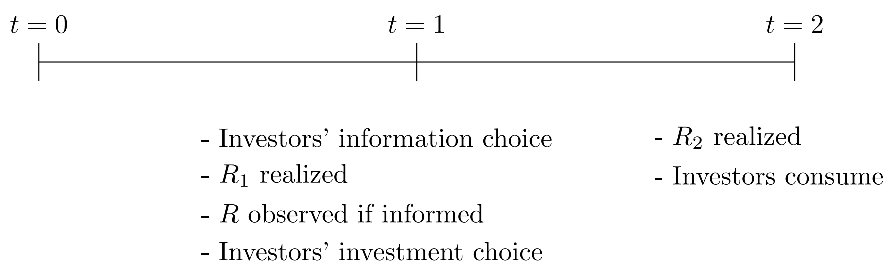
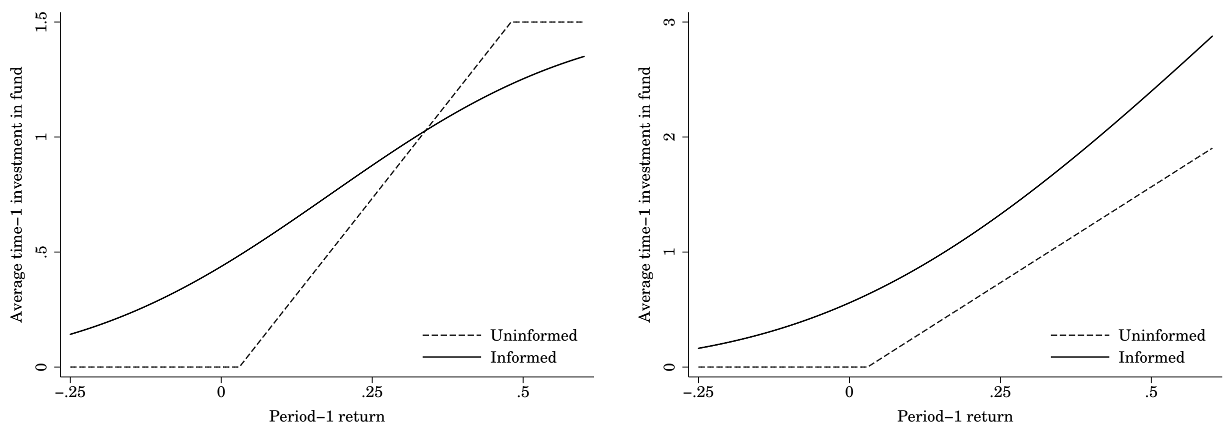


Figure 3
MODEL TIMELINE



(a) With borrowing constraint (b) Without borrowing constraint

Figure 4
AVERAGE TIME-1 INVESTMENT OF UNINFORMED AND INFORMED PAYOFF
AS A FUNCTION OF PERIOD-1 FUND PAYOFF

In the two panels above, the solid lines correspond to informed investors, i.e., those who observe managerial ability R, while the dashed lines are for uninformed investors, i.e., those who only see period-1 payoff R_1 and not R. The risk-free rate used is $R_F = 1.04$, while the coefficient of risk aversion is $\rho = 2$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$. The borrowing constraint for Panel (a) is $\bar{B} = 0.5$, while that for Panel (b) is $\bar{B} = \infty$.

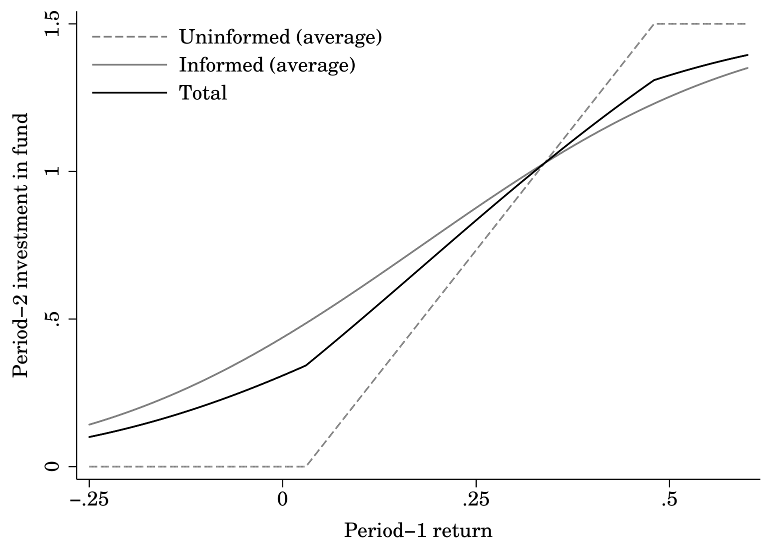
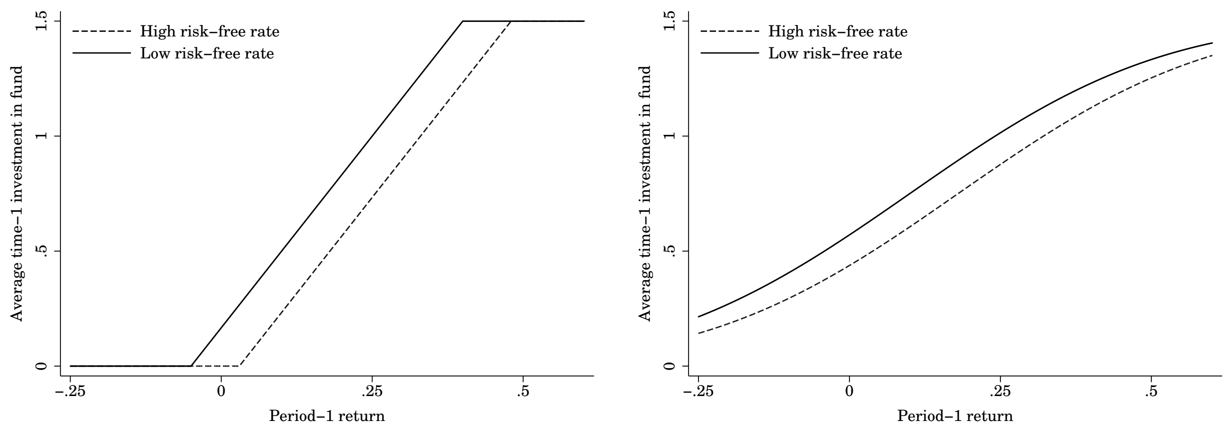


Figure 5

Total time-1 investment as a function of period-1 fund payoff

The gray solid and dashed lines are the average time-1 investment of, respectively, informed and uninformed investors as a function of period-1 payoff, R_1. Informed investors are those who observe managerial ability R, while uninformed investors are those who only see R_1 and not R. The black solid line is the total time-1 investment of all of the fund's investors as a function of R_1. The risk-free rate used is $R_F = 1.04$, the coefficient of risk aversion is $\rho = 2$, the borrowing constraint is $\bar{B} = 0.5$, and the maximum investor-level information cost is $\bar{c} = 0.0478$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.



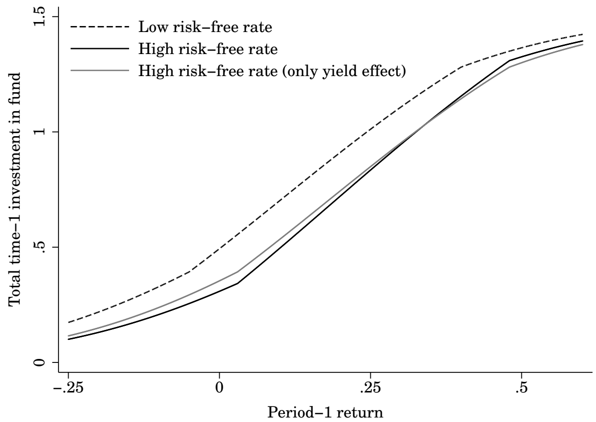
(a) Uninformed

(b) Informed

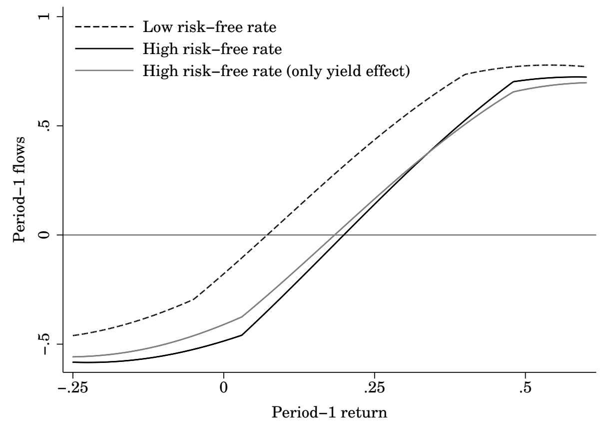
Figure 6

Effect of the risk-free rate on average time-1 investment

The solid and dashed lines in the panels above are the the average time-1 investment as a function of period-1 payoff when the risk-free rate R_F is, respectively, high ($R_F = 1.04$) and low ($R_F = 1$). Panel (b) is for informed investors, i.e., those who observe managerial ability R, while Panel (a) is for uninformed investors, i.e., those who only see period-1 payoff R_1 and not R. The coefficient of risk aversion used is $\rho = 2$ and the borrowing constraint is $\bar{B} = 0.5$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.



(a) Total time-1 investment

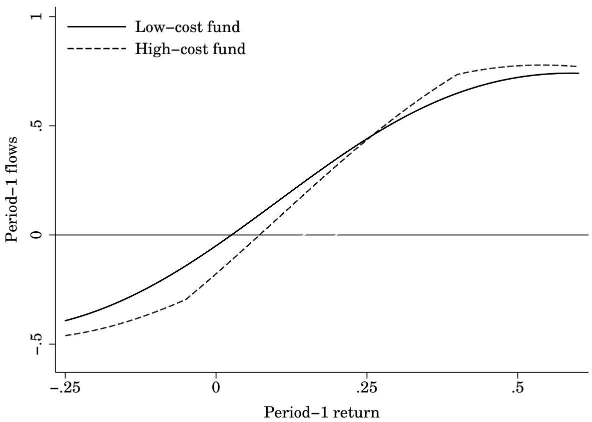


(b) Period-1 flows

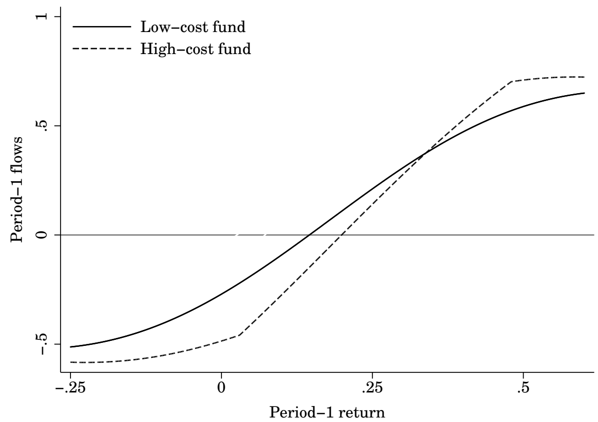
Figure 7

Effect of the risk-free rate on total time-1 investment and on period-1 flows

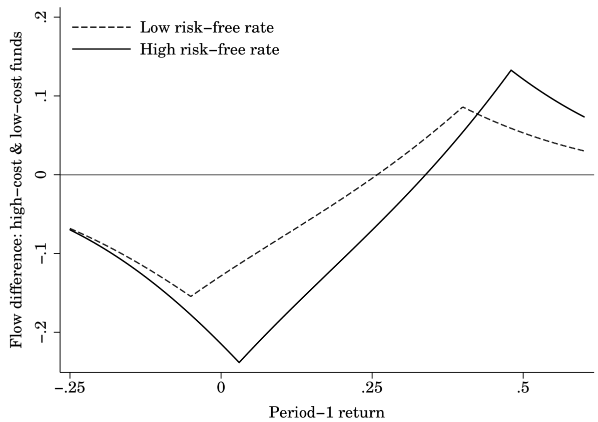
Panel (a) shows the total time-1 investment $I_1(R_1, R_F)$ of all the fund's investors as a function of period-1 payoff R_1, while Panel (b) contains the period-1 flows as a function of R_1. Period-1 flows $f_1(R_1, R_F)$ are defined as $f_1(R_1, R_F) = (I_1(R_1, R_F) - I_0 R_1)/I_0$, where $I_0 = 0.6$ is the fund's assets at time 0. The black solid and dashed lines in both panels correspond to the case when the risk-free rate R_F is, respectively, high ($R_F = 1.04$) and low ($R_F = 1$). The gray solid lines are for the case when the risk-free rate is high, but the fraction of the informed among the fund's investors is the same as when the risk-free rate is low. Informed investors are those who observe managerial ability R, while uninformed investors are those who only see R_1 and not R. The coefficient of risk aversion is $\rho = 2$, the borrowing constraint is $\bar{B} = 0.5$, and the maximum investor-level information cost is $\bar{c} = 0.0478$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.



(a) Low risk-free rate



(b) High risk-free rate

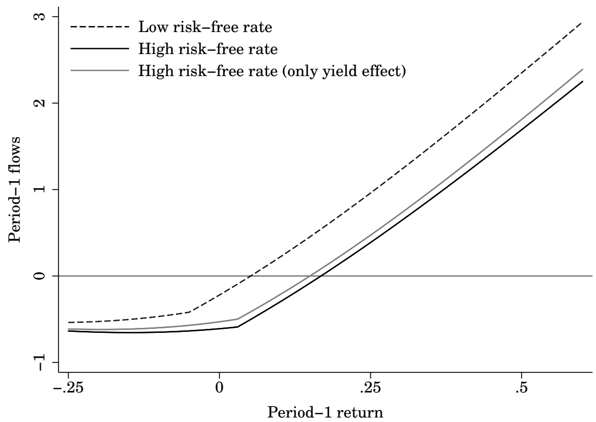


(c) Difference in flows

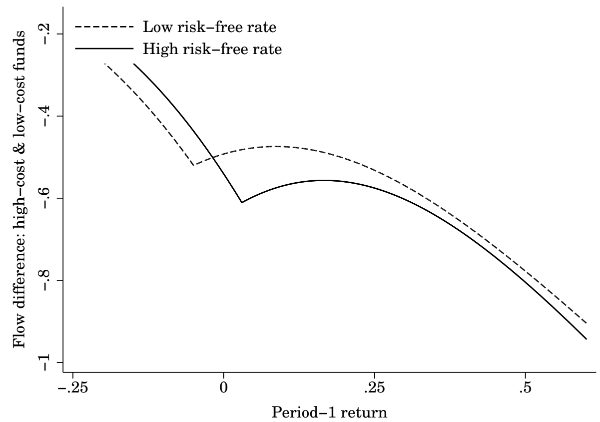
Figure 8

Effect of the risk-free rate on period-1 flows of high-information-cost and low-information-cost funds

The solid and dashed lines in Panels (a) and (b) correspond to the period-1 flows into the fund as a function of period-1 payoff R_1 for, respectively, a low-information-cost and a high-information-cost fund. Period-1 flows $f_1(R_1, R_F)$ are defined as $f_1(R_1, R_F) = (I_1(R_1, R_F) - I_0 R_1)/I_0$, where $I_1(R_1, R_F)$ is the total time-1 investment in the mutual fund and $I_0 = 0.6$ is the fund's assets at time 0. The fund with low information costs has a maximum investor-level information cost of $\bar{c}_L = 0$, while that of the high-information-cost fund is $\bar{c}_H = 0.0478$. Panels (a) and (b) are, respectively, for a low ($R_F = 1$) and high ($R_F = 1.04$) risk-free rate regimes. The solid and dashed lines in Panel (c) are, respectively, the difference between the flows of the high and low-information-cost funds when the risk-free rate is (1) high and (2) low. The coefficient of risk aversion is $\rho = 2$ and the borrowing constraint is $\bar{B} = 0.5$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.



(a) Period-1 flows



(b) Difference in flows

Figure 9

Empirical implications if there is no borrowing limit

Panel (a) shows the total period-1 flows as a function of period-1 payoff R_1. Period-1 flows $f_1(R_1, R_F)$ are defined as $f_1(R_1, R_F) = (I_1(R_1, R_F) - I_0 R_1)/I_0$, where $I_1(R_1, R_F)$ is the total time-1 investment in the mutual fund and $I_0 = 0.6$ is the fund's assets at time 0. The black solid and dashed lines in Panel (a) correspond to the case when the risk-free rate R_F is, respectively, high ($R_F = 1.04$) and low ($R_F = 1$). The gray solid line is for the case when the risk-free rate is high, but the fraction of the informed among the fund's investors is the same as when the risk-free rate is low. Informed investors are those who observe managerial ability R, while uninformed investors are those who only see R_1 and not R. The solid and dashed lines in Panel (b) are, respectively, the difference between the flows of the high and low-information-cost funds when the risk-free rate is (1) high and (2) low. The fund with low information costs has a maximum investor-level information cost of $\bar{c}_L = 0$, while that of the high-information-cost fund is $\bar{c}_H = 0.1064$. The coefficient of risk aversion is $\rho = 2$ and the borrowing constraint is $\bar{B} = \infty$. The other parameter values are $\mu = 1.05$, $\alpha_0 = 20$, and $\alpha_T = 20$. Time-invariant manager ability R is normally distributed with mean μ and variance $1/\alpha_0$. Conditional on R, period-1 payoff R_1 is also normally distributed with mean R and variance $1/\alpha_T$.

Table I

Summary statistics

The table below shows the summary statistics for the 4,002 US open-end equity mutual funds included in the empirical analysis. The funds were active at least once from January 1994 to December 2011. The definitions of the variables are in the main text.

Variable	All funds					Young	Old
	Mean	Median	SD	Min	Max	Mean	Mean
Per-unit flows	0.000	-0.003	0.044	-0.161	0.208	0.007	-0.002
Performance	-0.001	-0.001	0.010	-0.144	0.142	-0.001	-0.001
Volatility of returns	0.053	0.050	0.023	0.002	0.216	0.054	0.053
Age (in months)	167	119	152	37	1,052	57	204
TNA (in millions)	1,426	264	5,623	5	202,306	382	1,786
Expense ratio	0.012	0.012	0.005	0.001	0.026	0.012	0.012
Max. front load	0.013	0	0.018	0	0.058	0.010	0.013
Max. exit fees	0.006	0	0.009	0	0.040	0.006	0.006
I(Institutional fund)	0.198	0	0.345	0	1	0.211	0.193
I(Retirement fund)	0.015	0	0.101	0	1	0.024	0.012
I(Index fund)	0.076	0	0.265	0	1	0.119	0.061

Table II

Federal funds rate and the flow-performance relationship

The table below contains the estimates of the regressions of monthly per-unit flows on lagged end-of-month effective Federal funds rate, fund performance dummies, and their interaction terms. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)
Federal funds rate	−0.030	0.001		−0.191***	
	(0.021)	(0.029)		(0.045)	
I(Low performance)	−0.013***	−0.011***	−0.011***	−0.011***	−0.011***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)×		−0.076***	−0.079***	−0.071***	−0.074***
Federal funds rate		(0.025)	(0.025)	(0.025)	(0.025)
I(Medium performance)	−0.007***	−0.007***	−0.007***	−0.006***	−0.006***
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)×		−0.029	−0.030	−0.035*	−0.037*
Federal funds rate		(0.020)	(0.020)	(0.020)	(0.020)
Log MTNA	−0.003***	−0.003***	−0.004***	−0.004***	−0.005***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Log MTNA×				0.033***	0.035***
Federal funds rate				(0.005)	(0.005)
Volatility of returns	0.005	0.004	−0.045*	0.002	−0.046**
	(0.020)	(0.020)	(0.023)	(0.020)	(0.023)
Lagged per-unit flows	0.234***	0.234***	0.232***	0.233***	0.231***
	(0.012)	(0.012)	(0.012)	(0.012)	(0.012)
Log age	−0.014***	−0.014***	−0.013***	−0.014***	−0.014***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Expense ratio	−0.846***	−0.840***	−0.913***	−0.836***	−0.895***
	(0.117)	(0.117)	(0.113)	(0.116)	(0.112)
Maximum front load	−0.025	−0.025	−0.025	−0.023	−0.024
	(0.021)	(0.021)	(0.021)	(0.021)	(0.021)
Maximum exit fees	0.114***	0.114***	0.117***	0.103***	0.105***
	(0.032)	(0.032)	(0.031)	(0.031)	(0.031)

(Continued)

Table II–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)
I(Institutional fund)	−0.002*	−0.002*	−0.002*	−0.001	−0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Retirement fund)	−0.001	−0.000	−0.000	0.000	0.000
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
I(Index fund)	0.002	0.003	0.003	0.002	0.002
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Fund fixed effects	Yes	Yes	Yes	Yes	Yes
Month fixed effects			Yes		Yes
Observations	357,679	357,679	357,679	357,679	357,679
Adjusted R^2	0.154	0.154	0.165	0.155	0.166

Table III

CONTROLING FOR OTHER MACROECONOMIC VARIABLES

The tables below contain the estimates of the regressions of monthly per-unit flows on the lagged end-of-month effective Federal funds rate, fund performance dummies, and their interaction terms. The two panels likewise contain macroeconomic variables, which are interacted with performance in Panel A and with performance dummies in Panel B. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The levels and forecasts of the macroeconomic variables are their values from the previous quarter. Inflation rate is the annualized percentage change in the Consumer Price Index, while GDP growth rate is the annualized percentage change in the Gross Domestic Product. Unemployment rate is the rate of civilian unemployment. The forecasts are the median one-step ahead forecasts from the Survey of Professional Forecasters. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: Interactions of macro variables with performance

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	-0.169^{***}		-0.158^{***}		-0.182^{***}	
	(0.048)		(0.049)		(0.053)	
I(Low performance)	-0.001	-0.001	-0.002	-0.001	-0.002^{*}	-0.002
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)×	-0.113^{***}	-0.117^{***}	-0.085^{***}	-0.091^{***}	-0.078^{**}	-0.083^{***}
Federal funds rate	(0.026)	(0.026)	(0.029)	(0.029)	(0.030)	(0.030)
I(Medium performance)	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{***}	-0.002^{**}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)×	-0.056^{***}	-0.058^{***}	-0.042^{*}	-0.045^{**}	-0.038^{*}	-0.041^{*}
Federal funds rate	(0.020)	(0.020)	(0.021)	(0.021)	(0.022)	(0.021)
Inflation rate	0.015				0.021^{*}	
	(0.011)				(0.011)	

(Continued)

Table III–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Performance×	−0.026*	−0.027*			−0.029*	−0.029*
Inflation rate	(0.015)	(0.015)			(0.016)	(0.015)
GDP growth rate	−0.112*				−0.119	
	(0.063)				(0.091)	
Performance×	0.332***	0.333***			0.396***	0.403***
GDP growth rate	(0.074)	(0.075)			(0.137)	(0.137)
Unemployment rate	−0.037				−0.391	
	(0.030)				(0.245)	
Performance×	0.132***	0.134***			0.253	0.262
Unemployment rate	(0.014)	(0.014)			(0.328)	(0.329)
Inflation rate forecast			−0.242**		−0.250***	
			(0.095)		(0.088)	
Performance×			0.203**	0.192**	0.184**	0.173*
Inflation rate forecast			(0.079)	(0.078)	(0.089)	(0.088)
GDP growth rate forecast			0.006		0.101	
			(0.150)		(0.211)	
Performance×			0.220	0.223	−0.388	−0.397
GDP growth rate forecast			(0.207)	(0.204)	(0.335)	(0.332)
Unemployment rate forecast			−0.015		0.345	
			(0.029)		(0.240)	
Performance×			0.089***	0.093***	−0.147	−0.152
Unemployment rate forecast			(0.021)	(0.021)	(0.328)	(0.329)
Log MTNA×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects		Yes		Yes		Yes

(Continued)

Table III–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Observations	357,679	357,679	357,679	357,679	357,679	357,679
Adjusted R^2	0.156	0.167	0.156	0.167	0.157	0.167

Panel B: Interactions of macro variables with performance dummies

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	−0.056		−0.009		−0.062	
	(0.054)		(0.055)		(0.065)	
I(Low performance)	−0.004	−0.001	−0.005	−0.002	−0.006	−0.003
	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
I(Low performance)×	−0.096**	−0.120***	−0.108**	−0.128***	−0.097*	−0.120**
Federal funds rate	(0.045)	(0.044)	(0.043)	(0.041)	(0.052)	(0.049)
Inflation rate	−0.023				−0.017	
	(0.017)				(0.016)	
I(Low performance)×	0.021	0.021*			0.019	0.020
Inflation rate	(0.012)	(0.012)			(0.013)	(0.013)
GDP growth rate	0.295***				0.462***	
	(0.081)				(0.142)	
I(Low performance)×	−0.228***	−0.239***			−0.381***	−0.389***
GDP growth rate	(0.066)	(0.065)			(0.119)	(0.118)
Unemployment rate	−0.016				−0.335	
	(0.055)				(0.410)	
I(Low performance)×	−0.074	−0.100**			−0.286	−0.356
Unemployment rate	(0.050)	(0.049)			(0.316)	(0.313)
Inflation rate forecast			−0.113		−0.151	

(Continued)

Table III–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
			(0.145)		(0.145)	
I(Low performance)×			−0.012	−0.021	0.023	0.018
Inflation rate forecast			(0.110)	(0.108)	(0.123)	(0.121)
GDP growth rate forecast			0.277		−0.594	
			(0.257)		(0.400)	
I(Low performance)×			−0.138	−0.153	0.474	0.460
GDP growth rate forecast			(0.180)	(0.174)	(0.304)	(0.297)
Unemployment rate forecast			−0.014		0.287	
			(0.052)		(0.381)	
I(Low performance)×			−0.064	−0.087*	0.213	0.257
Unemployment rate forecast			(0.048)	(0.046)	(0.293)	(0.293)
I(Med. perf.)×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
I(Med. perf.)×Macro var.	Yes	Yes			Yes	Yes
I(Med. perf.)×Macro var. forecast			Yes	Yes	Yes	Yes
Log MTNA×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Month fixed effects		Yes		Yes		Yes
Observations	357,679	357,679	357,679	357,679	357,679	357,679
Adjusted R^2	0.149	0.163	0.148	0.163	0.149	0.163

Table IV

Fund age, the federal funds rate, and the flow-performance relationship

The table below contains the estimates of the regressions of monthly per-unit flows on the lagged end-of-month effective Federal funds rate, fund performance dummies, a fund age dummy, and their interaction terms. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The variable *I(Young fund)* is a dummy for a fund whose age belongs to the bottom quartile. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)
Federal funds rate			-0.172^{***}	
			(0.051)	
I(Young fund)	0.008^{***}	0.010^{***}	0.006^{***}	0.003^{*}
	(0.001)	(0.001)	(0.002)	(0.001)
I(Young fund)×			0.095^{**}	0.137^{***}
Federal funds rate			(0.039)	(0.038)
I(Low performance)	-0.013^{***}	-0.012^{***}	-0.003^{***}	-0.002^{**}
	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)×			−0.036	−0.047
Federal funds rate			(0.030)	(0.029)
I(Low performance)×		-0.002^{**}	0.002	0.002
I(Young fund)		(0.001)	(0.002)	(0.002)
I(Low performance)×			-0.147^{***}	-0.143^{***}
I(Young fund)×			(0.043)	(0.043)
Federal funds rate				
I(Medium performance)	-0.007^{***}	-0.007^{***}	-0.002^{***}	-0.002^{**}
	(0.000)	(0.000)	(0.001)	(0.001)
I(Medium performance)×			−0.018	−0.024
Federal funds rate			(0.022)	(0.021)
I(Medium performance)×		-0.002^{**}	−0.000	−0.000
I(Young fund)		(0.001)	(0.001)	(0.001)
I(Medium performance)×			−0.056	−0.055
I(Young fund)×			(0.034)	(0.034)
Federal funds rate				

(Continued)

Table IV–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)
Log MTNA×Fed funds rate			Yes	Yes
Performance×Macro variables			Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes
Month fixed effects				Yes
Observations	357,679	357,679	357,679	357,679
Adjusted R^2	0.149	0.149	0.153	0.166

Table V

Fund age, the 1-year Treasury yield, and the flow-performance relationship

The table below contains the estimates of the regressions of monthly per-unit flows on the lagged end-of-month 1-year Treasury constant maturity rate, fund performance dummies, a fund age dummy, and their interaction terms. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The variable *I(Young fund)* is a dummy for a fund whose age belongs to the bottom quartile. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)
1-year Treasury yield	-0.040^{*}	-0.242^{***}		-0.190^{***}	
	(0.022)	(0.057)		(0.053)	
I(Young fund)				0.005^{***}	0.002
				(0.002)	(0.002)
I(Young fund)× 1-year Treasury yield				0.108^{**}	0.159^{***}
				(0.043)	(0.041)
I(Low performance)	-0.013^{***}	-0.002	-0.001	-0.002^{**}	-0.002^{**}
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)× 1-year Treasury yield		-0.085^{***}	-0.088^{***}	-0.040	-0.049
		(0.032)	(0.031)	(0.031)	(0.030)
I(Low performance)× I(Young fund)				0.003	0.003
				(0.002)	(0.002)
I(Low performance)× I(Young fund)× 1-year Treasury yield				-0.158^{***}	-0.154^{***}
				(0.047)	(0.047)
I(Medium performance)	-0.007^{***}	-0.002^{**}	-0.002^{**}	-0.002^{**}	-0.002^{**}
	(0.000)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)× 1-year Treasury yield		-0.047^{**}	-0.049^{**}	-0.025	-0.029
		(0.023)	(0.023)	(0.023)	(0.023)
I(Medium performance)× I(Young fund)				0.000	0.000
				(0.001)	(0.001)
I(Medium performance)× I(Young fund)× 1-year Treasury yield				-0.066^{*}	-0.066^{*}
				(0.037)	(0.036)

(Continued)

Table V–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)
Log MTNA×1-yr Treas. yield		Yes	Yes	Yes	Yes
Performance×Macro variables		Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes
Month fixed effects			Yes		Yes
Observations	357,679	357,679	357,679	357,679	357,679
Adjusted R^2	0.154	0.157	0.167	0.153	0.166

Table VI

FUND AGE, VOLATILITY, THE FEDERAL FUNDS RATE, AND THE FLOW-PERFORMANCE RELATIONSHIP

The table below contains the estimates of the regressions of monthly per-unit flows on the lagged end-of-month effective Federal funds rate, fund performance dummies, a fund age dummy, fund return volatility, and their interaction terms. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. The variable *I(Young fund)* is a dummy for a fund whose age belongs to the bottom quartile. The volatility of excess returns is the standard deviation of the past year's monthly excess returns. The definition of the other fund controls are in the main text. Standard errors that are two-way clustered at the fund and month levels are shown in parentheses below the point estimates. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)
Federal funds rate			-0.339^{***}	
			(0.073)	
I(Young fund)	0.008^{***}	0.010^{***}	0.006^{***}	0.003^{*}
	(0.001)	(0.001)	(0.002)	(0.001)
I(Young fund)×			0.094^{**}	0.134^{***}
Federal funds rate			(0.039)	(0.037)
Volatility of returns	0.007	-0.028	-0.104^{***}	-0.134^{***}
	(0.018)	(0.025)	(0.039)	(0.037)
Volatility of returns×			3.020^{***}	2.591^{**}
Federal funds rate			(1.034)	(1.099)
I(Low performance)	-0.013^{***}	-0.017^{***}	-0.012^{***}	-0.010^{***}
	(0.001)	(0.001)	(0.002)	(0.002)
I(Low performance)×			0.098	0.054
Federal funds rate			(0.062)	(0.057)
I(Low performance)×		-0.002^{**}	0.002	0.002
I(Young fund)		(0.001)	(0.002)	(0.002)
I(Low performance)×			-0.138^{***}	-0.136^{***}
I(Young fund)×			(0.043)	(0.042)
Federal funds rate				
I(Low performance)×		0.087^{***}	0.153^{***}	0.116^{***}
Volatility of returns		(0.023)	(0.035)	(0.031)
I(Low performance)×			-1.908^{*}	-1.367
Volatility of returns×			(1.068)	(0.997)

(Continued)

Table VI–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)
Federal funds rate				
I(Medium performance)	Yes	Yes	Yes	Yes
I(Med. perf.)×Interacted variables		Yes	Yes	Yes
I(Med. perf.)×Fed funds rate			Yes	Yes
I(Med. perf.)×Int. var.× FF rate			Yes	Yes
Log MTNA×Fed funds rate			Yes	Yes
Performance×Macro variables			Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes
Month fixed effects				Yes
Observations	357,679	357,679	357,679	357,679
Adjusted R^2	0.149	0.150	0.153	0.166

Table VII

Controling for prior belief of managerial ability

The table below contains the estimates of the regressions of monthly per-unit flows on the lagged end-of-month effective Federal funds rate, fund performance dummies, a fund age dummy, and their interaction terms. Previous 12-month performance decile fixed effects are added in Panel A, while fund family fixed effects are included in Panel B. The dependent variable, monthly per-unit flows, is the monthly net flow divided by the total net assets at the start of the month. Monthly net flow is defined as

$$\text{MonthlyFlow}_{im} = \text{TNA}_{im} - (1 + R_{im})\text{TNA}_{it-1} - \text{ACQ}_{im},$$

where TNA_{im} is fund i's total net assets, R_{im} the monthly return, and ACQ_{im} the total net assets of any acquired mutual funds in month m. Performance is measured as the percentile of the previous month's 4-Factor Carhart alpha. The variable *I(Low performance)* takes value 1 if performance is in the lowest quintile, while *I(Medium performance)* is 1 if performance is in the three middle quintiles. Previous 12-month performance is computed as

$$\text{Alpha}_{im}^{12\text{m}} = \frac{1}{12} \sum_{m'=m-18}^{m-7} \left[R^e_{im'} - \hat{\beta}^{\text{MKT}}_{im'} \text{MKT}_{m'} - \hat{\beta}^{\text{SMB}}_{im'} \text{SMB}_{m'} - \hat{\beta}^{\text{HML}}_{im'} \text{HML}_{m'} - \hat{\beta}^{\text{MOM}}_{im'} \text{MOM}_{m'} \right]$$

where $R^e_{im'}$ is the excess return of fund i in month m', $\text{MKT}_{m'}$, $\text{SMB}_{m'}$, and $\text{HML}_{m'}$ are the three Fama-French factors, and $\text{MOM}_{m'}$ the momentum factor. The variable *I(Young fund)* is a dummy for a fund whose age belongs to the bottom quartile. The definition of the other fund controls are in the main text. Standard errors are shown in parentheses below the point estimates. In Panel A, they are two-way clustered at the fund and the month levels. Standard errors are two-way clustered at the fund family and the month levels in Panel B. The superscripts *, **, and ** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A: 12-month performance decile fixed effects

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	−0.125***			−0.149***		
	(0.046)			(0.046)		
I(Young fund)				0.001	−0.001	−0.000
				(0.001)	(0.001)	(0.001)
I(Young fund)×				0.124***	0.148***	0.137***
Federal funds rate				(0.041)	(0.040)	(0.040)
I(Low performance)	−0.002***	−0.002**	−0.002**	−0.003***	−0.002***	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)

(Continued)

Table VII–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
I(Low performance)× Federal funds rate	−0.054*	−0.061**	−0.064**	−0.038	−0.047*	−0.051*
	(0.028)	(0.028)	(0.027)	(0.028)	(0.027)	(0.027)
I(Low performance)× I(Young fund)				0.002	0.002	0.002
				(0.002)	(0.002)	(0.002)
I(Low performance)× I(Young fund)× Federal funds rate				−0.133***	−0.119**	−0.110**
				(0.050)	(0.050)	(0.049)
I(Medium performance)	−0.002***	−0.002***	−0.002***	−0.003***	−0.002***	−0.002***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)× Federal funds rate	−0.009	−0.013	−0.019	0.002	−0.003	−0.009
	(0.019)	(0.019)	(0.018)	(0.019)	(0.019)	(0.018)
I(Medium performance)× I(Young fund)				0.002	0.002	0.002
				(0.001)	(0.001)	(0.001)
I(Medium performance)× I(Young fund)× Federal funds rate				−0.095***	−0.093***	−0.088**
				(0.035)	(0.035)	(0.035)
Log MTNA×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
Performance×Macro variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Fund fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
12-mo. perf. decile fixed effects	Yes	Yes		Yes	Yes	
Month fixed effects		Yes			Yes	
12-mo. perf. decile×Month FE			Yes			Yes
Observations	279,590	279,590	279,590	279,590	279,590	279,590
Adjusted R^2	0.177	0.192	0.198	0.178	0.192	0.198

(Continued)

Table VII–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Panel B: Fund family fixed effects						
Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
Federal funds rate	−0.033			−0.097*		
	(0.056)			(0.055)		
I(Young fund)				0.006***	0.006***	0.006***
				(0.002)	(0.002)	(0.002)
I(Young fund)× Federal funds rate				0.103**	0.107**	0.135***
				(0.042)	(0.042)	(0.046)
I(Low performance)	−0.002**	−0.002*	−0.002	−0.002	−0.001	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Low performance)× Federal funds rate	−0.075**	−0.088***	−0.093***	−0.044	−0.059*	−0.059*
	(0.032)	(0.031)	(0.034)	(0.031)	(0.031)	(0.032)
I(Low performance)× I(Young fund)				−0.001	−0.002	−0.002
				(0.002)	(0.002)	(0.002)
I(Low performance)× I(Young fund)× Federal funds rate				−0.103**	−0.099**	−0.118**
				(0.051)	(0.050)	(0.056)
I(Medium performance)	−0.002***	−0.002***	−0.002***	−0.002**	−0.002**	−0.002**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
I(Medium performance)× Federal funds rate	−0.034	−0.042*	−0.031	−0.022	−0.030	−0.016
	(0.024)	(0.023)	(0.024)	(0.023)	(0.023)	(0.023)
I(Medium performance)×				−0.002	−0.002	−0.002

(Continued)

Table VII–*Continued*

Dependent variable: *Per-unit flows*	(1)	(2)	(3)	(4)	(5)	(6)
I(Young fund)				(0.002)	(0.002)	(0.002)
I(Medium performance)×				−0.039	−0.035	−0.050
I(Young fund)×				(0.041)	(0.041)	(0.047)
Federal funds rate						
Log MTNA×Fed funds rate	Yes	Yes	Yes	Yes	Yes	Yes
Performance×Macro variables	Yes	Yes	Yes	Yes	Yes	Yes
Fund-level controls	Yes	Yes	Yes	Yes	Yes	Yes
Family fixed effects	Yes	Yes		Yes	Yes	
Month fixed effects		Yes			Yes	
Family×Month FE			Yes			Yes
Observations	343,148	343,148	298,856	343,148	343,148	298,856
Adjusted R^2	0.130	0.143	0.185	0.133	0.146	0.189