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The Cross Section of Money Market Fund Risks and Financial Crises

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The Cross Section of Money Market Fund Risks and Financial Crises*

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Abstract

This paper examines the relationship between money market fund (MMF) risks and outcomes during crises, with a focus on the ABCP crisis in 2007 and the run on money funds in 2008. I analyze three broad types of MMF risks: portfolio risks arising from a fund's assets, investor risk reflecting the likelihood that a fund's shareholders will redeem shares disruptively, and sponsor risk due to uncertainty about MMF sponsors' support for distressed funds. I find that during the run on MMFs in September and October 2008, outflows were larger for MMFs that had previously exhibited greater degrees of all three types of risk. In contrast, as the asset-backed commercial paper (ABCP) crisis unfolded in 2007, many MMFs suffered capital losses, but investor flows were relatively unresponsive to risks, probably because investors correctly believed that sponsors would absorb the losses. However, the consequences of MMF risks were quite costly for some sponsors: Using a unique data set of sponsor interventions, I show that sponsor financial support was more likely for MMFs that previously earned higher gross yields (a measure of portfolio risk) and funds with bank-affiliated sponsors. Funds' gross yields and bank affiliation (but not funds' ratings) also would have helped forecast holdings of distressed ABCP. This paper provides some useful lessons for investors and policymakers. The significance of MMF risks in predicting poor outcomes in past crises highlights the importance of monitoring such risks, and I offer some useful proxies for doing so. The paper also argues for greater attention to the systemic risks posed by the industry's reliance on discretionary sponsor support.

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1 Introduction

Money market funds (MMFs or "money funds") have an impressive record of price stability. From the introduction of the rules specifically governing these funds in 1983 until the Lehman bankruptcy in September 2008, only one small MMF lost money for investors, and that loss, in 1994, had little broader impact on the industry. Although MMF prospectuses and advertisements must warn that "it is possible to lose money by investing in the Fund" (U.S. Securities and Exchange Commission, 1998a, 2003), investors virtually never lost anything. Indeed, the perceived safety of MMFs typically prompted inflows to the funds during periods of heightened uncertainty and motivated some academic researchers to suggest that money funds might function well as "narrow banks" that provide liquidity services (Gorton and Pennacchi, 1993; Scott, 1998; Miles, 2001; Pennacchi, 2006).

However, two crises in the MMF industry during the financial turmoil that began in 2007 underlined the importance of money fund risks for MMF investors and sponsors, as well as for the broader financial system. The meltdown of the market for asset-backed commercial paper (ABCP) that began in August 2007 caused capital losses for many money funds that held ABCP, but the losses were absorbed by MMF sponsors (that is, asset management firms and their parents and affiliates), so MMF investors lost nothing. In contrast, losses on Lehman Brothers debt following that firm's bankruptcy in September 2008 caused the Reserve Primary Fund to "break the buck"—its share price fell below $1—and cost its shareholders liquidity as well as principal (as of this writing, the assets of the fund still had not been completely distributed). Moreover, the damage quickly spread beyond Reserve and its investors amid a broader run on MMFs. Other money fund investors were put at risk as concerns about the funds' vulnerabilities prompted a vicious cycle of redemptions, efforts by MMFs to sell assets, declines in prices for money market instruments, and the possibility of capital losses that motivated further redemptions. A broader liquidity crisis developed as MMF managers, facing enormous redemptions, curtailed their lending to firms and institutions. The run on MMFs appears to have been slowed only by announcements on September 19 of unprecedented government interventions to support MMFs and short-term funding markets.

This paper examines the relationship between MMF risks and outcomes during crises, with a focus on the ABCP crisis in 2007 and the run on money funds in 2008. I describe three broad types of MMF risks: (1) *portfolio* risks arising from the credit, liquidity, and interest-rate risks posed by a fund's assets; (2) *investor* risk due to the composition of an MMF's investors and the likelihood that they will suddenly and disruptively redeem shares; and (3) *sponsor* risk that reflects the possibility that an MMF sponsor will *not* provide financial support for an ailing fund. For each type of risk, I review the relevant academic literature and develop proxies for use in empirical analyses. In addition, I construct a unique data set of sponsor support actions and MMF holdings of distressed assets. I employ this data set and the risk proxies in an empirical study of the links between

MMF risks and the cross section of MMF crisis outcomes, including net redemptions and sponsor support actions. I find that MMF risks measured well before the unfolding of each crisis had important predictive power for outcomes during the crisis, and I conclude by discussing some policy implications of these results.

The two crises I study provide different perspectives on the importance of MMF risks. The run on MMFs in 2008 was not indiscriminate; I find that redemptions from prime MMFs marketed to *institutional* investors were correlated significantly with ex ante indicators for each of the three types of risk. For example, outflows were larger for MMFs that had paid higher gross yields in the previous year and thus were likely carrying greater portfolio risks, for funds with larger pre-crisis flow volatility that signified greater investor risk, and for funds that had sponsors with wider credit default swap (CDS) spreads and hence greater sponsor risk. Meanwhile, net redemptions from *retail* prime MMFs during the run varied with investor risk proxies but not significantly with portfolio or sponsor risk measures, perhaps because retail investors—who generally did not redeem shares en masse—were less cognizant of MMF vulnerabilities and posed lower investor risk for the funds. Indeed, one lesson from the distinction between institutional and retail investors' behavior during the run is the interactions among fund risks: MMFs with greater investor risks were also more sensitive to portfolio and sponsor risks.

Interactions among fund risks were also consequential during the ABCP crisis, as widespread sponsor support absorbed funds' losses. With sponsor risks apparently dormant, other MMF risks—at least as perceived by fund shareholders—also remained latent, and the funds saw only modest net outflows that exhibited little cross-sectional correlation with ex ante risks. However, MMF risks were consequential for money fund sponsors; their financial support for their funds reflected concerns about actual or expected losses in funds' portfolios as well as concerns about investors' potential responses to those risks. Using a unique data set of sponsor support actions in the wake of the ABCP crisis, I show that portfolio risks, as measured by gross yields in the year prior to the crisis, are useful for predicting whether sponsors intervened to support their funds. A separate analysis of MMFs' holdings of distressed ABCP corroborates this result. Interestingly, sponsor risk played a more complex role in ABCP crisis than during the run in 2008. MMFs with bank-affiliated sponsors, which presumably had particularly deep pockets with which to support ailing money funds, were more likely both to hold troubled ABCP and to receive financial support to absorb losses. However, controlling for bank affiliation, riskier sponsors (those with higher pre-crisis CDS spreads) were more likely to experience problems.

My findings provide some useful lessons for MMF shareholders and policymakers alike. The significance of MMF risks in predicting poor outcomes in past crises underscores the importance of monitoring these risks, and this paper offers some useful proxies for doing so. For example, shareholders and regulators might track funds' gross yields for early signs of undue portfolio risks, particularly in light of asset managers' incentives to take on risks to boost yields. This paper

also shows that MMF risks are broader than the portfolio risks that are the focus of the current regulatory framework for money funds. The importance of investor risk during the run in 2008 lends some support for the Securities and Exchange Commission's (SEC's) 2009 proposals to require additional liquidity for funds that are marketed to riskier investors, such as institutional investors, and the proxies for investor risk that I employ may be useful for identifying funds with riskier clienteles. The link between sponsor risk and holdings of distressed paper during the ABCP crisis indicates that the sponsor-support option may distort incentives for portfolio managers, and the role of sponsor risk in channeling concerns about financial institutions to their off-balance-sheet MMFs during the 2008 run suggests that expectations for such support may contribute to transmission of financial shocks. These concerns at least warrant greater attention to the systemic risks posed by the MMF industry's reliance on sponsor support.

Importantly, the analysis in this paper focuses on risks that explain *cross-sectional* variation in money funds' experiences during episodes of financial turmoil. As such, I do not focus on some of the generic features of MMFs that make them structurally vulnerable to runs—such as MMFs' practice of rounding their net asset values (NAVs) to the nearest penny—or analyze the types of events that can trigger runs. My results do suggest that fund-specific risks are important during crises and that such risks may interact with the structural vulnerabilities of MMFs to contribute to broader risks. For example, incentives for investors to redeem shares in funds with rounded NAVs are strengthened when portfolio risks are larger, when other MMF investors are more risk averse and more sophisticated (and hence more likely to redeem shares quickly), and when sponsors are less likely to bail out troubled MMFs. The aggregate importance of cross-sectional variation was also evident in the example of the Reserve Primary Fund, which demonstrated that even a single poorly run fund may impose significant costs on the rest of the industry as well as on the broader financial system. Hence, by highlighting some ex ante risk measures that predicted poor outcomes for individual MMFs during past crises, this paper provides guidance on monitoring—and perhaps mitigating—MMF risks to reduce the likelihood of another crisis.

Section 2 of this paper describes data sources. Section 3 reviews the historical significance of MMF risks, academic literature relevant to their study, and the two crises that I examine in this paper. Section 4 introduces proxies for portfolio, investor, and sponsor risks. Section 5 describes my empirical analysis of the run in 2008, and section 6 turns to an analysis of the ABCP crisis in 2007. Section 7 concludes the paper and discusses policy implications.

2 Data sources

The U.S. MMF industry comprises three basic types of funds: (i) prime funds, which chiefly invest in short-term private debt instruments such as commercial paper, bank certificates of deposit (CDs), and floating-rate notes issued by private firms; (ii) government-only MMFs, which typically hold only obligations of the Treasury, U.S. government agencies, and government-sponsored

enterprises, as well as repurchase agreements collateralized with such instruments; and (iii) tax-exempt MMFs, which generally hold municipal securities. This paper focuses on prime MMFs, which bore the brunt of the strains during the MMF crises in 2007 and 2008. Prime funds account for most MMF assets; Investment Company Institute (ICI) weekly data show that assets under management in U.S. MMFs totaled $3.58 trillion as of September 10, 2008 (just before the Lehman bankruptcy and the run on MMFs): $2.18 trillion in prime MMFs, $0.89 trillion in government-only funds, and $0.52 trillion in tax-exempt funds.[1]

The fund-level data used in this paper mostly come from iMoneyNet, a data vendor that provides weekly and monthly data on each MMF's assets under management, yields, expense ratios, portfolio composition, and weighted average maturity (WAM). The iMoneyNet data are survivorship-bias free, as they include defunct funds. iMoneyNet also classifies MMFs by fund type and investor type—MMFs are considered either "institutional" or "retail," depending on the types of investors to whom the funds are marketed. I make several adjustments and corrections to the iMoneyNet data. For example, I analyze only MMFs with at least 12 months of pre-crisis data and funds with at least $100 million in assets, and I make several corrections to MMF assets recorded during the run in 2008. These adjustments are described in section A.1 of the appendix.

I obtained some fund and sponsor data from other sources. For example, data on credit-default swap (CDS) spreads for MMF sponsors came from Markit, and I used Moody's data to corroborate iMoneyNet MMF ratings information.

An important contribution of this paper is my compilation of a unique data set of sponsor-support actions and the securities that prompted such actions. The data come both from public sources and from confidential SEC records. Many of the sponsor-support records are public because sponsors' actions required some relief from prohibitions under the Investment Company Act of 1940 (ICA). That relief typically came in the form of a "no-action" letter from SEC staff, and the SEC has published these no-action letters on its website.[2] An additional source of public information on sponsor support is the financial statements of asset management companies and their parent firms.[3]

The SEC also obtains data on sponsor support arrangements that remain confidential. For example, SEC rule 2a-7 requires a fund to notify the Commission in the event of a default of any security representing more than 0.5 percent of the fund's assets, and the fund must also describe how it intends to respond to the default. In other cases, funds have voluntarily apprised SEC staff of support actions that did not trigger notification requirements. SEC staff provided me with a complete list of the sponsor support actions for MMFs for which the Commission had been notified

[1] See `http://www.ici.org/pdf/mm_data_2010.pdf`.

[2] The ICA restricts transactions between mutual funds and their sponsors. In particular, no-action relief was needed when advisers or their affiliates purchased from money funds securities which were still technically eligible as MMF portfolio securities. See `http://www.sec.gov/divisions/investment/im-noaction.shtml#money`.

[3] Peter Crane has compiled a useful listing of support information collected from publicly available SEC data and from financial statements (Crane, 2009).

between August 2007 and March 2009. These include support arrangements to protect MMFs from losses or runs in the aftermath of both the ABCP crisis and the Lehman bankruptcy. Together with the public information described above, these data represent the most complete available record of sponsor support for MMFs affected by the financial turmoil that began in 2007—although the fact that some support can occur without notification of the SEC suggests that the data still may not reflect every instance of support.

Information about MMFs' holdings of specific securities (such as individual ABCP issues and Lehman debt securities) comes from two sources. The first is each fund's closest previous quarterly portfolio-holdings filing with the SEC, which is available on the SEC's EDGAR database. Where appropriate, I supplement those data with information garnered from records of sponsor support and other SEC notifications described above, since these records typically name the distressed securities at issue.

The unit of observation in my analysis is the MMF. One money market fund may comprise multiple share classes, each of which is a claim on the same portfolio assets. All share classes in an MMF have the same *gross* yield—that is, the yield earned on portfolio instruments before fees. However, different share classes have different fee structures (expense ratios) and pay investors different *net* yields (net yield is gross yield less the expense ratio).[4]

3 Money market fund risks: history and literature

The financial turmoil that began in 2007 heightened awareness of MMF risks among investors, academics, and policymakers. Prior to the ABCP crisis and the run in 2008, MMF risks—particularly investor and sponsor risks—appear to have been viewed as unimportant or latent. MMF assets grew at an average annual rate of 13 percent over the quarter century from the end of 1983 to the eve of the Lehman crisis (Investment Company Institute, 2010, p. 160), and the funds' perceived safety was undoubtedly part of their appeal to investors. MMFs' long record of stability also impressed some academics, who advocated MMFs as alternatives to banks as providers of liquidity in the economy. This section provides a brief overview of the perceptions of MMF risks and how these views have been shaped by the crises that I study in this paper.

3.1 Perspectives on MMF risks prior to the financial turmoil in 2007

The importance of governing MMF portfolio risks always has been central to money fund regulation, operations, and monitoring. The provisions of the SEC's rule 2a-7, which applies only

[4]To derive a single observation for a fund with multiple share classes, I cumulate the assets for all of its share classes and compute asset-weighted measures of other fund characteristics (for example, expense ratios) that vary across share classes. For money market funds with both retail and institutional share classes, I created two fund observations for each month by cumulating the retail and institutional share classes separately.

to MMFs and hence distinguishes them from other types of mutual funds, are primarily limitations on MMFs' credit, interest-rate, and liquidity risks consistent with the funds' maintenance of a stable NAV. As financial innovation has introduced new risks to MMFs, the SEC has tightened portfolio restrictions. For example, the Commission adopted new diversification requirements, new limits on holdings of lower-rated ("second-tier") assets, and a more stringent WAM limit in 1991, and it issued guidance to clarify that certain derivative instruments were inappropriate for MMF portfolios in 1994. MMFs that receive "AAA" (or equivalent) ratings from ratings organizations must satisfy additional restrictions, beside those in rule 2a-7, that are primarily constraints on portfolio risks (see, for example, Moody's Investors Service, 2005; Standard & Poor's, 2007; and Fitch Ratings, 2009).

When, despite the risk-limiting provisions of rule 2a-7, MMF assets have lost value, fund sponsors historically have absorbed the losses to prevent funds' NAVs from declining. For example, sponsors picked up losses on three commercial paper issues in 1989 and 1990, and, in 1994, 25 MMF sponsors intervened to support their funds when a jump in short-term interest rates caused assets held by the funds to lose value (Investment Company Institute, 2009, pp. 175-176). Nothing *required* these sponsors to provide support, but because allowing a fund to break the buck would have been destructive to a sponsor's reputation and franchise, sponsors backstopped their funds voluntarily. Asset managers' incentive to preserve reputation and their record of support for MMFs led industry observers to view sponsors as a source of stability—not risk—for MMFs and to regard sponsor support as almost a given. *Stigum's Money Market*, a classic reference guide to money markets, notes that "...a money fund run by an entity with deep pockets, while it may not have federal insurance, certainly has something akin to private insurance ... [and] that insurance is likely to prove adequate to cover any losses sustained by the fund" (Stigum and Crescenzi, 2007, p. 1117).

Because of the relative safety of their portfolios and sponsors' practice of absorbing losses when they have occurred, MMFs are usually recipients of flight-to-quality *inflows* during periods of high uncertainty and market turmoil. For example, Baba et al. (2009) showed that MMFs typically attracted inflows when stock market implied volatility, as measured by the VIX, was high.[5] The largest weekly inflow to MMFs (as a fraction of assets) recorded by ICI in the past decade came in the week following the September 11, 2001 terrorist attacks, when MMF assets grew 3.8 percent.

Perhaps because MMFs historically have been so safe, MMF risks have attracted only limited attention in the academic literature on MMFs, particularly before the financial turmoil erupted in 2007. Portfolio risks have garnered most of the discussion, but even these have often been viewed as tangential or benign. Domian (1992) and DeGennaro and Domian (1996) found that MMF portfolio managers could not earn extra-normal returns by anticipating interest-rate changes,

[5]More generally, Carpenter and Lange (2003) found that heightened equity market volatility boosted total M2 assets, which include retail MMFs.

and DeGennaro and Domian concluded that "MMFs in general cannot outperform similar investments without taking commensurately higher risks." Although they added that they could not rule out the possibility that individual managers might outperform the market, they did not study risk taking. Domian and Reichenstein (1998), analyzing the variation in MMFs' *net* yields, emphasized the importance of the expense ratios charged by the funds, rather than the risk and return of MMF portfolio assets. These authors concluded that, controlling for investment objective, MMFs with more than $300 million in assets "are essentially commodities" with little meaningful differentiation in portfolios. Advocates of MMFs as "narrow banks" have pointed to the transparency and liquidity of MMF portfolios as evidence that runs on the funds should be unlikely (Gorton and Pennacchi, 1993; Scott, 1998).

However, MMF portfolio risks were central in Collins and Mack (1994), who examined changes in *aggregate* MMF portfolio risk in an event study of the SEC's adoption in 1991 of amendments to rule 2a-7 that further restricted funds' exposures to credit and interest-rate risks. Collins and Mack estimated the time-series relationship between funds' yields and market risk premiums and concluded that risk-taking did indeed decline. Koppenhaver (1999) examined the cross-section of MMF net and gross yields and found that both varied positively with MMFs' holdings of agency securities and commercial paper and with funds' WAMs.

With MMFs typically attracting inflows during crises, investor risk—the risk reflecting the composition of a fund's shareholders and the likelihood that they will redeem shares suddenly—does not appear to have been a concern among academicians. Indeed, research focusing on MMFs' suitability as "narrow banks" suggested that MMF investors' behavior might mitigate broader risks. Gorton and Pennacchi (1993) noted that MMF investors did not run from funds following commercial paper defaults, Scott (1998) emphasized that the transparency of MMF portfolios would prevent an "ignorance-driven panic," and Miles (2001) showed that, following monetary policy shocks, MMFs attracted net inflows and increased lending to private borrowers. Miles concluded that MMFs "are, if anything, perceived as *safer* than commercial banks and certainly less risky than smaller depository institutions." Similarly, Pennacchi (2006) showed that MMFs attracted net inflows following commercial paper-Treasury bill spread increases (which he interpreted as liquidity shocks) and used this evidence to argue that a system of insurance for MMF shares, rather than bank deposits, might improve money market liquidity following such a shock.

3.2 The ABCP crisis in 2007

The ABCP crisis, which caused substantial losses for many MMFs, nonetheless appears to have reinforced prior notions about MMF safety and the stabilizing effect of sponsor support. The crisis began in earnest on August 6, 2007, when the American Home Mortgage Investment Corporation filed for bankruptcy and its Broadhollow ABCP program exercised the option to extend its maturity. Another ABCP program, Ottimo Funding Ltd., was unable to roll its paper on the same day

and began to liquidate (Standard & Poor's, 2008b). Amid heightened concerns about exposures of some ABCP to distressed securities, including subprime mortgages, many ABCP programs began to encounter difficulties rolling their paper, and two ABCP programs defaulted in August. Covitz et al. (2009) show evidence that an indiscriminate run on ABCP began that month, as investors became unwilling to purchase reissued paper regardless of program characteristics.

As large investors in the ABCP market, MMFs were vulnerable to the credit and liquidity risks posed by distressed programs, and many MMF portfolio holdings lost value. However, MMF sponsors absorbed these losses by purchasing securities out of their funds at above-market prices and by entering capital support agreements to guarantee securities still in the funds. The SEC reported that sponsors intervened to support at least 44 MMFs because of exposures to distressed ABCP, and no MMF broke the buck (U.S. Securities and Exchange Commission, 2009a, note 38).

Sponsors' actions evidently allayed investors' concerns; despite the exposures of many MMFs to troubled ABCP, MMF investors responded with only a modest pullback from prime MMFs in August 2007. As shown by the solid black line in figure 1, panel A, prime MMFs, which mainly invest in private debt instruments such as ABCP, saw only very small net outflows (about $14 billion, or 0.8 percent of assets) in the three weeks ending August 29, 2007.[6] To be sure, some individual funds suffered more significant outflows; the *Wall Street Journal* reported that one very large Credit Suisse MMF saw redemptions of more than half its assets beginning in August 2007, and the authors cited the fund's exposure to distressed ABCP and its unstable investor base as factors behind the large outflows (Smith and Lauricella, 2007). But section 6.1 of this paper shows that net flows of individual funds during this episode generally did not vary significantly with proxies for MMF portfolio risk. Surprisingly, given the role of sponsor support in shoring up MMFs during this crisis, net flows also did not vary significantly with sponsor risk.

In any case, prime funds' small aggregate outflows were short-lived, as assets began growing rapidly in September 2007. As illustrated in panel A of figure 1, prime MMF assets increased $425 billion (24 percent) from August 2007 to August 2008, as investors moved cash into vehicles that were seen as safe.[7] The poor performance of alternative cash-management vehicles, such as "enhanced cash" funds and auction-rate securities, likely boosted MMF inflows over this period (see Investment Company Institute, 2009, pp. 46-50 and Baba et al., 2009).

One MMF sponsor that appears to have exploited investors' confidence in MMFs and the funds' growth following the ABCP crisis was Reserve Management, Inc., which operated the Reserve Primary Fund. Reserve's cofounders introduced the first MMF in 1970 and for decades reportedly maintained a relatively conservative investment policy, even among MMFs (Nocera, 1994; U.S. Securities and Exchange Commission, 2009b). As shown by the thin solid black line in

[6]More notable than the outflows from prime MMFs in August 2007 were the simultaneous flight-to-quality *inflows* to government-only MMFs, which—as illustrated by the dashed blue line in panel A—grew $115 billion (23 percent) in the three weeks following the American Home Mortgage bankruptcy.

[7]Government-only MMFs grew even faster over this period; their assets expaned 46 percent.

panel B of figure 1, in the decade before mid-2007, the Primary Fund typically earned a gross yield below that of its average competitor. But the ICI has documented a change in Reserve's portfolio management beginning in the summer of 2007, when the Primary Fund began purchasing commercial paper—including Lehman debt securities—and its gross yield jumped relative to that of its peers (Investment Company Institute, 2009, pp. 53-57; see also U.S. Securities and Exchange Commission, 2009b). Net yield, the dashed black line, shot up, too, and investors took notice: Between August 2007 and August 2008, the Primary Fund's market share surged as its assets more than tripled (panels B and C).

3.3 The run on MMFs in 2008

The Reserve Primary Fund was holding Lehman Brothers debt valued at $785 million (at amortized cost) when Lehman declared bankruptcy early on Monday September 15, 2008. Losses on this exposure caused the Primary Fund to break the buck. The run that followed underlined the importance of all three types of MMF risks: portfolio, investor, and sponsor risks.

Clearly, portfolio risk was central to Reserve's demise. Moreover, aggregate flows to different types of MMFs reflected broader concerns about portfolio risks. As shown in panel A of figure 1, nearly all of the massive net redemptions from MMFs during the run in 2008 came from prime MMFs (the black line), which—unlike government-only and tax-exempt funds—mainly held the debt instruments of private issuers such as Lehman Brothers. Prime funds' aggregate assets dropped $450 billion (21 percent) over the four weeks beginning on September 10. Amid a general flight to quality, government-only funds (the blue dashed line) attracted very large inflows over the same period. Tax-exempt funds (the green dotted line) had moderate net outflows.

In addition, the striking distinction between institutional and retail investors' behavior during the crisis highlighted the importance of investor risks. As of September 10, 2008, institutional funds accounted for 63 percent ($2.17 trillion) of total assets under management in MMFs and 63 percent of prime MMF assets ($1.32 trillion). As illustrated in figure 2, panel A, prime funds marketed to institutional investors suffered the brunt of the run, with net redemptions of $410 billion (30 percent of assets under management) in the four weeks beginning September 10. Prime MMFs for retail investors saw outflows of just $40 billion (5 percent of assets) over the same period.

Sponsor risk also played a critical role in the run. The Primary Fund was not unique in holding Lehman's debt at the time of its bankruptcy, but other MMFs with Lehman exposures obtained sufficient sponsor support to avoid breaking the buck (Investment Company Institute, 2009, pp. 60-62). What distinguished the Primary Fund was the inability of Reserve to provide the capital needed to absorb the MMF's losses.[8] Indeed, sponsor support burgeoned during the run:

[8]The crucial importance of sponsor support apparently was not lost on Reserve's principals, who, according to an SEC complaint on the matter, falsely assured investors, ratings organizations, and the press immediately after Lehman's bankruptcy on September 15 that sponsor support would protect the Primary Fund's $1 NAV. Such support was not forthcoming, however, and these assurances ultimately failed to prevent massive redemptions requests. Reserve an-

The SEC reported that almost 20 percent of all MMFs received support in September and October 2008 (U.S. Securities and Exchange Commission, 2009a, p. 20).

Reserve's inability to support its Primary Fund after the Lehman Brothers bankruptcy clearly undermined investor confidence in sponsor support. Panel B of figure 2 depicts daily net flows to prime funds during the crisis.[9] Heavy redemptions—at least from institutional MMFs—began immediately following Lehman's bankruptcy on September 15, but outflows surged after Reserve's announcement late on September 16 that the Primary Fund had broken the buck.

The run hit the MMF industry unevenly. As noted above, outflows were concentrated in institutional prime funds, but even among these funds, there was much cross-sectional disparity in net flows. The red bars in panel C of figure 2 show the distribution of outflows from institutional prime MMFs from September 9 to October 7. (Retail fund flows, the blue bars, exhibited much less dispersion.) Of the 116 institutional prime funds in my sample, ten saw assets shrink by more than 50 percent during this period and another twelve lost between 40 and 50 percent of assets, but 20 had net *inflows* over the same period. This heterogeneity provides an opportunity to test hypotheses about the links between individual MMFs' risks and outcomes during the crisis.

3.4 Post-crisis perspectives

All three types of MMF risk have attracted new attention since the beginning of the financial turmoil in 2007. Researchers and policymakers have focused on portfolio risk, in particular. Jank and Wedow (2008) examined the performance of German MMFs before and during the subprime crisis that began in 2007.[10] They found that MMFs that took on more portfolio risk earned higher returns than their less risky counterparts during periods of normal money market liquidity but that the riskier MMFs fared relatively worse during periods of low liquidity. As noted in section 3.2, ICI documented a substantial increase in the portfolio risk of the Reserve Primary Fund beginning in mid-2007, just over a year before that fund broke the buck (Investment Company Institute, 2009). In a study of the effectiveness of the Federal Reserve's Asset-Backed Commercial Paper Money Market Mutual Fund Liquidity Facility (AMLF), Duygan-Bump et al. (2010) found that MMFs with greater ABCP exposures initially suffered larger outflows during the run in 2008 but recovered quickly with the announcement of the AMLF. Furthermore, the SEC in 2010 adopted amendments to rule 2a-7 that impose further constraints on portfolio risk, including new liquidity

nounced that the Primary Fund had broken the buck at 4 pm on Tuesday, September 16 (U.S. Securities and Exchange Commission, 2009b).

[9] Net flows depicted in this panel reflect my adjustments to daily assets data for several MMFs. I describe the adjustments in section A.1 of the appendix.

[10] German MMFs, unlike US funds, report mark-to-market (accumulating) NAVs, so individual MMF returns were a useful measure of outcomes during the crisis. As a proxy for portfolio risk, Jank and Wedow used each fund's share of assets held in "debt securities," a residual category that excludes German Treasury bills, bank deposits, CP, and "other assets." (The authors argue that the share of debt securities in an MMF's portfolio is a measure of the MMF's liquidity risk, but this measure likely comprises broader portfolio risks, including credit risk.)

requirements for MMF assets, "to make money market funds more resilient and less likely to break a buck as a result of disruptions such as those that occurred in the fall of 2008" (U.S. Securities and Exchange Commission, 2010).

Investor risk also has received greater attention, especially in the aftermath of the run in 2008. Disparities in outflows from institutional and retail funds prompted the SEC to propose new liquidity requirements for MMFs that would have been more stringent for institutional funds than for retail funds.[11] In addition, ratings organizations, the SEC, and the ICI have highlighted the investor risks arising from "hot money" that flows into and out of MMFs in response to even small yield changes (Fitch Ratings, 2009; U.S. Securities and Exchange Commission, 2009a, pp. 56, 66-68; Investment Company Institute, 2009, pp. 83-84). For example, investors' growing use of MMF portals, which facilitate comparisons of MMF yields and the transfer of monies from fund to fund, may have heightened investor risks (Baba et al., 2009). Fitch's MMF rating criteria, published a year after the run, note that a fund with "an over-reliance on hot money sources such as portals may need an additional liquidity buffer" (Fitch Ratings, 2009).

The MMF crises at issue in this paper have also brought an increased awareness of the importance of sponsor risk. Baba et al. (2009) reported that during the run in 2008, "[t]he largest redemptions occurred at institutional prime funds managed by the remaining securities firms and small independent managers, which investors doubted could support their funds." In assigning MMF ratings, ratings agencies began focusing more specifically on sponsors' resources and abilities to support their MMFs (Moody's Investors Service, 2008; Fitch Ratings, 2009; Standard & Poor's, 2007, 2008a). The SEC's new rules for MMFs, adopted in 2010, facilitate sponsor support for funds during emergencies (U.S. Securities and Exchange Commission, 2010, p. 94-97).[12]

4 Money market fund risks and proxies

Prime MMFs are financial intermediaries that provide both maturity and credit transformation. The funds hold risky assets that may mature in a year or more but issue shares that are redeemable

[11] The SEC proposed new requirements for holdings of "daily liquid assets" and "weekly liquid assets" and suggested that the liquidity requirements for institutional funds be *double* those for retail funds. The Commission's rationale for the distinction between institutional and retail funds was based on the greater historical liquidity needs of institutional funds, as reflected, for example, in their higher flow volatility and larger outflows during the run in 2008 (see U.S. Securities and Exchange Commission, 2009a, pp. 55-65). The SEC ultimately adopted new liquidity requirements for MMFs that were the same for institutional and retail funds, but included a "general liquidity requirement" that an MMF "hold securities that are sufficiently liquid to meet reasonably foreseeable shareholder redemptions," which presumably would cause institutional funds to hold more liquid assets on average than retail funds (U.S. Securities and Exchange Commission, 2010, pp. 51-54, 56-67).

[12] Specifically, the new rules allow an MMF sponsor to purchase from a fund securities that have defaulted or are "distressed," but which are still "eligible" as MMF portfolio holdings under rule 2a-7. Purchases of such securities are generally restricted under section 17 of the ICA because of concerns that a transaction between an MMF and an affiliated party might not be in the interests of the fund. In the past, the SEC had routinely provided no-action relief for MMF sponsors that purchased such securities from MMFs to protect the funds, but the new rules were intended to prevent delays in sponsor support by allowing a sponsor to intervene without getting no-action relief first.

on demand, and MMF shares historically have been safer than many of the assets the funds hold, even though MMFs (unlike some other financial intermediaries) do not have capital cushions or insurance to guarantee the stable value of their liabilities. Instead, MMFs' record of safety reflects regulatory constraints on portfolio composition, conservative asset management, broad investor bases, and financial support from sponsors. Yet, none of these is fail-safe, so MMFs are subject to the portfolio, investor, and sponsor risks that are the focus of this paper. In this section, I discuss these risks and describe proxies that I use for them in my empirical analyses.

4.1 Portfolio risk

Portfolio risks comprise credit, liquidity, and interest-rate risks, all of which have played significant roles in past episodes of MMF stress. Credit risks that turned out badly triggered substantial sponsor support to absorb MMF losses in 1989 and 1990 as well as during the ABCP crisis nearly two decades later, and Reserve's poor management of credit risks in the Primary Fund's portfolio helped to start the run on MMFs in 2008. Liquidity risks came into the spotlight during the run, as MMFs sought to sell securities to meet redemption requests but encountered unreceptive secondary markets for instruments such as term commercial paper—in part, because the dealers who typically make those markets were themselves short of liquidity. At least a couple of MMFs that reportedly had no exposures to Lehman Brothers or other distressed issuers nonetheless had to take extraordinary steps (one closed and the other began paying redemptions in-kind) because sales of securities into illiquid markets would have caused capital losses (Investment Company Institute, 2009, p. 62). Finally, interest-rate risk was responsible for the first instance of an MMF breaking the buck, in 1994, when the Community Bankers Mutual Fund, a small institutional MMF, incurred losses on a sizable position in interest-sensitive structured notes as rates rose suddenly (U.S. Securities and Exchange Commission, 1998b).[13] Although all three types of portfolio risk are important in assessing MMF risks, these risks blur during crises, when unusual discounts on securities (and hence, higher interest rates) may reflect impaired credit quality, impaired liquidity, or both. Thus, I generally do not attempt to distinguish among different types of portfolio risks in this paper.

4.1.1 Gross yield as a proxy for portfolio risk

MMFs' history of maintaining stable NAVs precludes the use of price variation as a measure of portfolio risk. However, given the typical relationship between risk and return, one alternative proxy for a fund's portfolio risk is the gross yield that it earns on its assets. MMF gross yields do not vary much, in part because of rule 2a-7's constraints on fund portfolios. As shown in the second column of table 1, the cross-sectional standard deviation of annual gross yields for prime

[13]Poorly managed interest-rate risk also caused an MMF to break the buck in 1977 (Gorton and Pennacchi, 1993, note 13), but this event occurred before the SEC adopted rule 2a-7.

funds (line 1) was only 12 basis points in the five years from 2004 to 2008. The much larger 29 basis point cross-sectional standard deviation in the *net* yields that the funds paid to shareholders (line 2) primarily reflected variation in expense ratios (line 3).[14]

Even so, gross yields at prime funds varied with the composition and maturity of their assets in ways that suggest that gross yields are a useful proxy for portfolio risk. Section A.2 of the appendix shows that, over a sample period from 2004 to 2008, holdings of relatively safe assets, such as Treasury and agency securities and repurchase agreements, tended to reduce MMF gross yields. At the same time, larger holdings of riskier assets, such as ABCP, floating-rate notes, and other bank obligations, boosted funds' gross yields. Longer WAM also increased gross yields.

Why would MMF sponsors take on greater portfolio risk? Higher portfolio risks increase the likelihood that an MMF will experience capital losses and shortfalls in liquidity, but—for a given level of fees charged—a higher gross yield attracts cash inflows to a fund and boosts its expected future fee revenue (see, for example, Christoffersen, 2001; Christoffersen and Musto, 2002; Jank and Wedow, 2008).[15] In section A.3 of the appendix, I analyze the effects of gross yields on subsequent net flows and find that, over a sample period extending from January 1997 to August 2008, an institutional fund that, all else equal, maintained for a year a gross yield that was one standard deviation above average would have expected to attract net flows that were 6 percentage points (of assets) larger than average. For retail MMFs, the analogous effect was a smaller 2 percentage point gain in net flows.[16] How MMF sponsors and portfolio managers chose to balance the potential costs and benefits of greater portfolio risk is beyond the scope of this paper, but there is evidence that some sponsors—including, notably, Reserve Management Company—elected to take on greater risk than their peers in order to attract greater inflows.

Tables 2a and 2b list means, standard deviations, and the 10th and 90th percentiles for the risk proxies used in my empirical analyses. As shown on line 1 of table 2a, the distributions of *gross* yields for institutional and retail funds in the year prior to the run in 2008 were very similar.[17] Gross yields for both types averaged 3.88 percent (columns 1 and 5), and standard deviations (columns 2 and 6) were also similar. (Statistics for expense ratios, which appear on line 4 of the

[14]The fact that variation in MMFs' net yields was primarily due to variation in expense ratios, rather than gross yields, prompted Domian and Reichenstein's (1998) conclusion that MMFs "are essentially commodities."

[15]The relationship between mutual fund performance and subsequent inflows is the subject of an extensive literature that mostly analyzes long-term mutual funds (see, for example, Wharton School, University of Pennsylvania, 1962; Friend et al., 1970; Smith, 1978; Ippolito, 1992; Chevalier and Ellison, 1997; Sirri and Tufano, 1998; Del Guercio and Tkac, 2002).

[16]Because higher gross yields attract new cash from performance-sensitive investors, a fund's gross yield may also reflect investor risk. However, the empirical evidence suggests that gross yield, especially leading up to the run in 2008, was predominantly an indicator of portfolio risk. Simple correlations between gross yield and several measures of investor risk are all insignificant. Moreover, my analyses include multiple controls for investor risk. See sections 4.4 and 5.2.

[17]Gross yields, like several other risk proxies reported on tables 2a and 2a, are computed over the year ending just prior to the onset of each crisis. A year's data are useful in computing several of these proxies (such as the sensitivity of flow to yield, line 7), and may help smooth through some of the seasonal variation in MMF yields and flows described in Farinella and Koch (2000).

table, indicate that retail MMFs charged much higher fees than institutional funds, so retail funds earned smaller net yields.) As shown in columns 1 and 5 on the first line of table 2b, gross yields for both institutional and retail funds averaged 5.37 percent in the year before the ABCP crisis. The distribution of gross yields for MMFs was very tight during this period: Standard deviations for institutional and retail MMFs were just 2 and 3 basis points, respectively (columns 2 and 6).

4.1.2 MMF ratings as a proxy for portfolio risk

Many MMF carry "AAA" or similar top ratings from ratings organizations, particularly S&P, Moody's, and Fitch. For example, Fitch's "AAAmmf" rating represents its judgment that an MMF has "[e]xtremely strong capacity to achieve fund's investment objective of preserving principal and providing shareholder liquidity through limiting credit, market, and liquidity risk" (Fitch Ratings, 2009). Thus, AAA ratings may be viewed as rating agency opinions that MMF portfolio risks are relatively low.[18] I include, as a binary proxy for (low) portfolio risk, the existence of a AAA rating from at least one of the three major ratings organizations. As shown on line 2 of table 2a, 53 percent of institutional MMFs had triple-A ratings on the eve of the run in 2008, but only 18 percent of retail funds had such ratings.

4.1.3 Controlling for portfolio holdings of specific distressed securities

Money funds' exposures to several specific distressed securities, such as Lehman Brothers' obligations and troubled ABCP issues, played central roles in the two MMF crises that I study in this paper. Past holdings of problematic securities are not promising predictors of future MMF strains—funds are, for example, unlikely to begin purchasing Lehman paper again. However, controlling for such exposures may be important in understanding the cross-sectional variation in outcomes (particularly net flows) of MMFs during past crises.

The critical role of the Lehman Brothers bankruptcy in the run in 2008 motivates controlling for MMFs' holdings of Lehman debt in analyzing redemptions during that crisis. To do so, I use the sources described in section 2 to identify MMFs that held Lehman's obligations at the time of its bankruptcy. As shown on line 3 of table 2a, those sources indicate that 12 percent of both institutional funds (column 1) and retail funds (column 5) held Lehman debt on the eve of the run.

Multiple ABCP issues caused problems for MMFs during the ABCP crisis. As a broad proxy for exposures to distressed securities in this episode, I use an indicator variable equal to one for

[18] Increasingly, ratings organizations are considering investor and sponsor risks in assigning ratings to MMFs (Moody's Investors Service, 2008; Fitch Ratings, 2009). Thus, particularly in the aftermath of the 2008 run, top MMF ratings may be viewed as opinions on each MMF's combination of portfolio, investor, and sponsor risks, although portfolio risks appear to remain central to the ratings organizations' analysis of MMFs. For the period covered by my analysis, however, ratings agencies seem to have focused almost exclusively on portfolio risks. (The exact nature of the risks analyzed by the agencies matters little for the interpretation of my results, as I find that AAA ratings generally had little predictive power for the outcomes for MMFs during the two crises that I study.)

MMFs that held ABCP issues that ultimately prompted sponsor-support actions for at least one MMF. Line 3 of table 2b shows that 57 percent of institutional funds (column 1) and 44 percent of retail funds (column 5) held problematic paper as the crisis unfolded.

4.1.4 Alternative proxies for portfolio risk

Gross yields may be more than compensation for risk; a higher gross yield may reflect a portfolio manager's ability to obtain superior *risk-adjusted* yield. One approach to capturing portfolio risk more directly would be to use portfolio characteristics, such as WAM and shares of assets held in Treasury securities and ABCP (and other characteristics discussed in section A.2 of the appendix) as proxies. Indeed, Jank and Wedow (2008) used the share of individual German MMFs' assets in one apparently risky asset class as a proxy for these funds' liquidity risk. Instead of analyzing every conceivable permutation of fund characteristics in my analyses, I employ—as an alternative to my main specification—the fund portfolio measures in an instrumental variables framework. That is, I use portfolio characteristics to instrument for gross yields and hence capture, as a proxy for portfolio risk, the component of gross yields that is measured by portfolio attributes. Section 5.2 discusses this approach in more detail.

Another approach to measuring portfolio risk in MMFs would be to estimate risk-factor loadings using an arbitrage-pricing model applied to MMF gross yields. Collins and Mack (1994) used such an approach in an event-study analysis of changes in the *aggregate* riskiness of MMFs following the adoption of amendments to rule 2a-7 in 1991. One hurdle to using this approach to pinpoint cross-sectional MMF risks, however, is that amortized-cost accounting prevents funds' yields from fluctuating directly with the market yields of the assets they hold, so MMFs' factor loadings would be biased down (and their "alphas" biased up). Even if yields did move with market rates, the riskiness of individual funds that invested in more exotic instruments might be understated by loadings on conventional market risk factors. Hence, an arbitrage-pricing framework is probably not well suited to study of cross-sectional variation in risks of stable-NAV MMFs.

4.2 Investor risk[19]

As figure 2 illustrates, institutional and retail shareholders subjected MMFs to starkly different degrees of investor risk during the run in 2008. But why? Compared with their retail counterparts, many institutional MMF shareholders may be particularly risk-averse and, at the same time, possess greater sophistication and resources to monitor MMFs carefully and redeem shares preemptively at the first sign of any heightened risk. Institutional investors may face very strong

[19]Broadly speaking, investor risk is a form of liquidity risk, which also includes portfolio risks arising from the illiquidity of (some) portfolio assets. However, I use the term "investor risk" to highlight the liquidity risks attributable specifically to a fund's investors, and I employ "portfolio risk" to encompass the liquidity risks arising from the illiquidity of assets. This terminology not only eases exposition but also reflects the difficulty of distinguishing portfolio liquidity risks from other portfolio risks, particularly during crises.

incentives to avoid losses on MMF shares; capital losses in client accounts may expose institutional investors with fiduciary responsibilities to legal liability, and losses may jeopardize careers of corporate treasurers. Some institutional investors are precluded by law, regulation, or policy from investing in funds without stable NAVs (Investment Company Institute, 2009), so any risk of NAV fluctuations may prompt these investors to redeem MMF shares.

Sophisticated, risk-averse investors also may be particularly attuned to differences between MMF share prices, which are rounded to the nearest penny, and their mark-to-market values (Standard & Poor's, 2007, pp. 27). Rounded NAVs help MMFs maintain stable NAVs, but they also create destabilizing arbitrage opportunities for shareholders when a fund suffers a small capital loss (less than 0.5 percent of assets) that is rounded away. When redeeming investors receive $1 for shares that are worth less, the mark-to-market value of remaining shares declines as losses are concentrated among fewer shares, and the fund moves closer to breaking the buck. So, any loss (or expected loss) in a rounded-NAV fund triggers an incentive for shareholders to redeem before others do.

Net flows to MMFs following changes in short-term interest rates—which affect the mark-to-market value of MMF shares but not their $1 share prices—indicate that some investors, particularly institutional investors, exploit even small discrepancies between prices and values. For example, Lyon (1984) estimated that arbitrage flows reduced the net yields earned by passive investors in institutional MMFs by about 10 basis points annually. Monetary policy easing cycles present numerous opportunities for investors to take advantage of MMFs' rounded prices, and the resulting arbitrage flows have occurred mostly in institutional funds.[20] Sophisticated investors who are more prone to exploit share-price inefficiencies probably subject funds to heightened investor risk during crises.

The relatively higher degree of investor risk in institutional funds may also reflect greater flow volatility in these funds and a greater responsiveness of cash flows to net yield (see section A.3). That is, institutional funds may have relatively larger shares of "hot money" than retail MMFs. As noted in section 3.4, in the aftermath of the run in 2008, regulators and ratings organizations have identified "hot money" as a source of investor risks for money funds.

Other than the distinction between institutional and retail funds, publicly available data provide little direct information about individual funds' investors and the risks they represent. Below, I suggest four proxies for the degree of investor risk in MMFs.

[20]Reductions in the federal funds rate (FFR) target that raise the value (but not the price) of MMF shares may be especially easy to exploit because the profitable transaction is a purchase of MMF shares (even *after* the policy action), so investors need not hold shares in advance to exploit the opportunity. Of the thirteen reductions in the FFR target between 2001 and 2003, the second-to-last, a 50-basis-point cut in the target on November 6, 2002, prompted the largest inflows, perhaps because institutional investors had learned from others' behavior as the easing cycle progressed. Assets under management in money funds, which had been trending down for almost a year before this policy action amid very low short-term interest rates, jumped $168 billion (8 percent of assets) in the three weeks following the reduction in the policy rate. Institutional funds attracted virtually all ($167 billion) of the inflow.

4.2.1 MMF expense ratios as a proxy for investor risk

One indicator of the sophistication of the investors in a money fund—and the risks of large redemptions should the fund encounter difficulties—is the fund's expense ratio. Domian and Reichenstein (1998) found that the net yields of prime funds with more than $300 million in assets "are driven exclusively or almost exclusively by expenses," and they warned that "expenses are a dead-weight loss to investors." Still, *someone* must hold shares in high-expense MMFs, and Christoffersen and Musto (2002) argued that such investors "have distinguished themselves from the population in general ... as relatively more willing to pay high prices for bad prospects." Hortaçsu and Syverson (2004) argued that lower expense ratios (in equity funds) attract more sophisticated investors with lower search costs and less need for costly services. In addition, lower expense ratios may reflect lower shareholder servicing costs (per dollar of assets under management) that are associated with larger average account sizes. While holders of larger accounts are not necessarily more sophisticated than smaller shareholders, investors with more at stake in a fund may have greater incentives to monitor it carefully.

As shown on line 4 of table 2a, the average expense ratio for institutional funds in the year prior to the run (column 1) was less than half of that for retail funds (column 5). At the same time, there was wide dispersion in expense ratios for both types of funds (columns 2 through 4 and 5 through 8). Line 4 of table 2b shows summary statistics for the year before the ABCP crisis.

4.2.2 MMF growth, flow volatility, and yield sensitivity as proxies for investor risk

I use three proxies for the investor risks posed by MMFs' exposure to "hot money" and other sources of flow volatility. The first is the growth of the fund over the previous year, which is probably only a crude indicator of the hot money in a fund, since many factors might contribute to its growth. (I measure growth and flows throughout this paper in terms of the logarithm of net flows, that is, the natural log of the sum of one plus the ratio of net flow to lagged assets.[21]) The second measure is a fund's weekly flow volatility (the standard deviation of weekly log net flows for the previous year), which may reflect a fund's exposures to hot money and to concentrations of similar investors with correlated transactions patterns. The third, the sensitivity of a fund's weekly net flows in the previous year to its own lagged net yields, is designed to capture the component of a fund's flow variability that is due to hot-money flows. For each fund, this measure is the estimated coefficient from a regression of the fund's weekly log net flow on its relative net yield in the previous week.

Lines 5 through 7 of table 2a list summary statistics for the three "hot money" investor risk proxies for the year ending August 2008. All three measures were considerably larger, on average,

[21] I multiply by 100 to make this measure similar to net flows as a percentage of lagged assets: Log net flow = $100 \times ln(1 + \frac{\text{net flow}}{\text{lagged assets}})$. Net flow is the change in assets, net of increases due to accrual of yield.

for institutional funds (column 1) than for retail funds (column 5). Table 2b shows analogous summary statistics for the year ending July 2007.

4.3 Sponsor risk

When the mark-to-market value of an MMF's shares falls below 99.5 cents, the fund's sponsor (that is, its adviser and the adviser's affiliates or parent firm) has two choices: provide capital support to bring the value back to at least 99.5 cents, or allow the fund to reprice its shares below $1—that is, break the buck.[22] Sponsor support is expressly voluntary, and a sponsor's ability and commitment to support its funds is not officially monitored or regulated, so MMF investors can never be certain that a sponsor will support an ailing fund. Historically, however, sponsors with the resources to support their funds have done so, and even asset managers that subsequently exited the MMF business have supported their money funds to preserve their broader reputations.[23] In both instances in which MMFs did break the buck, the sponsor simply lacked the wherewithal to absorb the fund's losses (Eaton, 1994; U.S. Securities and Exchange Commission, 2009b) and its reputation as an investment adviser was destroyed. Hence, sponsors have gone to such lengths to prevent passing capital losses along to MMF shareholders, and sponsor support has come to be seen as a form of "private insurance" (Stigum and Crescenzi, 2007). However, as is the case for other forms of private insurance, the surety of sponsor support for MMFs depends on the financial strength of the sponsor. Sponsor risk reflects the possibility that a sponsor will not be able to support its funds.

4.3.1 Bank affiliation as a proxy for sponsor risk

As one proxy for sponsor risk, I use a dummy indicating whether an MMF's sponsor was affiliated with a bank. Bank affiliation presumably would have been associated with lower sponsor risk because banks have access to lender-of-last-resort liquidity through the Federal Reserve's discount window and may have greater resources for supporting affiliated funds during a crisis. Indeed, many MMFs received support from bank affiliates during the ABCP crisis in 2007 and the run in 2008, and some sizable non-bank firms obtained bank charters during the turmoil that followed

[22]The MMF's board of directors—not its sponsor—ultimately must determine whether to reprice shares below $1. That decision, according to rule 2a-7, should be based on the board's "prompt consideration" of whether "the extent of any deviation from the money market fund's amortized cost price per share may result in material dilution or other unfair results to investors or existing shareholders." However, the sponsor must decide whether to provide financial support to prevent such a deviation. (Sponsors generally do not commit in advance to support an MMF that might later suffer losses, because an explicit commitment would subject the sponsor to potentially large contingent liabilities and likely force the sponsor to consolidate the fund on its balance sheet.)

[23]Credit Suisse reported a total of $1.8 billion in losses related to support of its MMFs on its income statements in 2007 and 2008, even though the firm exited the MMF business in late 2008 (Credit Suisse, 2008, pp. 65-66; Credit Suisse, 2009, pp. 27, 45, 434).

the Lehman bankruptcy, presumably to obtain access to the discount window.[24] Indeed, Baba et al. (2009) reported that bank-affiliated MMFs experienced smaller-than-average net redemptions during the run. Line 8 of tables 2a and 2b show that about half of both institutional and retail prime MMFs were affiliated with banks at the onset of each crisis episode.

4.3.2 Sponsor CDS spreads as a proxy for sponsor risk

As a second proxy for sponsor risk, I use the five-year CDS spread of the sponsor's senior debt securities. Because the financial condition of some large institutions that sponsored MMFs deteriorated quickly before the beginning of the run in 2008, I use each sponsor's CDS spreads averaged over the first week of September 2008. (Spreads during the week *after* the Lehman bankruptcy might be endogenous if MMF outflows worsened strains on sponsors). CDS spreads are only available for sponsors of 43 percent of prime MMFs (line 11 of table 2a). Mean spreads for sponsors of both institutional and retail funds averaged about 140 basis points (line 9). Both the average CDS spread and the dispersion of spreads were much larger immediately before the run in 2008 than they had been just prior to the onset of the ABCP crisis (table 2b, line 9).

4.4 Interactions among risk proxies

Tables 3a and 3b provide simple correlations for the MMF risk proxies used in this paper, as measured before the run in 2008 and prior to the onset of the ABCP crisis in 2007, respectively. Panels A and B of each table show correlations for institutional funds and retail funds, respectively. (Numbering of the variables in the rows and columns of these tables is the same as that for tables 2a and 2b). For clarity, I report only correlations that are significant at the 5 percent level.

The correlations point to some distinctions among the proxies for portfolio risk. For example, among institutional funds in the year before the run in 2008 (table 3a, panel A), none of the pairwise correlations among the portfolio-risk proxies—gross yield, triple-A ratings, and Lehman exposure (the first three lines and columns)—was significant. Intriguingly, table 3b shows that triple-A ratings for both institutional and retail funds were uncorrelated with distressed ABCP exposure during the ABCP crisis (line 3, column 2). However, MMFs with such exposures did exhibit higher gross yields in the year before the ABCP crisis (line 3, column 1).

The evidence for links among the proxies for investor risk was also mixed. Lower expense ratios in institutional funds were correlated with other measures of investor risk both before the run in 2008 (table 3a, lines 6 and 7, column 4) and before the ABCP crisis (table 3b, lines 5 and 6, column 4), but other pairwise correlations were generally not significant. The two proxies for

[24] In analyzing the run in September and October 2008, I treat MMF sponsors that obtained bank charters after Lehman's bankruptcy as non-bank entities, except in the weekly regressions discussed in section 5.3. (In those regressions, a sponsor's bank-affiliation is recorded as of the beginning of each week.) Relabeling sponsors that obtained bank charters during the run as bank-affiliated does not materially alter my results.

sponsor risk, CDS spread and bank affiliation, were significantly negatively correlated only for institutional MMFs in the year before the ABCP crisis.

Some of the correlations among proxies for different types of risk are relevant to interpretation of my results. For example, in the year prior to the run in 2008, MMF gross yields were not significantly correlated with three of the measures of investor risk and were *negatively* correlated with the standard deviation of weekly flows (see both panels of table 3a, lines 4 through 7, column 1). Although higher gross yields may attract riskier investors, the correlations support the view that gross yield during this episode was a proxy for portfolio risk, rather than investor risk.

The correlations on table 3a also preview the links between MMF risks and outflows from institutional and retail funds during the run in 2008. For example, as shown on line 12 of panel A, several risk factors were associated with larger outflows from institutional funds during the run in 2008: higher gross yield (column 1), a lower expense ratio (column 4), greater flow sensitivity (column 7), a higher CDS spread (column 9), and larger size (column 10). Correlations between net flows and risks for retail funds (panel B) were quite different from those for institutional funds. This point is explored in more detail in section 5.1.

The size of an MMF was an important predictor of outflows during the run in 2008 and, particularly for institutional funds, was correlated with multiple risk proxies in both episodes (see line 10 and column 10 in the top panels of tables 3a and 3b). For example, in both episodes, larger institutional funds had lower expense ratios and thus probably faced greater investor risk from relatively sophisticated shareholders. Even controlling for expense ratios, larger, sophisticated investors may have been more likely to invest in bigger funds. Larger institutional funds were more likely to have had triple-A ratings, an indicator of lower portfolio risk, but larger funds also were more likely to have held Lehman debt in 2008 and distressed ABCP in 2007. In addition, fund size may have intensified concerns about sponsor risk because greater amounts of capital might have been needed to absorb losses in larger funds. Thus, links between size and multiple forms of MMF risk complicate the interpretation of the role of fund size in explaining outcomes during crises.

5 MMF risks and the cross section of outflows during the 2008 run

To analyze prime MMF flows during the run that followed the Lehman bankruptcy, I run a series of cross-sectional regressions in which the dependent variable is net flows from September 9 to October 7, 2008 (the Lehman bankruptcy occurred on September 15, and ICI aggregate data indicate that prime funds had large outflows through the first week of October). As discussed in section 2, I use data from iMoneyNet for prime money funds that had been in existence for at least a year, had assets exceeding $100 million, and had reliable flows data during the run. The sample includes 116 institutional funds and 135 retail funds. Explanatory variables include the proxies

for fund risks (and fund size), as listed on tables 2a and 4:

$$\begin{aligned} flow^i_{run} = {} & \beta_1 gyield^i_{t\in P} + \beta_2 AAA^i_{t=\bar{P}} + \beta_3 Lehman^i_{t=\bar{P}} \\ & + \beta_4 exprat^i_{t\in P} + \beta_5 growth^i_{t\in P} + \beta_6 flowSD^i_{t\in P} + \beta_7 flowSens^i_{t\in P} \\ & + \beta_8 bank^i_{t=\bar{P}} + \beta_9 CDS^i_{t=\bar{P}} + \beta_{10} assets^i_{t=\bar{P}} + constant + \varepsilon^i. \end{aligned} \tag{1}$$

Here, $flow^i_{run}$ is fund i's log net flow during the run, $gyield^i_{t\in P}$ is the gross yield of fund i over the year ending August 2008 (period P), and $AAA^i_{t=\bar{P}}$ is a dummy variable equal to one if and only if fund i had a triple-A rating from at least one ratings organization as of the end of August 2008 (at time $\bar{P}$). Other explanatory variables are listed on tables 2a and 4 in the same order that they appear in equation (1).

Table 4 reports results from six regressions. These include separate estimations for institutional and retail MMFs, because their outflow dynamics differed so starkly during the run, as well as selected significance results from a pooled regression that includes both institutional and retail funds. Because CDS spreads are available for sponsors of less than half of the money funds in the sample, I run an extra set of regressions to include these spreads.

5.1 Empirical results

The first three columns of table 4 summarize the results of regressions that exclude CDS spreads. Column 1 shows results for institutional funds.

Line 1 shows that greater portfolio risk, as measured by higher gross yields in the year prior to September 2008, was associated with significantly larger outflows during the run. Other indicators of portfolio risk—whether the fund had a triple-A rating (line 2) or had Lehman exposure (line 3)—had no significant effect on outflows. The insignificance of the Lehman dummy is surprising, given the role of Lehman's bankruptcy in triggering the run. However, I show in section 5.3 below that Lehman exposures did have a significant negative effect on fund flows early in the run, but that the impact was reversed in later weeks.

Investor risk also was an important predictor of institutional MMF outflows during the run in 2008: Three of the four investor risk proxies had significant effects (with the expected signs) on net flows. Line 4 indicates that funds with higher expense ratios had larger net flows (smaller outflows) during the run—a result that stands in contrast with the usual negative effect of expense ratios on flows (see section A.3 of the appendix). Although a fund's growth over the previous year (line 5) had no significant effect, lines 6 and 7 show that institutional funds with greater weekly flow volatility and higher sensitivity to yields had significantly greater outflows during the run.

In fact, three indicators of investor risk (the expense ratio, flow volatility, and flow sensitivity) can explain much of the enormous difference in the outflows from institutional and retail funds during the run in 2008. The regression results for institutional funds imply that an institu-

tional fund with investor risks similar to those of a retail fund would have had net flows that were 20.2 "percentage points" larger than an institutional fund with average investor risk.[25] This total is a very substantial portion of the 20.8 percentage point difference in mean flow for institutional and retail funds.[26] The calculation is merely illustrative, as it only takes into account differences in investor risk proxies and ignores the striking differences in institutional and retail investors' *responses* to risks. Still, the explanatory power of these risk proxies shows that a simple distinction between institutional and retail investors is not the only important measure of investor risk.

Bank affiliation (line 8) did not have a significant effect on net flow. However, line 10 shows that larger institutional MMFs suffered proportionally more severe outflows during the run; indeed, twelve large MMFs accounted for more than half of the aggregate outflow from institutional funds. As discussed in section 4.4, fund size may have been linked to multiple forms of MMF risk.

Column 3 shows results for retail prime funds. A couple of risk factors with significant explanatory power for institutional MMF outflows during the run were less helpful in explaining retail fund flows, and R-squares for retail MMFs are lower. The estimated coefficient on gross yield, line 1, is insignificant. Higher expense ratios were associated with smaller outflows (line 4), but the magnitude of the effect was much smaller than it was for institutional MMFs. Indeed, as indicated in column 2, estimated coefficients on gross yield and the expense ratio are significantly different for institutional and retail funds. This column reports significance levels for tests that institutional and retail fund coefficients are different, based on a pooled regression of both types of funds in which an institutional fund dummy is interacted with each explanatory variable.[27]

Nonetheless, investor risk does appear to have been important in explaining the variation in retail MMF flows during the run. In addition to the expense ratio, flow volatility (line 6) enters the regression significantly with the expected sign. Finally, fund size (line 10) was also a significant predictor of outflows from retail funds.

Sponsor risk, too, had significant consequences for institutional prime funds during the run. Columns 4 and 6 report results from regressions that include sponsor CDS spreads, at a cost of considerable reductions in sample size.[28] As shown in column 4, higher sponsor CDS spreads (line 9) were associated with significantly greater outflows. (In this sample, the coefficient on the bank-affiliation dummy, an indicator of low sponsor risk, is positive but marginally significant.) For

[25]This result is based on regression coefficients from the full-sample institutional regression (lines 4, 6, and 7 in the first column of table 4). I multiply coefficients for each of these three investor-risk proxies by the difference between the proxy's sample mean among retail funds and its sample mean among institutional funds (columns 5 and 1, respectively, of table 2a) and sum these products: $20.2 = 39.30(0.63 - 0.29) - 2.06(2.76 - 5.13) - 0.38(1.51 - 6.91)$. For ease of exposition, I refer to the units of log flows in terms of percentage points. The actual units are 100 times the natural logarithm of the sum of one plus the ratio of net flow to lagged assets. See note 21.

[26]Compare columns 1 and 5 on line 12 of table 2a.

[27]An *F*-test rejects (with a *p*-value of essentially zero) the null hypothesis that the coefficients for institutional and retail funds in this pooled regression are all equal.

[28]I also ran regressions similar to those reported in columns 1 and 3 of table 4, but with dummy variables indicating whether CDS spreads were available for each fund's sponsor. The dummies were generally negative but insignificant.

retail funds, however, sponsor risk was not important in explaining outflows (column 6). Other results for the CDS spreads sample are similar to those for the full sample, although coefficients on the investor risk proxies are generally estimated with less precision (for example, weekly flow sensitivity is no longer significant in the institutional-fund regression).[29]

The significance of proxies for portfolio, investor, and sponsor risk in these regressions show that the run in 2008 was not simply an indiscriminate panic. MMFs with greater risks bore the brunt of the outflows during the run. R-squares from the regressions indicate that risk proxies explain a sizable portion of the cross-sectional variance in flows, particularly for institutional funds. Moreover, the particularly strong links between risk proxies and outflows from institutional funds point to interactions in MMF risks: Funds with greater investor risks (due, in part, to their more sophisticated investors) were also more sensitive to portfolio and sponsor risks.

Table 5 provides some additional insight into the economic significance of the regression results by reporting estimated impacts on net flow of 1-standard-deviation increases in each right-hand-side variable (for dummy variables, which are indicated with an asterisk (*), the entry represents the estimated effect of a 0-to-1 change in that variable on net flow, which typically represents about a 2-standard-deviation change).[30] For example, line 1 of column 1 shows that, for institutional prime funds, a 1-standard-deviation increase in gross yield paid over the year ending in August 2008 was, all else equal, associated with 9 percentage points greater outflow during the run. Normalized changes in other risk proxies also had substantial predicted effects on net flows for institutional funds (columns 1 and 3). For retail funds (columns 2 and 4), normalized changes in most risk proxies had much smaller predicted effects on net flows.

5.2 Does the link between outflows and gross yields reflect portfolio risk?

The role of gross yields in explaining outflows from institutional MMFs during the run in 2008 underlines the importance of interpreting the information contained in these yields. Section 4.1.1 and section A.2 of the appendix offer evidence that an MMF's gross yield is a useful summary statistic for its portfolio risk. As noted in section 4.4, one alternative interpretation—that higher gross yields indicated greater investor risk—is not supported by any significant pairwise correlation between gross yield and the proxies for investor risk. Moreover, the multiple controls for investor risk in equation (1) should pick up effects of investor risk that are related to gross yield.

Another possibility, discussed in section 4.1.4, is that higher gross yields also reflected greater portfolio manager talent. One way to control for any confounding effect of manager ability is to use portfolio characteristics to instrument for gross yields in regressions of the form of equation (1). As noted in section A.2 of the appendix, gross yields of individual prime MMFs varied

[29] Again, an *F*-test rejects (with a near-zero *p*-value) the null hypothesis that the coefficients for institutional and retail funds are all equal in a pooled regression includes CDS spreads.

[30] See columns 2 and 6 in table 2a for standard deviations of the explanatory variables.

significantly with the shares of their assets held in different types of instruments and with their WAMs. Manager ability should have been orthogonal to these broad portfolio measures. Thus, I run a two-stage least-squares (2SLS) regression in which the portfolio measures from table A1 serve as instruments for gross yields.[31]

Results are shown in table 6. For comparison, column 1 repeats the output of the baseline regression for institutional funds from the first column of table 4. The 2SLS regression results, listed in column 2, are quite similar; the estimated coefficient on gross yield is highly significant but a little smaller than that from the regression in which gross yield appears directly. The instrumental variables results corroborate the view that institutional MMFs with higher gross yields had larger outflows because of investors' concerns about greater portfolio risks.

5.3 MMF risks and outflows by week during the 2008 run

The run on MMFs in September and October 2008 was punctuated by very significant financial and policy events. As indicated by panel B of figure 2, these included the Lehman bankruptcy early on Monday, September 15; Reserve's announcement at 4 p.m. on Tuesday, September 16 that the Primary Fund had repriced its shares at 97 cents; the announcements of the Treasury's Temporary Guarantee Program for MMFs and the Federal Reserve's AMLF on the morning of Friday, September 19; and the announcement of the Federal Reserve's Commercial Paper Funding Facility (CPFF) on October 7. Hence, a closer look at the timing of the links between MMF risks and outflows may be informative in understanding the role of risks during the run.

To do so, I run weekly regressions similar to equation (1) but in which the dependent variable is net flow measured over a particular week.[32] The more precise timing of the flows in these regressions allows some modifications to the sample, which are described more fully in section A.1. For example, several MMFs that are excluded from the full-sample regressions because of measurement problems can be included in a subset of the weekly regressions, and each weekly regression includes CDS spreads measured over the previous week, to capture the effects of any deterioration in sponsors' financial condition. For each specification (including and excluding CDS), I run a separate regression for each of the seven weeks ending on Tuesdays from September 2 to October 14, reflecting the timing of iMoneyNet's weekly taxable MMF data. Results are

[31] An alternative approach is to include portfolio measures *instead of* (rather than instruments for) gross yield. For example, including only funds' ABCP portfolio shares corroborates Duygan-Bump et al.'s (2010) finding—based on an analysis of *all* prime funds and a different sample period than I use—that funds with higher ABCP exposures had larger outflows during the run. (If gross yield *and* ABCP share are both included in my baseline specification for institutional funds, the coefficient on gross yield remains significantly negative and ABCP share is negative and significant at the 12 percent level.) A temptation here is to run every permutation of the portfolio characteristics in a "horse race" to pinpoint *the* key characteristics that spooked investors. My aim is simpler—to show that portfolio risk was important in prompting outflows during the run.

[32] iMoneyNet provides *daily* assets data for a subset of the funds it tracks, although for many MMF share classes, daily asset observations appear to be flatlined for each week. I also ran regressions at a daily frequency, but the daily results added little to the insights that the weekly regressions provide.

depicted graphically in figures 3a (for regressions that omit CDS spreads) and 3b (regressions that include CDS spreads). For brevity, I only report results for institutional MMFs.[33]

The figures illustrate the timing of both the economic and statistical significance of each of the risk proxies. The solid line in each panel plots, for each week, the predicted effect of a one-standard-deviation increase in an explanatory variable on net flow as a percentage of lagged assets.[34] (The plots also show predicted effects of one-standard-deviation changes in dummy variables, rather than 0-to-1 changes.) The dashed lines are the upper and lower bounds of a quasi 95 percent confidence interval for the predicted effects derived by using a two-standard-error confidence interval for each estimated coefficient.[35]

Figure 3a shows that, in the full-sample regressions that exclude CDS, the risk proxies had virtually no significant effect on fund flows in the two weeks prior to the Lehman bankruptcy (the weeks ending September 2 and 9). However, by the third week (September 10-16), which included the Lehman bankruptcy and ended just as the Reserve Primary Fund announced that it had broken the buck, risk proxies began to have significant effects. Two investor risk proxies (the expense ratio, panel 4, and flow sensitivity to yield, panel 7), size (panel 10), and—notably—the Lehman-exposure dummy (panel 3) are all significant with the predicted signs. Institutional MMFs suffered their worst outflows of the entire episode during the fourth week (September 17-23), and, on the 19th, the government announced both the Treasury Guarantee Program for MMFs and the Federal Reserve's AMLF. In that week, higher gross yields (panel 1) began to enter significantly and two investor risk proxies remained significant (panels 4 and 7). However, the coefficient on the Lehman-exposure dummy (panel 3) was positive! By the fifth week, with the government programs in place, only a couple of risk proxies were significant, and in the final two weeks (ending in October), almost none were.

When CDS spreads are added to the regression, the patterns of significance among the proxies change somewhat (in part because the sample size declines), but the overall picture (figure 3b) is similar. Gross yield (panel 1) was a significant predictor of flows one week earlier (during the week ending September 16) than it was in the full-sample regression. Two investor risk proxies (panels 6 and 7) and the Lehman-exposure dummies (panel 3) are no longer significant. The CDS spread itself was significant at least at the 10 percent level for four weeks spanning September 3-30—starting even before the Lehman bankruptcy—although the magnitude of the predicted effect increased substantially in the week that included the Lehman collapse and Reserve's break-the-buck announcement.[36]

[33] Results for retail funds, as well as results for all MMFs in tabular form, are available upon request.

[34] Predicted effects reported here have been converted from log net flows to net flows as a percent of lagged assets.

[35] For example, upper bounds for the predicted effects of higher gross yield (panel 1) are computed by adding two standard errors to each weekly estimated coefficient on gross yield and multiplying the result by the standard deviation of gross yield for institutional prime funds.

[36] p-values for the null hypothesis that the CDS spread was zero for the weeks ending September 9, 16, 23, and 30 were 0.044, 0.093, 0.057, and 0.002, respectively.

In summary, the week-by-week regressions indicate that proxies for risk were generally most significant—and had the largest predicted effects—just as the run was peaking. Three additional points are worth noting. First, the Lehman-exposure dummy predicted significantly greater outflows (at least in the full sample) in the week from September 9-16 but *smaller* outflows in the following week. One possible explanation is that institutional investors redeemed shares preemptively in the days just before the Reserve Primary Fund broke the buck but subsequent announcements of support actions by sponsors of MMFs (other than Reserve) with Lehman exposure allayed investor concerns and slowed the outflows. For example, on September 17, BNY Mellon announced support for its Dreyfus MMFs that held Lehman debt (Condon, 2008). This may explain why the Lehman-exposure dummy was not significant in the regressions that cover the full period of the run.

Second, the weekly graphs highlight that fund size had a strikingly large and significant effect on outflows at the peak of the run. As noted in section 4.4, size probably reflected multiple forms of MMF risk.

Third, a weekly analysis of *retail* funds (not shown) indicates that MMF risk proxies did have significant effects on fund flows, but only rather late in the run. For the week ending September 30, coefficients for Lehman exposure, weekly flow volatility, weekly flow sensitivity, and fund size are negative and significant. The delayed response of retail investors is also apparent in panel B of figure 2; outflows from retail funds peaked later than those from institutional funds.

6 The ABCP crisis and MMF risks

The crisis in the market for ABCP that erupted in August 2007 caused severe strains for some MMFs and for short-term funding markets. However, the broader consequences were far less momentous than those of the run in 2008, in part because capital losses of MMFs in 2007 were absorbed by their sponsors, no fund broke the buck, and MMFs suffered no large-scale run. As such, MMF risks played a different role in this crisis than they did during the run a year later. Below, I examine links between MMF risks and three types of ABCP crisis outcomes for individual MMFs: prime funds' net flows in the three weeks from August 7 to 28, 2007; sponsor interventions to support MMFs that held distressed ABCP; and fund exposures to distressed ABCP.

6.1 MMF risks and the cross-section of outflows during the ABCP crisis

Given the links between MMF risks and outflows during the run in 2008, a natural question is whether the small aggregate outflow from prime funds during the ABCP crisis masked significant cross-sectional correlation between fund risks and flows. Anecdotal evidence suggests such a story; as noted in section 3.2, at least one MMF suffered very large outflows because of holdings of distressed ABCP. Still, the standard deviation of prime institutional MMF flows was much

smaller during the ABCP crisis (table 2b, line 12, column 2) than it was during the 2008 run (table 2a). The dispersion of retail fund flows as the ABCP crisis unfolded (table 2b, line 12, column 6) nearly matched that of institutional funds.

To test the relationship between MMF risks and net flows during the ABCP crisis, I estimate slightly revised versions of equation (1), with net flows to institutional and retail prime MMFs in the three weeks ending August 28, 2007 as dependent variables. Explanatory variables are the risk proxies described in section 4 and are listed in table 2b. The only important differences between these risk factors and those used to analyze the run in 2008 are the dates over which the measures are computed and the specific distressed-asset exposures of concern (line 3). For analysis of the ABCP crisis, the relevant exposures were to distressed ABCP issues that caused problems for other MMFs. Correlations among the risk proxies appear on table 3b.

Regression results are shown in table 7. Whereas multiple risk proxies were useful in predicting the net flows of institutional prime MMFs during the 2008 run, net flows to these funds exhibited little significant responsiveness to risks during the ABCP crisis. A couple of explanatory variables are marginally significant in the full-sample regression (column 1), but one of these (flow sensitivity, line 7) has the "wrong" sign. In the regression that includes CDS spreads (column 4), these spreads are only marginally significant (at the 11 percent level).[37]

Oddly, retail fund flows appear to have been somewhat more responsive to MMF risks, but only in the smaller sample that includes CDS spreads (column 6). In that specification, holdings of distressed ABCP (line 3) had a statistically significant negative effect on net flow, and the investor risk proxies were all significant at least at the 10 percent level—but two of them (the expense ratio, line 4, and growth over the previous year, line 5) had the "wrong" signs. None of the risk proxies is significant at the 5 percent level in the full-sample regression for retail funds (column 3).[38]

Taken together, the risk proxies had far less explanatory power for the cross-sectional variation in net flows during the ABCP crisis than they did for variation in flows during the run in 2008: Three of the four R-squares on table 7 are less than half those for the corresponding regressions on table 4. For MMF investors, money fund risks apparently remained mostly latent through the ABCP crisis, amid the widespread interventions by sponsors to absorb losses. Again, the evidence points to important interactions among MMF risks: When sponsor risk was perceived to be low, portfolio and investor risks had little impact on net flows.

[37] Although the estimated coefficient on CDS spreads for institutional prime MMFs in this regression is only marginally significant, it is nearly as large in magnitude as that on CDS spreads for such funds during the run in 2008. However, even if we take these magnitudes as given, higher sponsor CDS spreads during the ABCP crisis were much less consequential for MMFs than such spreads were during the run in 2008. A one-standard-deviation increase in CDS spread in the first week of August 2007 was only 25 basis points and hence would predict only 3.5 percentage points more outflow from these funds. As shown on line 9, column 3 of table 5, a one-standard-deviation increase in sponsor CDS spread in early September 2008 was associated with 12 percentage points more outflow during the run.

[38] An *F*-test based on a pooled institutional-retail regression that excludes CDS spreads does *not* reject the null hypothesis that the coefficients for institutional and retail funds (reported in columns 1 and 3 of table 7) are jointly equal. However, such a test does reject the null (at the 5 percent level) when CDS spreads are included.

6.2 MMF risks and sponsor financial support following the ABCP crisis

For some MMF sponsors, however, the consequences of money fund risks were quite costly during the ABCP crisis (Crane, 2009; Credit Suisse, 2008, 2009). Indeed, sponsors' record of financial support for their funds provides another perspective on MMF outcomes during this episode. Because sponsors' actions reveal their concerns about actual or expected losses in funds' portfolios, as well as concerns about investors' reactions to fund risks, the support actions indicate where NAV fluctuations or large outflows likely would have occurred in the absence of interventions.[39]

Some of the predicted relationships between MMF risks and sponsor support actions should be similar to the links between risks and outflows during the run in 2008. Greater portfolio risk, all else equal, should be associated with a higher probability of a sponsor bailout. Support actions might also be linked to investor risk, since heavy redemptions can exacerbate losses for MMFs.

However, a key distinction between MMF outflows and sponsor support as outcomes of interest is in their links to sponsor risk. Section 5 shows that MMF investors responded to sponsor risk by disproportionately redeeming shares from MMFs with riskier sponsors during the run in 2008. As such, sponsor risk is an important dimension of MMF risk. But when the outcome of concern is a sponsor's intervention to support an ailing fund, sponsor risk may have multiple roles. A sponsor with deep financial resources may be more likely to bail out a troubled MMF, so *lower* sponsor risk may predict the "bad" outcome (support). But a link between sponsor financial strength and MMF support also might reflect moral hazard, if portfolio managers made riskier investments believing that deep-pocketed affiliates could absorb losses. In addition, anticipation of a sponsor's need to provide support for its MMFs might drive up its CDS spreads, so sponsor risk itself may be endogenous.

As described in section 2, I obtained information about sponsor-support interventions from public sources, including the SEC's website and the financial statements of asset managers, as well as from confidential SEC records. These data are thus a more complete record of support than is available from public records, although, as noted earlier, some sponsor interventions still may be unrecorded. Table 8 provides some summary statistics, measured just before the ABCP crisis, for all prime funds in my sample (column 1) and for the funds with records of sponsor support (column 2).[40] The table combines data for institutional and retail funds because I find no statistical evidence that the relationship between MMF risks and support actions was different for the two types of funds.

[39] Ideally, sponsor support records would quantify the market value of each sponsor's contribution to a fund's assets to allow estimation of the magnitude of NAV decline that would have occurred without intervention. However, most of the records provide, at best, information about the total amounts of distressed assets purchased from funds or the notional size of wraps provided for distressed assets. Thus, I was not able to construct a continuous measure of support applicable to all the funds that received it.

[40] As noted in section 2, the sample includes funds with at least $100 million in assets and 12 months of history in the iMoneyNet database as of July 31, 2007. The unit of analysis is the money market fund; multiple share classes for a single fund are combined into one observation (see note 4).

Of the 249 prime money funds in the sample as of July 31, 2007 (line 1), 39 funds (16 percent) had records of sponsor support due to holdings of distressed ABCP.[41] Line 2 shows that 20 of the 116 institutional prime MMFs received support, as did 19 of the 133 retail prime funds. Supported funds were somewhat larger than average (line 3) and had earned gross yields that were just a touch higher than average in the year before the ABCP crisis began (line 4). Supported funds also were more likely than other prime funds to have had a triple-A rating: One-third of all MMFs had such a rating, but triple-A funds accounted for almost half the funds that received support (line 5). The next four lines indicate that sponsor-supported funds exhibited greater investor risk than the rest of the prime fund industry by several measures: They had lower expense ratios (line 6), more rapid growth in the previous year (line 7), and greater flow volatility and sensitivity to yield (lines 8 and 9). Supported funds were more likely than average to be bank-affiliated (line 10) and to have sponsors with CDS spreads in the Markit database (line 11). The CDS spreads of sponsors of MMFs that received support were somewhat higher than average, both in the week before the onset of the crisis (line 12) and in the year beforehand (line 13). In addition (not shown), CDS spreads for bank sponsors averaged 16 basis points less than those of other sponsors in the first week of August 2007, and 10 basis points less in the year before the onset of the ABCP crisis.

To test the relationship between sponsor support and MMF characteristics, including risk proxies, I define:

$$S^i \equiv \begin{cases} 1 & \text{if fund } i \text{ received sponsor support due to exposure to distressed ABCP} \\ 0 & \text{otherwise.} \end{cases}$$

I use a probit regression to estimate:

$$\begin{aligned} Pr(S^i = 1) = \Phi\Big(& \beta_1 gyield^i_{t\in P} + \beta_2 AAA^i_{t=\bar{P}} + \beta_3 exprat^i_{t\in P} + \beta_4 growth^i_{t\in P} \\ & + \beta_5 flowSD^i_{t\in P} + \beta_6 flowSens^i_{t\in P} + \beta_7 bank^i_{t=\bar{P}} + \beta_8 CDS^i_{t=\bar{P}} + \beta_9 CDS^i_{t\in P} \\ & + \beta_{10} inst^i_{t=\bar{P}} + \beta_{11} assets^i_{t=\bar{P}} + constant \Big). \end{aligned} \tag{2}$$

Explanatory variables are listed, in the order in which they appear in equation (2), in table 9. I estimate one pooled regression for institutional and retail funds because the relationship between support and MMF characteristics was not statistically different for institutional and retail funds.[42] The explanatory variables are the same as those used to estimate equation (1), with three changes.

[41] The SEC indicated that 44 funds had received such support (U.S. Securities and Exchange Commission, 2009a, note 38). I found records of support for 43 unique MMFs, but two were for government-only funds, one was for a fund with no iMoneyNet data, and one for a fund that was less than one year old.

[42] In a pooled regression of institutional and retail funds (not shown), in which an institutional-fund dummy was interacted with each explanatory variable, none of the individual estimated coefficients was significantly different (at the 5 percent level) for the two types of funds, and the interactive institutional dummy variables were jointly insignificant.

First, I do not include the indicator variable for exposures to distressed securities, which I constructed using securities identified in sponsor-support records. Second, equation (2) includes a dummy for institutional funds.

A third change is motivated by concerns about the endogeneity of CDS spreads. Although sponsors' early-August CDS spreads ($CDS^i_{t=\bar{P}}$) are useful for examining the sponsor-risk effect on subsequent net flows, spreads measured on the eve of the ABCP crisis may have already reflected concerns about the costs of MMF bailouts for sponsors. If so, early-August spreads should enter the regression positively, while CDS spreads measured earlier should be less predictive—or enter negatively, if sponsor financial strength caused moral hazard for managers. Hence, I include in the regression average CDS spreads measured over the preceding year ($CDS^i_{t\in P}$).

The first two columns of table 9 list the results of estimating equation (2). Column 1 shows results for the full sample of MMFs when CDS spreads are excluded, and column 2 provides results for the subsample for which sponsor CDS spreads are available.

As shown on line 1, portfolio risk—as indicated by funds' gross yields earned over the previous year—was a statistically significant predictor of sponsor support during the ABCP crisis. It was also economically important: Based on the full-sample result (column 1), a one-standard-deviation increase in a fund's gross yield (only 3 basis points in the pooled sample of all prime funds) is associated with a 13 percentage point increase in the probability that the fund was the recipient of sponsor support. (Based on the regression that includes CDS spreads, the predicted effect is 39 percentage points.) The importance of gross yield in predicting sponsor support makes sense: Riskier portfolios were more likely to experience losses that sponsors ultimately absorbed. In contrast, a triple-A rating (line 2) had no significant predictive power in the full sample and had the "wrong" sign in the CDS sample: Controlling for CDS spreads, funds with triple-A ratings were more likely to have been the recipients of sponsor support.[43]

The evidence for a link between investor risk and sponsor bailouts is less compelling. Among the indicators of investor risk, only the volatility of net flows over the previous year (line 5) was significant (marginally so in the CDS regression). Moreover, as noted above, tests for institutional-retail differences in the relationship between sponsor support and MMF risks found no evidence for any distinction. Given the overwhelming evidence during the run in 2008 that institutional funds represented greater investor risk, this suggests that such risk was not a factor in sponsor interventions. One interpretation of these results is that sponsor support was provided when portfolio assets soured, regardless of the additional risks that investors may have posed.

Sponsor risk had a significant but somewhat ambiguous role in predicting sponsor support. Bank-affiliated MMFs were more likely to receive support (line 7). Indeed, Baba et al. (2009)

[43]One possible explanation is that a triple-A rating reflected a sponsor's *motivation* (conditional on financial strength) to support an ailing fund, although the ratings organizations' narrow focus on portfolio risks, particularly prior to 2008, makes such an explanation seem dubious. As shown in section 6.3 below, triple-A ratings were not helpful in predicting whether MMFs held distressed ABCP.

noted that bank-affiliated fund managers "were over-represented among support providers." As noted above, the link between banks and MMF support may reflect a greater propensity of deep-pocketed sponsors to bail out troubled funds, conditional on similar exposures to distressed securities, or it may reveal a moral hazard problem for bank-affiliated portfolio managers. An additional consideration is that the banks may have been more likely to disclose financial support for affiliated MMFs because banks face more rigorous regulatory oversight and disclosure requirements than some other financial services firms.

The link between sponsor CDS spreads and support is more puzzling: The estimated coefficient on early-August spreads (line 8) is negative and insignificant, while that on spreads registered over the preceding year is positive and highly significant. This pattern is exactly opposite what we would expect if spreads were endogenously reflecting the likelihood of sponsor support. But the role of sponsor risk is odd: Apparently, aside from a sponsor's bank affiliation, *riskier* sponsors were more likely to intervene later to support their funds.[44]

6.3 MMF risks and holdings of distressed ABCP

Analysis of MMFs' holdings of distressed ABCP can help interpret links between risks and poor outcomes for the funds. For example, a finding that bank-affiliated advisers were more likely to have *invested* in problematic ABCP would be evidence in favor of a moral-hazard explanation for the link between bank affiliation and sponsor support. The potential incompleteness of sponsor-support records also makes portfolio exposures information valuable for the study of MMFs during this episode.

Using funds' most recent SEC filings (see section 2) prior to the onset of the ABCP crisis, I identified 124 MMFs that held ABCP that ultimately triggered sponsor support actions for at least one MMF. The third column of table 8 provides some summary statistics on these funds, which accounted for nearly half of the money funds in the sample—more than triple the number that reportedly received sponsor support. Compared with the full sample (column 1), funds that held distressed paper were a bit more likely to be institutional funds, were larger, had flows that were more sensitive to yield, and were more likely to be affiliated with banks. Otherwise, funds that held distressed paper were similar to other MMFs.

Finally, as shown in column 4 of the table, I combine the indicators of sponsor support and exposure to distressed paper to capture MMFs that apparently held problematic securities that were not identified using the portfolio records. This combination adds just four funds to the list of those that held distressed securities.

To examine the relationship between exposures to distressed ABCP and the riskiness and

[44] If bank affiliation is dropped from the regression, coefficients on sponsor CDS are similar to but smaller in magnitude than those reported in column 2 (the coefficient on CDS spreads over the previous year remains significant).

other characteristics of MMFs, I redefine:

$$S^i \equiv \begin{cases} 1 & \text{if fund } i \text{ held distressed ABCP} \\ 0 & \text{otherwise.} \end{cases}$$

Using this definition of S^i, I reestimate equation (2) separately for the two criteria for identifying funds that held distressed ABCP: portfolio disclosures alone and portfolio disclosures plus sponsor support records. Results appear in columns 3 through 6 of table 9.

Again, as shown on line 1, portfolio risk—as measured by gross yield—was an important predictor of MMF problems. Gross yield is statistically and economically significant in every regression reported here; a one-standard-deviation increase in gross yield is predicted to raise the likelihood that a fund held distressed paper by 15 to 18 basis points, depending on specification. In contrast, fund ratings (line 2) were not helpful in predicting exposures to problematic ABCP.

The link between investor risk and holdings of distressed paper is less clear. One indicator of lower investor risk (the expense ratio, line 3) and one of greater investor risk (flow sensitivity to yield, line 6) are positively related to holdings of distressed ABCP in most of the specifications listed in columns 3 through 6. Taken literally, this might imply that funds with less sophisticated, hot-money investors were more likely to hold distressed securities. An institutional-fund dummy (line 9) is positive and significant in a couple of specifications (only marginally so in one), but tests of the null hypothesis that all estimated coefficients for institutional and retail funds are jointly equal do not reject the null for any of the regressions shown on table 9.

As line 7 shows, MMFs with bank-affiliated sponsors were significantly more likely to hold distressed ABCP than other funds. Depending on specification and sample, bank affiliation increased the probability that a fund held distressed paper by between 26 and 41 percentage points. The strength of this result aids in interpreting the link between bank affiliation and sponsor support—bank-affiliated funds evidently were more likely to receive support because they were more likely to hold problematic ABCP—and points to a potential moral hazard problem for bank-affiliated MMF managers. Moral hazard is not the only possible explanation, but some others are no more charitable. For example, it is possible that bank-affiliated managers were more likely to purchase risky ABCP for their funds because they had more institutional familiarity than other managers with complex instruments like paper issued by structured investment vehicles (SIVs).

The role of sponsor CDS spreads in predicting holdings of distressed paper again seems puzzling. In the regression defining S^i based solely on portfolio disclosures (column 4), CDS spreads are insignificant. When $S^i \equiv 1$ also for funds that received support (column 6), coefficients on sponsors' CDS spreads in the year before the crisis are positive and significant (line 9) but spreads immediately beforehand (line 8) are insignificant. Controlling for bank affiliation, funds with *riskier* sponsors were more likely to purchase problematic assets.[45]

[45]When bank affiliation is dropped from the regression, sponsor CDS is insignificant. As noted above, bank-affiliated

Finally, larger MMFs (line 10) were significantly more likely to hold distressed paper than their smaller counterparts. A one standard deviation increase in fund assets boosted the predicted likelihood of such holdings by about 15 percentage points in the regressions summarized in columns 3 through 6.

7 Conclusions and policy implications

This paper argues that MMFs are subject to three types of risk: (1) portfolio risks arising from the credit, liquidity, and interest-rate risks posed by a fund's assets; (2) investor risk due to the composition of an MMF's investors and the likelihood that they will suddenly and disruptively redeem shares; and (3) sponsor risk that reflects the possibility that an MMF sponsor will *not* provide financial support for an ailing fund. I describe proxies for each type of risk and provide evidence that these measures were useful in explaining the cross-sectional variation in outcomes for funds during crises, particularly the catastrophic run on MMFs in September and October 2008. Indeed, one important finding of this paper is that the run on MMFs was not indiscriminate; ex ante risk proxies explain a large portion of the substantial variance in outflows during the crisis.

Portfolio risk is the focus of much of the risk-limiting regulation that governs MMFs as well as the ratings criteria applied to MMFs by ratings organizations. I show that portfolio risk, as measured by gross yield, was a significant and economically important predictor of outflows during the run in 2008. Moreover, the portfolio risks that motivated redemptions during the run were broader than direct exposure to Lehman debt, which prompted larger outflows only early in the run. Gross yield was also useful in predicting sponsor support for ailing funds during the ABCP crisis in 2007 and for predicting holdings of distressed ABCP during that episode. In retrospect, these results are intuitive: Risky securities should pay higher rates that boost MMF portfolios' gross yields and should—if yields reflect systematic risk—perform poorly during crises. The ABCP crisis and the run on MMFs a year later provided a laboratory to test whether higher yields in MMFs were, in fact, conveying information about risks that was observable well before the crises. I find that higher yields did offer such a signal.

However, I find that another possible indicator of portfolio risk—whether a fund had a triple-A rating—was of little use in predicting crisis outcomes, including outflows during the run in 2008 or exposure to distressed paper during the ABCP crisis. This is perhaps surprising, as ratings organizations' publications suggest that a top rating should be useful as an indicator of an MMF's (low) risk, particularly as reflected in its portfolio quality.

The link between other forms of MMF risk and outcomes is more complex. Investors generally have fled to, not from, MMFs during episodes of financial turmoil, and sponsors have been

sponsors had lower CDS spreads than those of other sponsors just prior to the ABCP crisis. Because the bank-affiliated funds were more likely to hold distressed ABCP, failing to control for bank affiliation misses the broader positive correlation between sponsor CDS spreads in the year before the crisis and holdings of distressed assets.

seen as a source of stability rather than risk. Hence, investor and sponsor risks of MMFs have remained largely latent, even during crises. Not surprisingly, these risks historically have received less attention from regulators, ratings organizations, and academics than have portfolio risks.

Investors' muted response to the ABCP crisis illustrates the usual latency of investor and sponsor risks. Souring paper put considerable strains on MMFs, and many would have broken the buck without sponsor support. Nonetheless, investors' net flows to MMFs as the crisis erupted in August 2007 were not significantly related to sponsor and portfolio risks, and there was no consistent pattern of association between outflows and investor risk.

In contrast, the severity of the financial crisis in September 2008 and Reserve's inability to absorb losses in its Primary Fund undermined confidence in sponsors' ability to support MMFs and brought sponsor and investor risks to the fore. Institutional investors reacted to sponsor risk by redeeming shares more aggressively from MMFs with sponsors that had higher CDS spreads on the eve of the run. Meanwhile, the consequences of investor risk were apparent in the aggregate pattern of outflows during the run, as institutional investors redeemed shares at ten times the pace of retail redemptions. Even among institutional funds, I find that proxies for investor risk, including funds' expense ratios, flow volatility, and flow sensitivity to yield, helped predict the cross section of outflows.

The two crises also underline important interactions among the three types of MMF risks. For example, the particularly strong links between risk proxies and outflows from institutional funds during the run in 2008 show that funds with greater investor risks were also more sensitive to portfolio and sponsor risks. In addition, the contrast between the responsiveness of institutional fund flows to all three types of MMF risks during the run in 2008 and the relative inertness of funds' flows during the ABCP crisis in 2007 indicates that heightened sponsor risk in 2008 intensified the consequences of other risks.

Although sponsor risk was not a significant factor in the cross-section of net flows during the ABCP crisis, one proxy for sponsor risk—whether an MMF was affiliated with a bank—was a significant predictor of poor outcomes during this episode. Bank-affiliated money funds were more likely to receive sponsor support *and* to hold distressed ABCP in their portfolios. Somewhat more puzzling is that, controlling for bank affiliation, *riskier* sponsors—those with higher pre-crisis CDS spreads—were more likely to have experienced problems in their MMFs.

This paper provides some useful lessons both for policymakers and investors. The significance of MMF risks in explaining poor outcomes in past crises highlights the importance of monitoring these risks, and I offer some useful proxies for doing so. For example, shareholders and regulators might track funds' gross yields for early signs of problematic portfolio risks, particularly given asset managers' incentives to boost yields. My indicators of investor risk may be useful in the SEC's ongoing efforts to reflect such risk in setting liquidity requirements for MMFs.[46]

[46] In adopting new liquidity requirements for MMFs, the SEC noted that institutional and retail MMFs have substan-

This paper's findings also raise concerns about the systemic risks associated with sponsor support actions for MMFs and the expectations of safety that these actions have fostered among investors. Clearly, sponsor support of MMFs was critical in helping funds weather the ABCP crisis in 2007 and the run in 2008. But the extensive record of sponsor support has probably attracted many highly risk-averse investors who would not hold MMFs without the conviction that the funds are effectively (privately) insured. Hence, sponsor support has likely increased investor risk for MMFs. The fact that funds with bank sponsors were more likely to have held distressed ABCP and to have received sponsor bailouts in the wake of the ABCP crisis also suggests that the possibility of sponsor support may undermine incentives for prudent asset management.

Furthermore, during the run in 2008, concerns about the ability of sponsors to support their MMFs evidently prompted heavier redemptions from money funds with weaker sponsors, and thus transmitted the sponsors' strains to off-balance-sheet MMFs and into short-term funding markets. Thus, by fostering expectations of implicit recourse to sponsors, past support actions had created a channel for the transmission during crises of strains between entities that should not have been related. Whether or not such support was actually delivered, it may have contributed to financial strains. Bailouts of MMFs during the run required scarce capital from sponsors at a time when liquidity was in short supply and worsened some sponsors' financial condition (Standard & Poor's, 2008a). But Reserve's *failure* to provide support that investors had come to expect was catastrophic for the Reserve franchise and destabilizing for the financial system. Moreover, despite the apparent importance of sponsor support for MMFs, the practice is discretionary, unregulated, and opaque, and it is probably most unreliable when systemic risks are most salient. Indeed, other forms of discretionary financial support did not fare well during the financial turmoil, such as dealers' support for auction-rate securities (Han and Li, 2009).

Thus, my findings argue for additional attention to the systemic risks posed by the MMF industry's reliance on sponsor support. However, a full discussion of the strengths and weaknesses of the current "system" of discretionary sponsor support for MMFs is well beyond the scope of this paper. Simplistic responses to the risks posed by sponsor support—such as a ban on support actions—may do more harm than good. The SEC's action in 2010 to require more extensive disclosure of sponsor interventions should at least improve researchers' and policymakers' understanding of the practice.

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tially different investor risks and liquidity needs, but set a single requirement for both types of funds, in part because of the "difficulty in drawing bright lines" between them (see note 11). Still, the SEC indicated that it would continue to look for a "workable objective definition that would accurately identify funds with lower liquidity needs" (U.S. Securities and Exchange Commission, 2010, pp. 58-61). Of course, proxies that are useful for *measuring* risk may have drawbacks if used to determine regulatory distinctions: Although MMFs with lower expense ratios exhibited greater investor risks during the run, this author would *not* suggest imposing more stringent liquidity standards for MMFs because they charge lower fees!

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Table 1. Gross yields, net yields, and expense ratios of prime MMFs, 2004-2008
(percent)

MMF characteristic	(1) Mean[1]	(2) Cross-sectional standard deviation[2]
1. Gross yield	3.57	0.12
2. Net yield	3.08	0.29
3. Expense ratio	0.49	0.27

Notes.
1. Sample averages of unadjusted fund-level annual data for all prime MMFs (1348 observations over 5 years).
2. For each variable, the standard deviation is calculated after subtracting from each observation the annual asset-weighted average for that variable for all prime MMFs in the same year.

Table 2a. MMF characteristics and risk proxies before and during the run in 2008

	Institutional funds (N=116)				Retail funds (N=135)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Mean	S.D.	10th pctl.	90th pctl.	Mean	S.D.	10th pctl.	90th pctl.
Portfolio risk proxies								
1. Gross yield[1]	3.88	0.14	3.69	4.03	3.88	0.16	3.68	4.06
2. Triple-A rating?[2,3]	0.53	0.50	0.00	1.00	0.20	0.40	0.00	1.00
3. Lehman exposure?[3]	0.12	0.33	0.00	1.00	0.12	0.32	0.00	1.00
Investor risk proxies								
4. Expense ratio[1]	0.29	0.18	0.13	0.51	0.63	0.20	0.39	0.91
5. Growth (log net flow), previous year[1,4]	13.31	37.18	-34.36	56.69	4.11	29.26	-18.52	26.12
6. Standard deviation of weekly flow[1]	5.13	3.18	1.78	8.98	2.76	3.20	0.65	5.52
7. Weekly flow sensitivity to relative yield[1]	6.91	14.24	-5.54	25.68	1.51	5.38	-4.37	8.87
Sponsor risk proxies								
8. Bank-affiliated fund?[3,5]	0.53	0.50	0.00	1.00	0.48	0.50	0.00	1.00
9. Average CDS spread, Sept. 2-9, 2008[6]	1.40	0.81	0.84	2.18	1.39	0.95	0.81	2.18
Other								
10. Log of assets (in $ billions) as of Sept. 9, 2008	1.25	1.68	-1.07	3.38	0.41	1.50	-1.58	2.40
11. Has CDS spread data, Sept. 2-9, 2008?[3]	0.43	0.50	0.00	1.00	0.43	0.50	0.00	1.00
Memo: Log net flow, Sept. 9 - Oct. 7, 2008[4]	-25.81	31.13	-62.31	5.30	-4.98	14.06	-15.63	8.75

Notes.

1. Year from September 1, 2007 to August 31, 2008.

2. As of August 31, 2008.

3. Indicator variable: 1=yes and 0=no.

4. Log net flow is 100 times the natural logarithm of the sum of 1 and the ratio of net flow over this episode to assets at beginning of episode, that is, 100*ln(1+flow/lagged assets).

5. Bank-affiliation data are as of September 14, 2008 (when Bank of America purchased Merrill Lynch).

6. CDS spreads are available only for 50 observations for institutional funds and for 58 observations for retail funds.

Table 2b. MMF characteristics and risk proxies before and during the ABCP crisis in 2007

	Institutional funds (N=116)				Retail funds (N=133)			
	(1) Mean	(2) S.D.	(3) 10th pctl.	(4) 90th pctl.	(5) Mean	(6) S.D.	(7) 10th pctl.	(8) 90th pctl.
Portfolio risk proxies								
1. Gross yield[1]	5.37	0.02	5.34	5.39	5.37	0.03	5.32	5.40
2. Triple-A rating?[2,3]	0.53	0.50	0.00	1.00	0.18	0.39	0.00	1.00
3. Distressed ABCP exposure?[3]	0.57	0.50	0.00	1.00	0.44	0.50	0.00	1.00
Investor risk proxies								
4. Expense ratio[1]	0.29	0.17	0.13	0.51	0.65	0.20	0.42	0.92
5. Growth (log net flow), previous year[1,4]	18.80	36.98	-14.39	62.73	2.41	32.91	-21.13	26.34
6. Standard deviation of weekly flow[1]	5.16	3.18	2.04	9.37	2.54	2.71	0.71	4.74
7. Weekly flow sensitivity to relative yield[1]	2.85	65.48	-56.38	72.36	-1.59	18.07	-18.55	14.09
Sponsor risk proxies								
8. Bank-affiliated fund?[2,3]	0.52	0.50	0.00	1.00	0.47	0.50	0.00	1.00
9. Average CDS spread, August 1-7, 2007[5]	0.41	0.25	0.20	0.83	0.35	0.19	0.18	0.58
Other								
10. Log of assets (in $ billions) as of August 7, 2007	1.22	1.57	-0.97	3.15	0.35	1.53	-1.57	2.39
11. Has CDS spread data, August 1-7, 2007?[3]	0.53	0.50	0.00	1.00	0.47	0.50	0.00	1.00
Memo: Log net flow, August 7-28, 2007[4]	-0.80	11.50	-14.41	10.32	0.46	10.33	-6.03	7.64

Notes.

1. Year from July 1, 2006 to June 30, 2007.

2. As of June 30, 2007.

3. Indicator variable: 1=yes and 0=no.

4. Log net flow is 100 times the natural logarithm of the sum of 1 and the ratio of net flow over this episode to assets at beginning of episode, that is, 100*ln(1+flow/lagged assets).

5. CDS spreads are available only for 61 observations for institutional funds and for 63 observations for retail funds.

Table 3a. Correlations of MMF characteristics and risk proxies before and during the run in 2008

A. Institutional MMFs (N=116)	(1) Gross yield	(2) Aaa rated?	(3) Held Lehman?	(4) Expense ratio	(5) Growth prev. yr.	(6) SD of flow	(7) Flow sens.	(8) Bank-affil.?	(9) CDS spread[1]	(10) Log assets	(11) Has CDS?
1. Gross yield	1										
2. Triple-A rating?		1									
3. Lehman exposure?			1								
4. Expense ratio		-0.345 *		1							
5. Growth, prev. year					1						
6. SD weekly flow	-0.338 *	0.223		-0.319 *		1					
7. Flow sensitivity		0.199		-0.254 *			1				
8. Bank-affiliated?								1			
9. CDS spread[1]									1		
10. Log of assets		0.285 *	0.261 *	-0.338 *			0.257 *			1	
11. Has CDS spreads?										0.186	1
12. Log flow (event)	-0.311 *			0.424 *			-0.368 *		-0.310	-0.537 *	

B. Retail MMFs (N=135)	(1) Gross yield	(2) Aaa rated?	(3) Held Lehman?	(4) Expense ratio	(5) Growth prev. yr.	(6) SD of flow	(7) Flow sens.	(8) Bank-affil.?	(9) CDS spread[2]	(10) Log assets	(11) Has CDS?
1. Gross yield	1										
2. Triple-A rating?	-0.237 *	1									
3. Lehman exposure?	0.188		1								
4. Expense ratio				1							
5. Growth, prev. year					1						
6. SD weekly flow	-0.247 *	0.377 *				1					
7. Flow sensitivity						0.188	1				
8. Bank-affiliated?		0.185				0.204		1			
9. CDS spread[2]	-0.272								1		
10. Log of assets	0.196		0.188							1	
11. Has CDS spreads?								0.272 *			1
12. Log flow (event)		-0.297 *		0.234 *		-0.490 *	-0.183	-0.237 *		-0.172	

Notes. See table 2a for variable descriptions. Correlations shown are significant at the 5 percent level (* indicates signficance at the 1 percent level).

1. Based on 50 observations with CDS spreads.

2. Based on 58 observations with CDS spreads.

Table 3b. Correlations of MMF characteristics and risk proxies before and during the ABCP crisis in 2007

A. Institutional MMFs (N=116)	(1) Gross yield	(2) Aaa rated?	(3) ABCP problem?	(4) Expense ratio	(5) Growth prev. yr.	(6) SD of flow	(7) Flow sens.	(8) Bank-affil.?	(9) CDS spread[1]	(10) Log assets	(11) Has CDS?
1. Gross yield	1										
2. Triple-A rating?		1									
3. ABCP exposure?	0.295 *		1								
4. Expense ratio		-0.323 *		1							
5. Growth, prev. year				-0.319 *	1						
6. SD weekly flow				-0.307 *		1					
7. Flow sensitivity	0.255 *		0.290 *			-0.291 *	1				
8. Bank-affiliated?	-0.272 *							1			
9. CDS spread[1]								-0.554 *	1		
10. Log of assets	0.285 *	0.260 *	0.259 *	-0.326 *	0.275 *	-0.199				1	
11. Has CDS spreads?								0.326 *			1
12. Log flow (event)				0.213	-0.252 *				-0.263	-0.238 *	

B. Retail MMFs (N=133)	(1) Gross yield	(2) Aaa rated?	(3) ABCP problem?	(4) Expense ratio	(5) Growth prev. yr.	(6) SD of flow	(7) Flow sens.	(8) Bank-affil.?	(9) CDS spread[2]	(10) Log assets	(11) Has CDS?
1. Gross yield	1										
2. Triple-A rating?		1									
3. ABCP exposure?	0.266 *		1								
4. Expense ratio		-0.188		1							
5. Growth, prev. year				-0.170	1						
6. SD weekly flow	-0.179	0.426 *			-0.172	1					
7. Flow sensitivity		-0.227 *					1				
8. Bank-affiliated?		0.189	0.272 *			0.178	-0.369 *	1			
9. CDS spread[2]					-0.302				1		
10. Log of assets			0.292 *	-0.179	0.257 *	-0.236 *				1	
11. Has CDS spreads?			0.289 *		0.184			0.381 *			1
12. Log flow (event)				-0.172		-0.174					

Notes. See table 2b for variable descriptions. Correlations shown are significant at the 5 percent level (* indicates signficance at the 1 percent level).

1. Based on 61 observations with CDS spreads.

2. Based on 63 observations with CDS spreads.

Table 4. Regression results: MMF risk proxies and net flows in September and October 2008

Model:	No CDS Spreads			Includes CDS spread		
	(1)	(2)	(3)	(4)	(5)	(6)
Investor type:	Institutional	*	Retail	Institutional	*	Retail
Portfolio risk proxies						
1. Gross yield (percentage points)	-67.60	***	-4.05	-161.23	***	-5.25
September 2007 - August 2008	(-4.40)		(-0.76)	(-4.69)		(-0.49)
2. Triple-A rating?	3.43		-3.26	6.73		-0.46
(1=yes, 0=no)	(0.77)		(-0.76)	(0.93)		(-0.07)
3. Lehman exposure?	3.50		-0.30	1.85		-0.92
(1=yes, 0=no)	(0.48)		(-0.17)	(0.20)		(-0.20)
Investor risk proxies						
4. Expense ratio (percentage points)	39.30	**	11.11	57.46	**	15.08
September 2007 - August 2008	(3.48)		(2.44)	(3.58)		(1.55)
5. Growth (log net flow)	0.06		0.04	0.04		0.01
September 2007 - August 2008	(0.83)		(0.86)	(0.38)		(0.08)
6. Standard deviation of weekly flow	-2.06		-1.95	-3.00		-2.14
(percentage points)	(-2.84)		(-2.77)	(-1.67)		(-2.78)
7. Weekly flow sensitivity to	-0.38		-0.28	-0.30		0.06
relative net yield	(-2.34)		(-1.10)	(-1.00)		(0.23)
Sponsor-risk proxies						
8. Bank affiliated?	4.62		-3.58	12.91	**	-6.61
(1=yes, 0=no)	(1.00)		(-1.73)	(1.92)		(-1.58)
9. Average CDS spread (pctg. points)				-15.85	**	-1.05
September 2-9, 2008				(-2.84)		(-0.69)
Other						
10. Log of assets	-8.12	***	-1.95	-8.29	**	-3.78
September 9, 2008	(-5.74)		(-2.99)	(-4.51)		(-5.13)
11. Constant	242.97	***	12.56	619.83	***	19.52
	(4.06)		(0.62)	(4.44)		(0.45)
Number of observations	116		135	50		58
R-squared	0.501		0.369	0.649		0.475

Notes. Dependent variable is log flow from September 9 to October 7, 2008. Log flow is defined as 100*ln(1+flow/lagged assets), where flow is equal to the change in assets less accrued yield. t-statistics in parentheses are based on robust standard errors.

* t-tests of the hypothesis that coefficients for institutional and retail funds are the same, based on a pooled institutional-retail fund regression with interactive coefficients (an indicator variable for institutional funds multiplied by each coefficient). */**/*** denotes significance at the 10/5/1 percent level.

Table 5. Regression results: Estimated effects of 1-standard-deviation changes in explanatory variables on net flows during the run in 2008 (percentage points of flow)

Model:	No CDS Spreads		Includes CDS spread	
	(1)	(2)	(3)	(4)
Investor type:	Institutional	Retail	Institutional	Retail
Portfolio risk proxies				
1. Gross yield (percentage points) September 2007 - August 2008	-8.9	-0.6	-16.4	-0.8
2. Triple-A rating?*	3.5	-3.2	7.0	-0.5
3. Lehman exposure?*	3.6	-0.3	1.9	-0.9
Investor risk proxies				
4. Expense ratio (percentage points) September 2007 - August 2008	7.2	2.2	10.3	2.8
5. Growth (log net flow) September 2007 - August 2008	2.3	1.2	1.9	0.2
6. Standard deviation of weekly flow	-6.3	-6.0	-8.1	-8.9
7. Weekly flow sensitivity to relative net yield	-5.2	-1.5	-4.2	0.3
Sponsor-risk proxies				
8. Bank affiliated?*	4.7	-3.5	13.8	-6.4
9. Average CDS spread (pctg. points) September 2-9, 2008			-12.0	-1.0
Other				
10. Log of assets September 9, 2008	-12.8	-2.9	-12.9	-5.4

Notes. Estimates based on regressions summarized in table 4. For each continuous variable, estimated effect is computed by multiplying the estimated coefficient on the variable by the standard deviation of the variable.
*Estimated effect for each dummy variable is the estimated coefficient on the variable converted to percentage points of assets.

Table 6. MMF risk proxies, instruments for gross yield, and net flows to institutional prime MMFs in September and October 2008

Specification	(1) OLS	(2) 2SLS[1]
Portfolio risk proxies		
1. Gross yield (percentage points)	-67.60	-54.74
September 2007 - August 2008	(-4.40)	(-3.10)
2. Triple-A rating?	3.43	2.92
(1=yes, 0=no)	(0.77)	(0.63)
3. Lehman exposure?	3.50	0.52
(1=yes, 0=no)	(0.48)	(0.07)
Investor risk proxies		
4. Expense ratio (percentage points)	39.30	38.80
September 2007 - August 2008	(3.48)	(3.31)
5. Growth (log net flow)	0.06	0.06
September 2007 - August 2008	(0.83)	(0.84)
6. Standard deviation of weekly flow	-2.06	-1.63
(percentage points)	(-2.84)	(-1.91)
7. Weekly flow sensitivity to	-0.38	-0.39
relative net yield	(-2.34)	(-2.11)
Sponsor-risk proxies		
8. Bank affiliated?	4.62	4.20
(1=yes, 0=no)	(1.00)	(0.91)
Other		
9. Log of assets	-8.12	-8.51
September 9, 2008	(-5.74)	(-5.82)
10. Constant	242.97	191.92
	(4.06)	(2.74)
Number of observations	116	112
R-squared	0.501	0.500

Notes. Dependent variable is log flow from September 9 to October 7, 2008. Log flow is defined as 100*ln(1+flow/lagged assets), where flow is equal to the change in assets less accrued yield. t-statistics in parentheses are based on robust standard errors.

1. Instruments for gross yield are portfolio shares of various instruments (Treasury and agency securities, repurchase agreements, time deposits, ABCP, floating rate notes, other domestic-bank obligations, other foreign-bank obligations), WAM, and the share of assets maturing in seven days or less. The instruments are listed on lines 1-7 and lines 9-10 of table A1 in the appendix.

Table 7. Regression results: MMF risk proxies and net flows in August 2007

Model:	No CDS Spreads			Includes CDS spread		
	(1)	(2)	(3)	(4)	(5)	(6)
Investor type:	Institutional	*	Retail	Institutional	*	Retail
Portfolio risk proxies						
1. Gross yield (percentage points)	7.42		44.19	69.76		-1.57
August 2006 - July 2007	(0.17)		(1.13)	(1.26)		(-0.07)
2. Triple-A rating?	3.79		1.44	2.21		0.80
(1=yes, 0=no)	(1.56)		(0.78)	(0.68)		(0.31)
3. Distressed ABCP exposure?	-1.91		-3.62	-2.59		-3.59
(1=yes, 0=no)	(-0.66)		(-1.11)	(-0.53)		(-2.23)
Investor risk proxies						
4. Expense ratio (percentage points)	10.46	**	-7.42	18.11	**	-8.00
August 2006 - July 2007	(1.82)		(-1.36)	(1.50)		(-1.83)
5. Growth (log net flow)	-0.06		0.04	-0.06		0.05
August 2006 - July 2007	(-1.39)		(0.47)	(-0.90)		(2.04)
6. Standard deviation of weekly flow	-0.03		-0.72	0.27		-0.86
(percentage points)	(-0.09)		(-1.70)	(0.42)		(-2.43)
7. Weekly flow sensitivity to	0.03	**	-0.07	0.02	**	-0.10
relative net yield	(1.64)		(-1.66)	(0.68)		(-2.47)
Sponsor-risk proxies						
8. Bank affiliated?	0.88		-0.37	-1.77		-2.21
(1=yes, 0=no)	(0.44)		(-0.22)	(-0.53)		(-1.51)
9. Average CDS spread (pctg. points)				-14.46		0.87
August 1-7, 2007				(-1.64)		(0.22)
Other						
10. Log of assets	-1.46		-0.35	0.08		-0.08
August 7, 2007	(-1.78)		(-0.67)	(0.07)		(-0.17)
11. Constant	-41.95		-228.67	-374.47		18.84
	(-0.18)		(-1.11)	(-1.27)		(0.16)
Number of observations	116		133	61		63
R-squared	0.159		0.135	0.221		0.414

Notes. Dependent variable is log flow from August 7 to August 28, 2007. Log flow is defined as 100*ln(1+flow/lagged assets), where flow is equal to the change in assets less accrued yield. t-statistics in parentheses are based on robust standard errors.

* t-tests of the hypothesis that coefficients for institutional and retail funds are the same, based on a pooled institutional-retail fund regression with interactive coefficients (an indicator variable for institutional funds multiplied by each coefficient). */**/*** denotes significance at the 10/5/1 percent level.

Table 8. Summary statistics for sponsor support and exposures to distressed ABCP

(as of July 31, 2007, unless noted)

	(1) All prime money market funds	(2) Funds that received sponsor support for distressed ABCP	(3) Funds that held distressed ABCP	(4) Funds that either received sponsor support for or held distressed ABCP
1. Number of funds	249	39	124	128
(share of all MMFs, percent)	*(100)*	*(16)*	*(50)*	*(51)*
2. Number of institutional funds	116	20	66	68
(share of line 1, percent)	*(47)*	*(51)*	*(53)*	*(53)*
3. Average assets under management (billions of dollars)	6.66	7.77	8.81	8.81
4. Average gross yield, year ending July 31, 2007 (percent)	5.37	5.38	5.38	5.38
5. Number of triple-A rated funds	85	19	45	46
(share of line 1, percent)	*(34)*	*(49)*	*(36)*	*(36)*
6. Average expense ratio, year ending July 31, 2007 (percent)	0.48	0.43	0.47	0.47
7. Average growth, year ending July 31, 2007 (percent)	10.56	24.09	13.67	14.92
8. Average standard deviation of log flow, year ending July 31, 2007 (percent)	3.76	4.78	3.77	3.76
9. Average flow sensitivity to net yield, year ending July 31, 2007	0.48	8.56	9.30	10.24
10. Number of bank-affiliated funds	122	26	72	74
(share of line 1, percent)	*(49)*	*(67)*	*(58)*	*(58)*
11. Number of funds with CDS spread data	124	33	75	79
(share of line 1, percent)	*(50)*	*(85)*	*(60)*	*(62)*
12. Average CDS spread week of August 1-7, 2007 (pctg. pts.)	0.38	0.40	0.37	0.38
13. Average CDS spread year ending July 31, 2007 (pctg. pts.)	0.15	0.18	0.15	0.16

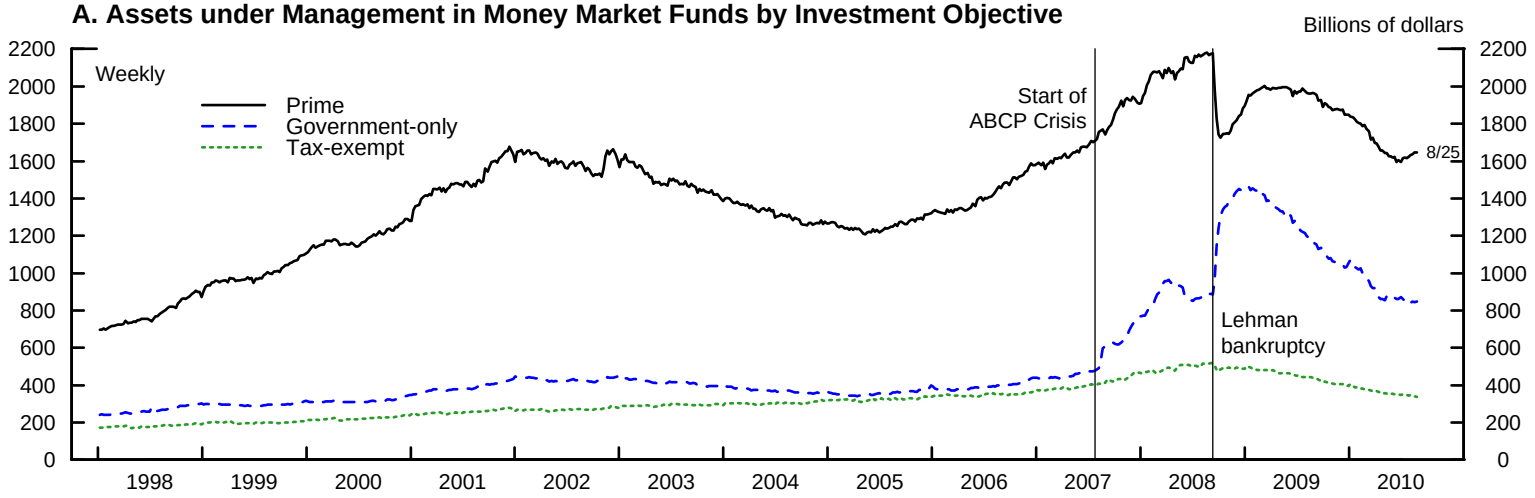
Table 9. Probit analysis of sponsor support and holdings of distressed securities

Criterion:	Funds that received sponsor support for distressed ABCP		Funds that held distressed ABCP		Funds that either received sponsor support for or held distressed ABCP	
	(1)	(2)	(3)	(4)	(5)	(6)
Explanatory variables	No CDS Spreads	Includes CDS	No CDS Spreads	Includes CDS	No CDS Spreads	Includes CDS
Portfolio risk proxies						
1. Gross yield (percentage points)	17.44	40.65	14.68	17.04	16.24	24.47
August 2006 - July 2007	(4.34)	(4.00)	(4.46)	(3.33)	(4.70)	(3.76)
2. Triple-A rating?	0.25	0.80	-0.02	0.19	-0.04	0.24
(1=yes, 0=no)	(1.05)	(2.11)	(-0.08)	(0.65)	(-0.20)	(0.78)
Investor risk proxies						
3. Expense ratio (percentage points)	-0.09	0.33	1.27	1.41	1.21	1.34
August 2006 - July 2007	(-0.17)	(0.39)	(2.35)	(1.70)	(2.18)	(1.54)
4. Growth (log net flow)	0.00	0.00	0.00	0.00	0.00	0.01
August 2006 - July 2007	(1.29)	(0.50)	(-0.65)	(0.41)	(-0.06)	(1.41)
5. Standard deviation of weekly flow	0.08	0.07	0.04	0.05	0.05	0.04
(percentage points)	(2.29)	(1.84)	(1.26)	(1.24)	(1.35)	(0.96)
6. Weekly flow sensitivity to	0.00	0.00	0.01	0.00	0.01	0.01
relative net yield	(0.76)	(-0.21)	(2.53)	(1.26)	(3.18)	(2.16)
Sponsor-risk proxies						
7. Bank affiliated?	0.57	1.33	0.67	0.85	0.71	1.14
(1=yes, 0=no)	(2.71)	(3.61)	(3.61)	(2.67)	(3.80)	(3.15)
8. Average CDS spread (pctg. points)		-0.80		-0.34		-0.24
August 1-7, 2007		(-0.90)		(-0.46)		(-0.31)
9. Average CDS spread (pctg. points)		10.36		3.18		5.21
August 2006 - July 2007		(3.22)		(1.48)		(1.99)
Other						
10. Institutional fund?	-0.38	-0.17	0.52	0.15	0.49	0.12
(1=yes, 0=no)	(-1.23)	(-0.43)	(2.01)	(0.42)	(1.86)	(0.33)
11. Log of assets	0.10	-0.02	0.25	0.28	0.25	0.28
August 7, 2007	(1.24)	(-0.15)	(3.96)	(3.12)	(3.91)	(2.81)
12. Constant	-95.35	-221.94	-80.29	-93.31	-88.60	-133.64
	(-4.40)	(-4.04)	(-4.53)	(-3.37)	(-4.77)	(-3.80)
Number of observations	249	124	249	124	249	124
Pseudo R-squared	0.161	0.325	0.192	0.216	0.215	0.301

Notes. Dependent variable for each regression is equal to 1 for money market funds that met the criterion indicated in the column header and 0 for all others. *z*-statistics based on robust standard errors are in parentheses.

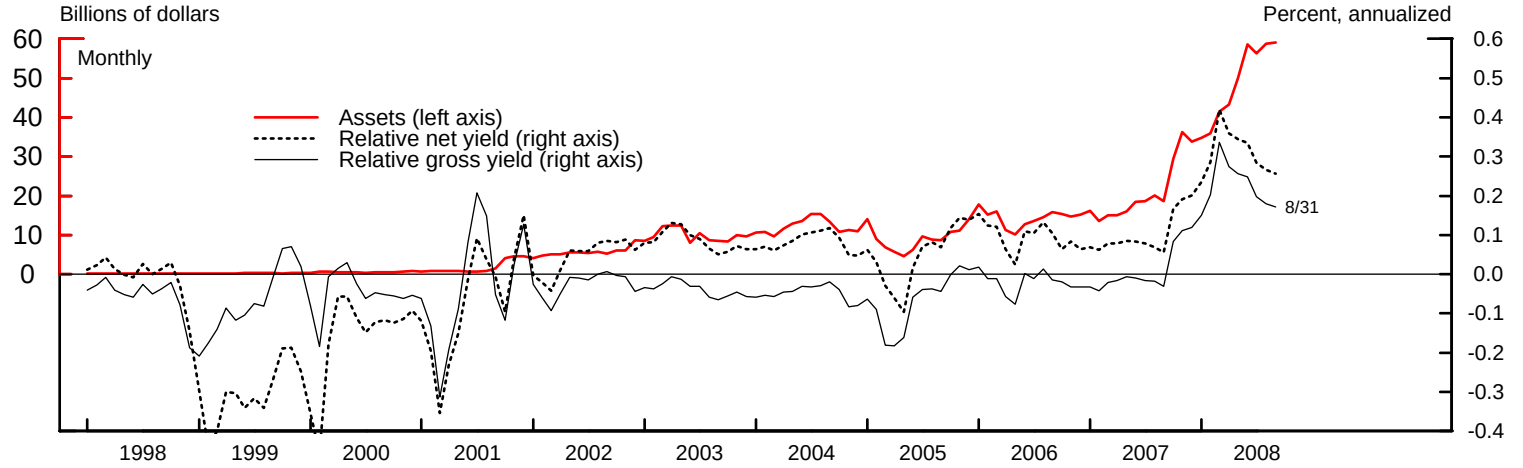
Figure 1

A. Assets under Management in Money Market Funds by Investment Objective



Source: Investment Company Institute.

B. Reserve Primary Fund: Assets and Relative Yields*

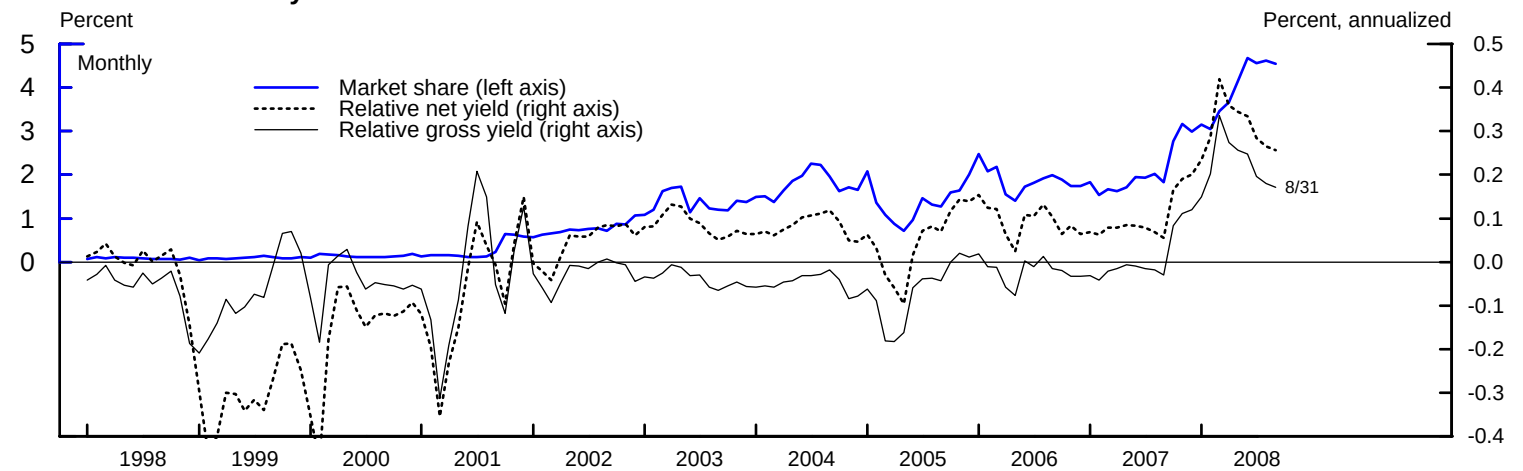


Source: iMoneyNet and author's calculations.

*Institutional share classes only.

Note: Relative net (gross) yield is net (gross) yield less asset-weighted average net (gross) yield for all institutional prime money market funds.

C. Reserve Primary Fund: Market Share and Relative Yields*



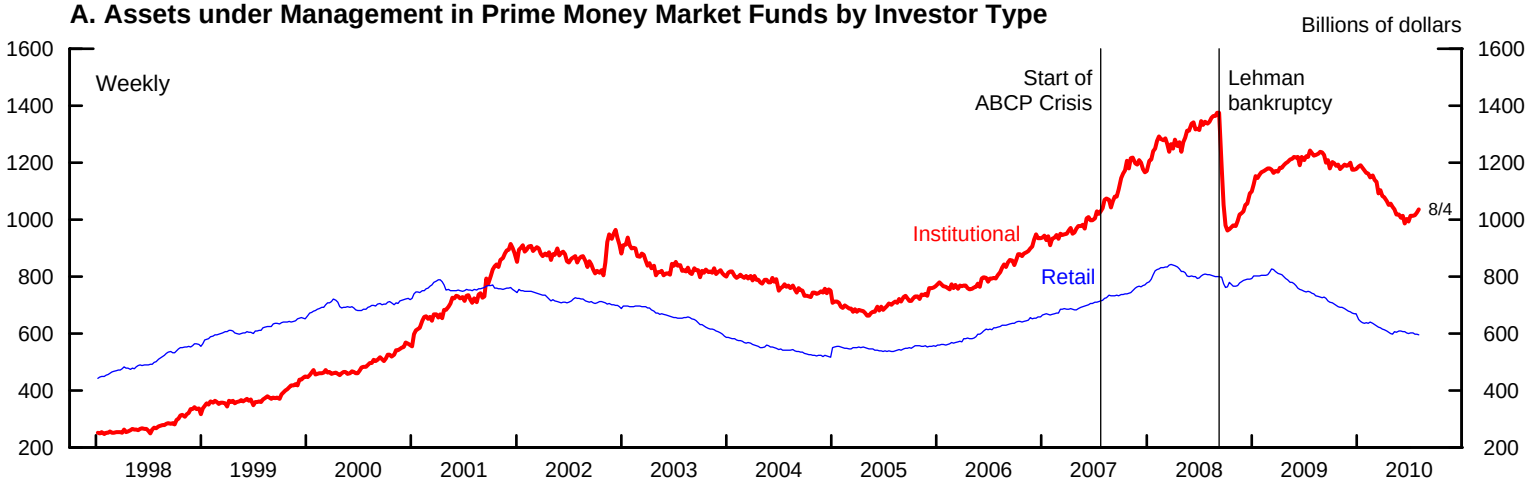
Source: iMoneyNet and author's calculations.

*Institutional share classes only.

Note: Relative net (gross) yield is net (gross) yield less asset-weighted average net (gross) yield for all institutional prime money market funds.

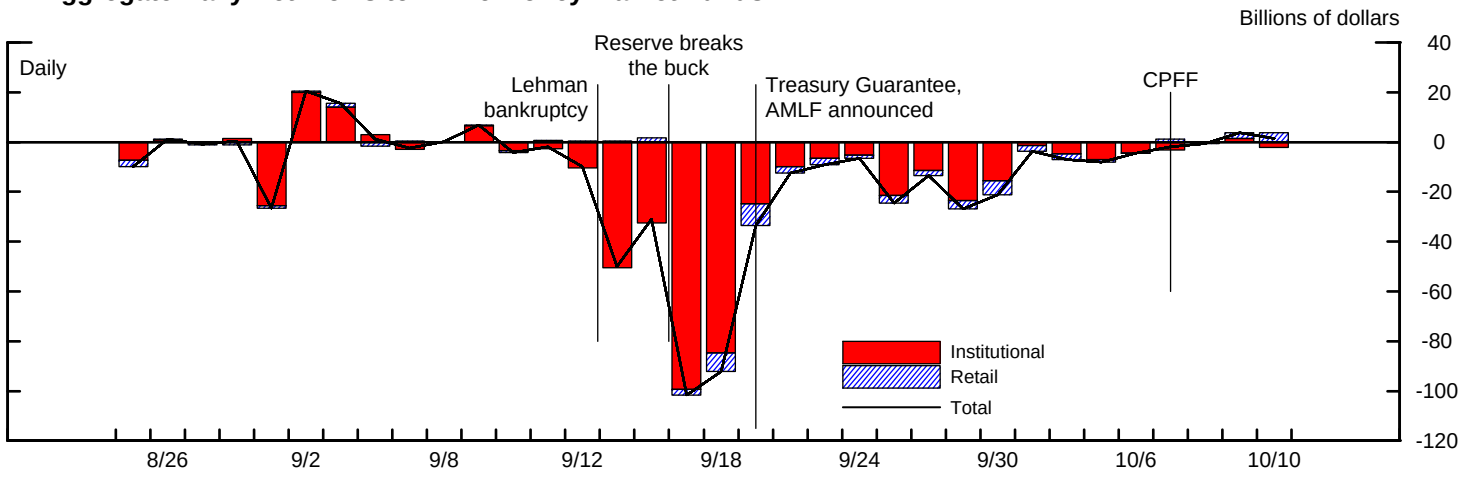
Figure 2

A. Assets under Management in Prime Money Market Funds by Investor Type



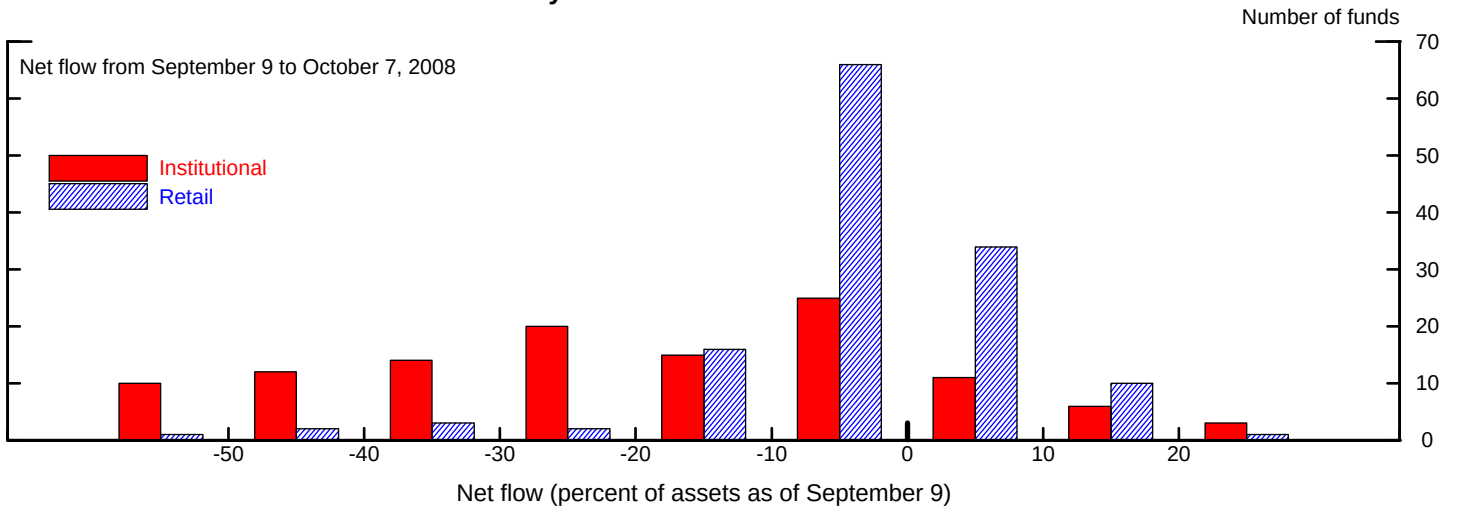
Source: Investment Company Institute.

B. Aggregate Daily Net Flows to Prime Money Market Funds



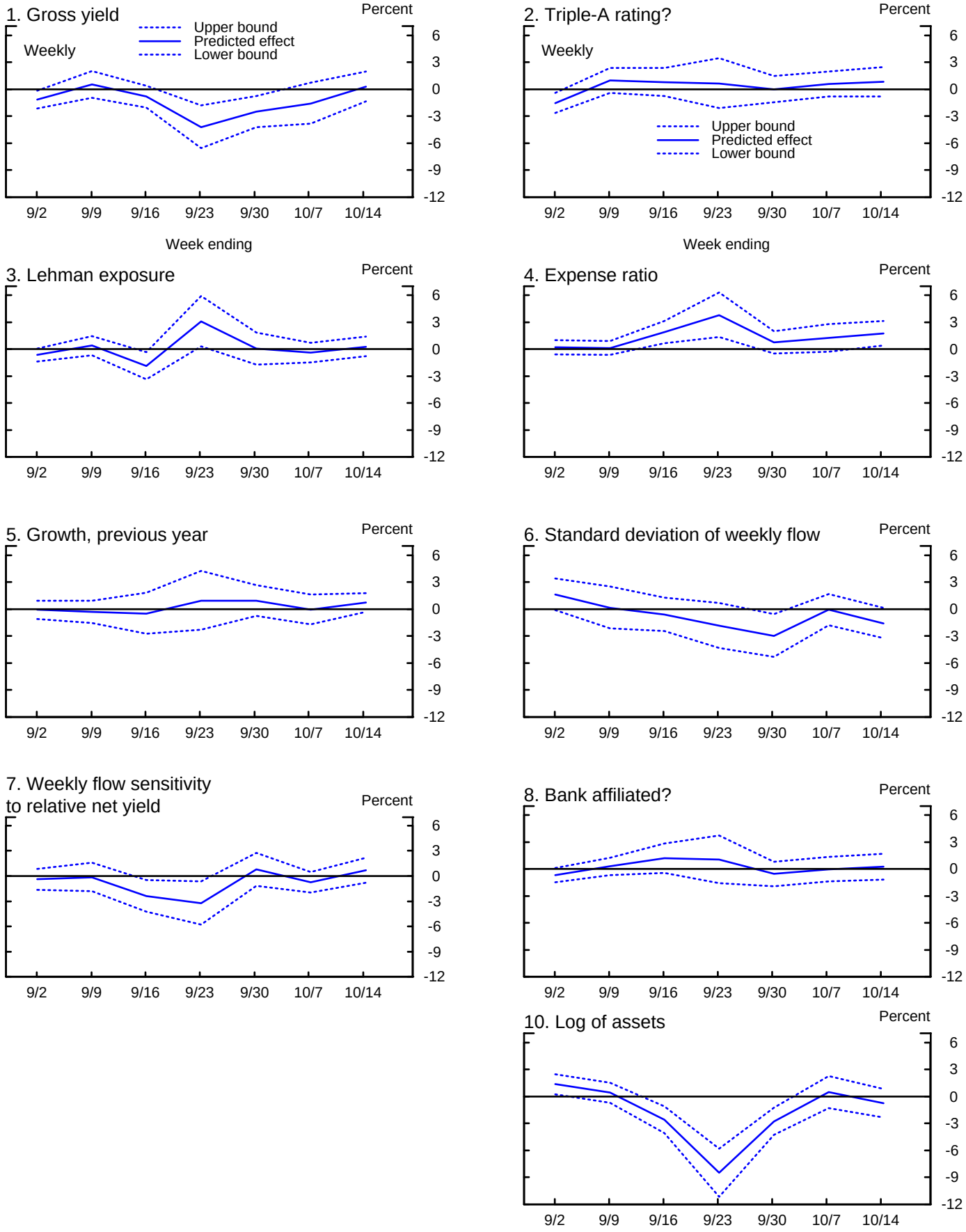
Source: iMoneyNet and author's adjustments (see section A.1 of the appendix).

C. Distribution of Net Flows to Prime Money Market Funds



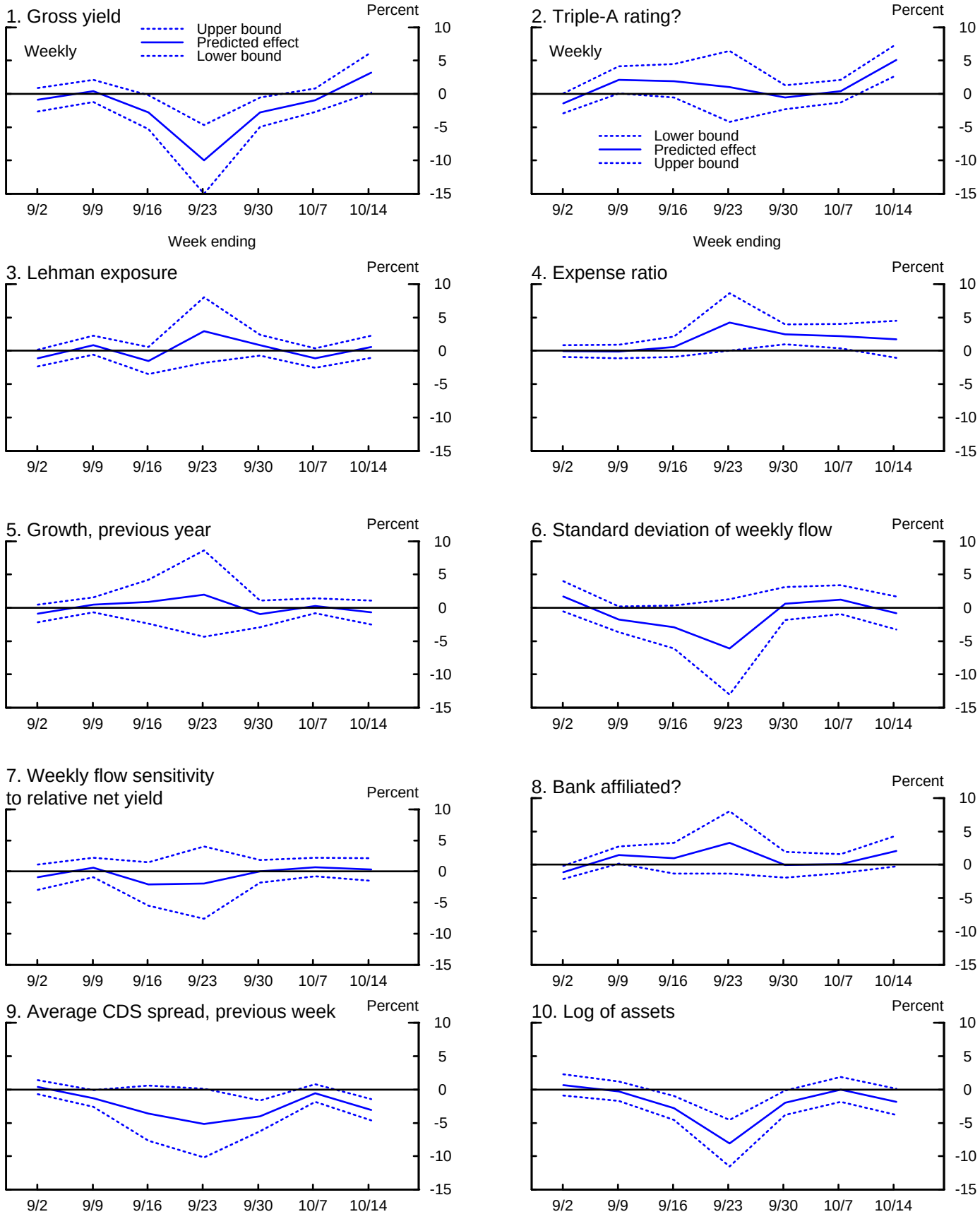
Source: iMoneyNet. Excludes funds with less than $100 million in assets, funds less than one year old as of August 2008, and funds with asset-reporting problems (see section A.1 of the appendix).

Figure 3a
Predicted Effects of Risk Proxies by Week
Institutional funds (no CDS spreads)



Note.This figure plots predicted effects based on seven weekly regressions described in section 5.3 of the text. The solid line in each panel plots---for each of the seven weeks ending on the specified dates---the predicted effects on net flows of one-standard-deviation increases in the explanatory variable in the panel title. Predicted effects on net flows are expressed as percentages of lagged assets. The dashed lines in each panel are the upper and lower bounds of quasi 95 percent confidence intervals for the predicted effects. Confidence intervals are computed by using a two-standard-error confidence interval for each estimated coefficient.

Figure 3b
Predicted Effects of Risk Proxies by Week
Institutional funds (including CDS spreads)



Note.This figure plots predicted effects based on seven weekly regressions described in section 5.3 of the text. The solid line in each panel plots---for each of the seven weeks ending on the specified dates---the predicted effects on net flows of one-standard-deviation increases in the explanatory variable in the panel title. Predicted effects on net flows are expressed as percentages of lagged assets. The dashed lines in each panel are the upper and lower bounds of quasi 95 percent confidence intervals for the predicted effects. Confidence intervals are computed by using a two-standard-error confidence interval for each estimated coefficient.

Appendix

A.1 Adjustments to iMoneyNet data

I make several types of adjustments to the iMoneyNet data. First, some variables in the iMoneyNet data set—notably MMF ratings and the bank-affiliation of MMF sponsors—represent only current (not historical) information. iMoneyNet provided historical snapshots of these data to assist in my compilation of real-time information.

Second, I drop several funds from the sample. For the analysis of each crisis episode, I include only MMFs with at least 12 months of iMoneyNet data prior to the onset of the crisis and at least $100 million in assets (the average prime MMF had $7 billion in assets on the eve of the Lehman bankruptcy). The very small funds typically had flows that were highly volatile relative to their assets and, given the economies of scale in the MMF industry (Domian and Reichenstein, 1998), probably served different roles for asset managers than funds of more typical size. For analysis of the run in 2008, I drop two extreme outliers with *inflows* exceeding 100 percent of assets (no other fund in the sample grew more than 28 percent during the run), although dropping these funds has no material effect on my results. I also drop five MMFs with flow measurement problems during the run (including funds that disappeared), but I include them where appropriate—in some cases, after correcting assets data (see below)—in the analysis of *weekly* flows discussed in section 5.3. All told, the 54 funds I exclude from the analysis of the ABCP crisis managed 1 percent of prime MMF assets at the time, and the 50 funds dropped from the baseline analysis of the run in 2008 accounted for 7 percent of assets on the eve of that crisis.

Third, I make corrections to assets (and net flows) reported for three MMFs in September and October 2008: the Reserve Primary Fund, the Federated Prime Obligations Fund, and the Putnam Prime Money Market Fund. I use these corrected assets data only in the weekly regressions reported in section 5.3 (the funds are excluded from the full-sample regressions). Weekly results are similar whether data for these funds are included or not.

According to iMoneyNet data, the Reserve Primary Fund's assets dropped from $62.6 billion on Friday, September 12, 2008 to $39.8 billion on Monday the 15th, $35.3 billion on the 16th, and $7.1 billion on the 17th. However, Reserve announced in October 2008 that "[t]he Fund's total assets have been approximately $51 billion since the close of business on September 15" (The Reserve, 2008), apparently because the fund failed to honor redemption requests (U.S. Securities and Exchange Commission, 2009b). To estimate the assets of individual Primary Fund share classes (which included both institutional and retail classes) on September 15 and the following days, I distribute the $11.6 billion decline in assets that Reserve reported for September 15 to different share classes in proportion to their declines in assets that day as reported by iMoneyNet.

The Putnam Prime Money Market Fund was closed on September 17, and its $12.3 billion in assets were absorbed by the Federated Prime Obligations Fund on September 24 (Federated

Investors and Putnam Investments, 2008). iMoneyNet reports only $8.4 billion in assets for the Putnam fund as of September 17 (down from $12.3 billion the previous day) and a jump in the Federated MMF's assets from $21.8 billion on September 23 to $34.1 billion on September 24. Hence, to track *aggregate* daily and weekly assets and net flows, I hold the Putnam fund's assets at $12.3 billion from September 16 to 23. The disappearance of the Putnam fund's assets on September 24 offsets that day's jump in assets for the Federated fund. However, I do not use net flows data for the Federated Prime Obligations Fund after September 23 in my cross-sectional analyses because the merger appears to have affected net flows to that fund even after the merger. Although the Federated MMF's assets had declined only 3.1 percent from September 19 (when the Treasury Guarantee and the AMLF were announced) to September 23, assets fell 23.5 percent in the two days following the merger—perhaps as former Putnam investors redeemed shares after losing liquidity for a week.

Fourth, the narrow sample periods that I use in the weekly regressions discussed in section 5.3 allow some modifications to the sample employed for the full-period regressions. Several MMFs, including the three discussed above, that are dropped from the full-period regressions because of measurement problems can be included for some of the weekly regressions. This adds four funds to the institutional sample for the first three weeks that I study (they begin to drop out after that) and one additional fund to the retail sample. The institutional and retail samples that include CDS spreads are unchanged. Inclusion or exclusion of the additional funds makes no material difference in the weekly regression results.

In addition, each weekly regression includes CDS spreads measured over the previous week, to capture the effects of any deterioration in sponsors' financial condition. Finally, two large MMF sponsors (Morgan Stanley and Goldman Sachs) became bank holding companies on September 21; in the weekly regressions, the bank-affiliation dummy is set as of the beginning of each week.

A.2 Gross yield and portfolio risk

To explore the link between gross yield and portfolio risk in greater detail, I run a panel regression of each prime MMF's annual gross yield in each year from 2004 to 2008 on a number of its portfolio characteristics measured in the same year. The first two columns of table A1 provide summary statistics for the explanatory variables in the regression. Lines 1 through 8 list portfolio shares held in different types of assets, including relatively safe assets, such as Treasury and agency securities (line 1) and repurchase agreements (line 2), and some relatively riskier ones, such as ABCP (line 4), floating-rate notes (line 5), and other domestic and foreign bank obligations (lines 6 and 7).[47] Portfolio weighted average maturity (line 9), which averaged 41 days in this period, and the share

[47] Other domestic and foreign bank obligations are bank liabilities other than time deposits and CP. These obligations are mostly jumbo CDs.

of assets maturing in seven days or less (line 10) are indicators of portfolio maturity and liquidity. I also include in the regression the natural log of assets (line 11), in part because other researchers have found that MMF yields vary with size (see, for example, Domian and Reichenstein, 1998, and Jank and Wedow, 2008). Finally, the regression includes an indicator of whether a fund was institutional (line 12). I estimate a simple panel regression of the form:

$$r_t^i = \Gamma X_t^i + constant + \varepsilon_t^i. \tag{A-1}$$

Each variable in the regression is expressed net of its asset-weighted average among all prime MMFs in the same year. For example, r_t^i is fund i's "relative" gross yield—that is, its gross yield in year t less the asset-weighted average gross yield of all other prime funds in year t.[48] X_t^i is a vector of the fund characteristics listed on lines 1 through 12 of table A1 (other CP, line 8, is omitted from the regression).

The third column of the table shows estimation results. As indicated on lines 1 and 2, larger shares of Treasury and agency securities and repurchase agreements depressed gross yields, on average.[49] In contrast, larger shares of fund assets held in riskier asset classes, including ABCP, floating-rate notes, and other bank obligations (lines 4 through 7), were associated with greater relative gross yields. For example, a 1-standard-deviation (16.86 percentage point) increase in the share of an MMF's portfolio held in floating-rate notes would be associated with a 3.3 basis point (16.86 percentage points $\times \frac{0.0020 \text{ percent}}{\text{percentage point}}$) increase in gross yield—a substantial predicted effect, given the small variation in gross yields among MMFs during this period (see table 1). Longer WAM also increased gross yields (line 9), but other fund characteristics had no significant effect on gross yields over this period. (The significance of the portfolio characteristics in explaining gross yields motivates my use of the attributes listed on lines 1-7 and 9-10 of table A1 as instruments for gross yield. See section 5.2 of the text.)

One potential shortcoming of gross yield as a measure of portfolio risk is that it may not capture concentration risks among a fund's assets, although the nature of such risks in MMFs suggests that funds with greater concentration risks typically also would have higher gross yields. SEC rules generally prohibit an MMF from holding more than five percent of its assets in the securities of any single non-government issuer, but the private debt instruments held by prime MMFs generally have been heavily concentrated in financial-sector issues. Thus, a fund's holdings of private debt may be a crude measure of its concentration risk.[50] Since private debt holdings

[48] A panel regression with time (year) fixed effects yields similar results but amounts to computing relative measures using unweighted means.

[49] The regression coefficient on the share of a particular asset category represents the estimated effect on gross yield of raising the share of assets in that category by 1 percentage point while reducing by the same amount the share held in the category excluded from the regression (other CP).

[50] Consider, for example, the asset categories listed in table A1. Private debt instruments (lines 3 through 8) made up an average of 81 percent of MMF portfolios over the five-year span covered by this table. Of that, at least one-third (time deposits, ABCP, and other domestic and foreign bank obligations) was financial-sector exposures. In addition,

boost MMFs' gross yields, these yields likely would vary positively with concentration risks.

A.3 Gross yield and net flow to money market funds

To examine the relationship between gross yield and net flows to MMFs, I use monthly data from iMoneyNet for a sample period extending from January 1997 to August 2008 (just before the Lehman bankruptcy, Reserve's capital loss, and the run on MMFs). For each MMF in each month, I decompose gross yield into three components: (1) The average effective federal funds rate (FFR) prevailing in that month; (2) the MMF's *category-average gross yield*, that is, the asset-weighted mean gross yield for all MMFs of the same category in that month, less the average effective FFR; and (3) the MMF's *relative gross yield*, which is defined as its gross yield less its category-average gross yield. (The analysis covers just two categories of money funds: institutional and retail prime MMFs.) I estimate an empirical model of net new cash flow to each fund as a function of these three components of gross yield and several other controls:

$$f_t^i = \pi r_{t-1}^i + \gamma c_{t-1}^i + \phi FFR_{t-1} + \beta ExpRatio_{t-1} + \sum_{s=1}^{5} \theta_s f_{t-s}^i + \Gamma X_t^i + \varepsilon_t^i. \qquad \text{(A-2)}$$

The unit of observation for this regression is the MMF-month, and each fund-level observation combines data for all of the share classes of the fund.[51] The dependent variable in the regression, f_t^i, is fund i's log net flow in month t.[52]

The model includes the three components of gross yield, lagged one month: relative gross yield, r_{t-1}^i, category-average gross yield, c_{t-1}^i, and the effective federal funds rate, FFR_{t-1}. Also included are the expense ratio and four lags of net flow. The vector X_t^i is a set of additional controls, including the logarithm of the MMF's assets (lagged 5 months); the fund's 12b-1 fee, if any; the fee waiver, if any; a dummy for whether the fund was waiving fees; fund fixed effects; calendar-year time fixed effects; and calendar-month seasonal fixed effects.[53]

I estimated equation (A-2) separately for institutional and retail MMFs. Results for institutional funds are shown in the first column of table A2. Lines 1 through 3 show estimated coefficients for the three components of gross yields: relative gross yields, category-average gross yields, and the effective FFR. Most relevant to a cross-sectional analysis of MMF risks is the highly significant estimated effect of relative gross yield, line 1, on net flow. This effect is also economically important. Based on the estimated coefficient on relative gross yield of 7.29, a one-standard-deviation increase in gross yield (8.3 basis points over this sample period) was associated with an

most "other" (unsecured) CP, which accounted for one-third of MMF assets on average, was likely financial-sector issuance, since the share of financial CP in total unsecured CP averaged 82 percent over this period.

[51] See in note 4 in the text.

[52] That is, $f_t^i = 100 \times ln(1 + \frac{\text{net flow}}{\text{lagged assets}})$. See note 21 in the text.

[53] Christoffersen (2001) found that fee waivers played an important role in attracting assets to retail money funds, in particular. Farinella and Koch (2000) documented seasonal patterns in MMF net flows.

0.6 percent increase in net flow per month.[54] An institutional fund that maintained a gross yield that was one standard deviation above its category average for a year would have expected to attract net flows that were 6 percentage points (of assets) larger than the flows received by a typical competitor.[55]

The regression results shown in table A2 underscore the incentives that MMF advisers had to boost gross yields, whether they passed the increase on to shareholders (by keeping expense ratios fixed and allowing net yield to rise) or not. Indeed, the results provide some marginally significant evidence that a fund that raised gross yield and expenses by equal amounts—and thus boosted adviser revenue but left net yield unchanged—attracted larger subsequent inflows. Point estimates of coefficients on relative gross yield (line 1) are larger in magnitude than those for expense ratios (line 4), and line 13 of the table reports significance levels for F tests of the hypothesis that $\pi + \beta = 0$, which is rejected at the 10 percent level.

Results for retail funds are shown in column 3. For such funds, the advantages of a relatively high gross yield are statistically significant, but less compelling than those for institutional funds. The difference between retail and institutional funds' sensitivity to relative gross yields is not only statistically significant, as indicated by column 2,[56] but also economically important. A retail fund that maintained a one-standard-deviation gross-yield spread over its category average for a year would, all else equal, have expected to attract only 2 percentage points more flow than its average competitor. This result suggests that managers of retail funds faced weaker incentives to take portfolio risks than managers of institutional funds.

Retail and institutional investors responded differently to category-average gross yields, too. Larger category-average gross yields tended to draw assets to all retail funds; indeed, retail investors appear to have been about as sensitive to *average* MMF yield as they were to the relative yields earned by individual funds. In contrast, institutional investors responded to relative gross yield but not to category-average gross yield, suggesting that these investors tended to purchase shares in the highest yielding funds, regardless of the average yield spread (relative to the FFR) achieved by the MMF industry. One interpretation of these results is that for institutional investors, MMFs served as substitutes for direct holdings of money market instruments, which paid yields that moved closely with average MMF yields. Thus, only relative yields differentiated MMFs from these substitutes. For retail investors, MMFs competed with bank deposits (Investment Company Institute, 2010, pp. 34-35), which paid rates that did not move closely with funds' average yields, so category-average yields attracted inflows to retail funds.

[54] That is, 0.6 percent $= 100(e^{(0.00083 \times 7.29/100)} - 1)$.

[55] The boost to annual flow from a higher gross yield is somewhat less than the annualized one-month impact because of the negative estimated coefficients on lagged net flow.

[56] Significance levels reported in this column are those for interactive coefficients from a combined regression of institutional and retail MMFs (not shown) in which an institutional fund dummy is interacted with each explanatory variable listed on table A2.

Table A1. Gross yields of prime MMFs and selected fund characteristics, 2004-2008 (annual data)

MMF characteristic (units are percent, unless indicated)	(1) Mean[1]	(2) Cross-sectional standard deviation[2]	(3) Gross-yield regression: Est. coeff. and t-statistic[3]
Portfolio share held in:			
1. Treasury and agency securities	8.06	12.49	-0.0019 (-7.37)
2. Repurchase agreements	10.64	11.73	-0.0008 (-2.66)
3. Time deposits	2.16	4.03	0.0000 (-0.01)
4. ABCP	12.23	13.51	0.0011 (4.76)
5. Floating-rate notes	20.05	16.86	0.0020 (10.03)
6. Other domestic-bank obligations	7.10	8.79	0.0027 (7.85)
7. Other foreign-bank obligations	6.17	9.82	0.0012 (3.76)
8. Other CP (omitted from regression)	33.60	21.83	
9. Portfolio weighted average maturity (days)	41.29	9.83	0.0015 (4.52)
10. Share of assets maturing in seven days	29.97	14.53	-0.0002 (-0.72)
11. Log of assets (in billions of dollars)	0.40	1.59	-0.0035 (-1.75)
12. Instititional-fund dummy	0.47	0.50	0.0032 (0.54)
13. Constant			-0.0005 (-0.10)
Number of observations			1348
Adjusted R-squared			0.252

Notes.

1. Sample averages of unadjusted fund-level annual data for all prime MMFs.

2. For each variable, the standard deviation is calculated after subtracting from each observation the annual asset-weighted average for that variable for all prime MMFs in the same year.

3. Dependent variable is each MMF's annual gross yield (in percent) in a given year, less the asset-weighted mean gross yield for all prime MMFs in the same year. Unit of observation is the fund-year. All explanatory variables are expressed in terms of deviation from annual asset-weighted averages for all prime MMFs in the same year. t-statistics in parentheses are based on robust standard errors.

Table A2. Net Flows to Prime Money Market Funds and Gross Yields in Previous Month

	(1) Institutional funds	(2) Difference significant? (p-value)*	(3) Retail funds
1. Relative gross yield (π) in previous month	7.29 (5.73)	0.000	1.85 (3.23)
2. Category-average gross yield in previous month	-0.93 (-0.95)	0.015	1.72 (3.68)
3. Effective FFR in previous month	0.59 (3.34)	0.884	0.62 (6.37)
4. Expense ratio (β) in previous month	-3.27 (-1.68)	0.970	-3.34 (-4.58)
5. 1st lag of log flow	-0.09 (-8.23)	0.546	-0.08 (-8.58)
6. 2nd lag of log flow	-0.04 (-5.15)	0.044	-0.01 (-1.38)
7. 3rd lag of log flow	0.01 (1.09)	0.497	0.00 (0.00)
8. 4th lag of log flow	-0.02 (-4.08)	0.133	-0.01 (-1.48)
9. 5th lag of log assets	-2.33 (-11.35)	0.002	-1.56 (-10.98)
10. 12b-1 fee in previous month	-1.32 (-0.54)	0.134	2.63 (2.67)
11. Fee waiver in previous month	1.29 (0.73)	0.628	0.38 (0.59)
12. Any fee waiver in previous month? (1=yes, 0=no)	-0.38 (-1.11)	0.791	-0.28 (-1.53)
13. *p*- value for test that $\pi + \beta = 0$	0.071		0.100
Number of observations	15704		22840
Adj. R-squared	0.066		0.073

Notes. Dependent variable is monthly log flow to prime MMFs from January 1997 to August 2008. Monthly log flow is defined as 100*ln(1+flow/lagged assets). Flow is equal to the change in assets less accrued yield. t-statistics in parentheses are based on robust standard errors. Model also includes fund fixed effects, calendar-year time fixed effects, and calendar-month seasonal fixed effects.

*p-values based on a pooled institutional-retail fund regression with interactive coefficients (an indicator variable for institutional funds multiplied by each coefficient).