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# Does the buck stop here? A comparison of withdrawals from money market mutual funds with floating and constant share prices

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ABSTRACT

Recent reform proposals call for an elimination of the constant net asset value (NAV) or "buck" in money market mutual funds to reduce the occurrence of runs. Outside the United States, there are several countries that have money market mutual funds with and without constant NAVs. Using daily data on individual fund flows from these countries, this paper evaluates whether the reliance on a constant NAV is associated with higher fund redemptions. The data suggest that funds with a constant NAV experienced more negative net flows during the period of the run on the Reserve Primary Fund, even after controlling for measures of fund risk and risk aversion. However, I do not find convincing support for the hypothesis that the effect of sponsor strength on fund flows was stronger for constant NAV money market funds.



## 1. Introduction

In the United States, money market mutual funds maintain a constant share price, also known as a constant net asset value (NAV), of $1 per share. As such, a share in a money market mutual fund is similar to a deposit contract since the shareholder is effectively guaranteed the return of her initial investment upon withdrawal of her money from the fund. Unlike a deposit contract, there is no deposit insurance for money market mutual funds, so the lack of such insurance may make them susceptible to a bank run (Diamond and Dybvig, 1983). Indeed, such a run did occur on September 16th 2008, following the collapse of Lehman Brothers. The Reserve Primary Fund "broke the buck" as its share price was reduced below $1 to $0.97, due to its holdings of Lehman's commercial paper. This was followed by massive redemptions in other money market mutual funds and the U.S. Treasury introduced a temporary guarantee program for money market mutual funds to prevent a market-wide run from occurring (FINRA, 2010). This was complemented by the Federal Reserve's asset-backed commercial paper money market mutual fund liquidity facility, which provided liquidity to money market funds that needed to satisfy an influx of redemptions (Duygan-Bump et al., 2013).

In the aftermath of this event, there have been several proposals to reform the structure of the money market mutual fund industry, as part of a broader set of proposals to reform shadow banking (Financial Stability Board, 2011). One of the primary proposals is to abandon the constant share price of $1 per share in favor of a floating share price.[1] In this case, if the intrinsic value of the fund falls in value, this will be reflected in the share price, and the redeeming shareholders should have less incentive to run for the exits. Therefore, it is generally believed that moving away from a constant share price structure will reduce the risk of a run. Nonetheless, there may still be a risk of runs in floating share price money market mutual funds as well. Jank and Wedow (2015), for example, find evidence of runs from illiquid money market mutual funds in Germany, where mutual funds do not have a constant share price structure. There is also some anecdotal evidence that suggests a

[1] The Technical Committee of the International Organization of Securities Commissions (2012) has examined several proposals in a recent consultation report. Other proposals include calls for money market mutual funds to pay insurance fees (like deposit insurance) and to maintain a minimum buffer (see the discussion of this proposal by The Squam Lake Group (2011)). Following the crisis, several countries have implemented increased disclosure and stricter restrictions on the portfolios of money market mutual funds (See Section 2 for a discussion of these requirements).

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floating NAV does little to reduce the occurrence of runs on money market mutual funds (e.g., HSBC, 2011; Bengtsson, 2013).

The focus of this paper is to empirically examine whether floating share prices provide a benefit in reducing run-like behavior. Chen et al. (2010) use a global games approach to model payoff complementarities and financial fragility in mutual funds. In their model, investor withdrawals impose a negative externality on the remaining fund shareholders, especially in those funds that may need to liquidate illiquid asset holdings (Edelen, 1999). This amplifies the effect of fund performance on flows in illiquid funds, since investors may redeem their shares on the self-fulfilling belief that other investors also are redeeming shares. They confirm their model empirically in the flow-performance relation in equity mutual funds. Money market mutual funds with a constant NAV (CNAV) impose an additional negative externality on remaining fund shareholders: when returns are poor in the first period (such that the value of the fund's holding per share falls below $1), early redemptions at a $1 NAV reduce the returns of the remaining shareholders. A variable NAV (VNAV) may overcome the externality introduced by CNAV funds; however, it critically depends on the extent to which the variable NAV correctly reflects the costs of liquidating the underlying holdings during a period of heavy redemptions. Thus, it is an empirical question as to whether there is much of a difference between VNAV and CNAV mutual funds in preventing runs. The main difference between these two types of money market funds is the use of amortized cost accounting.[2] VNAV money market mutual funds measure the value of their positions using market prices or fair value (which in some cases may be based on amortized cost accounting). For CNAV money market funds, the value is recorded as the initial cost, plus the straight line amortization of the position's premium or discount at the time of purchase through to the position's maturity date.

Unlike the United States, many European countries have money market mutual funds with and without constant NAVs and hence provide an opportunity to examine how flow behavior is different under these structures. This paper fills a void in the academic literature since it is essentially the first to examine the pricing structure of money market mutual funds. The only prior paper, to the best of my knowledge, is Lyon (1984), which investigates the effect of the SEC allowing money market mutual funds to use amortized cost accounting (i.e., a CNAV structure) in the United States in the late 1970s. This prior paper is concerned with flow behavior and evidence of arbitrage in this structure, and not directly on the link between the pricing structure and the incidence of runs.[3] In a concurrent paper, Gordon and Gandia (2014) compare CNAV funds that maintain a stable net asset value against those CNAV funds that are "accumulating" income and, after controlling for various other factors, do not find any difference in redemptions around the Lehman crisis for these two types of funds. Their analysis is at the share class level and the money market funds they examine often have both a "stable" and "accumulating" share class that have a claim on the same pool of underlying assets so redemption incentives in one share class may be affected by redemption behavior in the other share class. The analysis in this paper does not suffer from this problem since it is at the fund level, and compares CNAV funds to VNAV funds.

Using data from international mutual funds, this paper uses a quantile regression analysis and finds that constant share price funds experienced a larger drop in net flows during the period of the run on the Reserve Primary Fund, after controlling for variables such as prior returns and investor risk, which may have an impact on flow behavior. The results are also quantitatively similar when comparing CNAV and VNAV funds in a country-by-country analysis and when comparing CNAV and VNAV share classes within the same fund so the results are not likely due to institutional differences across countries or differences in fund portfolio risk. Given concerns that differences in the investor base may lead to differences in redemption behavior between the two types of funds, I also include variables to proxy for the risk of the fund's investor base. I find that, based on these measures, funds with more investor risk experienced a larger drop in flows during the period of the run on the Reserve Primary Fund. After controlling for investor risk, the results show that the decrease in net flows during this period was larger in CNAV funds than in VNAV funds. Thus, the results are robust to controlling for observable measures of investor risk.

Fund sponsors provide an implicit guarantee that should mitigate the incidence of runs in CNAV money market mutual funds. Funds with sponsors in a better financial condition are more likely to benefit from such a guarantee. This paper tests for the presence of such support in both VNAV and CNAV money market funds. There should be less of a need for such sponsor support in VNAV funds because by definition there is no guarantee that these funds maintain their value. The results do not provide strong support for this proposition. While a larger non-money fund business (a measure of the incentive to provide support to avoid spillovers) attenuated the drop in crisis flows in U.S. dollar CNAV funds relative to VNAV funds, this effect was stronger in standalone funds. These funds do not have the wherewithal to provide this support, and this suggests that the result of non-money fund business on crisis flows may be related to some other factor not related to sponsor support.

Although this paper documents a larger drop in flows in CNAV mutual funds during the crisis, it does not necessarily imply that VNAV funds are the preferred structure since the analysis is not a holistic evaluation of all the benefits and disadvantages of the two structures. Importantly, there are several advantages of CNAV money market funds that are not considered in this paper. First, the CNAV structure may reduce tax, bookkeeping and operational costs for investors. Second, because some investors can only invest in cash pools with a stable NAV, the industry argues that a switch to a floating NAV could result in extra risk to the financial system if these funds are directed towards less regulated vehicles outside of the current regulatory framework (e.g., Investment Company Institute, 2012).

The rest of the paper is organized as follows. In the next section, I provide an overview of the institutional background of CNAV money market funds in the United States and Europe, before discussing the main testable hypotheses in Section 3. In Section 4, I describe the data and report summary statistics. Section 5 describes the empirical methodology and presents empirical findings. In Section 6, I discuss robustness checks and provide some concluding remarks in Section 7.

## 2. Institutional background on CNAV money market funds

The U.S. and European framework for CNAV funds is broadly similar. Both frameworks have portfolio restrictions limiting liquidity and credit risk of the funds, to ensure that CNAV money market funds will be able to maintain a stable price. Further, both require the fund to monitor deviations between the fund's price and its underlying value so that its price fairly reflects the fund's value per share. Given these similarities, the main analysis in this paper compares CNAV and VNAV funds across several different countries in a pooled regression framework. However, given the possibility that institutional differences could influence the results

[2] A constant or stable NAV is a function of three components: amortized cost accounting, penny rounding, and distribution of income. These components allow the fund to maintain a constant share price (usually $1).

[3] Greene and Hodges (2002), Chalmers et al. (2001) and Zitzewitz (2003) also find evidence that is consistent with arbitrage and stale prices in equity mutual funds.

despite these broad similarities, the paper later examines the differences between CNAV and VNAV funds in a within-country regression framework.

U.S. and European regulators both state conditions under which money market funds may use amortized cost accounting, which allows money market funds to maintain a constant net asset value.[4] In rule 2a-7, the SEC restricts MMF portfolio holdings to minimize the funds' exposure to credit risk and interest rate risk. Prior to the crisis, all portfolio investments were to have a remaining maturity of one year or less, and the dollar-weighted portfolio maturity could not exceed 90 days.[5] Illiquid securities could not represent more than ten percent of the fund's assets. Further, the portfolio needed to consist of securities that a major rating company determined as "high quality", along with a requirement that the board determine that the security "...presents minimal credit risk to the fund."

European money market funds also had similar risk-limiting conditions. Funds were allowed to use amortized cost accounting for some money market instruments, provided the fund followed the guidelines set out by the Committee of European Securities Regulators (2007).[6] Specifically, amortized cost accounting could be applied to money market instruments with a residual maturity of less than three months and with no specific sensitivity to market parameters, including credit risk. Alternatively, funds investing solely in high-quality instruments with residual maturities less than or equal to 397 days and with a weighted average portfolio maturity of 60 days could use the amortized cost method.[7] Further, triple-A rated CNAV money market mutual funds are members of the Institutional Money Market Funds Association (IMMFA), a European self-regulatory trade association that sets a code of practice for its members. The code of practice is similar to the U.S. regulations in that it places restrictions on portfolio credit quality and maturity, limiting the weighted average portfolio maturity and setting minimum credit ratings on the securities in the fund's portfolio.

Post-crisis, these conditions were also tightened in both countries. To the extent that this tightening made money market funds safer, we should expect to see less large redemptions in CNAV funds after these regulations were put in place. In the U.S., the SEC amended rule 2a-7 to tighten restrictions on the credit quality, maturity, and liquidity of portfolio holdings for money market funds. The maximum dollar-weighted average maturity was reduced to 60 days, and a maximum dollar-weighted average life to maturity was introduced and set at 120 days.[8] As for the liquidity requirements, a minimum of ten percent of a fund's portfolios must be invested in "Daily Liquid Assets" and a minimum of thirty percent must be invested in "Weekly Liquid Assets". The amended rule 2a-7 also requires monthly website disclosure of portfolio holdings, including information on each portfolio security's amortized cost value.[9]

In Europe, the IMMFA amended the code to tighten the risk-limiting conditions including adding diversification limits, a maximum final legal maturity of 397 days, and requirements on the credit ratings and minimum criteria on credit ratings. As well, the code requires monthly disclosure of all portfolio holdings.

In both regions, CNAV funds must monitor the fund's valuation and pricing methodology and take steps such that this methodology fairly reflects the fund's value per share. In the United States, the board must monitor the deviation between the fund's amortized cost-based price and the fund's value based on market prices that the fund would receive based on the sale of the security. Similarly, under CESR guidelines in Europe, the fund must ensure that there is not a material discrepancy between the value of the money market instrument and its amortized cost valuation. IMMFA members must monitor deviations between market value and amortized cost value at a weekly frequency or greater. Because of this framework and monitoring, Fisch and Roiter (2012) argue that CNAV money market funds are only CNAV funds under certain circumstances. Given the stigma associated with "breaking the buck," there is the possibility that a fund may not adjust its price in a timely manner, and hence it is an empirical question as to whether there is a difference in flow behavior between the two types of funds.

## 3. Hypothesis development

The pricing structure of a money market fund (i.e., CNAV vs. VNAV) could influence redemptions in the fund during a time of stress. Chen et al. (2010) use a global games approach to show that financial fragility may exist in (VNAV) mutual funds. In their model, there are strategic complementarities in funds with illiquid assets: withdrawing shareholders impose a negative externality on remaining shareholders. Investor redemptions decrease future fund returns to remaining investors, since the fund incurs direct and indirect costs to readjust its underlying portfolio as a result of these redemptions, and these costs are not incorporated in the price investors receive for their redemptions (Chordia, 1996; Nanda et al., 2000; Edelen, 1999). Self-fulfilling beliefs amplify the effect of fund performance on flows in illiquid funds, because investors may redeem their shares on the belief that other investors also are redeeming shares.

Equity and corporate bond funds holding more illiquid assets experienced more redemptions following poor performance than funds holding liquid assets (Chen et al., 2010; Goldstein et al., 2015). This effect of liquidity on financial fragility is also present in some VNAV money market funds.[10] Jank and Wedow (2015) show that the more illiquid German VNAV funds experienced more outflows from mid-2007 to mid-2008 when the subprime crisis increased illiquidity in the money markets.[11] Bengtsson (2013) also provides anecdotal examples of CNAV and VNAV money market funds that experienced outflows during periods of financial market stress.

This effect should be more pronounced in CNAV funds. CNAV money market funds rely on a constant share price that does not reflect the true value of the underlying portfolio and this imposes an additional externality on remaining investors. Thus the extent

[4] Under amortized cost accounting, a fund can value its holdings at their acquisition cost, adjusted to linearly amortize the premium or discount until the holding's maturity.

[5] Prior to the crisis, the SEC made significant amendments to rule 2a-7 in 1986, 1991, and 1996. Refer to Money Market Working Group (2009), Appendix E for a detailed history of the rule 2a-7 amendments.

[6] In Europe, most money market funds (and other mutual funds) are structured as Undertakings for Collective Investment in Transferrable Securities (UCITS) and can be marketed throughout the European Union.

[7] While these rules provide for the use of amortized cost accounting, some national regulators, such as those in France and Ireland, have imposed more stringent rules (Technical Committee of the International Organization of Securities Commissions, 2012).

[8] Funds can use the next interest rate reset date for floating rate notes as its maturity when calculating dollar-weighted average maturity, but not when calculating dollar-weighted average life to maturity.

[9] In addition, funds must report the market value of each portfolio security to the SEC, which becomes publicly available with a 60 day lag. Musto (1997, 1999) examines the effect of mandatory portfolio disclosure on money market mutual fund's investment decisions and money market yields around portfolio disclosure dates.

[10] While money market funds generally hold liquid, short-term assets, the secondary market for commercial paper is generally thin. Most of the liquidity is provided by dealers, who may face their own liquidity and capital pressures during times of stress (Duygan-Bump et al., 2013; Covitz and Downing, 2007).

[11] Jank and Wedow (2015) show that German VNAV money market funds held almost 70% of their portfolio in debt securities, which include floating and fixed rate securities as well as asset backed securities. In their empirical analysis, they use this proportion to cross-sectionally classify funds according to the liquidity of their portfolios, and find evidence that the more illiquid funds experienced more outflows.

of strategic complementarities should be greater and CNAV mutual funds should be more likely to experience outflows, relative to VNAV funds, after a period of poor performance. In this sense, the fixed share price makes CNAV money market funds more similar to banks, where there is a large literature discussing financial fragility and the potential for investor runs (e.g., Diamond and Dybvig, 1983; Goldstein and Pauzner, 2005).

Since the crisis, there is a growing literature providing strong evidence that U.S. dollar-denominated CNAV money market funds are prone to outflows during market stress (McCabe, 2010; Kacperczyk and Schnabl, 2013; Schmidt et al., 2015; Chernenko and Sunderam, 2014). Less clear is whether stress-induced outflows are larger in CNAV or VNAV money market funds. This leads to our hypothesis:

**H1.** During the crisis, CNAV money market funds experienced more negative net flows, relative to VNAV money market funds, after controlling for investor risk, portfolio risk and sponsor risk.

Previous research has shown that outflows in CNAV funds are affected by the level of portfolio risk, investor risk, and sponsor risk associated with the fund (McCabe, 2010). VNAV funds may be different from CNAV funds along these dimensions so it is important to control for these characteristics when assessing flow behavior. For example, CNAV funds and VNAV funds may exhibit different run behavior if a different subset of investors is attracted to each of these types of funds. A more risk averse investor is more likely to withdraw early.

**Investor risk** is measured using management expense ratios (MERs or fund fees) and the volatility of investor flows prior to the crisis.[12] Fees are a suitable proxy for the responsiveness of flows to performance, as well as the institutional nature of the investor base. Performance-sensitive investors migrate to the better prospect money market funds (i.e., those that charge lower fees), while performance-insensitive investors remain in the funds that charge higher fees (Christoffersen and Musto, 2002). Institutional share classes have much lower fees than retail share classes, and they are more likely to waive fees.[13] Using U.S. data, Schmidt et al. (2015) demonstrate that institutional investors exhibited more run-like behavior in large money market mutual funds in complexes that had higher proportions of institutional investors. This may be because institutional investors are more risk averse, because of legal or regulatory constraints requiring them to invest in stable NAV funds, the potential for legal liability, and career concerns (McCabe, 2010). At the same time, institutional investors have a greater level of sophistication combined with better information relative to retail investors (e.g., due to their economies of scale, they have access to information on fund flows and fund holdings from data vendors).

Flow volatility has been used as a measure of investor risk by McCabe (2010) and Schmidt et al. (2015). Schmidt et al. (2015) find U.S. investors were more likely to run from funds with higher flow volatility and lower expense ratios, which they suggest are measures of "hot money". McCabe (2010) suggests that flow volatility may reflect "concentrations of similar investors with correlated transaction patterns, and finds that U.S. CNAV funds with higher flow volatility had lower net flows during the Lehman crisis. A higher level of daily *Flow Volatility* could be indicative of investors that are more sensitive to relative fund performance and changing market conditions.

This paper uses realized gross returns in the period prior to the crisis as a measure of fund **portfolio risk**. In CNAV funds, gross returns are similar to gross yields, since there is no capital appreciation in CNAV fund shares. However, gross returns are used here because they are more comparable across CNAV and VNAV funds than gross yields, since VNAV fund returns include not only the yield on a security but also include changes in the value of the portfolio. Previous literature shows that both gross and net yields are a good measure of portfolio risk in U.S. dollar-denominated CNAV funds and are related to other measures of portfolio risk.[14] Gordon and Gandia (2014) examine both net yields as well as the share of each fund's portfolio invested in different asset classes such as ABCP as measures of portfolio risk. In a multiple regression analysis including net yields and these portfolio shares as measures of fund portfolio risk, net yields are the only significant portfolio risk variable. Kacperczyk and Schnabl (2013) regress a fund's spreads (gross yields less risk free rate) on holding risk (i.e., portfolio shares in different asset classes) and find statistically significant coefficients on many of these measures and a very high overall r-squared in their regression (greater than 95%). McCabe (2010) also finds a negative relation between gross yields and net flows in U.S. CNAV funds during the period of the Lehman crisis. He also does not find any significant correlation between gross yields and measures of investor risk, supporting the interpretation that gross yield is a measure of portfolio risk rather than a measure of greater investor risk. Given these results, this paper uses gross realized returns as a measure of portfolio risk.[15]

**Sponsor risk** is measured by the incentive of fund sponsors to provide support to the fund. In CNAV money market mutual funds, fund sponsors may provide an implicit guarantee to reduce the likelihood of a self-fulfilling run. During the 2007–2009 financial crisis, 62 CNAV money market funds in Europe and the United States received some form of financial support from their fund sponsor (Shilling, 2010). Sponsors in better financial condition were more likely to provide such support: during the run on money market funds in 2008, U.S. CNAV funds that had sponsors with wider CDS spreads experienced larger outflows (McCabe, 2010).[16] Given that including CDS spreads substantially reduces sample size, this paper measures the incentives to provide sponsor support as a measure of sponsor risk. Specifically, funds with more potential for spillovers of money market fund risk to other lines of business sponsors should be more likely to provide support; therefore, I use the proportion of the fund sponsor's mutual fund assets under management that are not in money market mutual funds as at August 2008 as a measure of sponsor strength. A fund sponsor's presence in other lines of business may have an impact on the likelihood of providing sponsor support since a negative event may have an impact on the fund sponsor's reputation and impact their other lines of business. Kacperczyk and Schnabl (2013) show, for example, that funds with a greater non-money market fund business were more likely to change their fund name to mimic its sponsor name

[12] There is little publicly available data on the risk aversion of the investor base of money market funds. Investors are not required to report their mutual fund holdings, and mutual funds do not provide in-depth information on their investor base.

[13] Christoffersen (2001) shows that 79% of institutional money market funds waive fees whereas 55% of retail funds waive fees, suggesting that institutional funds face more price competition than retail funds. Moreover, fees have historically accounted for the majority of performance differences in prime money market mutual funds, and low-performing institutional money market funds lower fees (using fee waivers) to improve their net performance (Christoffersen, 2001).

[14] Gross yields are preferable to net yields, since gross yields represent the risk of the underlying portfolio and since net yields are affected by MERs, which are a measure of investor risk.

[15] The analysis does not include more portfolio characteristics (holdings by asset type, maturity of fund holdings) since there is no comparable public source for holdings information of the funds in the sample. Funds operate in different countries with no unified repository of information for securities filings in Europe (like EDGAR in the US).

[16] There may be strategic complementarities in the decision to provide sponsor support. In particular, if a sponsor believes other fund sponsors will also be providing support, this implies higher liquidation prices, and a lower cost of the sponsor in offering support (Parlatore, 2014).

between October 1, 2009 and September 30, 2011. They suggest that funds change names to "signal to their investors the potential safety of their operations".

Thus, if investors rely on these implicit guarantees, CNAV funds with sponsors that have more incentives to provide support should be less likely to experience fund redemptions during the crisis.[17] While there is some mixed evidence of a spillover of large redemptions in flagship (VNAV) mutual funds to other funds in a family (International Monetary Fund, 2015), these spillover effects are likely to be larger in CNAV funds that "break the buck". The price of a VNAV fund fluctuates and investors should not expect a fund sponsor to support a poorly performing fund to maintain a certain price (Ramirez et al., 2015). Funds are required to clearly disclose that loss of money is a risk of investing in a non-money market fund.[18] Thus, crisis flows in CNAV funds should be higher in funds with more incentives to provide such support; no such relation should exist in VNAV funds.

**H2.** During the crisis, CNAV money market fund net flows increase with the potential for sponsor support, whereas VNAV money market fund outflows are unaffected by the potential for sponsor support.

## 4. Sample and descriptive statistics

Morningstar is the source of the money market mutual fund data in this paper. I begin by selecting all money market mutual funds domiciled in the United States and Europe. Funds that are not denominated in Euros or U.S. dollars are removed from the sample. Morningstar provides information at the fund share class level. Funds often have several share classes catering to different clients (e.g., institutional or retail), with different minimum investment criteria, and with different management fees. For all of these share classes, I collect daily information on the net asset value per share, the assets under management at the share class level, as well as the assets under management at the fund level from January 1, 2006 through December 31, 2011. This paper focuses on those funds that report their fund size at a daily frequency. To remove data that is not reported at a daily frequency, I count the number of observations of fund size in every month and remove those observations where the fund does not report the fund size at least 10 times in that month.

The analysis in this paper is performed at the fund level, not the share class level. Therefore, for each fund, I use the information from the largest share class to classify the funds into different categories. For example, funds can be classified as either institutional funds or retail funds. A fund is classified as institutional if its largest share class is classified as institutional according to Morningstar. This information is available for most, but not all funds. For those funds without a Morningstar Institutional classification, I classify them as institutional if the minimum required investment is greater than €100,000 or $100,000, depending on the fund's currency. Previous studies have also used this minimum investment threshold for classifying a fund as institutional. Retail investors generally do not have sufficient funds to meet this minimum investment criterion. As well, if the fund's largest share class is a class of type "I", it is classified as institutional.

Funds focusing on government securities are also excluded from the analysis.[19] Government securities are less information-sensitive than non-government securities and funds holding mostly government securities should be less prone to runs than funds holding private sector securities. This was the case in the United States in September 2008, when there was a run from prime money market funds to government money market funds (Duygan-Bump et al., 2013). Funds are classified as a government fund if the fund name contains "Gov", "Sovereign" or "Treasury" and are hence removed. Municipal funds, identified as those with a fund name that contains "Muni", are also removed. Small funds, with an average fund size less than €50 million or $50 million, are also excluded. Morningstar does not categorize funds as having a constant or a floating NAV. Therefore, I use the following algorithm to determine a fund's NAV structure. If a fund's share price is equal to $1, €1, $10, or €10 throughout the entire sample period, it is categorized as a CNAV fund. This definition classifies those money market funds that use amortized cost accounting but choose to accumulate income instead of distribute income as VNAV funds.

At the end of the third quarter in 2011, Money market funds in France, Luxembourg, Ireland, and the United States had assets under management of $490 billion, $376 billion, $475 billion, and $2.6 trillion, respectively (European Fund and Asset Management Association, 2011). As Table 1 shows, the sample examined in this paper covers a substantial portion of these markets. Our sample market size is smaller as a result of the focus on non-government funds, on funds denominated in Euros and U.S. dollars (which eliminates Sterling funds in Ireland, for example), and funds that report their fund size at a daily frequency. From Table 1, it is also apparent that VNAV mutual funds are, on average, smaller than CNAV mutual funds, with the average CNAV fund size being a multiple of the average VNAV fund size. Part of this is the result of a skewed distribution in that the very large money market mutual funds are CNAV funds. It is also apparent that Europe contains mostly VNAV funds and a handful of CNAV funds, whereas the United States contains mostly CNAV funds. For Euro-denominated funds, 95% of the VNAV funds are domiciled in France, Spain and Luxembourg. Meanwhile, 92% of the CNAV Euro-denominated funds are located in Ireland. Similarly, 83% of U.S. dollar-denominated VNAV funds are domiciled in France, Ireland, and Luxembourg, whereas 92% of U.S. dollar-denominated CNAV funds are located in the United States. This may potentially introduce some bias in the results if there are institutional differences across the two regions, and if these institutional differences are important in determining flows during the crisis. Given that the institutional framework appears similar between the countries and, if anything, the U.S. contains more strict rules governing portfolio investments, this bias is likely to work against finding larger outflows in CNAV funds.

Table 2 examines differences between CNAV and VNAV funds in the period just before the crisis and shows that VNAV and CNAV funds differ along several dimensions. CNAV funds are larger and have lower MERS – both of which are the result of a more institutionally-oriented investor base. As well, CNAV funds have a higher flow volatility than VNAV funds.[20] This could reflect more investor risk or could reflect the additional run risk inherent in CNAV money market funds (i.e., CNAV funds have more outflows following poor performance). Euro-denominated VNAV funds had higher returns than their CNAV counterparts, which is consistent with the

[17] Risk-taking may also be lower in funds that provide more sponsor support. If this were the case, funds with sponsors in worse financial condition and with more reputational concerns may undertake less risk, which would reduce the potential for outflows. Kacperczyk and Schnabl (2013) find that risk-taking is lower in funds with sponsors with limited financial resources and lower in those funds where there are concerns about negative spillovers to the rest of the fund sponsor's business. The empirical analysis controls for the effect of portfolio risk on outflows.

[18] https://www.sec.gov/about/forms/formn-1a.pdf.

[19] There is a large government-only money market fund sector in the U.S., whereas Europe does not have a large number of government-only funds. Overall, European money market funds had small exposures to Euro-area government obligations, with only 7% were invested in Euro-area government securities.

[20] *Flow Volatility* is calculated as the standard deviation of daily flows in the July to August 2008 period.

**Table 1**
Summary statistics.

| Panel A: Euro-denominated money market mutual funds | | | | | |
|---|---|---|---|---|---|
| | | Number of funds | Number of institutional funds | Average fund size (€M) | Total fund assets (€B) |
| Belgium | *VNAV* | 3 | 0 | 331 | 0.99 |
| Finland | *VNAV* | 1 | 0 | 374 | 0.37 |
| France | *VNAV* | 262 | 23 | 1076 | 282 |
| Germany | *VNAV* | 5 | 0 | 267 | 1.33 |
| Ireland | *VNAV* | 5 | 2 | 337 | 1.68 |
| | *CNAV* | 11 | 4 | 3798 | 41.77 |
| Italy | *VNAV* | 1 | 0 | 377 | 0.38 |
| Luxembourg | *VNAV* | 55 | 13 | 991 | 54.5 |
| | *CNAV* | 1 | 1 | 20,689 | 20.69 |
| Spain | *VNAV* | 53 | 2 | 172 | 9.1 |
| Switzerland | *VNAV* | 4 | 1 | 1059 | 4.24 |
| Panel B: U.S. dollar-denominated money market mutual funds | | | | | |
| | | Number of funds | Number of institutional funds | Average fund size ($M) | Total fund assets ($B) |
| Belgium | *VNAV* | 1 | 0 | 74 | 0.07 |
| France | *VNAV* | 7 | 1 | 65 | 0.45 |
| Ireland | *VNAV* | 6 | 2 | 1007 | 6.0 |
| | *CNAV* | 11 | 7 | 5758 | 63.3 |
| Italy | *VNAV* | 1 | 0 | 260 | 0.26 |
| Luxembourg | *VNAV* | 32 | 5 | 595 | 19.1 |
| | *CNAV* | 3 | 1 | 24,846 | 74.5 |
| Switzerland | *VNAV* | 4 | 0 | 2292 | 9.17 |
| United States | *VNAV* | 3 | 2 | 275 | 0.825 |
| | *CNAV* | 175 | 77 | 5109 | 894 |

This table reports summary statistics for both constant net asset value (CNAV) and variable net asset value (VNAV) non-government money market mutual funds in the United States and several European countries. A money market mutual fund is defined as a CNAV fund if it maintains a fixed share price of $1, $10, €1, or €10. Otherwise, the fund is considered to be a VNAV fund.

hypothesis that CNAV funds restricted risk-taking over concerns about spillovers to the rest of their business. However, U.S. dollar-denominated CNAV fund returns were not any different from those of CNAV funds.[21]

In both the U.S. dollar and Euro sample, the two investor risk measures, *Flow Volatility* and *MER*, are negatively correlated. This is expected since investor risk is higher in funds with lower MERs and higher flow volatility. In addition, as McCabe (2010) suggests, riskier investors are attracted to larger funds: *MER* is negatively correlated with fund size, while *Flow Volatility* is positively correlated. As well, it is the funds with more potential for spillovers, measured by *Fund Business*, that had less investor risk, given the negative correlation between *Fund Business* and *Flow Volatility* and the positive correlation between *Fund Business* and *MER*. Perhaps funds with more potential for spillovers reduced the potential for negative spillovers by focusing on a less risky investor base. Alternatively, investors associated with more investor risk (i.e., institutions) may be attracted towards funds that have more potential for sponsor support.

In the U.S. dollar sample, fund size is also positively correlated with the measure of portfolio risk (*Return*) and the measure of the potential for sponsor support (*Fund Business*). Thus, in the U.S., this could suggest that larger funds may have more outflows due to higher investor risk and portfolio risk, while this could be offset somewhat with more potential for sponsor support.

In the Euro-denominated sample, pre-crisis flows were negatively correlated with *MER* and positively correlated with *Flow Volatility* and fund size, suggesting funds with a higher level of investor risk benefited from inflows during this period. No such relation exists in the U.S. dollar sample. This difference is due to differences in the composition of funds in each sample, since the Euro-denominated sample is mostly VNAV funds. In U.S. dollar-denominated VNAV funds, there is a positive correlation between pre-crisis flows and *Flow Volatility* and fund size, similar to the Euro-denominated sample (not reported here). In Euro-denominated funds prior to the crisis, funds with higher returns also experienced larger net flows. This, however, could be the result of poorly performing funds experiencing outflows, as there were problems in European money market funds in the year prior to the Lehman crisis (Bengtsson, 2013; Jank and Wedow, 2015).

## 5. Empirical methodology and findings

### 5.1. Fund flows and fund share price structure

*Hypothesis 1* is interested in the strategic complementarities between shareholders in CNAV and VNAV funds, respectively. Recent literature has suggested that quantile regression methodologies can be used to estimate models with multiple equilibria (Echenique and Komunjer, 2009; Angeletos and Pavan, 2013). In global games models such as in this paper, there is a good equilibrium in which investors do not redeem their shares, as well as a bad equilibrium where all investors redeem their shares. Examining the average behavior (using OLS) may not appropriately capture the strategic complementarities inherent in investor behavior, since some of this behavior may only be observed in tail outcomes.

Schmidt et al. (2015) test for strategic complementarities in U.S. CNAV money market funds using quantile regressions for exactly this reason. They argue that prior studies, which do not use quantile regression analysis, capture only average effects and cannot account for the natural heterogeneity in fund flows that occurs when only a handful of funds move experience run-like behavior. For these reasons, I use quantile regressions to estimate the

[21] In the subsequent regression analysis, *MER*, *Flow Volatility*, *Return*, and *Fund Business* are demeaned relative to the average of these variables within each currency of denomination.

**Table 2**
Comparison of CNAV and VNAV funds.

| | VNAV funds | CNAV funds | Difference | Std. error | *p*-Value |
|---|---|---|---|---|---|
| *Panel A: Euro-denominated money market mutual funds* | | | | | |
| Flow | 0.0005 | 0.0008 | −0.0003 | 0.0008 | 0.71 |
| MER | 0.50 | 0.21 | 0.30 | 0.11 | 0.01 |
| Flow volatility | 0.009 | 0.021 | −0.012 | .002 | 0.00 |
| Ln (Fund size) | 19.86 | 20.89 | −1.03 | 0.37 | 0.01 |
| Fund Business | 0.56 | 0.47 | 0.09 | 0.07 | 0.20 |
| Return | 0.047 | 0.037 | 0.009 | 0.002 | 0.00 |
| *Panel B: U.S. dollar-denominated money market mutual funds* | | | | | |
| Flow | 0.001 | 0.000 | 0.001 | 0.0004 | 0.01 |
| MER | 0.52 | 0.43 | 0.09 | 0.04 | 0.02 |
| Flow volatility | 0.008 | 0.014 | −0.005 | 0.001 | 0.00 |
| Ln (Fund size) | 19.55 | 21.60 | −2.05 | 0.22 | 0.00 |
| Fund Business | 0.72 | 0.52 | 0.20 | 0.05 | 0.00 |
| Return | 0.025 | 0.025 | −0.001 | 0.001 | 0.35 |

*Panel C: Significant pairwise correlations for U.S. Dollar-denominated funds*

| | Flow | MER | Flow volatility | Ln (Fund size) | Fund Business |
|---|---|---|---|---|---|
| MER | | | | | |
| Flow volatility | | −0.52*** | | | |
| Ln (Fund size) | | −0.30*** | 0.26*** | | |
| Fund Business | | 0.21*** | −0.21*** | 0.41*** | |
| Return | | | | 0.15** | |

*Panel D: Significant pairwise correlations for Euro-denominated funds*

| | Flow | MER | Flow volatility | Ln (Fund size) | Fund Business |
|---|---|---|---|---|---|
| MER | −0.12** | | | | |
| Flow volatility | 0.16*** | −0.46*** | | | |
| Ln (Fund size) | 0.19*** | −0.36*** | 0.21*** | | |
| Fund Business | | 0.11** | −0.35*** | | |
| Return | 0.17*** | | | | |

This table reports *t*-tests to compare several key variables for the sample of CNAV and VNAV funds. For each fund, I calculate the mean of *Flow*, *MER*, *Ln*(*Fund Size*), *Fund Business*, and *Return* in the period of July and August 2008. Similarly, *Flow Volatility* is the standard deviation of flows over the same period. All variables are described in Appendix A. Panel A compares Euro-denominated funds and reports the mean difference between the trading attribute of the VNAV funds and the CNAV funds, the standard error of the mean difference estimate, and the *p*-value from a *t*-test of the null hypothesis that the difference between the two groups is statistically indistinguishable from zero. Panel B presents the same results for U.S. dollar-denominated money market funds. Finally, Panel C displays the pairwise correlation amongst these explanatory variables for U.S. Dollar funds, while Panel D presents correlations for Euro-denominated funds. Correlations are only reported where they are significant at least at the 10% threshold. * indicates statistical significance at the 10% threshold.
** Indicates statistical significance at the 5% threshold.
*** Indicates statistical significance at the 1% threshold.

relation between large fund outflows and whether a fund utilizes a constant or floating share price structure. The quantile regression estimates the quantiles (i.e., percentiles) of individual fund daily net flows, conditional on explanatory variables:[22]

$$\begin{aligned} Netflow_{it} = {} & \beta_1 CNAV + \beta_2 Crisis + \beta_3 CNAV * Crisis + \beta_4 Return \\ & + \beta_5 Return * Crisis + \beta_6 Guarantee + \beta_7 CNAV * Guarantee \\ & + \beta_8 US + \beta_9 Post\text{-}Guarantee + \beta_{10} CNAV * Post\text{-}Guarantee \\ & + \beta_{11} MER + \beta_{12} MER * Crisis + \varepsilon_{it} \end{aligned} \quad (1)$$

In the first set of regressions, estimates are obtained for the 25th, 50th, and 75th percentiles.[23] The results for the 25th percentile are of most interest since these are associated with large fund outflows. The 75th percentile, on the other hand, is associated with fund inflows (i.e., the right hand side of the net flow distribution). In a multiple equilibria model where the bad equilibrium is associated with large outflows, any variable inducing the bad equilibrium should have a strong, negative coefficient in the 25th quantile regressions. The variable should be weaker, or even zero, in the median and 75th quantile regressions. Conversely, a coefficient that was stronger (more negative) in the 75th quantile regression would be inconsistent with a hypothesis that the bad equilibrium was associated with investors redeeming on the belief other investors were redeeming, since it implies that the reason that the variable caused fund net flows to decrease was because fund inflows were smaller, not because fund outflows were larger. If a variable affects the volatility of flows, the coefficients of the variable in the 25th percentile and 75th percentile regressions would be of similar magnitude but have the opposite sign.

This model follows a differences-in-differences approach. *CNAV* captures the baseline difference between CNAV funds and VNAV funds in the pre-crisis period. The CNAV structure should have only a small effect on fund outflows in the pre-crisis period. Therefore, the coefficient on this variable should either be equal to zero, or negative at the 25th percentile reflecting the incentives for investors to redeem when the value of the CNAV fund holdings falls below $1. Similarly, the coefficient should be slightly positive at the 75th quantile given CNAV investors may have an incentive to invest when the value of the fund is above $1. *Crisis* is a dummy variable that is equal to one from September 15, 2008 through September 19th, 2008, and zero otherwise. The crisis time period

[22] Lynch and Musto (2003), Chevalier and Ellison (1997), and Sirri and Tufano (1998) document a convex flow-performance relation using mutual fund flows, and Christoffersen (2001) finds a convex relation for money market fund flows. This means that investors' flows are less sensitive to poor performance than they are to good performance. Convexity is not examined here because daily money market fund returns are based on amortized cost accounting and not on the market value of the fund's portfolio.

[23] While OLS estimates are generated by minimizing the sum of squared residuals, the estimates in a quantile regression are generated by minimizing the sum of (symmetrically weighted) absolute residuals (Koenker and Hallock, 2001). In the case of the median, it is simply the sum of absolute residuals. Standard errors are estimated using a bootstrap method with 200 replications. To allow for arbitrary serial correlation in the error terms within funds, I use a clustered bootstrap that samples the complete time series of each fund with replacement.

corresponds to the time when the Reserve Primary Fund "broke the buck", and there was a sharp decline in assets under management at U.S. prime money market mutual funds. Since strategic complementarities exist in both CNAV and VNAV funds, this coefficient is expected to be negative, especially in the left tail, 25th quantile regression.

Under *Hypothesis 1*, which posits that CNAV mutual funds are more likely to experience more negative net flows when fund performance is poor, the coefficient on the interaction between *CNAV* and *Crisis*, $\beta_3$, is expected to be negative. Absent any additional strategic complementarities, CNAV funds should experience the same change in net outflows experienced by VNAV funds during the crisis (i.e., the CNAV*Crisis* coefficient would be zero). Since the hypothesis is concerned with redemption behavior in the tails, the coefficient is expected to be stronger in the 25th quantile regressions. The coefficient on the interaction between *CNAV* and *Crisis* tests the hypothesis that fund flows in CNAV funds were different from VNAV funds during the week when the Reserve Primary Fund broke the buck.[24]

During the period of the U.S. Treasury guarantee program, U.S. CNAV money market fund investors were protected on the downside. Therefore, the analysis includes a dummy variable, *Guarantee,* that is equal to one during the period from September 20th, 2008 through September 19th, 2009, and zero otherwise. This corresponds to the time when the U.S. Treasury provided a guarantee for U.S. money market mutual funds. Some jurisdictions, such as Luxembourg, also offered to support money market funds in this period.[25] This support likely benefitted CNAV funds more than VNAV funds, given that investors would prefer a constant share price backed by state support over a variable share price vehicle. Thus, VNAV funds were not protected to the same extent by such a guarantee. Given that there was still some market turbulence during the Treasury guarantee period, and other competing products that have state guarantees, VNAV funds likely experienced outflows and the coefficient on *Guarantee* is likely to be negative. Due to the presence of state support or guarantees, CNAV money market funds should be less likely to experience outflows during this period and according to *Hypothesis 2* the $\beta_7$ coefficient in Eq. (2) should be positive. This coefficient should be stronger in the 25th quantile regressions, since the Treasury guarantee program only extended to the amount of money each investor had in the CNAV money market funds at the time the guarantee was implemented; therefore it should not have engendered any additional inflows evidenced by an effect at the 75th quantile.

During the post-guarantee period, money market fund regulations were tightened in several jurisdictions (see Section 2). *Post-guarantee* is a dummy variable that is equal to one during the period from September 20th, 2009 onwards, and zero otherwise. The coefficient on this variable could be either positive or negative, as it captures the general flows out of VNAV money market funds in this period, which could be influenced by several external factors. However, if these restrictions reduced the riskiness and increased the liquidity of CNAV money market mutual funds more so than VNAV funds, there should be less of a difference in outflow behavior between CNAV money market funds and VNAV money market funds, as measured by a positive $\beta_{10}$ coefficient.

Portfolio risk is measured using *Return*: fund returns just prior to the crisis. Given prior research on U.S. dollar-denominated CNAV funds, it is expected that funds that had more portfolio risk will experience more negative net flows during the crisis, so the $\beta_4$ coefficient should be negative. *MER* is a measure of investor risk, and funds with more investor risk (lower MERs) should experience more negative net flows during the crisis, given that strategic complementarities should be stronger when investor risk is higher. Thus, in the 25th quantile regressions, the $\beta_{12}$ coefficient on *MER*Crisis* should be positive.

The results from this regression are presented in Table 3. For both U.S. dollar and Euro funds, the $\beta_1$ coefficient associated with *CNAV* is negative and statistically significant at the 25th quantile, and is positive and statistically significant at the 75th quantile of flows. Hence, prior to the crisis CNAV funds experienced both larger inflows as well as larger outflows than VNAV funds. This could suggest that the CNAV pricing structure could be giving investors an additional incentive to invest in or redeem from funds when the price does not reflect the underlying value of the fund's assets. Alternatively, investor risk could be larger in CNAV funds than in VNAV funds prior to the crisis, even after controlling for investor risk using MERs. The coefficient on *Crisis* (measured at the 25th quantile) was negative and statistically significant in both Euro- and U.S. dollar-denominated funds. This suggests that there were some pronounced outflows in all money market funds during the crisis, and is consistent with the idea that VNAV funds may exhibit some fragility too.

At the 25th quantile, the $\beta_3$ coefficient associated with the interaction *CNAV*Crisis* is negative and is statistically significant, suggesting that the crisis period had a larger impact on outflows for CNAV funds relative to VNAV funds. There is no such impact at the 75th quantile, and a smaller effect at the median for U.S. dollar denominated funds. Overall, this is consistent with the hypothesis that CNAV funds experienced more outflows than VNAV funds. During the crisis, risk-taking, as measured by *Return*, did not seem to have an additional impact on fund flows. Previous research has found that crisis flows are negatively related to this measure of portfolio risk in U.S. CNAV money market funds (e.g., McCabe, 2010). The lack of an effect of portfolio risk on crisis flows is due to the fact that the relation between crisis flows and portfolio risk is weaker in VNAV money market funds. That is, a higher level of portfolio risk in VNAV funds does not increase strategic complementarities to the same extent as in CNAV funds, since it does not increase the likelihood that the fund's shares are mis-valued relative to a fixed price.[26]

The U.S. Treasury provided a guarantee for U.S. domiciled funds, and other jurisdictions offered some support for their money market funds, which should have prevented outflows from CNAV funds. Given that there was still some market turbulence during the Treasury guarantee period, and other competing products that have state guarantees, VNAV funds likely experienced outflows and this is consistent with the negative coefficient on *Guarantee* in the U.S. dollar, 25th quantile regression. Essentially the *Guarantee* coefficient represents the change in flows we would expect for CNAV funds, if their change in flow behavior is similar to VNAV funds. When examining the level of net flows (at the 25th percentile) over this period, CNAV net flows were more negative than those in VNAV funds (the sum of the *CNAV*, *Guarantee*, and *CNAV*Guarantee* coefficients is more negative than the *Guarantee* coefficient). In a difference in difference analysis, it is not the level of flows that matters, it is about whether behavior in the treatment group (CNAV funds) changed relative to the behavior in the control group (VNAV funds) as a result of the experiment (Guarantee period). Despite more negative flows in CNAV funds during the *Guarantee*

[24] An alternative approach would be to test whether CNAV fund flows are different from VNAV fund flows in separate regressions partitioned on the periods (e.g., crisis vs. pre-crisis). This approach yields similar results. The advantage of the setup here is that the interaction term provides a direct test of whether CNAV flow behavior during the crisis is significantly different from CNAV flow behavior in the pre-crisis period.

[25] On October 14 2008, Luxembourg prime minister Jean-Claude Juncker pledged that "the Luxembourg Government together with the Luxembourg Central Bank would take all necessary steps to secure the liquidity of money market funds established under Luxembourg law. This can be done through the temporary provision of special liquidity for the benefit of such funds against the supply of eligible collateral to the Central Bank." (Mayer Brown, 2009).

[26] In the robustness section, the *Return*Crisis* coefficient is negative and statistically significant in the sample of U.S. dollar, U.S. domiciled funds, which are predominantly CNAV funds. This is consistent with the prior literature on U.S. CNAV funds.

**Table 3**
Quantile regressions of fund net flows on crisis period and fund risk measures by percentile.

| | US dollar-denominated funds | | | Euro-denominated funds | | |
|---|---|---|---|---|---|---|
| | 25th | Median | 75th | 25th | Median | 75th |
| CNAV | −0.005 | 0.000 | 0.004 | −0.006 | 0.001 | 0.008 |
| | (5.48)*** | (0.21) | (3.54)*** | (3.93)*** | (1.19) | (5.54)*** |
| Crisis | −0.005 | 0.000 | 0.002 | −0.001 | −0.000 | −0.001 |
| | (2.68)*** | (0.40) | (1.75)* | (2.57)** | (2.07)** | (4.45)*** |
| CNAV*Crisis | −0.005 | −0.002 | −0.002 | −0.007 | −0.009 | −0.005 |
| | (1.80)* | (2.00)** | (1.64) | (2.38)** | (2.25)** | (1.31) |
| Return | 0.065 | −0.000 | −0.019 | 0.007 | 0.005 | 0.010 |
| | (1.62) | (0.11) | (0.46) | (0.35) | (0.93) | (0.29) |
| Return*Crisis | 0.128 | 0.017 | −0.263 | 0.032 | 0.002 | −0.008 |
| | (0.52) | (0.13) | (1.11) | (0.84) | (0.13) | (0.14) |
| Guarantee Date | −0.001 | −0.000 | −0.002 | −0.000 | −0.000 | −0.001 |
| | (3.57)*** | (2.21)** | (3.75)*** | (3.57)*** | (4.45)*** | (7.58)*** |
| CNAV*Guarantee | 0.001 | −0.000 | −0.000 | 0.001 | −0.000 | 0.001 |
| | (2.57)** | (1.08) | (0.22) | (0.91) | (0.28) | (0.62) |
| US | 0.002 | −0.000 | −0.002 | | | |
| | (2.36)** | (1.03) | (1.74)* | | | |
| Post Guarantee | −0.001 | −0.000 | −0.002 | −0.001 | −0.001 | −0.002 |
| | (3.49)*** | (1.63) | (3.28)*** | (6.85)*** | (8.63)*** | (11.37)*** |
| CNAV*Post Guarantee | 0.001 | −0.000 | −0.000 | 0.000 | −0.001 | −0.001 |
| | (1.53) | (1.59) | (0.18) | (0.18) | (0.80) | (0.67) |
| MER | 0.004 | −0.000 | −0.005 | 0.002 | −0.000 | −0.003 |
| | (5.42)*** | (1.65)* | (4.49)*** | (5.84)*** | (4.24)*** | (8.94)*** |
| MER*Crisis | 0.014 | 0.005 | 0.003 | 0.001 | 0.000 | 0.000 |
| | (2.51)** | (1.71)* | (1.10) | (1.63) | (0.35) | (0.86) |
| Constant | −0.002 | 0.000 | 0.004 | −0.003 | 0.000 | 0.004 |
| | (7.34)*** | (1.15) | (9.12)*** | (18.62)*** | (0.30) | (19.37)*** |
| *N* | 229,245 | 229,245 | 229,245 | 440,075 | 440,075 | 440,075 |

This table displays the results of quantile regressions measured at the 25th, 50th, and 75th quantile for both U.S. dollar-denominated funds and Euro-denominated funds. The dependent variable in these quantile regressions is a fund's daily net inflows, as a proportion of fund assets. All other variables are described in Appendix A. Standard errors are measured using a clustered bootstrap with 200 replications. Absolute value of *t* statistics are in parentheses.

* Indicates statistical significance at the 10% threshold.
** Indicates statistical significance at the 5% threshold.
*** Indicates statistical significance at the 1% threshold.

period, the results suggest that the difference in flows between VNAV funds and CNAV funds shrunk during the Guarantee period (the *CNAV*Guarantee* coefficient is negative), suggesting that state support and guarantees benefited CNAV funds more than VNAV funds during this period (the difference in flows pre-crisis is equal to the *CNAV* coefficient). Finally, in the post-guarantee period, net flows were smaller or more negative than in the pre-crisis period, since there is a statistically significant, negative coefficient on the *Post Guarantee* variable at the 25th and 75th quantiles. During this period, there is no differential effect of fund type (CNAV vs. VNAV) on net flows, since the coefficient on the *CNAV*Post Guarantee* interaction term is not statistically significant in any specification.

Funds with more investor risk – those with lower MERs and higher flow volatility – had more negative flows in the crisis and non-crisis periods (Table 4). In the non-crisis period, funds with higher MERs had more muted flows: at the 25th percentile net flows were less negative in higher MER funds. Also, consistent with prior studies, funds with higher expense ratios had a smaller decrease in net flows during the crisis: the coefficient on *MER*Crisis* is positive and statistically significant. A one standard deviation increase in MER (0.35) is associated with a decrease in daily crisis outflows (at the 25th quantile) in the U.S. of 0.3% (0.009 * 0.35). The results are similar, but of opposite sign, when *Flow Volatility* is used in place of *MER* as a measure of investor risk. These measures of investor risk are expected to be of opposite sign since they are negatively related (Table 2). Funds with a higher flow volatility experienced larger outflows (more negative net inflows) during the crisis. Similarly, Schmidt et al. (2015) also find that flow volatility increases both left tail and right tail flows in the crisis period and interpret this as evidence of "hot money".

In the pre-crisis period, the effect of *CNAV* on fund flows is weaker when *Flow Volatility* is used as a measure of investor risk (the coefficient on *CNAV* is less negative). The coefficient on *CNAV* captures any differences between the funds during normal (non-crisis) times that are not accounted for by any other variable in the regression. Since CNAV funds have more investor risk than VNAV funds, evidenced by higher flow volatility and lower MERs than VNAV funds (Table 2), we should expect the inclusion of either of these variables to reduce the coefficient on CNAV. The inclusion of *Flow Volatility* reduces the coefficient on CNAV more and indicates that there is less of a difference between CNAV and VNAV funds in normal times after controlling for differences in *Flow Volatility*.[27]

Hypothesis 1 is concerned with whether net flows for CNAV funds became more negative than expected, i.e., relative to the effect on VNAV funds. The coefficient on *CNAV*, plus the coefficient on *Crisis*, measures the baseline expected flows during the crisis of CNAV funds, if they maintained their pre-crisis flows relative to VNAV funds. The fact that the *CNAV* coefficient is smaller just means that the baseline expected flows are different. The effect of interest is whether flows are different relative to this baseline, indicated by the *CNAV*Crisis* interaction coefficient. During the crisis, the change in flows in CNAV funds was larger than those in VNAV funds even after controlling for two measures of investor risk: MERs and flow volatility. CNAV funds still experienced a larger drop in flows during the crisis when using either measure of investor risk, as indicated by the negative, statistically significant coefficient on the *CNAV*Crisis* interaction term. In both U.S. dollar-denominated and Euro-denominated funds, there is a negative effect of the crisis on VNAV fund flows.

[27] Some of this is also mechanical. The 25th quantile regression measures the tail of the flow distribution, which should be lower when the standard deviation of flows is larger. Since *Flow Volatility* is measured during the pre-crisis period, this will have an impact on the *CNAV* coefficient.

**Table 4**
Quantile regressions at the 25th percentile – robustness to investor risk aversion measures.

| | US dollar-denominated funds | | Euro-denominated funds | |
|---|---|---|---|---|
| CNAV | −0.005 | −0.002 | −0.006 | −0.001 |
| | (5.48)*** | (5.87)*** | (3.93)*** | (0.93) |
| Crisis | −0.005 | −0.006 | −0.001 | −0.001 |
| | (2.68)*** | (4.29)*** | (2.57)** | (2.43)** |
| CNAV*Crisis | −0.005 | −0.003 | −0.007 | −0.007 |
| | (1.80)* | (2.17)** | (2.38)** | (1.81)* |
| Return | 0.065 | 0.020 | 0.007 | 0.010 |
| | (1.62) | (1.12) | (0.35) | (0.69) |
| Return*Crisis | 0.128 | −0.020 | 0.032 | 0.013 |
| | (0.52) | (0.11) | (0.84) | (0.44) |
| Guarantee Date | −0.001 | −0.001 | −0.000 | −0.000 |
| | (3.57)*** | (2.69)*** | (3.57)*** | (3.78)*** |
| CNAV*Guarantee | 0.001 | 0.000 | 0.001 | 0.001 |
| | (2.57)** | (0.99) | (0.91) | (0.93) |
| US | 0.002 | 0.001 | | |
| | (2.36)** | (3.07)*** | | |
| Post Guarantee | −0.001 | −0.000 | −0.001 | −0.001 |
| | (3.49)*** | (2.00)** | (6.85)*** | (7.83)*** |
| CNAV*Post Guarantee | 0.001 | −0.000 | 0.000 | 0.000 |
| | (1.53) | (0.01) | (0.18) | (0.17) |
| MER | 0.004 | | 0.002 | |
| | (5.42)*** | | (5.84)*** | |
| MER*Crisis | 0.014 | | 0.001 | |
| | (2.51)** | | (1.63) | |
| Flow volatility | | −0.392 | | −0.313 |
| | | (18.21)*** | | (16.35)*** |
| Flow Volatility*Crisis | | −0.632 | | −0.100 |
| | | (4.56)*** | | (1.66)* |
| Constant | −0.002 | −0.004 | −0.003 | −0.004 |
| | (7.34)*** | (15.33)*** | (18.62)*** | (26.59)*** |
| *N* | 229,245 | 229,245 | 440,075 | 439,906 |

This table displays the results of quantile regressions measured at the 25th quantile for both U.S. dollar-denominated funds and Euro-denominated funds. The dependent variable in these quantile regressions is a fund's daily net inflows, as a proportion of fund assets. All other variables are described in Appendix A. Standard errors are measured using a clustered bootstrap with 200 replications. Absolute value of *t* statistics are in parentheses.
* Indicates statistical significance at the 10% threshold.
** Indicates statistical significance at the 5% threshold.
*** Indicates statistical significance at the 1% threshold.

### 5.2. Fund flows, fund share price structure, and sponsor financial condition

If there is an implicit guarantee in CNAV money market mutual funds then, according to *Hypothesis 2*, a CNAV fund should experience more sustained outflows following poor performance if there is a lower level of fund sponsor support. I use *Fund Business* – the proportion of the fund sponsor's mutual fund assets under management that are not in money market mutual funds as at August 2008-as a measure of the likelihood of sponsor support. A fund sponsor's presence in other lines of business may have an impact on the likelihood of providing sponsor support since a negative event may have an impact on the fund sponsor's reputation and impact their other lines of business. Kacperczyk and Schnabl (2013) show, for example, that funds with a greater *Fund Business* were more likely to change its fund name to mimic its sponsor name between October 1, 2009 and September 30, 2011. They suggest that funds change names to "signal to their investors the potential safety of their operations". I interact *Fund Business* with the crisis variables in the quantile regressions. Given the results in the previous section, I estimate the following regression at the 25th quantile:

$$\begin{aligned} Netflow_{it} = {} & \beta_1 CNAV + \beta_2 Crisis + \beta_3 CNAV * Crisis + \beta_4 Return \\ & + \beta_5 Return * Crisis + \beta_6 Guarantee + \beta_7 CNAV \\ & * Guarantee + \beta_8 US + \beta_9 Post\text{-}Guarantee + \beta_{10} CNAV \\ & * Post\text{-}Guarantee + \beta_{11} MER + \beta_{12} MER * Crisis \\ & + \beta_{13} Fund\ Business + \beta_{14} Fund\ Business * Crisis \\ & + \beta_{15} CNAV * Fund\ Business + \beta_{16} CNAV * Fund\ Business \\ & * Crisis + \varepsilon_{it} \end{aligned} \quad (2)$$

In regression (2) the coefficient of interest is the $\beta_{16}$ coefficient on the triple interaction variable, *CNAV*Fund Business*Crisis*. If CNAV fund redemptions are related to sponsor strength, whereas VNAV fund redemptions are not, the coefficient on this interaction variable should be negative. For U.S. dollar-denominated funds, the coefficient on this triple interaction term is positive and statistically significant (Table 5). The coefficient value of 0.026 means that a CNAV fund with a sponsor who's entire business was in non-money market funds would have a 25th quantile of daily outflows that is 2.6% higher than a CNAV fund with a sponsor who had no non-money market fund business. This effect can be illustrated by examining the combined crisis flows for CNAV and VNAV funds with different levels of *Fund Business*. For example, the 25th quantile of daily crisis flows for a VNAV fund with a mean level of *Fund Business* was −0.005,[28] whereas by increasing *Fund Business* by one standard deviation these flows would become -0.0087.[29] On the other hand, the 25th quantile of daily crisis flows for a CNAV fund with a mean level of *Fund Business* was −0.015, whereas by increasing *Fund Business* by one standard deviation these flows would become −0.0094. Thus, the difference between CNAV and VNAV daily crisis flows shrinks as *Fund Business* increases, which provides some support to Hypothesis 2. However, even in these funds with more potential for spillovers and incentives to provide support, CNAV crisis fund flows are still worse than VNAV crisis fund flows.

[28] *Constant* coefficient (−0.002) plus *Crisis* coefficient (−0.003).
[29] −0.005 plus one standard deviation (0.31) times (*Fund Business* Coefficient (−0.001) + Fund Business*Crisis coefficient (−0.011)).

**Table 5**
Quantile regressions at the 25th percentile – fund sponsor strength.

| | US dollar-denominated funds | | | Euro-denominated funds | | |
|---|---|---|---|---|---|---|
| | All | Standalone | Conglo-merate | All | Standalone | Conglo-merate |
| CNAV | −0.005 | −0.004 | −0.005 | −0.004 | −0.007 | −0.004 |
| | (5.44)*** | (1.77)* | (4.97)*** | (2.82)*** | (0.51) | (1.04) |
| Crisis | −0.003 | 0.004 | −0.003 | −0.001 | −0.003 | −0.001 |
| | (2.00)** | (0.96) | (1.49) | (2.13)** | (1.34) | (1.78)* |
| CNAV*Crisis | −0.005 | −0.014 | −0.005 | −0.008 | −0.012 | −0.012 |
| | (2.80)*** | (2.99)*** | (1.80)* | (1.86)* | (1.22) | (1.01) |
| Return | 0.059 | 0.001 | 0.080 | 0.010 | 0.012 | 0.011 |
| | (1.35) | (0.01) | (1.63) | (0.51) | (0.16) | (0.60) |
| Return*Crisis | 0.038 | 0.387 | −0.158 | 0.035 | −0.314 | 0.035 |
| | (0.17) | (0.95) | (0.65) | (0.93) | (1.37) | (0.86) |
| Guarantee Date | −0.001 | −0.000 | −0.001 | −0.000 | −0.000 | −0.000 |
| | (3.22)*** | (0.38) | (5.48)*** | (2.57)** | (1.99)** | (1.87)* |
| CNAV*Guarantee | 0.001 | 0.000 | 0.001 | 0.000 | −0.001 | 0.001 |
| | (1.78)* | (0.14) | (2.63)*** | (0.53) | (1.14) | (1.00) |
| US | 0.002 | 0.001 | 0.002 | | | |
| | (2.38)** | (0.41) | (1.70)* | | | |
| Post Guarantee | −0.001 | −0.000 | −0.001 | −0.001 | −0.001 | −0.000 |
| | (2.26)** | (0.09) | (2.53)** | (4.70)*** | (4.36)*** | (3.97)*** |
| CNAV*Post Guarantee | 0.001 | −0.000 | 0.001 | −0.000 | 0.003 | −0.002 |
| | (0.92) | (0.03) | (1.03) | (0.12) | (0.94) | (1.84)* |
| MER | 0.004 | 0.005 | 0.004 | 0.002 | −0.002 | 0.002 |
| | (4.45)*** | (3.18)*** | (3.23)*** | (5.16)*** | (1.34) | (6.66)*** |
| MER*Crisis | 0.011 | 0.011 | 0.009 | 0.001 | −0.000 | 0.001 |
| | (2.54)** | (1.67)* | (1.63) | (1.19) | (0.22) | (1.09) |
| Fund Business | −0.001 | −0.005 | 0.000 | 0.004 | 0.003 | 0.003 |
| | (0.40) | (1.07) | (0.19) | (6.93)*** | (1.56) | (7.25)*** |
| Fund Business*Crisis | −0.011 | −0.020 | −0.012 | −0.000 | 0.008 | −0.000 |
| | (1.89)* | (0.94) | (1.61) | (0.29) | (1.25) | (0.42) |
| CNAV*Fund Business | 0.004 | 0.010 | 0.003 | 0.003 | 0.003 | 0.005 |
| | (2.52)** | (2.03)** | (1.57) | (0.45) | (0.09) | (0.39) |
| CNAV*Fund Business*Crisis | 0.026 | 0.042 | 0.026 | −0.005 | −0.015 | 0.004 |
| | (4.12)*** | (1.92)* | (2.97)*** | (0.37) | (0.75) | (0.10) |
| Constant | −0.002 | −0.003 | −0.002 | −0.003 | −0.002 | −0.003 |
| | (5.80)*** | (2.42)** | (5.03)*** | (18.82)*** | (4.17)*** | (20.25)*** |
| *N* | 216,089 | 76,442 | 139,647 | 429,408 | 58,276 | 371,132 |

This table displays the results of quantile regressions measured at the 25th quantile. The dependent variable in these quantile regressions is a fund's daily net inflows, as a proportion of fund assets. Standard errors are measured using a clustered bootstrap with 200 replications. Absolute value of *t* statistics are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% thresholds respectively.

To investigate the effect of sponsor support in more detail, I examine whether this relation between *Fund Business* and crisis flows is stronger in funds whose sponsors are part of a financial conglomerate (e.g., banking or insurance group). Funds with more potential for spillovers in this group not only have the incentives, but also have the resources to provide support, relative to standalone mutual fund groups. Kacperczyk and Schnabl (2013) perform a similar test. For standalone U.S. dollar funds, the effect of the crisis on CNAV fund flows are stronger relative to funds with sponsors that are in a conglomerate, as evidenced by the more negative *CNAV*Crisis* coefficient. This effect, however, is driven by differences in the crisis flows between standalone and conglomerate VNAV funds. In the standalone sample, the *Crisis* coefficient (which measures the effect on VNAV funds) is 0.004, whereas it is -0.003 in conglomerate funds. Neither of these coefficients is statistically significant but they do have an impact on the *Crisis*CNAV* such that this coefficient is driven by differences in VNAV funds between the two groups, not the difference between CNAV funds.

Presumably, the impact of the guarantee should be stronger for those funds that do not have a sponsor behind them, but this is not the case in U.S. dollar funds. The *CNAV*Guarantee* coefficient is positive and statistically significant in the conglomerate group, and not statistically significant in the standalone group. Therefore, this is contrary to Hypothesis 2, which suggests that sponsor support is more important for CNAV funds. The only explanation for the stronger effect of the Treasury guarantee in conglomerate funds is that many of these conglomerates were under stress themselves, and investors were exiting some funds sponsored by these sponsors. For example, Gordon and Gandia (2014) show that funds with investment banking sponsors experienced more outflows during the crisis.

While the spillover effect on CNAV crisis redemptions should be stronger in conglomerate-sponsored funds (those that have the ability to support a poorly performing fund), the effect is actually stronger in standalone funds. The *CNAV*Crisis*Fund Business* coefficient is more negative in the sample of funds managed by standalone sponsors. This is inconsistent with Hypothesis 2. Overall, the results in this paper do not provide convincing support for the hypothesis that sponsor support matters more for CNAV funds than for VNAV funds.

### 5.3. Fund flow, fund share price structure and fund size

Previous studies have found a relation between fund size and redemptions from money market funds during the crisis in U.S. dollar-denominated CNAV funds (e.g., McCabe, 2010). Larger funds may attract more sophisticated institutional investors, potentially explaining why crisis redemptions are related to fund size even after controlling for investor risk using management expense ratios (McCabe, 2010). This paper has controlled for investor risk using *MER*s and *Flow Volatility*, but there may be some component of investor riskiness that fund size explains that these measures cannot explain. To address potential influence of fund size on redemptions, I repeat the analysis on subsamples based on fund size.

Consistent with earlier studies, larger U.S. dollar-denominated CNAV funds experienced a larger increase in redemptions

**Table 6**
Quantile regressions at the 25th percentile – by size quartile.

| | Q1 | Q2 | Q3 | Q4 |
|---|---|---|---|---|
| *Panel A: U.S. dollar-denominated funds* | | | | |
| CNAV | −0.005 | −0.003 | −0.006 | −0.005 |
| | (1.31) | (1.86)* | (2.87)*** | (2.47)** |
| Crisis | −0.001 | −0.004 | −0.002 | −0.001 |
| | (0.72) | (1.55) | (0.47) | (0.27) |
| CNAV*Crisis | −0.000 | −0.000 | −0.003 | −0.016 |
| | (0.03) | (0.11) | (0.67) | (3.42)*** |
| Return | 0.057 | 0.118 | −0.007 | 0.023 |
| | (1.00) | (1.07) | (0.06) | (0.22) |
| Return*Crisis | 0.419 | 0.048 | 0.226 | −0.912 |
| | (1.87)* | (0.10) | (0.43) | (0.81) |
| Guarantee Date | −0.001 | −0.002 | −0.002 | −0.000 |
| | (3.37)*** | (5.78)*** | (1.76)* | (0.45) |
| CNAV*Guarantee | 0.003 | 0.001 | 0.002 | −0.000 |
| | (2.58)*** | (0.66) | (1.92)* | (0.46) |
| US | 0.001 | 0.001 | 0.002 | 0.002 |
| | (0.25) | (1.07) | (0.96) | (1.58) |
| Post Guarantee | −0.000 | −0.001 | −0.002 | −0.001 |
| | (1.00) | (3.43)*** | (1.58) | (1.93)* |
| CNAV*Post Guarantee | 0.001 | −0.000 | 0.003 | −0.000 |
| | (1.20) | (0.07) | (1.81)* | (0.15) |
| MER | 0.001 | 0.005 | 0.008 | 0.008 |
| | (0.90) | (2.89)*** | (6.51)*** | (8.86)*** |
| MER*Crisis | −0.002 | 0.012 | 0.007 | 0.018 |
| | (0.44) | (1.81)* | (0.79) | (3.24)*** |
| Constant | −0.001 | −0.003 | −0.002 | −0.003 |
| | (3.81)*** | (5.81)*** | (3.19)*** | (1.94)* |
| *N* | 51,349 | 58,218 | 60,687 | 58,991 |
| *Panel B: Euro-denominated funds* | | | | |
| CNAV | −0.003 | 0.002 | −0.006 | −0.005 |
| | (6.97)*** | (4.20)*** | (1.94)* | (2.17)** |
| Crisis | −0.001 | −0.000 | −0.001 | −0.002 |
| | (0.70) | (0.52) | (1.81)* | (2.19)** |
| CNAV*Crisis | 0.008 | −0.016 | −0.006 | −0.004 |
| | (6.13)*** | (15.35)*** | (0.50) | (0.47) |
| Return | −0.006 | 0.039 | −0.011 | 0.054 |
| | (0.26) | (1.71)* | (0.32) | (0.99) |
| Return*Crisis | 0.128 | 0.010 | 0.061 | 0.114 |
| | (1.47) | (0.15) | (0.49) | (0.41) |
| Guarantee Date | −0.001 | −0.000 | −0.000 | −0.000 |
| | (1.90)* | (0.94) | (2.16)** | (0.46) |
| CNAV*Guarantee | −0.000 | −0.003 | −0.000 | 0.001 |
| | (0.09) | (1.57) | (0.07) | (0.50) |
| Post Guarantee | −0.001 | −0.000 | −0.001 | −0.001 |
| | (2.23)** | (2.31)** | (2.97)*** | (4.16)*** |
| CNAV*Post Guarantee | 0.003 | 0.001 | −0.004 | −0.000 |
| | (2.57)** | (0.25) | (0.84) | (0.17) |
| MER | −0.000 | 0.001 | 0.002 | 0.005 |
| | (0.42) | (1.64) | (4.51)*** | (8.03)*** |
| MER*Crisis | 0.001 | −0.000 | 0.002 | 0.003 |
| | (0.93) | (0.18) | (1.49) | (1.28) |
| Constant | −0.002 | −0.003 | −0.003 | −0.003 |
| | (5.75)*** | (11.49)*** | (10.27)*** | (12.84)*** |
| *N* | 100,851 | 111,135 | 111,546 | 116,543 |

This table displays the results of quantile regressions measured at the 25th quantile. Panel A displays the results for U.S. dollar-denominated funds, and each column represents a subsample of funds based on size quartile Q1 contains the smallest funds and Q4 contains the largest funds. Panel B presents the results for Euro-denominated funds. The dependent variable in these quantile regressions is a fund's daily net inflows, as a proportion of fund assets. All other variables are described in Appendix A. Standard errors are measured using a clustered bootstrap with 200 replications. Absolute value of $t$ statistics are in parentheses.

* Indicates statistical significance at the 10% threshold.
** Indicates statistical significance at the 5% threshold.
*** Indicates statistical significance at the 1% threshold.

(i.e., more negative net flows) than smaller CNAV funds during the crisis. In Table 6, Panel A, the sum of the coefficients on *Crisis* and *Crisis*CNAV* are larger in the larger size quartiles (e.g., Q4). In the smaller size quintiles, the crisis effect is indistinguishable from zero. Even the level of redemptions – adding in the *CNAV* coefficient – was greater in the larger CNAV fund quartiles. Supporting the view that investor risk is more important in the larger size quintiles, the coefficient on the interaction term, *MER*Crisis*, is statistically significant and is of a greater magnitude in the larger quartiles.

In Euro-denominated CNAV funds investigated here, the same relation does not hold (Panel B). While the three largest quartiles all exhibited similar flows during the crisis, crisis net flows are most negative in the second smallest size quartile, Q2 (the sum of the coefficients on *Crisis* and *Crisis*CNAV* are most negative in this size quartile). Previous research has suggested that the relation between fund size and crisis flows could be due to larger funds having more sophisticated investors or more portfolio risk (McCabe, 2010), or because they have larger investors that are more "hot money" (Schmidt et al., 2015). Apparently this relation is not robust in my sample of Euro-denominated mutual funds. Several smaller European money market funds suspended redemptions in 2007 (Bengtsson, 2013) so investors in smaller funds may have been more aware of the risk of runs in the U.S. than their counterparts in the United States, which may explain why CNAV funds in quartile Q2 also experienced larger outflows during the crisis. However, in the smallest quartile, CNAV funds received positive net inflows during the crisis week (although they did start redeeming the following week). This could be due to small investors being less sophisticated, with less information on stress in money market funds in a different continent and taking a longer time to incorporate this information into their decision-making.

Nonetheless, Hypothesis 1 is not a test of whether larger funds had more negative net flows during the crisis; it is a test of whether CNAV funds had more negative net flows than VNAV funds during the crisis period. The subsample analysis by size quartile is meant to control for any influence that size might have on crisis flows. The test of Hypothesis 1 is whether VNAV funds experienced as much stress as in CNAV funds. In several size quartiles where CNAV fund crisis redemptions were larger, CNAV fund crisis redemptions were larger than those in VNAV funds. The results suggest that while some differences persist between CNAV and VNAV funds, a portion of this difference is due to differences in fund size across the two types of funds.

## 6. Robustness tests

The analysis thus far has pooled funds in various countries into a single regression framework. However, there could be institutional differences across countries that may influence the results if, for example, CNAV funds happened to be domiciled in a country whose institutional framework makes its funds more susceptible to runs (i.e., potentially differences in disclosure requirements, fund portfolios, etc.).[30] Similarly, since the U.S. dollar sample is dominated by funds domiciled in the United States that may lead to results that reflect the difference between U.S.-domiciled funds and non-U.S. domiciled funds. However, this is likely to bias against finding a difference between CNAV and VNAV funds, since constraints on CNAV funds are stricter than in other countries (See Section 2 for a discussion of the institutional environment in Europe and the U.S.). To address these concerns, Table 7 also runs the analysis at a country level for those countries that have both CNAV and VNAV

[30] Despite some potential differences in the institutional framework across countries, in the aggregate European money market funds appear to have had Eurozone portfolio holdings similar to prime U.S. money market funds. Just prior to the crisis, European money market funds had significant exposures to Euro-area financial institutions: according to the European Central Bank, at the end of 2007, 35% of aggregate Euro-area money market fund assets were invested in Euro-area Monetary Financial Institutions (https://stats.ecb.europa.eu/stats/download/bsi_mmf/bsi_mmf/bsi_mmf_u2.pdf). In the U.S., the largest prime money market funds held about 30% of their assets in Euro-area banks and almost 50% of their assets in European banks (International Monetary Fund, 2011).

**Table 7**
Robustness of results in individual countries.

| | US Dollar | | | | Euro | |
|---|---|---|---|---|---|---|
| | Non-US | US | Luxembourg | Ireland | Luxembourg | Ireland |
| CNAV | −0.006 | −0.003 | −0.004 | −0.006 | −0.008 | −0.005 |
| | (6.34)*** | (2.76)*** | (2.88)*** | (1.26) | (10.14)*** | (1.04) |
| Crisis | −0.001 | −0.008 | −0.002 | −0.009 | −0.000 | 0.001 |
| | (0.86) | (2.16)** | (0.63) | (0.29) | (0.08) | (0.34) |
| CNAV*Crisis | −0.031 | −0.000 | −0.018 | −0.038 | −0.015 | −0.011 |
| | (6.97)*** | (0.14) | (1.75)* | (1.63) | (9.09)*** | (1.47) |
| Return | 0.003 | 0.134 | 0.016 | 0.016 | −0.074 | 0.024 |
| | (0.09) | (1.53) | (0.38) | (0.15) | (1.19) | (0.24) |
| Return*Crisis | 0.372 | −0.817 | 0.328 | 0.349 | 0.151 | −0.077 |
| | (2.07)** | (1.83)* | (1.40) | (0.44) | (1.34) | (0.34) |
| Guarantee Date | −0.001 | −0.001 | −0.001 | −0.001 | −0.001 | −0.001 |
| | (4.99)*** | (2.64)*** | (4.91)*** | (0.80) | (2.24)** | (1.51) |
| CNAV*Guarantee | 0.000 | 0.001 | 0.003 | −0.001 | 0.004 | 0.001 |
| | (0.21) | (1.17) | (2.94)*** | (0.62) | (13.08)*** | (1.02) |
| Post Guarantee | −0.001 | 0.000 | −0.001 | −0.001 | −0.001 | −0.000 |
| | (2.49)** | (0.15) | (2.96)*** | (0.81) | (3.91)*** | (0.43) |
| CNAV*Post Guarantee | 0.000 | −0.000 | 0.002 | −0.001 | −0.003 | 0.000 |
| | (0.32) | (0.38) | (2.41)** | (0.48) | (10.07)*** | (0.18) |
| MER | 0.002 | 0.006 | 0.002 | 0.022 | 0.002 | 0.005 |
| | (2.12)** | (6.83)*** | (1.45) | (0.85) | (2.49)** | (0.57) |
| MER*Crisis | 0.001 | 0.018 | 0.001 | −0.058 | −0.003 | −0.006 |
| | (0.13) | (3.40)*** | (0.21) | (0.33) | (1.49) | (0.31) |
| Constant | −0.002 | −0.002 | −0.002 | 0.001 | −0.002 | −0.002 |
| | (4.87)*** | (2.28)** | (3.77)*** | (0.30) | (5.09)*** | (1.15) |
| Observations | 72,916 | 156,329 | 48,862 | 13,710 | 62,901 | 14,582 |

This table displays the results of quantile regressions measured at the 25th quantile, by country or region of the fund. The dependent variable in these panel fixed effect regressions is a fund's daily net inflows, as a proportion of fund assets. All other variables are described in Appendix A. Standard errors are clustered at the fund level. Absolute value of *t* statistics are in parentheses.
* Indicates statistical significance at the 10% threshold.
** Indicates statistical significance at the 5% threshold.
*** Indicates statistical significance at the 1% threshold.

**Table 8**
Within fund quantile regressions by share class.

| | 25th | Median | 75th |
|---|---|---|---|
| CNAV | −0.008 | 0.000 | 0.008 |
| | (5.78)*** | (0.00) | (5.68)*** |
| Crisis | −0.004 | −0.000 | −0.002 |
| | (2.35)** | (0.53) | (2.08)** |
| CNAV*Crisis | −0.007 | −0.003 | −0.001 |
| | (1.76)* | (1.81)* | (0.11) |
| Guarantee Date | −0.001 | −0.000 | −0.001 |
| | (1.31) | (0.10) | (2.01)** |
| CNAV*Guarantee | 0.000 | 0.000 | −0.000 |
| | (0.36) | (0.00) | (0.10) |
| US | −0.003 | −0.000 | 0.003 |
| | (1.62) | (3.15)*** | (1.72)* |
| Post Guarantee | −0.000 | 0.000 | −0.002 |
| | (0.33) | (0.00) | (3.02)*** |
| CNAV*Post Guarantee | 0.001 | 0.000 | −0.001 |
| | (0.58) | (0.00) | (0.58) |
| Euro | −0.001 | 0.000 | 0.002 |
| | (1.00) | (0.00) | (1.73)* |
| Constant | −0.002 | 0.000 | 0.002 |
| | (2.71)*** | (0.00) | (2.61)*** |
| *N* | 87,979 | 87,979 | 87,979 |

The analysis in this table is performed at the share class level. It examines only those share classes that are part of funds that have both a CNAV and a VNAV share class. This table displays the results of quantile regressions measured at the 25th, 50th, and 75th quantiles. The dependent variable in these quantile regressions is a share class's daily net inflows, as a proportion of share class assets. All other variables are described in Appendix A. Standard errors are measured using a clustered bootstrap with 200 replications. Absolute value of *t* statistics are in parentheses.
* Indicates statistical significance at the 10% threshold.
** Indicates statistical significance at the 5% threshold.
*** Indicates statistical significance at the 1% threshold.

funds. Since the sample size is much smaller at the country level and in several cases may only be comparing a handful of funds to each other, the results are not expected to be statistically significant in some cases. Nonetheless, the purpose of this exercise is to illustrate that the differences are not due to differences in flow behavior across countries. And, it is comforting that even in these smaller samples there are cases where CNAV crisis flows are statistically different from VNAV fund crisis flows.

In the first regression column in Table 7, the U.S. dollar regression is first re-run excluding funds domiciled in the United States. The results from the earlier regression are in fact stronger. CNAV funds experienced more outflows, especially in the period around the run on the Reserve Primary Fund. Thus, it is not institutional differences between U.S.-domiciled and non-U.S.-domiciled funds that are driving the difference between CNAV and VNAV funds during the crisis. Further, in all of the countries examined, the coefficient associated with the *CNAV*Crisis* interaction variable is negative. And, in U.S.-denominated and Euro-denominated Luxembourg funds, this coefficient is statistically significant. In the U.S., the coefficient is close to zero. One of the reasons the U.S. *CNAV*Crisis* coefficient is not as large as in other countries is the larger (and statistically significant) coefficients on *MER*Crisis* and *Return*Crisis* as compared to other countries. The effects of investor risk and shareholder risk on crisis flows in the U.S. is consistent with earlier studies that focus on the effect of the crisis on money market funds, mainly in the United States. U.S. domiciled funds that experienced higher returns prior to the crisis experienced more negative net flows during the crisis. However, the inclusion of these variables reduces the statistically significance of the *CNAV*Crisis* coefficient, partially because controlling for investor risk and sponsor risk attenuates the effect of CNAV funds on crisis outflows, and partially because the inclusion of these additional variables increases the standard error of the *CNAV*Crisis* variable.[31]

[31] When either of these variables is removed, the *CNAV*Crisis* coefficient in the U.S. is larger, but not statistically significant.

**Table 9**
Summary statistics on proportion of sustained outflows.

| | | Pre-Crisis January 1, 2006–September 14, 2008 | Crisis September 15, 2008–September 19, 2008 | Guarantee period September 20, 2008–September 18, 2009 | Post-Guarantee period September 19, 2009–December 31, 2011 |
|---|---|---|---|---|---|
| U.S. Dollar, U.S.-based | *VNAV* | 0.000 | 0.000 | 0.000 | 0.000 |
| | *CNAV* | 0.012 | 0.083 | 0.012 | 0.010 |
| U.S. Dollar, European-based | *VNAV* | 0.003 | 0.004 | 0.009 | 0.004 |
| | *CNAV* | 0.013 | 0.164 | 0.028 | 0.018 |
| Euro-denominated | *VNAV* | 0.006 | 0.005 | 0.006 | 0.007 |
| | *CNAV* | 0.013 | 0.045 | 0.017 | 0.020 |

This table reports the proportion of sustained outflows for both constant net asset value (CNAV) and variable net asset value (VNAV) non-government money market mutual funds in the United States and several European countries. The variable that this table measures is sustained outflows. A fund is considered to experience sustained outflows if it sustains net outflows of 1% (as a proportion of fund size) or larger for three consecutive trading days. The measures reported in the table represent the proportion of daily observations during each sub-period when a fund experienced sustained outflows.

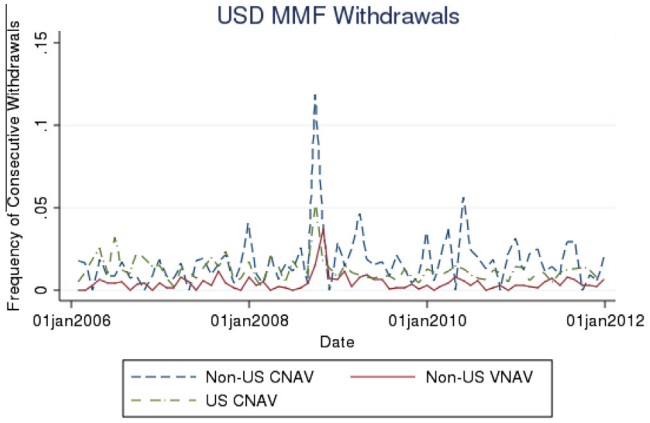


**Fig. 1a.** Withdrawals for U.S. dollar money market mutual funds. This figure displays withdrawal behavior for both constant net asset value (CNAV) and variable net asset value (VNAV) non-government money market mutual funds in both the United States and Europe. A money market mutual fund is defined as a CNAV fund if it maintains a fixed share price of $1, $10, €1, or €10. Otherwise, the fund is considered to be a VNAV fund. A fund is considered to experience consecutive withdrawals if it sustains withdrawals of 1% or larger for three consecutive trading days.

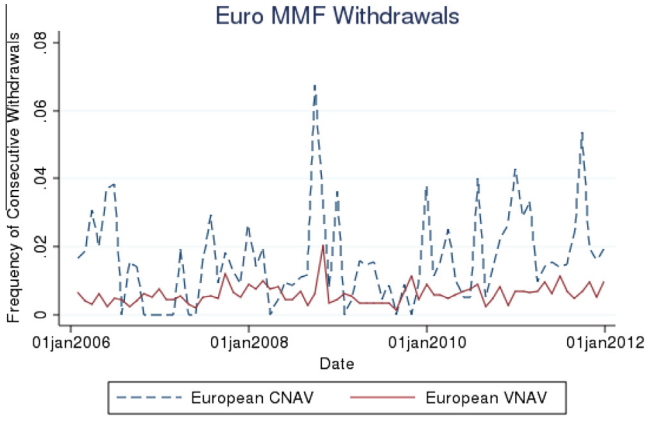


**Fig. 1b.** Withdrawals for Euro money market mutual funds. This figure displays withdrawal behavior for both constant net asset value (CNAV) and variable net asset value (VNAV) non-government money market mutual funds in Europe. A money market mutual fund is defined as a CNAV fund if it maintains a fixed share price of $1, $10, €1, or €10. Otherwise, the fund is considered to be a VNAV fund. A fund is considered to experience consecutive withdrawals if it sustains withdrawals of 1% or larger for three consecutive trading days.

In the U.S., there is no statistically significant difference between U.S. VNAV funds and U.S. CNAV funds during the guarantee period. This is surprising given that the guarantee was only extended to funds that "sought to maintain a stable $1.00 NAV" (FINRA, 2010). Nonetheless, the coefficient is positive, and the lack of statistical significance is likely due to it being a low power test, given only 3 U.S. VNAV funds in the sample (the same size effect was statistically significant in the larger, U.S. dollar sample in Table 3). In Luxembourg, there is a positive, statistically significant *CNAV*Guarantee* coefficient. This is consistent with the fact that Luxembourg money market funds also benefitted from the promise of government support during this period.

The results are also consistent with earlier results when controlling for institutional differences across countries at the share class level. Most funds have several share classes, and each share class has its own different features. Some share classes, for example, have higher minimum investments and lower expense ratios than other share classes within the same fund. Some funds offer both VNAV and CNAV share classes. I take advantage of this fact and restrict my sample to share classes that belong to funds that have at least one VNAV and one CNAV share class. By doing so, I can control for institutional, cross-country differences since share classes within the same fund must operate within the same institutional framework. As well, this approach also perfectly controls for portfolio risk, since the different share classes each have an equal claim to the same portfolio of assets. Table 8 presents results of 25th, 50th, and 75th quantile regressions at the share class level. Due to a smaller sample size, both Euro-denominated and U.S. dollar-denominated funds are analyzed within the same regression. Like earlier results, there is a negative, statistically significant coefficient on the *CNAV* variable at the 25th quantile, and a positive, statistically significant coefficient at the 75th quantile. The *Crisis* coefficient is also negative and statistically significant at the 25th quantile (and less so at the 75th quantile), showing that VNAV funds were also susceptible to run behavior in this period. Further, at the 25th quantile the coefficient on *CNAV*Crisis* is negative and statistically significant. This effect is smaller at the median and there is no such significance at the 75th quantile. This is consistent with *Hypothesis 1* and shows the results are robust when controlling for fund risk and institutional differences in this manner.

The main analysis in this paper examines daily fund flows. However, using flow behavior measured over a single day could be problematic for two reasons. First, institutions often deposit cash in money market mutual funds and withdraw this cash a day or a couple of days later (leading to negative autocorrelation in money market fund flows as discussed in Schmidt et al. (2015)). A measure at a daily frequency may incorrectly classify this type of flow as a run. Second, a large withdrawal from a fund

**Table 10**
Panel logit regressions describing outflow behavior.

| | US Dollar-denominated | Euro-denominated |
|---|---|---|
| Ln (Fund size) | 0.896 | 1.037 |
| | (1.30) | (0.34) |
| Crisis | 0.598 | 0.743 |
| | (0.48) | (0.74) |
| CNAV*Crisis | 11.403 | 4.486 |
| | (2.23)** | (1.86)* |
| Guarantee Date | 2.656 | 0.948 |
| | (3.84)*** | (0.37) |
| CNAV*Guarantee | 0.525 | 1.218 |
| | (2.22)** | (0.93) |
| Post Guarantee | 0.950 | 1.329 |
| | (0.20) | (2.67)*** |
| CNAV*Post Guarantee | 1.177 | 0.976 |
| | (0.55) | (0.12) |
| LIBOR-OIS Δ | 5.389 | 4.607 |
| | (5.65)*** | (2.63)*** |
| Observations | 150,908 | 243,824 |
| Number of funds | 191 | 292 |

The dependent variable in these panel logit fixed effect regressions is a dummy variable that is equal to one whenever a fund sustains net outflows of 1% of fund assets or larger for three consecutive trading days. *CNAV* is a dummy variable that is equal to one if the fund maintains a fixed share price of $1, $10, €1, or €10. Otherwise, the dummy variable takes the value of zero. *Ln(Fund Size)* is the logarithm of the fund's assets under management, measured at a daily frequency. All other variables are described in Appendix A. Standard errors are clustered at the fund level. Absolute value of *z* statistics are in parentheses.

* Indicates statistical significance at the 10% threshold.
** Indicates statistical significance at the 5% threshold.
*** Indicates statistical significance at the 1% threshold.

at a daily frequency may be the result of a single client removing money from the fund, which also should not be classified as a run. To address this issue, I construct a measure of sustained outflows: I consider a fund to experience a sustained outflow if its outflows are greater than 1% of its net assets over a consecutive 3-day period.

Table 9 and Fig. 1a display the frequency of these sustained outflows for U.S. dollar CNAV mutual funds domiciled in the United States as well as for European VNAV and CNAV U.S. dollar-denominated mutual funds. Sustained outflows occur relatively infrequently, about 1% of the time for VNAV funds. Showing the appropriateness of this measure, the frequency of runs spiked during September 2008, when there was a run on money market mutual funds in the United States. Interestingly, non-U.S. domiciled CNAV mutual funds experienced a similar pattern, with an even larger increase in sustained outflows in September 2008. The VNAV mutual funds, on the other hand, showed a milder increase in sustained outflows during this period, and throughout pretty much the entire sample period. A similar relation is also evident in Euro denominated funds (Fig. 1b). These findings are consistent with the first hypothesis that CNAV mutual funds are more like to experience sustained outflow behavior. The following daily fixed effects panel logit regression is estimated to test this hypothesis:

$$\begin{aligned}\Pr[Outflow_{it}=1] = \Lambda(&\beta_1 Ln(FundSize) + \beta_2 Crisis + \beta_3 CNAV * Crisis \\ &+ \beta_4 Guarantee + \beta_5 CNAV * Guarantee \\ &+ \beta_6 Post\text{-}Guarantee + \beta_7 CNAV * Post\text{-}Guarantee \\ &+ \beta_8 \Delta LIBOR - OIS + v_i + \varepsilon_{it}) \end{aligned} \quad (3)$$

In this regression, the dependent variable is the measure of sustained outflows: it takes the value of 1 when a fund has experienced three consecutive days of outflows greater than 1% of assets under management. At all other times, it is set equal to zero. Λ(.) is the logistic cumulative distribution function. The model includes standard errors that are clustered at the fund level. Given that this regression is measuring sustained outflows, rather than net flows as in previous regressions, the coefficients in this regression should be of the opposite sign compared to the earlier analysis.[32]

The results from this regression are presented in Table 10. For both U.S. dollar and Euro funds, the odds ratio $\beta_3$ coefficient associated with the interaction *CNAV*Crisis* is greater than one and is statistically significant, suggesting that the crisis period had a larger impact on the incidence of sustained outflows for CNAV funds relative to VNAV funds.[33] During the period of the Treasury guarantee, there was still a heightened level of sustained outflows for U.S. dollar VNAV funds, demonstrated by the statistically significant coefficient on Guarantee Date. This is consistent with the previous analysis. Moreover, for these funds there is a statistically significant, odds ratio coefficient on *CNAV*Guarantee* that is less than one, illustrating that the impact of the U.S. Treasury guarantee and other government support on halting outflows was more pronounced in U.S. dollar CNAV funds, relative to U.S. dollar VNAV funds. Finally, in the post-guarantee period, there is no differential effect of fund type (CNAV vs. VNAV) on the occurrence of sustained outflows, since the coefficient on the *CNAV*Post Guarantee* interaction term is not statistically significant.

## 7. Concluding remarks

There is an active push to reform money market mutual funds in the wake of the financial crisis and more specifically following the run on the Reserve Primary Fund and subsequent government support of money market funds in the United States. One of the primary proposals is to move away from the CNAV money market fund structure and towards the VNAV structure. Some observers have contended that such a move does little to reduce the occurrence of runs in money market mutual funds, based on anecdotal evidence of run behavior in ultrashort bond funds in the United States and enhanced money market funds in Europe, both of which maintain a VNAV structure (Investment Company Institute, 2012; HSBC, 2011). Similarly, Gordon and Gandia (2014) conclude that the distinction between stable CNAV funds and accumulating CNAV funds did not explain differences in crisis redemptions. However, the incentives to run amongst their accumulating and stable CNAV funds should be similar, since the only difference between the two is whether returns are distributed to shareholders (stable CNAV funds) or not (accumulating CNAV funds). In both cases, the price at which an investor can redeem the fund may not reflect the underlying value of the portfolio.

Rather than comparing two types of CNAV funds, this paper compares a sample of VNAV funds to stable CNAV funds and finds that, generally, the VNAV structure is less susceptible to run-like behavior relative to CNAV money market funds.[34] CNAV funds experienced more negative net flows during the week of the Lehman crisis, relative to VNAV mutual funds. Since U.S. dollar CNAV funds are predominantly in the United States, and VNAV funds are predominantly in Europe, institutional differences could have influenced the differential redemption behavior of these two types of funds during the crisis. Nonetheless, the difference between CNAV and VNAV funds still persists in non-U.S. domiciled funds and within Luxembourg and Ireland. CNAV funds are generally larger than

[32] Since this is a Fixed Effects regression, the *CNAV* variable (without interactions) is not included, since it is subsumed in the firm level fixed effects.

[33] Care should be taken when interpreting interaction effects in non-linear models (Ai and Norton, 2003). To avoid the problem of interpreting marginal effects of interaction terms, interaction effects will be interpreted as multiplicative effects in exponentiated form, i.e., as odds ratios (Buis, 2010).

[34] VNAV funds in my sample are defined as those that experience a price change so it may include some accumulating CNAV funds, in additional to pure VNAV funds.

VNAV funds, and some of the difference in crisis redemptions is driven by differences in fund size: in samples partitioned on fund size, differences between CNAV funds and VNAV funds persist in a handful of cases.

Previous literature has suggested that some CNAV funds benefit from an implicit guarantee provided by fund sponsors (e.g., McCabe, 2010). This implicit guarantee has both advantages and disadvantages. On the one hand, the presence of an implicit guarantee can reduce moral hazard and reduce risk-taking in money market mutual funds, since the fund sponsor would be concerned that the poor performance of the fund may have negative spillovers on the sponsor's other businesses (Kacperczyk and Schnabl, 2013). On the other hand, an implicit guarantee is a potential channel for contagion between the banking sector and money market mutual funds. This paper does not provide strong support for the hypothesis that the potential for sponsor support had a beneficial impact on crisis net flows for CNAV funds, vis-à-vis VNAV funds. Supporting this hypothesis, U.S. dollar CNAV funds with a larger non-money market fund business – those likely to provide support over concerns about spillovers to the rest of their business – experienced higher net flows (lower outflows), while this same relation did not exist in VNAV funds. However, this effect should be stronger in funds whose sponsors are part of a financial conglomerate, since they also have the means to provide support to their funds. This relation is in fact weaker in funds sponsored by a conglomerate entity. This is contrary to the idea that sponsor support motivated differences in redemption behavior between CNAV and VNAV funds.

Overall the results in this paper suggest that the VNAV structure is not a panacea: it will not fully eliminate run-like behavior. While CNAV funds experienced worse redemptions, VNAV funds also experienced redemptions in the week of the Lehman crisis. The extent to which the VNAV structure reduces runs may depend on how the VNAV price is calculated. Gordon and Gandia (2014) show that no difference exists between two types of funds that use amortized cost accounting. This paper finds that differences exist between CNAV funds (who use amortized cost accounting) and VNAV funds (who may not be using amortized cost accounting). Put together, these results suggest that, for the transition to a VNAV structure to be beneficial, the VNAV funds need to have a price that reflects the value of the underlying portfolio that is not based on amortized cost accounting.

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## Appendix A. Variable descriptions

| | |
|---|---|
| CNAV | A money market mutual fund is defined as a CNAV fund if it maintains a fixed share price of $1 or $10, or for the broad definition if it has never experienced a decline in its net asset value. Otherwise, the fund is considered to be a VNAV fund |
| Institutional | This dummy variable is set equal to 1 if the fund is a fund serving institutional investors. A fund is classified as institutional if its largest share class is classified as institutional according to Morningstar. This information is available for most, but not all funds. For those funds without a Morningstar Institutional classification, they are classified as institutional if the minimum required investment is greater than €100,000 or $100,000, depending on the fund's currency. As well, if the fund's largest share class is a class of type I, it is classified as institutional |
| Ln (fund size) | This is the logarithm of the fund's assets under management, measured at a daily frequency |
| Return | The annualized return of the fund over the period from July 2008 to August 2008. *Return* is demeaned, relative to its average within each currency of denomination |
| LIBOR-OIS change | This variable measures the three day change in the LIBOR-OIS spread (or EURIBOR-OIS spread for Euro-denominated funds) |
| Flow | This variable equals the net inflows to the money market fund, scaled by the fund size |
| Flow volatility | *Flow Volatility* is calculated as the standard deviation of daily flows in the July to August 2008 period. *Flow Volatility* is demeaned, relative to its average within each currency of denomination |
| MER | *MER* is the management expense ratio of the fund in 2008. *MER* is demeaned, relative to its average within each currency of denomination |
| Pre-Crisis | A dummy variable that is equal to one prior to September 15, 2008 |
| Crisis | A dummy variable that is equal to one from September 15, 2008 through September 19th, 2008, and zero otherwise |
| Guarantee | A dummy variable that is equal to one during the period from September 20th, 2008 through September 18th, 2009, and zero otherwise. This corresponds to the time when the U.S. Treasury provided a guarantee for U.S. money market mutual funds |
| Post Guarantee | A dummy variable that is equal to one during the period from September 20th, 2009 onwards, and zero otherwise |
| US | A dummy variable that is equal to one if the fund is domiciled in the United States |
| Standalone | A dummy variable that is equal to one if the fund sponsor is not part of a banking group or insurance group |
| Conglomerate | A dummy variable that is equal to one if the fund sponsor is part of a banking group or insurance group |
| Fund Business | Fund Business represents the proportion of the fund sponsor's mutual fund assets under management that are not in money market mutual funds as at August 2008. *Fund Business* is demeaned, relative to its average within each currency of denomination |

## References


Ai, C., Norton, E., 2003. Interaction terms in logit and probit models. Economics Letters 80, 123–129.

Angeletos, G.-M., Pavan, A., 2013. Selection-free predictions in global games with endogenous information and multiple equilibria. Theoretical Economics 8, 883–938.

Bengtsson, E., 2013. Shadow banking and financial stability: European money market funds in the global financial crisis. Journal of International Money and Finance 32, 579–594.

Buis, M., 2010. Stata tip 87: interpretations of interactions in non-linear models. The Stata Journal 10, 305–308.

Chalmers, J., Edelen, R., Kadlec, G., 2001. On the perils of financial intermediaries setting security prices: the mutual fund wild card option. Journal of Finance 56, 2209–2235.

Chen, Q., Goldstein, I., Jiang, W., 2010. Payoff complementarities and financial fragility: evidence from mutual fund outflows. Journal of Financial Economics 97, 239–262.

Chernenko, S., Sunderam, A., 2014. Frictions in shadow banking: evidence from the lending behavior of money market funds. Review of Financial Studies 27, 1717–1750.

Chevalier, J., Ellison, G., 1997. Risk taking by mutual funds as a response to incentives. Journal of Political Economy 105, 1167–1200.

Chordia, T., 1996. The structure of mutual fund charges. Journal of Financial Economics 41, 3–39.

Christoffersen, S., 2001. Why do money fund managers voluntarily waive their fees? Journal of Finance 56, 117–1140.

Christoffersen, S., Musto, D., 2002. Demand curves and the pricing of money management. Review of Financial Studies 15, 1499–1524.

Committee of European Securities Regulators, 2007. CESR's guidelines concerning eligible assets for investment by UCITS, CESR/07–044b.

Covitz, D., Downing, C., 2007. Liquidity or credit risk? The determinants of very short-term corporate yield spreads. Journal of Finance 62, 2308–2328.

Diamond, D.W., Dybvig, P.H., 1983. Bank runs, deposit insurance, and liquidity. Journal of Political Economy 91, 401–419.

Duygan-Bump, B., Parkinson, P., Rosengren, E., Suarez, G., Willen, S., 2013. How effective were the Federal Reserve emergency liquidity facilities? Evidence from the asset-backed commercial paper money market mutual fund liquidity facility. Journal of Finance 68, 715–737.

Echenique, F., Komunjer, I., 2009. Testing models with multiple equilibria by quantile methods. Econometrica 77, 1281–1297.

Edelen, R., 1999. Investor flows and the assessed performance of open-end mutual funds. Journal of Financial Economics 53, 439–466.

European Fund and Asset Management Association, 2011. International statistical release Q3 2011, supplementary table S4.

Financial Stability Board, 2011. Shadow banking: strengthening oversight and regulation, October.

FINRA, 2010. Treasury's Guarantee Program for Money Market Mutual Funds: What You Should Know, July.

Fisch, J., Roiter, E., 2012. A Floating NAV for Money Market Funds: Fix or Fantasy? Faculty scholarship paper 379

Goldstein, I., Jiang, H., Ng, D., 2015. Investor Flows and Fragility in Corporate Bond Funds Working paper.

Goldstein, I., Pauzner, A., 2005. Demand deposit contracts and the probability of bank runs. Journal of Finance 60, 1293–1328.

Gordon, J., Gandia, C.M., 2014. Money market funds run risk: Will floating net asset value fix the problem? Columbia Business Law Review 2014, 313–379.

Greene, J.T., Hodges, C.W., 2002. The dilution impact of daily fund flows on open-end mutual funds. Journal of Financial Economics 65, 131–159.

HSBC, 2011. Run Risk in Money Market Funds.

International Monetary Fund, 2011. Box 1.4: Why Do U.S. Money Market Funds Hold So Much European Bank Debt? Global financial stability report (September)

International Monetary Fund, 2015. The Asset Management Industry and Financial Stability? Global financial stability report (April) (Chapter 3)

Investment Company Institute, 2012. A Bad Idea: Forcing Money Market Funds to Float Their NAVs.

Jank, S., Wedow, M., 2015. Sturm und drang in money market funds: When money market funds cease to be narrow. Journal of Financial Stability 16, 59–70.

Kacperczyk, M., Schnabl, P., 2013. How safe are money market funds? Quarterly Journal of Economics 128, 1073–1122.

Koenker, R., Hallock, J.F., 2001. Quantile regression. Journal of Economic Perspectives 15, 143–156.

Lynch, A.W., Musto, D.K., 2003. How investors interpret past fund returns. Journal of Finance 58, 2033–2058.

Lyon, A.B., 1984. Money market funds and shareholder dilution. Journal of Finance 39, 1011–1020.

Mayer Brown, 2009. Summary of Government Interventions in Financial Markets – Luxembourg (September 8).

McCabe, P., 2010. The cross section of money market fund risks and financial crises. Finance and Economics Discussion Series 2010-51. Board of Governors of the Federal Reserve System.

Money Market Working Group, 2009. Report of the Money Market Working Group.

Musto, D.K., 1997. Portfolio disclosures and year-end price shifts. Journal of Finance 52, 1563–1588.

Musto, D.K., 1999. Investment decisions depend on portfolio disclosures. Journal of Finance 54, 935–950.

Nanda, V., Narayanan, M., Warther, V., 2000. Liquidity, investment ability, and mutual fund structure. Journal of Financial Economics 57, 417–443.

Parlatore, C., 2014. Fragility in Money Market Funds: Sponsor Support and Regulation Working paper.

Ramirez, S., Sierra Jimenez, J., Witmer, J., 2015. Canadian Open-End Mutual Funds: An Assessment of Potential Vulnerabilities Bank of Canada Financial System Review (June), pp. 47–55.

Schmidt, L., Timmerman, A., Wermers, R., 2015. Runs on Money Market Mutual Funds Working paper.

Shilling, H., 2010. Sponsor Support Key to Money Market Funds Moody's Investor Service Special Comment (August 9, 2010).

Sirri, E., Tufano, P., 1998. Costly search and mutual fund flows. Journal of Finance 53, 1589–1622.

Squam Lake Group, 2011. Reforming Money Market Funds Unpublished Working Paper.

Technical Committee of the International Organization of Securities Commissions, 2012. Money Market Fund Systemic Risk Analysis and Reform Options Consultation report CR07/12.

Zitzewitz, E., 2003. Who cares about shareholders? Arbitrage-proofing mutual funds. Journal of Law, Economics and Organization 19, 245–279.