PRELIMINARY (Incomplete) DRAFT
Please do not circulate
or attribute.

April 23, 2017

Interest Rates and Risk Aversion: Evidence from Money Market Fund Investors

Mark J. Flannery*

ABSTRACT

In a low-interest-rate environment, financial firms and/or their investors may accept an unusually large risk for a given expected return premium. There is convincing evidence that firms behave this way, but the evidence about individual investors is less well developed. Do investors change their risk preferences when market interest rates are low? We examine the flow-performance relation at U.S. money market funds and find that investors respond more strongly to return differentials when market rates are low. We conclude that changes in investors' risk preferences reinforce the incentives of financial firms to shift toward riskier portfolios when market rates are low.

* BankAmerica Professor of Finance, University of Florida, flannery@ufl.edu. I began this project while serving at the Chief Economist the U.S. Securities and Exchange Commission, where Maxwell Clarke provided extraordinary research assistance and data analysis.

1. **Introduction**

As world interest rates have remained at historically low levels since the financial crisis, the popular press and academic literature have repeatedly described a "reach for yield" (RFY) behavior that has two complementary aspects. First, on the "supply" side, financial institutions are driven by low interest rates to shift into higher-yielding, but riskier, securities in order to earn higher expected returns (Rajan (2005)). For example, a life insurance company may have outstanding insurance or annuity obligations that depend on earning some minimum long-term return. When available market returns fall, the insurance company may become unable to satisfy those obligations from its traditional investment strategy. The company might substitute into higher-yielding, but riskier, assets in order to increase the probability of fulfilling its contractual obligations. Similarly, some money market funds (MMFs) chose to subsidize operating expenses when rates fell in the crisis, shifting into higher-risk assets reduced the amount of that subsidy (Kacperczyk and Schnabl (2013), Chodorow-Reigh (2014)). Similar tendencies have been documented for other intermediaries.[1]

The second ("demand side") manifestation of RFY behavior concerns the effect of market rates on investors' risk preferences. Investors may accept more risk for a given expected return when rates are low:

> The low-rate environment and improved economic conditions are encouraging greater risk-taking across the financial system as investors are more likely to accept incremental gains in yield for disproportionate amounts of risk. (Financial Stability Oversight Council (2015), page 106)

[1] For example. Aramonte et al. (2015) find that U.S. banks increase the riskiness of their syndicated loans when rates fall, in order to satisfy the rate-dependent risk preferences of nonbank intermediaries. Chodorow-Reich (2014) concludes that money market funds reached for yield in 2009-2011, but not afterwards. Hanson and Stein (2015) suggest that "yield-oriented investors" (like banks) may be responsible for the otherwise puzzling effect of monetary policy on long-term interest rates. According to DiMaggio and Kacperczyk (20??, page 61),"Maddaloni and Peydró (2011) find that low short-term rates soften lending standards for retail and corporate loans. Jimenez, Ongena, Peydró, and Saurina (2014) show that lowering overnight interest rates induces less-capitalized banks to lend to riskier firms."

In other words, the required expected return premium on a fixed risk may be positively correlated with interest rate levels. At a 1% riskless rate, an investor might be willing to purchase commercial paper at a 30 bp return premium over Treasuries. But at a 5% riskless rate, the required return premium on equally risky paper would be higher – say 50 bp.

Reaching for yield could have broad future macroeconomic implications. For example, Chodorow-Reich (2014, p. 158) observes that "Policymakers may therefore be directly concerned about limiting reaching for yield if it causes risk premia to fall below their first-best level." Similarly, a private research company writes:

> The portfolio rebalancing that is produced by loose monetary policy can, however, become dangerous if it results in the valuations of riskier assets becoming excessively inflated. This is because bubbles inevitably burst, with adverse effects on the economy. (Capital Economics (2016))

If (when?) rates subsequently rise, investors will revert to a more normal required compensation for risk. Risky assets may therefore suffer large value declines as investors shift their portfolios toward lower-risk securities at higher interest rate levels.

If investors' risk aversion were independent of the interest rate level, supply-side pressures alone could generate RFY. However, intermediary portfolios would shrink as investors withdrew their funds from intermediaries shifting into riskier investment portfolios. However, if risk aversion declines with interest rates, institutional RFY would be reinforced by changes in customers' risk preferences, encouraging RFY and perhaps increasing institutions' sizes at lower market rates. If risk aversion moves inversely with interest rates, the supply of funds would fall to intermediaries that move into riskier assets. A levered firm's expected profits might still increase with the riskiness of its portfolio, but the optimal risk would be reduced by customers' higher risk aversion in a low-rate environment. Accordingly, financial institutions' optimizing decision to reach for yield implies very little about the ultimate investors' preferences. The question of investors' risk preferences cannot be answered solely by observing levered intermediaries' portfolios.

Unlike levered financial institutions, mutual funds' risk-taking behavior may directly reflect their customers' risk preferences. A large literature documents that managerial risk-taking reflects the terms of a portfolio manager's compensation contract (e.g. Brown, Harlow, and Starks (1996), Chevalier and Ellison (1997) and Chen and Pennacchi (2009)). Since mutual fund managers earn fees in proportion to their assets under management (AUM), they rationally reach for yield (take more portfolio risk) when the higher resulting expected returns will attract new investor dollars. Unlike the case of levered intermediaries, mutual funds' reach for yield must complement investors' preferences.[2]

The complexity of mutual fund portfolios has limited researchers' ability to identify risk shifting at stock or bond mutual funds. (Choi and Kronlund (20??) is an exception, discussed below.) MMF portfolios are much simpler than those of other mutual funds because their portfolio choices are tightly limited by the SEC's rule 2-a7. With less room for changing asset risks, MMF flow-performance measures are more likely to reflect their investors' risk preferences. (In other words, MMF risks are relatively constant on account of their limited range of permissible investments.) This paper examines the monthly flow-performance relationship at U.S. prime MMFs during the period 2002-2016 to infer how changes in the riskless interest rate affect investors' risk-taking preferences.

We follow many other researchers in specifying a flow-performance relation for MMF as:

$$Flow_{i,t} = \alpha + \beta R_i + \delta X_{i,t} + \tilde{\varepsilon}_{i,t} \tag{1}$$

where $Flow_{i,t}$ is the monthly increase in fund size, net of earned interest, as a proportion of the prior month-end's assets under management.

R_i is some combination of the fund's return over the recent past,

$X_{i,t}$ is a vector of control variables describing fund or market conditions.

Following Sirri and Tufano (1998), Chevalier and Ellison (1997), and many others, $Flow_{i,t}$ is defined as the monthly change in a fund's assets net of internal growth:

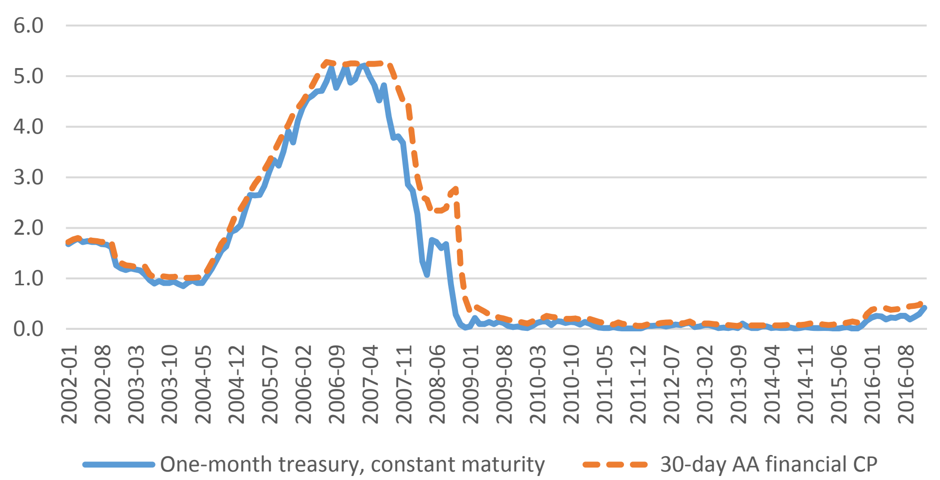
$$Flow_{i,t} = \frac{TNA_{i,t} - TNA_{i,t-1}(1+R_{i,t})}{TNA_{i,t-1}} \tag{2}$$

[2] Customers may, or may not, fully understand their institution's portfolio changes (Becker and Ivashina (2015), Choi and Kronlund (2016), Sensoy (2009), and Del Guercio and Reuters (2014))..

where $TNA_{i,t}$ is the net asset value for fund *i* at the end of month *t*. The coefficient of interest in equation (1) is β, which measures the flow of new investment funds to fund i given its recent performance. A larger β indicates that a given increase in a MMF's return is more attractive to investors. Perhaps more intuitively, β and investor risk aversion are inversely related. A larger β means that investors will accept the same portfolio risk for a smaller return.[3] We examine the movement of estimated β values over time, particularly in relation to the level of market interest rates.

Figure 1 plots the level of short-term market interest rates, measured by the secondary market return on 30-day Treasury bills and the rate on 30-day financial company commercial paper, for our sample period (January 2002 through December 2016). The sample includes a wide range of values for these (and other) short-term rates. Both rates declined following the brief recession in March through November of 2001, then rose about 400 bps in the two years following mid-2004. The initial market turmoil in August 2007 was followed by a sharp rate decline,[4] with a further sharp decline in the second

Figure 1: Short-term interest rates



[3] This statement assumes that MMF portfolio risks do not change. See the further discussion below, in Section 3??.

[4] Note that the CP rate gaps out from the TB rate starting in about 2006, creating the opportunity for MMF to increase their returns by moving into riskier securities. See Kacperczyk and Schnabl (2013) and DiMaggio and Kacperczyk (2017).

half of 2008. By the end of 2008, the bill rate had fallen to 3 bps. It remained very low until the end of 2015, and finished the sample period at 42 bps. This variation in the level of riskless rates may permit powerful tests of the hypothesis that MMFs' flow-performance relationship varies with the level of riskless rates.

To assess the impact of market rates on investors' risk aversion, we estimate a cross-sectional flow-performance relationship for active money market funds over time. We estimate β using both panel and Fama-MacBeth models. We compute our estimates separately for retail and institutional MMF share classes. For both investor types, we find that MMFs' flow-performance sensitivity is greater when riskless interest rates are lower, consistent with the hypothesis that investors become less risk-averse at lower market rates. For example, one of our estimates indicates that raising the treasury rate from 0% to 6.75% reduces the three-month flow-performance coefficient for retail fund shares from 11.41 to zero. While others have provided ancillary evidence about the rate-sensitivity of MMF flow-performance relations for institutional shares, we believe that the relation for retail shares is new to the literature.

The paper is organized as follows. Section 2 reviews the literature on reaching for yield in financial markets, especially at money market mutual funds. Hypotheses and regression specifications are presented in Section 3. Section 4 describes data sources and Section 5 reports results. The final section concludes.

2. Literature Review

Extensive research has concluded that mutual fund flows depend on the fund's recent performance (returns), as in regression (1) above.[5] We can view β as MMF investors' sensitivity to higher (or lower) fund returns. A larger β means that investors will invest more funds in the MMF's risky portfolio at a lower expected return. If investors risk aversion falls – perhaps in response to changes in the riskless rate of interest – we should observe funds experiencing a higher flow per unit of returns,

[5] References for stock and bond funds. Kacperczyk and Schnabl (2013) and DiMaggion and Kacerpczyk (2017) conclude similarly for MMFs.

ceteris paribus. Because risk-shifting benefits a fund manager only if the revised risk-return combination proves more attractive to investors, MMF fund flows should therefore provide evidence about the effect of interest rates on investors' risk preferences.[6]

Previous MMF studies have focused quite directly on how MMF reacted to low market rates that disrupted their traditional business model. Part of these studies, however, required an understanding of how MMF portfolio characteristics affected investors' demand for MMF shares. We now discuss three aspects of prior MMF studies: the extent to which MMF increased their portfolio risks when market rates dropped, the statistical and economic significance of β in (1), and differences between retail and institutional fund shareholders.

A. MMF Risk-shifting

Several recent papers point out that very low market rates disrupted MMFs' traditional value proposition: when attainable portfolio yields fell, fund managers could not provide positive returns to MMF investors without absorbing some of the administrative costs of running the funds. In response to the decline in riskless rates, some U.S. MMFs closed. Others shifted toward higher-yielding, but riskier, assets in order to reduce the extent of required subsidies.[7]

Kacperczyk and Schnabl (2013) (hereafter, KS) evaluate asset substitutions using weekly MMF data between January 2006 and August 2008. They begin by demonstrating (Figure II) that private money market instrument spreads widened out quite substantially during the summer of 2007. This afforded at least some MMF the opportunity to reach for yield by increasing their concentrations in private (as opposed to government-issued) securities. Indeed, KS say that "our main message is that

---

[6] Our analysis discusses below the effect of changing portfolio risk on investor preferences. This possibility is particularly relevant to our analysis because prior authors have concluded that MMFs shifted into riskier portfolios as market rates stayed low (Kacpercyzk and Schnabl (2013), DiMaggio and Kacpercyzk (2017)).

[7] Christopherson (2001) contends that it is difficult to change the terms of a mutual fund's offering prospectus. Rather than set their stated fees low, therefore, many funds state high fees and provide voluntary "fee rebates".

MMF are risky." (page 1079). They focus on identifying which MMF tended to increase their risks. They hypothesize that MMF operated by more extensive fund families should be more interested in maintaining MMF balances, because those customer relationships yield positive earnings in non-MMF activities. They find that MMF in larger fund families were more likely to shift toward higher-paying assets when market rates fell. KS also find that fund families with less non-MMF AUM were more likely to close their MMF as market rates remained low.

Di Maggio and Kacperczyk (2017) (hereafter, DK) seek to understand the impact of sharply. lower market rates on the industrial organization of the MMF "industry". They examine weekly fund information over the sample period 2005-2013. During that period, they identify no significant relation between the level of market rates and MMF portfolio risk when the annual, one-year Treasury rate exceeds 1%, At lower market rates, however, DK document higher MMF portfolio risks at lower market rates. (See their Table 7.)

Chodorow-Reich (2014) investigates reach for yield behavior in banks, life insurance companies, MMF, and pension funds. For the MMF, he demonstrates (Table 3) that funds with higher administrative expenses chose slightly riskier asset portfolios in 2009-2011. However, "the effects appear quite small in economic terms" (page 189) and "most dissipated by 2012" (page 199). He attributes the attenuation of MMF risk-shifting to two developments. First, the yields on riskier money market instruments had shrunken considerably after the crisis (his Figure 13). Second, the SEC's 2010 MMF regulations severely limited the extent to which funds could avail themselves of any remaining risk-shifting opportunities.

La Spada's (2017, pages 33, 37) findings about risk-shifting contradict those of DK and KS. He concludes that <u>higher</u> rates encourage MMF to shift toward riskier assets. In his model, funds seek to maximize yield while avoiding the danger of "breaking the buck." Higher yields are riskier, and therefore make it more likely that the NAV will fall below $0.995. Because a higher riskless rate reduces the probability of a fund "breaking the buck" it can afford to invest in <u>riskier</u> assets.

Strahan and Tanyeri (2015) evaluate the hypothesis that MMF shifted into riskier assets in response to the federal government's introduction of an MMF guarantee in the wake of Lehman's failure.

(Their sample runs from mid-September through yearend 2008.) Their main finding is that risky MMF experienced withdrawals in the wake of Lehman's failure, which they met by selling their safer assets. Within a quarter, however, these funds' asset risks had been restored to their initial levels. The government's MMF guarantee program did not encourage higher risk-taking by the affected MMFs.

Outside of MMFs, Choi and Kronlund (2016) evaluate bond mutual fund investment manager's incentive to RFY over the period 2002-2012. They define several types (manifestations) of reaching for yield: selecting bonds that have high yields for their ratings notch, for their maturity, or for the combination of their ratings and their maturities. They show that the typical investment-grade bond fund holds primarily assets rated between BBB- and AA+. Within each rating category, however, Choi and Kronlund identify a tendency for funds to hold the highest-yielding (and hence presumably most risky) available bonds, as shown by Becker and Ivashina (2015) for life insurance companies. Moreover, bond funds exhibit more reaching for yield when the term structure is lower and flatter (their Table 2).

B. Flow-performance Relationships for MMF

The discussion so far has focused on whether MMF increased their portfolio risks in order to provide higher yields. An equally important question is how investors react to riskier MMF yields. Several researchers have estimated a flow-performance relationship for MMFs.[8] For example, KS estimate the following regression model using weekly data over the period January 2006-August 2008:

$$Flow_{i,t+1} = \alpha_t + \beta\, Spread_{i,t} + \gamma X_{i,t} + \tilde{\varepsilon}_{i,t+1} \tag{3}$$

where ***Flow*** is the weekly increase in fund size, net of investment returns, as a proportion of the prior week's assets under management

Spread is the i^{th} fund's gross yield during the prior week, net of the one-month Treasury bill rate,

$\boldsymbol{X_{i,t}}$ is a vector of control variables,

They estimate several versions of (3) separately for a "pre-crisis" period (January 2006-July 2007) ad a "post crisis" period (August 2007 – August 2008). For institutional funds, the estimated β is small and

8 Two of these papers provide limited information on how interest rate levels affect a MMF's flow-performance relationship. In both of these papers, however, the flow-performance relation is a distinctly secondary concern.

insignificant during the pre-crisis period (their Table III). During their "post-crisis" period, however, they find an economically and statistically significant positive estimate for β. Taking these results at face value, institutional MMF apparently confront a flow-performance tradeoff only at relatively low ("post-crisis") interest rates. [9]

KS's time period is not ideal for establishing the impact of low rates on MMF flows, primarily because their sub-periods do not completely separate low from high market interest rates.. The average "post crisis" treasury rate is 3.49%, compared to the "pre-crisis" average of 5.09%. The transition to the lowest market rates did not occur until December 2008, which lies outside of KS' sample period.

DK study the effect of higher yields on fund flows by estimating the following regression using weekly data on the universe of prime U.S. money funds over the 2005-2013 time period:[10]

$$Flow_{i,t+1} = \alpha_t + \beta\, Spread_{i,t} + \gamma X_{i,t} + \delta(D_{Low\ Rates})(Spread_{i,t}) + \tilde{\varepsilon}_{i,t+1} \tag{4}$$

where ***Flow*** and ***X*** are the same as in (2),

$\boldsymbol{R_{i,t}}$ is the annualized fund return during the prior week, and

$\boldsymbol{D_{Low\ rates}}$ is a dummy variable equal to unity during weeks when the Fed funds target was between 0 and 1%.

Their Table 3 reports that the estimated δ is positive and highly significant. In words, the flow-performance sensitivity is higher when the Fed's interest rate target is below 1%.

DK's and KS's single-period effect of fund return on flow may be too simple to capture investors' behavior. Aside from theoretical insights, the models' implied effects of recent fund returns on subsequent flows are extremely (implausibly?) large. DK's estimated β in (4) implies that a one standard deviation increase in ***Spread*** induces a 2.08% inflow the following week. Cumulating this effect, DK

[9] KS present analogous results for retail MMF in their Table V, and find a significant flow-performance coefficient only in the "Pre" period.

[10] DK find that MMF are more likely to exit the industry when lower rates become more likely. They also show that money funds hold riskier assets and provide higher returns when the Fed makes announcements implying that the likelihood of continued low rates. (See their Table ??.)

conclude that "in one year, a fund with a one-standard-deviation higher return than the average would almost double its size relative to the average fund." (pages 65-66). During weeks when the Fed funds rate is below 1%, this estimated effect increases by about one-third – the relative value of $\hat{\delta}$ in (4). KS reach a slightly more moderate, but still suspiciously large, conclusion about institutional prime MMFs during the period 8/1/2007 through 8/31/2008: "a 1 standard deviation increase in fund yields raises annualized fund assets by 43%." (page 1077) Such large estimates of the effect of MMF returns on fund size may reflect an inappropriate regression specification, at least for weekly data.[11]

In the context of bond mutual funds, Choi and Kronlund (2016) conclude (see their Table 4B) that funds attract more new funds by reaching for yield when market rates are low.

C. *Investor classes*

Many mutual funds, including many MMF, offer several share classes that have a claim on the earnings of a single portfolio. Share classes intended for institutional investors tend to have larger minimum investments and lower fees than the share classes intended for retail investors.[12] One might expect institutionally-oriented share classes to respond to institutional preferences, including those that lead investors to seek higher expected returns when market rates fall. By contrast, individuals' risk preferences will be reflected in the flow-performance relationships estimated for retail share classes.

Prior research has yielded conflicting conclusions about the preferences of institutional vs. retail MMF investors. Several authors (Citations??) omit "retail" funds from their samples entirely, motivated by the conjecture that "institutional" MMF investors are more sensitive to fund return differentials than "retail" investors. For example, La Spada (2017) offers this justification for

[11] The specification apparently assumes that a rate increase that has persisted for many weeks has the same marginal effect on flows as it did in the first week it occurred.

[12]. Funds that sell through independent (unaffiliated) investment advisers can design separate share classes within each fund, with the share terms designed to satisfy the investment advisers.

evaluating only funds that included institutional share classes.[13] Chernenko and Sunderam (2014, Table 3) find that institutional investors react more strongly to MMF return differences than retail investors do in early 2011, while Strahan and Tanyeri (2015) report that institutional and retail funds exhibit similar-sized, significant flow-performance effects in the weeks immediately following Lehman's collapse. (See their Table 3.) As noted above, KS report different flow-performance results for retail and institutional MMFs. DK estimate a single flow-performance regression for all funds, including only an additive shift term to separate institutional from retail funds. This specification constrains institutional and retail share classes to have the same flow-performance estimated coefficient.

Previous researchers' decision to evaluate flows at the fund level may add noise to their analysis by muddying the distinction between retail and institutional shares. (Citations??) KS (page 1091) "classify a fund as institutional if it offers at least one institutional class and as retail if it does not offer institutional share classes." They compute expense ratios and other fund characteristics as weighted averages across the share classes within each fund.. DK (page 63) and La Spada (2017, page 27) follow the same procedures. In contrast to these studies, we conduct our analysis at the share-class level, permitting us to identify retail and institutional investors more accurately.[14] Because share class returns are correlated, we cluster our estimated standard errors at the fund level.

---

[13] DK include among the controls in their flow-performance regression ((n) above) an additive dummy variable identifying institutional funds. This inclusion does nothing to differentiate the possible responsiveness of institutional and retail MMF investors to fund returns. They do offer a footnote reporting that estimation results based only on institutional shares "are qualitatively similar" to those based on the full dataset. .

[14] The noise introduced by previous authors' criteria for categorizing fund investors may not have serious results. For example, KS note in a footnote (page 1091) that they obtain similar results when they include only institutional share classes in their analysis. Similarly, Strahan and Tanyieri's (2015) primary results come from estimations undertaken at the fund level, but they report in a footnote (page 125) that share-class-level flow data yielded "similar results to those reported below."

3. Hypotheses and Regression Specifications

Flow-performance relationships have been used extensively to capture the attractiveness of a mutual fund to current and potential investors (e.g. Sirri and Tufano (1998)). The suggestion that investors "reach for yield" in a low interest-rate environment implies that they accept a lower expected return per unit of risk when riskless rates are low. Holding constant a fund's risk, therefore, a larger flow should be associated with a given return differential, *ceteris paribus*, when market rates are lower. We test this hypothesis by estimating a series of monthly flow-performance relationships for U.S. MMF over the period January 2002 – December 2016 (180 months). We examine the impact of riskless market rates on flow-for-performance in two ways: a panel regression model and a series of (Fama-MacBeth) cross-sectional regressions.

A. Panel Estimation Specification:

Past specifications of MMF flow-performance regressions such as (2) or (3) warrant discussion.[15] First, MMF flows are restricted to reflect only the most recent period's fund return. Yet investors' reactions to a rate change might plausibly take longer than one period, and might plausibly remain relevant for more than a single period's flow. This seems particularly likely when the estimation period is a single week.[16] Second, and related, any yield change elicits a flow, regardless of its duration. Third, specification (3) measures fund performance in absolute terms, rather than relative to a riskless rate. Although this specification is legitimate in cross-sectional (Fama-MacBeth) regressions, intertemporal (panel) regressions should incorporate changes in the riskless rate over time and thereby express a fund's excess return as causing asset flows.

[15] Flow-performance specifications applied to other types of mutual funds have generally been more refined.

[16] We comment above that the annualized effect of a one standard deviation crease a funds return appear to be implausibly large. In part this may reflect the authors' apparent assumption that a rate increase that has persisted for many weeks has the same marginal effect on flows as it did in the first week it occurred.

A richer specification than (2) or (3) might yield substantially different results. We adjust the specification and estimate

$$Flow_{i,t} = d_i + \sum_{k=1}^{3} \beta_k R_{i,t-k} + RTB_t \sum_{k=1}^{3} \alpha_k R_{i,t-k} + c * RTB_t + \gamma * Controls_{i,t} + \tilde{\varepsilon}_{i,t} \qquad (5)$$

where $Flow_{i,t}$ is the inflow of new investments to fund i during month t, as defined above in (2)

$R_{i,t-j}$ is the i[th] MMF's return during month t-j, j = 1,3 ?

RTB_t is the average yield on a 1-month constant maturity Treasury during month t.

Controls = a set of control variables commonly used in the literature.

Fund Age$_{i,t}$ = number of days the fund has reported on the CRSP Mutual Fund file,

$TNA_{,I,t}$ = total net assets of the fund of which i is a class, measured at the end of month t

Industry Growth is the net flow of new funds to the entire set of MMF included in the regression at date t:

$$Industry\ Growth_t = \frac{\sum_i (TNA_{i,t} - TNA_{i,t-1}(1+R_{i,t}))}{\sum_j TNA_{j,t-1}} \qquad (6)$$

where $TNA_{i,t}$ and $R_{i,t}$ are share class i's total assets and return for the month t. *Industry Growth*$_t$ is computed separately for retail and institutional share classes.

This specification expands the time period during which a return innovation can affect fund flows, to three months. The usual type of flow-performance sensitivity should manifest as significantly positive β_j coefficients, or as a positive sum to two or three of the coefficients. We also permit the flow-performance coefficient $(\beta_k + \alpha_k RTB_t)$ to depend on the level of market rates. Investors' "reaching for yield" behavior will manifest as negative values of the α_k. If investors are willing to accept more risk per unit of expected compensation when the treasury rate is lower – that is, if investors reach for yield – we should find negative values for one or more α_k coefficients, and perhaps for their sums. Regression (5) includes two fund-level control variables (***Fund Age*** and ***TNA***) previously used by Chevalier and Ellison (Date?) and KS, among others. The variable ***Industry Growth*** is included to distinguish between investment flows between sample MMF, and those originating from outside the MMF industry. The idea is that when funds are flowing into the industry, the flows may not be fully captured by the β_k if investors tend to deposit additional funds into existing accounts. Differences in relative MMF returns will affect fund flows among MMF, while an aggregate change in investor preferences for MMF shares will affect many funds in the same direction. Standard errors are clustered by fund to avoid an unrepresentative influence of multiple share classes within the same fund.

What does the coefficients on lagged fun yields tell us? Assume the market is in equilibrium, with each investor holding the amount of MMF shares that balances his expected return against his perceived risk. Hold risk constant. Then a larger flow for a given yield differential means that the MMF shares have become more attractive: at the same yield, investors more willing to take the risk in in the MMF portfolio. If investors bear costs of ***Flow***, they are indicating that they value the extra return more than they had when beta was lower.

The estimated regression model (5) ignores the riskiness of fund returns. How does this omission affect the implications of β for investors' risk preferences? The cleanest case comes from assuming that MMF portfolio risks remained constant over time. Then β measures investors' willingness to adjust their investment portfolios in response to a change in an MMF's relative return. An increase (decrease) in β implies that the same return has become more (less) attractive. A flow-performance coefficient that does not vary with interest rates would imply constant risk preferences. In contrast, an estimated β that varies with market rates implies that risk aversion also varies, as evidenced by investors' varying willingness to hold a MMFs shares in response to a change in the fund's return. Alternatively, a flow-performance coefficient that is larger during periods of low rates (as we find here) implies that investors find a unit of return more valuable when returns are low. This would give rise to investor-initiated RFY behavior.

How would the potential for changing portfolio risk at MMF affect our inferences? Specifically, how would a tendency of MMF to increase their portfolio risk (as documented by previous authors) affect our interpretation of the estimated β? The flow-performance coefficient now measures the net effect of two offsetting effects: lower market rates encourage fund inflows because investors are more willing to take risks, while the rise in MMF portfolio risks tends to discourage inflows. A positive coefficient indicates that the change in investor preferences (RFY) exceeds the effect of the change in portfolio risk.

An increase in MMF portfolio risk therefore works against finding an interest-sensitive flow-performance relationship in the data.

By contrast, our methodology may be rendered uninformative if MMF generally reduce their risks when market rates fall. In this situation, a higher β at lower market rates might reflect either a reduction in investor risk aversion or the increased attractiveness of the same return at a lower risk. This ambiguity would make it impossible to identify changing risk preferences using only regression (N). Fortunately, the evidence indicates that MMF risk-taking rises when rates fall, leaving the logic of our interpretation of the fund flow coefficient qualitatively unaffected.

B. Fama-MacBeth Regression Specification

As an alternative test for the interest-sensitivity of investor preferences, we estimate the following cross-sectional regression specification monthly and combine those estimated coefficients as in Fama-MacBeth (1973):

$$Flow_{i,t} = \alpha + \sum_{k=1}^{3} \beta_k R_{i,t-k} + \beta_4 FundAge_{i,t} + \beta_5 TNA_{i,t} + \tilde{\varepsilon}_{i,t} \tag{7}$$

where the variables are defined immediately following the panel regression specification (5).[17] A larger β_k (or their sums) in (7) indicates a more pronounced flow-performance effect. That is, for the same small change in lagged performance one would expect a higher asset flow. In addition to examining the magnitudes and significance of the individual return coefficients (and their sum) for the entire sample period (or sub-periods), we evaluate how they vary with the level of market rates over the sample period. As for the panel estimates, we estimate (7) separately for retail and institutional share classes, clustering the standard errors at the fund level.

4. Data

[17] We omit the current Treasury rate and industry growth from (7) because they are constant across the sample within a month.

Our sample of money market funds includes all mutual funds identified as money market funds on the CRSP Survivor-Bias-Free US Mutual Fund Database. We collect monthly returns, total net assets and fund characteristics for each share class. (Recall that previous researchers generally analyze fund-level data.) CRSP identifies each share class as oriented toward retail or institutional clients. The sample period runs from January 2002 through December 2016 (180 months). We drop observations for which the share class is not open to new investment, We also drop (as unrepresentative) observations for which net total assets more than double or result in a zero asset value, observations for which net assets do not change despite a positive reported, and observations for which the monthly asset growth rate exceeds ??%.

Each share class is associated with a unique fund ("portfolio") and about ??% of the listed funds include multiple share classes. Share classes within the same fund hold claims to the same portfolio of assets; their returns differ by the amount of their differential fees. We use this portfolio number to cluster share class returns in our estimated regressions.

Our data describe a total of **N** share classes, of which **NN** come from funds with only retail shares classes, **NNN** come from funds with only institutional share classes, and **NNNN** come from funds with a combination of the two. The final sample contains 1,308 unique institutional share classes and 1,267 unique retail share classes across 180 months, for a total of 194,572 month-fund combinations. For any given month, the number of retail (institutional) share classes varies between 356 and 589 (342 to 788). After deletions for suspect or incomplete data, we have 999,999?? month-share class observations on ???? (????) unique retail (institutional) share classes.

In addition to information about MMF characteristics, our dataset incorporates the two market rates plotted in Figure 1: the yield on a 1-month constant maturity U.S. Treasury bill and the annualized yield on 30-day AA-rated nonfinancial commercial paper, both obtained from the Federal Reserve's H.15

release. We use the Treasury bill rate (RTB) in our regressions to proxy for the overall level of market rates.

Table 1 reports summary information about the variables used in our subsequent analysis, separately for institutional and retail share classes. Within each share type, we provide summary statistics for the entire sample period, and for two sub periods selected on the basis of the interest rate level. As shown in Figure 1, the period from January 2002 through mid-2007 experienced relatively "normal" interest rate levels. Rates then fell quite rapidly, yielding historically low rates from October 2008 through December 2016. Investor preferences are most likely to have shifted toward lower risk aversion during this latter part of our sample period.

5. Results

A. Panel Estimation Results

Table 2 reports separate estimation results for (5) for the full sample of institutional and retail share classes. The first three rows of Table 2 indicate that the lagged return coefficients (β_1 – β_3) vary in significance and sign, consistent with our agnosticism about the appropriate lag structure. When we sum the three lagged coefficients, however, we find significantly positive flow-performance relationships for both type of share class. (The retail share class is more responsive (9.03) to past returns than the institutional share class (7.07).) A permanent, one standard deviation (0.13%) increase in the return measure causes a retail inflow of 1.17% of assets within three months.

The level of market rates significantly affects the flow-performance measure for both institutional and retail shares. The retail effect (-135.88) is about twice the estimated institutional effect (-71.91). The negative effect of RTB on the flow-performance coefficient indicates that MMF retail investors respond more aggressively to any given yield differential at lower market rates. In other words, it appears that investors' risk aversion decreases with market rates. For retail investors, this implies that the three-month flow response to yield falls from 9.03 when RTB = 0 to zero when RTB = 6.65%.

The insignificance of institutional investors' sensitivity to market rates is worth further investigation, which we present in Table 3. We divide our share-class data into four quartiles based on the asset size of the share class' fund total assets. (The largest funds are in Q4.) The vast majority of MMF assets are contained in the top two quartiles: xx% and yy% (ww% and zz%) in Q3 and Q4 for the institutional (retail) classes' funds. We examine funds by asset size because their investors may behave differently. For example, Hanouna et al. (2015) find that equity mutual funds' asset volatilities are considerably larger for new, smaller funds than for their larger counterparts. Panel A of Tables 3, for, indicates that the institutional share classes' flow-performance relationship ($\sum \beta_j$) is statistically significant only for the two largest fund quartiles. The effect of RTB on the flow coefficient is significant only for the largest (Q4) quartile, which is why we see no significance in Table 2 on the $\sum \alpha_j$. This provides support for the rate-sensitivity of institutional investors' risk preferences only at the largest funds, although (again) these account for a great majority of institutional MMF assets. By contrast, three of the four retail size quartiles (in Table 3's Panel B) exhibit positive flow-performance effects and the largest two quartiles' estimates are consistent with the hypothesis that retail investors' risk preferences more inversely with market rates.

B. Fama-MacBeth Results

We report the results of our cross-sectional estimations of (7) in three ways. First, Figures 2A and 2B plot the estimated coefficient values for each month in the sample, indicating which differ significantly from zero. Second, we summarize the regression results for the retail and institutional MMF in Table 4, which reports the mean flow-performance coefficient values and their standard deviations, calculated using the method of Fama and MacBeth. Panel A of the Table summarizes the full sample results, while Panels B and C summarize results from the "normal" and "low" market interest rate periods. Finally, Table 5 reports the results of estimating a (WLS) regression of the estimated flow-performance coefficients on the level of monthly interest rates.

Figure 2A shows the winsorized sum of the coefficients on lagged institutional share class returns over the period January 2002- December 2016 for institutional funds. Each dot represents the summed betas on lagged performance. Red diamonds denote that the beta was significant and positive and green triangles indicate significant and negative. For comparison, we also plot the time series of the 30-day Treasury rate, already shown in Figure 1. Broadly, MMF flow sensitivities appear to compress during times of higher interest rates and expand as interest rates decrease later in the sample period. Figure 2B reports the same coefficient estimates for retail MMF share classes.

The estimated flow-performance regression coefficients are summarized in Table 4, for the full sample and for two sub-periods. Among institutional share classes, the first lagged return is significantly positive and the third lag is significantly negative with about the same magnitude, for all three sample periods. The sum of the three lagged yield coefficients is significantly positive in the full period and in the latter, low-rate, period. By contrast, the retail share classes exhibit no significant coefficient on any single month's returns, or on the sum of three lagged month returns.

Table 5 reports a formal test of interest sensitivity of the cross-sectional flow-performance estimates. Specifically, we estimate

$$\widehat{\beta_t} = \delta_0 + \delta_1 RTB_t + \widetilde{\varepsilon_t} \tag{8}$$

where $\widehat{\beta_t}$ is the estimated sum of the coefficients on three lagged share class returns and RTB_t is the month's 30-day treasury rate. Because the dependent variable in (8) includes observations with widely different standard errors, we deflate the terms in this specification by the estimated coefficient standard errors and compute weighted least squares. Qualitatively, the institutional results in Table 5 resemble those from Tables 2 and 3. When (8) is estimated across "All" available data points, the institutional share classes' flow-performance relationship does not change significantly with market rates. When we re-estimate (8) for the fund size quartiles, we again find that the largest fund groupings exhibit significant rate-sensitivity to their flow-performance estimates. The estimation for retail share classes in Table 5 produces a significantly negative coefficient for the overall sample and for the largest three fund quartiles. The implied effect of interest rates on flow-performance sensitivity is larger in Table 5 than it was in Table 2 for retail share classes.

6. Summary and Conclusions

Our analysis of flow-performance relationships in money market funds indicates that the risk aversion of money fund investors varies inversely with the level of market rates, as has been widely speculated. In other words, MMF investors become more willing to accept a given risk level when market rates are lower. Assuming that MMF portfolios did not become safer over the estimation period, these results imply that investors' aversion to MMF risk fell with market rates. For example, if the 30-day Treasury rate falls from 5% to 1%, the estimates in Table 2 indicate that the flow associated with a 10 bp difference in MMF returns roughly triples. Investors' preference changes thus reinforce institutional incentives to move toward riskier assets when rates are low. As investment managers seek higher nominal returns, their customers are leaning in the same direction.

With both the supply and the demand side of these markets accepting higher risk for a smaller return premium, one can readily see why some government officials fear a bubble in risky assets. As rates normalize in the coming years, the danger of an unusual decline in risky asset prices seems worth worrying about.

REFERENCES

Aramonte, Sirio, Seung Jung Lee, and Viktors Stebunovs Risk Taking and Low Longer-term Interest Rates: Evidence from the U.S. Syndicated Loan Market", (FRB wp #2015-068), July 2015

Becker, Bo and Victoria Ivashina, Reaching for Yield in the Bond Market, The Journal of Finance • VOL. LXX, NO. 5 • OCTOBER 2015

Brown, Harlow, and Starks (1996)

Capital Economics, "Global Markets Update: Bubble trouble?", March 23, 2016 (https://www.capitaleconomics.com/publications/global-markets/global-markets-update/bubble-trouble-16/).

Chernenko, Sergey and Adi Sunderam, Frictions in Shadow Banking: Evidence from the Lending Behavior of Money Market Mutual Funds, RFS 2014

Chevalier and Ellison (1997)

Chodorow-Reich, Gabriel, "The Effects of Unconventional Monetary policy on Financial Institutions" BPEA, Spring 2014, pages 155- 227.

Choi and Kronlund, "Reaching for Yield by corporate Bond Mutual Funds" (Oct 2016 working paper)

Christofferson, Susan, "Why do Money Fund Managers Voluntarily Waive their Fees?", v56 #3, June 2001 JF

Di Maggio, Marco and Marcin Kacperczyk, "The unintended consequences of the zero lower bound policy", *Journal of Financial Economics,* 2017 (V123), 59-80).

Financial Stability Oversight Council, 2015 *Annual Report*.

Hanouna, Paul, Jon Novak, Tim Riley, and Christof Stahel, Liquidity and Flows of U.S. Mutual Funds, SEC white paper (September 17, 2015).

Hanson and Stein "Monetary Policy and Long-term Real Rates" *Journal of Financial Economics,* 2015, v115(3), 429-448.

Hsiu-lang Chen and George G. Pennacchi, "Does Prior Performance Affect a Mutual Fund's Choice of Risk? Theory and Further Empirical Evidence", *Journal of Financial and Quantitative Analysis* 2009, v44(4), 745-775.

IMF 2015

Jimenez, Ongena, Peydro and Saurina (2014)

Kacperczyk, Marcin and Philipp Schnabl, "How Safe are Money Market Funds?", QJE (2013) 1073-1122.

La Spada, Gabriele, Competition, Reach for Yield, and Money Market Funds, NY Fed Staff Report No. 753 January 2017.

Maddaloni and Peydro (2011)

Rajan, Raghuram, "Has Finance Made the World Riskier?" European Financial Management, 12(4), 2006, 499-533.

Schmidt, Lawrence, Allan Timmermann, and Russ Wermers. "Runs on money market mutual funds." *The American Economic Review* 106, no. 9 (2016): 2625-2657.

Strahan, Philip E. and Basak Tanyeri, Once burned, twice shy: Money market fund responses to a systemic liquidity shock, JFQA 50(1/2), Feb/Apr 2015, 119-144.

Sirri, Erik R., and Peter Tufano. "Costly search and mutual fund flows." *The Journal of Finance* 53, no. 5 (1998): 1589-1622.

Figure 2A: title, explain in notes what we are showing. Address the issue of truncation in the graph, not in the data.

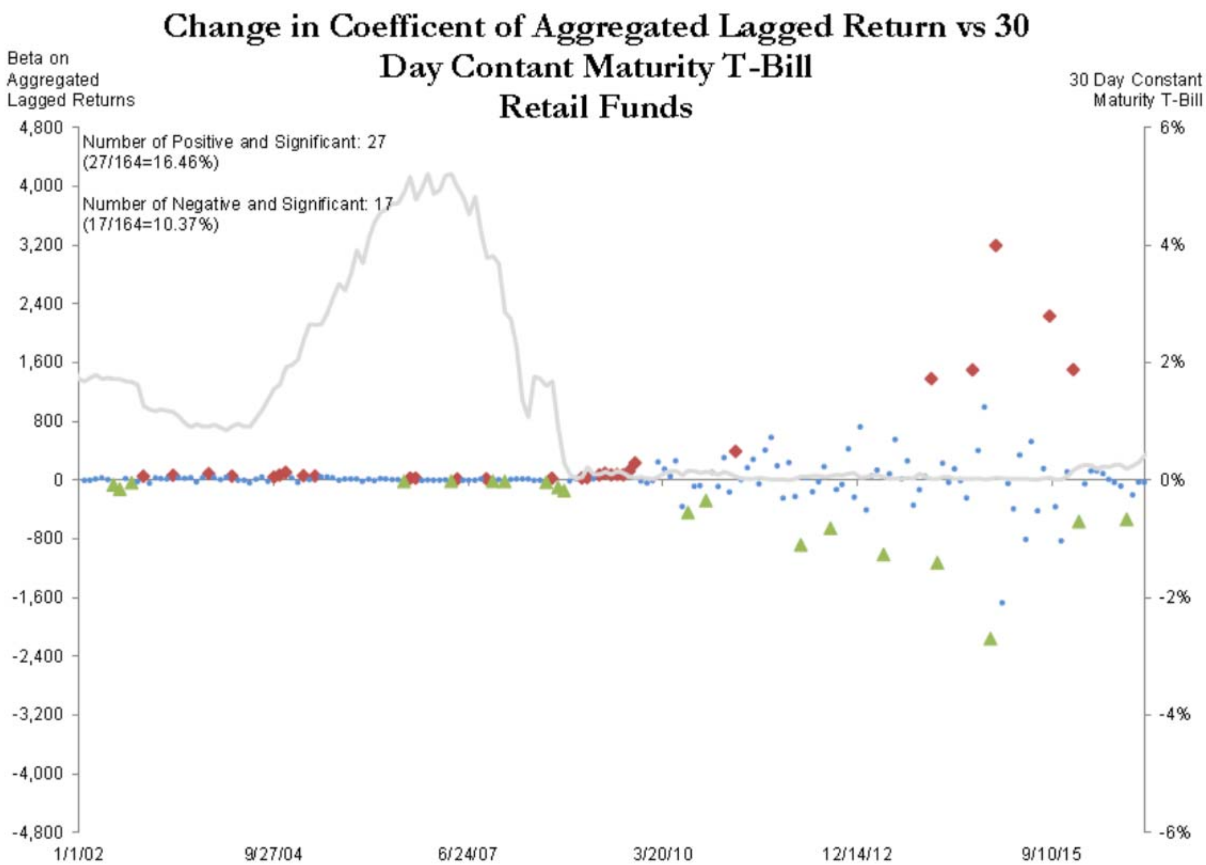


Figure 2B: to be provided.

Table 1: Summary Statistics

Panel A: Institutional Share Classes

	Nobs	Mean	SD	10%-ile	Median	90%-ile
Full Time Period Jan 2002 - Dec 2016						
Flow	123,287	-0.32%	18.09%	-15.73%	-0.57%	15.82%
Return	123,287	0.09%	0.13%	0.00%	0.02%	0.31%
Fund Age (days)	123,287	4,628	2,232	1,581	4,656	7,669
Net assets (Millions)	123,287	$8,662	$15,819	$177	$2,397	$22,490
Industry Growth	123,287	0.23%	2.81%	-3.01%	-0.11%	3.53%
RTB	180	1.20%	1.59%	0.02%	0.23%	4.36%
Comm Paper Rate	180	1.42%	1.72%	0.09%	0.42%	4.81%
High Interest Rate Environment Jan 2002 - Sep 2008						
Flow	53,875	0.47%	18.42%	-15.55%	-0.09%	17.44%
Return	53,875	0.20%	0.13%	0.06%	0.16%	0.40%
Fund Age	53,875	3,485	1,614	1,247	3,562	5,569
Net assets	53,875	$5,610	$10,457	$150	$1,513	$14,843
Industry Growth	53,875	0.73%	3.01%	-2.57%	0.41%	4.41%
RTB	81	2.57%	1.50%	0.91%	1.79%	4.89%
Comm Paper Rate	81	2.89%	1.59%	1.03%	2.39%	5.24%
Low Interest Rate Environment Oct 2008 - Dec 2016						
Flow	69,412	-0.93%	17.81%	-15.89%	-0.86%	14.48%
Return	69,412	0.01%	0.04%	0.00%	0.00%	0.02%
Fund Age	69,412	5,515	2,242	2,069	5,964	8,187
Net assets	69,412	$11,030	$18,622	$215	$3,494	$28,287
Industry Growth	69,412	-0.15%	2.58%	-3.29%	-0.17%	3.07%
RTB	99	0.09%	0.08%	0.02%	0.06%	0.23%
Comm Paper Rate	99	0.22%	0.31%	0.07%	0.13%	0.41%

Table 1, Panel B: Retail Share Classes

	Nobs	Mean	SD	10%-ile	Median	90%-ile
Full Time Period Jan 2002 - Dec 2016						
Flow	115,528	-0.47%	12.92%	-9.35%	-0.81%	8.50%
Return	115,528	0.09%	0.12%	0.00%	0.03%	0.28%
Fund Age (days)	115,528	5,023	2,195	1,826	5,052	7,974
Net assets (Millions)	115,528	$3,659	$11,029	$88	$714	$8,474
Industry Growth	115,528	-0.21%	1.73%	-2.30%	-0.29%	1.93%
RTB	180	1.20%	1.59%	0.02%	0.23%	4.36%
Comm Paper Rate	180	1.42%	1.72%	0.09%	0.42%	4.81%
High Interest Rate Environment Jan 2002 - Sep 2008						
Flow	61,321	-0.05%	13.40%	-9.48%	-0.56%	9.62%
Return	61,321	0.16%	0.12%	0.02%	0.12%	0.35%
Fund Age	61,321	3,957	1,647	1,369	4,351	5,875
Net assets	61,321	$2,763	$7,947	$70	$529	$6,610
Industry Growth	61,321	-0.02%	1.77%	-2.05%	-0.26%	2.26%
RTB	81	2.57%	1.50%	0.91%	1.79%	4.89%
Comm Paper Rate	81	2.89%	1.59%	1.03%	2.39%	5.24%
Low Interest Rate Environment Oct 2008 - Dec 2016						
Flow	54,207	-0.95%	12.35%	-9.19%	-1.02%	7.16%
Return	54,207	0.01%	0.03%	0.00%	0.00%	0.02%
Fund Age	54,207	6,229	2,112	2,979	6,724	8,613
Net assets	54,207	$4,671	$13,632	$116	$985	$11,708
Industry Growth	54,207	-0.42%	1.65%	-2.71%	-0.30%	1.77%
RTB	99	0.09%	0.08%	0.02%	0.06%	0.23%
Comm Paper Rate	99	0.22%	0.31%	0.07%	0.13%	0.41%

Table 2: Panel Regression Results

Estimation results for the panel regression (5)

$$Flow_{i,t} = d_i + \sum_{k=1}^{3} \beta_k R_{i,t-k} + RTB_t \sum_{k=1}^{3} \alpha_k R_{i,t-k} + c * RTB_t + \gamma * Controls_{i,t} + \tilde{\varepsilon}_{i,t}$$

over the sample period January 2002 – December 2016. The fund classes are split by both the investor class (institutional vs retail) and fund size. Fund classes are separated into four quartiles, according to the fund's assets under management. Additional assumptions are made to ensure the integrity of the data: the class must be open for new investment, observations where the net assets do not change despite a positive return are dropped, observations where fund flows more than double or total net assets drop to zero are excluded. We also include a dummy variable (not shown) for September 2008 to account for an effect of the Lehman brother collapse detailed in Strahan and Tanyeri (20??)). Standard errors are clustered at the fund level. In parentheses below each coefficient, we report a t-statistic or F-statistic for the hypothesis that the indicated coefficient differs significantly from zero. *, **, and *** represent statistical significance at the 10%, 5%, and 1% levels, respectively.

	Institutional		Retail	
R_{t-1}	7.10	*	15.65	***
	(1.74)		(4.54)	
R_{t-2}	8.46	*	2.02	
	(1.75)		(0.54)	
R_{t-3}	-8.48		-8.64	***
	-(1.42)		-(3.40)	
$\sum \beta_j$	7.07	***	9.03	***
(F-statistic)	(10.20)		(47.82)	
R_{t-1} * RTB_t	-235.54		-446.99	***
	-(1.59)		-(2.87)	
R_{t-2} * RTB_t	3.46		91.02	
	(0.02)		(0.71)	
R_{t-3} * RTB_t	160.17		220.09	*
	(0.77)		(1.90)	

$\sum \alpha_j$	-71.91		-135.88	***
(F-statistic)	(1.97)		(16.51)	
Fund Age	-0.13	***	-0.13	***
	-(3.68)		-(6.88)	
Net Assets	0.11	***	0.04	***
	(6.58)		(2.71)	
Industry Growth	0.42	***	0.91	***
	(15.45)		(21.24)	
Current Tbill	0.03		-0.14	
	(0.17)		-(1.29)	
Constant	0.00		0.01	***
	-(0.18)		(3.49)	
Adjusted R squared	0.009		0.017	
Observations	123,214		115,447	

Table 3: Quartile Estimates of Panel Regression (5).

Institutional Share Classes

	Q1		Q2		Q3		Q4	
R_{t-1}	-2.56		18.63	***	35.50	***	27.19	**
	-0.93		2.63		3.06		2.32	
R_{t-2}	12.10		-1.93		-12.63		37.58	
	1.53		-0.23		-0.75		1.63	
R_{t-3}	-8.26		-12.19	*	-13.99		-42.42	**
	-1.28		-1.70		-1.08		-2.46	
$\sum \beta_j$	1.28		4.51		8.87	**	22.35	***
(F-statistic)	0.16		1.15		5.97		25.60	
R_{t-1} * RTB_t	-300.13		-249.97		-1127.39	***	-120.93	
	-1.41		-0.97		-3.32		-0.29	
R_{t-2} * RTB_t	-3.50		196.83		510.53		-559.62	
	-0.01		0.70		0.94		-0.83	
R_{t-3} * RTB_t	274.51		17.21		510.19		422.89	
	1.15		0.06		1.00		0.86	
$\sum \alpha_j$	-29.12		-35.93		-106.67		-257.66	***
(F-statistic)	0.08		0.16		1.14		7.72	
Fund Age	-0.04		-0.07		-0.10		-0.08	
	-0.71		-0.96		-1.48		-1.12	
Net Assets	11.17	***	1.82	***	0.27	***	0.08	***

	6.65		3.95		4.10		7.81	
Industry Growth	0.31	***	0.38	***	0.47	***	0.40	***
	6.20		9.11		10.02		8.61	
Current Tbill	0.41		0.09		0.16		-0.41	
	1.32		0.28		0.38		-1.28	
Constant	-0.04	***	-0.02	**	-0.01		-0.01	
	-4.82		-2.35		-1.01		-1.15	
Adjusted R squared	0.01		0.01		0.01		0.01	
Observations	30,528		31,083		31,278		30,325	

Retail Share Classes

	Q1		**Q2**		**Q3**		**Q4**	
R_{t-1}	**Q1**		**Q2**		**Q3**		**Q4**	
	12.00		17.90	***	22.36	***	19.16	**
R_{t-2}	1.50		3.08		4.87		2.59	
	4.25		1.69		1.48		-6.90	
R_{t-3}	0.46		0.32		0.28		-0.90	
	-12.96	**	-14.42	***	-12.54	***	-2.70	
$\sum \beta_j$	-2.15		-3.30		-2.78		-0.71	
(F-statistic)	3.29		5.17	*	11.30	***	9.56	***

R_{t-1} * RTB_t	0.89		3.47		27.65		14.22	
	222.17		-148.86		-428.23	***	-715.61	***
R_{t-2} * RTB_t	0.76		-0.77		-3.13		-3.36	
	-326.49		170.77		-21.73		283.99	
R_{t-3} * RTB_t	-1.11		0.81		-0.10		1.12	
	168.28		-84.14		250.64		221.44	
$\sum \alpha_j$	0.78		-0.44		1.34		1.13	
(F-statistic)	63.96		-62.23		-199.31	***	-210.18	***
Fund Age	0.49		1.01		14.54		10.52	
	-0.20	***	-0.11	**	-0.01		-0.05	
Net Assets	-3.85		-2.44		-0.39		-1.53	
	21.70	***	6.13	***	1.26	***	0.02	
Industry Growth	5.60		7.00		4.55		1.57	
	0.91	***	1.02	***	0.89	***	0.83	***
Current Tbill	10.16		11.46		12.65		13.40	
	-0.38	*	-0.20		0.03		0.19	
Constant	-1.68		-1.12		0.19		0.91	
	-0.01		-0.01	*	-0.02	***	0.00	
Adjusted R squared	-0.95		-1.69		-3.25		0.07	
Observations	0.01		0.02		0.02		0.02	

Table 4: Fama-MacBeth summary of estimation results for equation (7), over three sample periods.

	Institutional Share Classes				Retail Share Classes			
Nobs	**R_{t-1}**	**R_{t-2}**	**R_{t-3}**	**$\Sigma\ \beta_{t-j}$**	**R_{t-1}**	**R_{t-2}**	**R_{t-3}**	**$\Sigma\ \beta_{t-j}$**
Panel A: Full Time Period Jan 2002 - Dec 2016, RTB average (range) = 1.20% (0.0% - 5.21%)								
180	***243.94***	-8.86	***-201.82***	***33.26***	95.51	-40.43	-23.39	31.70
	(3.21)	(0.10)	***(2.88)***	***(1.98)***	(1.28)	(0.53)	(0.30)	(0.90)
Panel B: High Interest Rate Environment Jan 2002 - Sep 2008, RTB average (range) = 2.57% (0.86% - 5.21%)								
81	***38.63***	-5.96	***-33.31***	-0.64	18.78	0.67	-13.61	5.84
	(2.47)	(0.38)	***(2.09)***	(0.13)	(1.64)	(0.06)	(1.71)	(1.38)
Panel C: Low Interest Rate Environment Oct 2008 - Dec 2016, RTB average (range) = 0.09% (0.0% - 0.42%)								
99	***411.93***	-11.22	***-339.70***	***61.01***	158.29	-74.05	-31.39	52.86
	(3.04)	(0.07)	***(2.71)***	***(2.03)***	(1.17)	(0.53)	(0.22)	(0.83)

Table 5: Interest-sensitivity of flow-performance estimates from cross-sectional regressions (WLS)

We estimate

$$\widehat{\boldsymbol{\beta}_t} = \boldsymbol{\delta_0} + \boldsymbol{\delta_1 RTB_t} + \widetilde{\boldsymbol{\varepsilon}_t} \qquad (8)$$

where $\widehat{\boldsymbol{\beta}}_t$ is the estimated sum of three coefficients on lagged share class returns estimated for the cross-section regression (7) for month t and RTB_t is the 30-day constant-maturity treasury rate for month t. Because the estimated coefficients differ substantially in their standard errors, we weight observations in (8) by the inverse of the coefficient's estimated standard deviation. Columns 2 – 5 report results for estimating (8) for quartiles of observations based on the associated MMF's asset size. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels.

Institutional Share Classes

	All		Q1		Q2		Q3		Q4	
RTB_t	-89.62		-161.20		-178.94		-735.75	***	-760.71	***
Constant	4.65	**	-2.82	*	7.68		32.78	***	44.26	***
Number of Obs	180		180		180		180		180	

Retail Share Classes

	All		Q1		Q2		Q3		Q4	
RTB_t	-374.83	***	-259.08		-416.94	***	-466.23	***	-533.11	***
Constant	17.92	***	10.68	*	16.45	***	22.42	***	22.57	***
Number of Obs	180		180		180		180		180	