The Impact of Regulation on Money Market Funds

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Declaration of Original Authorship

I confirm that this is my work and the use of all material from other sources has been properly and fully acknowledged.

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Abstract

This dissertation comprises three empirical studies that aim to investigate the role of financial regulation in curtailing the systemic risk posed by shadow banks. The focus of this work is on money market funds (MMFs), a type of shadow bank.

In the first empirical study, we examine prime MMFs after the introduction of the minimum liquidity requirements mandated in the 2010 Amendments to rule 2a-7 of the US Investment Company Act of 1940. We show that liquidity requirements have considerably increased the resilience of prime funds. We also show that funds increase their liquidity to meet expected redemptions. But liquidity does not shelter risky funds from lower inflows in a crisis.

In the second empirical study, we assess the response of MMFs and their investors to the 2016 Amendments to rule 2a-7. We show that following the segregation of retail and institutional prime MMFs required by the new rules, these funds have become different in their liquidity positions, maturity structure, competitiveness and risk management. Institutional prime MMFs maintain higher liquidity and tend to increase their liquidity actively as they increase the credit risk of their portfolios. On the contrary, retail prime MMFs have become more relaxed in their liquidity management, possibly because of lower market discipline that was previously enforced by the presence of institutional investors in their shareholder mix.

In the third study, we look at the changes in MMFs after the introduction of floating net asset value (NAV) requirements as mandated by the 2016 Amendments. We show that the floating NAV is seen by institutional investors as a new indicator of

performance that they utilize to make investment decisions. Institutional investors prefer funds that maintain higher NAV in order to benefit from capital gains. Furthermore, we observe that to increase NAV, funds tend to keep liquidity low, invest in longer maturity, higher risk securities. So, to boost NAV a fund must take on more risk, which could lead to amplification of risk during crisis periods.

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Chapter 1 Introduction

The global financial crisis has exposed the hidden fragilities of shadow banks which are known to have played a major role in aggravating the crisis. Once considered a safe-haven, money market funds (MMFs) came under increased regulatory scrutiny after September 2008 when the Reserve Primary Fund's net asset value (NAV) fell below $1.00 per share after the default of Lehman Brothers. This led to industry wide runs due to fears that other MMFs with similar portfolios might also "break the buck"[1]. Prime MMFs were particularly affected due to their higher risk investments in corporate debt instruments. The sizeable outflows from prime MMFs caused short-term funding markets to shrink considerably resulting in a credit crunch. In response, the US Treasury stepped in to guarantee investments in MMFs. Later, further support was provided by the Federal Reserve to stabilize the MMFs (Fed Board 2009; SEC 2009; PWG 2010). This led Securities and Exchange Commission (SEC) to make amendments in rule 2a-7 that governs MMFs which became effective in May 2010. The 2010 Amendments aimed to mitigate credit, liquidity and interest rate risk to improve the resilience of MMFs. It required them to increase liquidity, decrease average portfolio maturity, and understand the behaviour of their investors and adjust liquidity accordingly. In addition, the amendments increased the transparency of MMFs by mandating them to report detailed portfolio holdings each month.

[1] "Breaking the buck" occurs when the net asset value of a money market fund falls below $1.

Soon after, as the sovereign debt crisis worsened, MMFs that held securities of Eurozone banks came under increased redemption pressure which eventually led to $162 billion of outflows from June to August 2011. The substantial outflows risked straining money markets (FSOC 2011). These redemptions led to reduced lending to creditworthy non-European issuers (Chernenko and Sunderam 2014) and non-financial US firms (McCabe et al. 2013), hence adversely affecting the economy. These events raised doubts on the efficacy of the reforms (Rosengren 2012). This motivated a second wave of reforms which became effective in October 2016. The new rules imposed additional restrictions on liquidity and portfolio concentration, and improved reporting requirements. In addition, the amendments separated non-government institutional MMFs, which serve a more volatile shareholders base, from more stable non-government retail MMFs and required the former to float their NAV. This has resulted in a complete structural change in the money market fund industry.

Little research has focused on whether these reforms have achieved their intended outcome. This dissertation aims to study the impact of the reforms on risk-taking, resilience and portfolio composition of MMFs and the response of fund shareholders to the new rules. We collate a unique dataset which includes detailed portfolio holdings of MMFs from January 2009 to April 2018.[2] To the best of my knowledge

[2] This dissertation utilizes several data sources to construct a very comprehensive dataset for analysis of US MMFs: 1) detailed portfolio holdings are extracted from N-Q, N-CSRS, N-CSR, N-MFP, N-MFP1 and N-MFP2 forms filed monthly with SEC EDGAR database; 2) information about global ultimate owners of issuers from Wharton Research Data Services, Bloomberg, Global Legal Entity Identifier Foundation and Bureau van Dijk's databases including Amadeus, Bankscope, Orbis Bank Focus and Osiris; 3) default probabilities of the issuers obtained from the Risk Management Institute of the National University of Singapore; 4) US Treasury bill yields data is collected from the Federal Reserve Economic Data.

this is the first document that offers a comprehensive study of the impact of both waves of reforms using detailed pre- and post-reform data.

The first empirical study (chapter 3) focuses on the effectiveness of 2010 Amendments to rule 2a-7. We specifically focus on two reforms: (1) The minimum liquidity requirement, which mandates MMFs to hold at least 10 percent of their net assets in daily liquid assets and 30 percent of their net assets in weekly liquid assets[3], (2) The "know your investor" requirement, which encourages funds to assess the characteristics of their investors to determine their redemption behaviour and adjust their liquidity levels above the minimum requirements, accordingly.

The study contributes to literature that study the impact of 2010 Amendments (Gallagher et al. 2015) and shows that the impact of minimum liquidity requirements on a MMFs portfolio characteristics shows that the rules have led to a safer asset mix, have made MMFs more resilient to unexpected outflows, and have reduced portfolio risk, but has put downward pressure on MMFs' portfolio yields. We show that the MMFs with riskier securities tend to keep higher liquidity levels in crisis periods. In fact, some funds keep more liquidity than the required minimum, possibly to differentiate themselves as a safer fund, to attract risk-averse investors. Furthermore, we study the response of shareholders in a crisis scenario, when the MMFs holds riskier securities in combination with higher liquidity and find that higher liquidity does not shelter funds from redemptions which indicates that liquidity does not compensate for higher credit risk during a crisis. Even when the funds are equipped to meet redemptions, the investors are concerned about the

[3] See appendix A1 for definitions of weekly and daily liquidity.

preservation of capital. My findings are contrary to Jank and Wedow (2015) who argue that MMFs with higher liquidity have lower outflows in bad times. In addition, we document that the "know your investor" requirement has encouraged MMFs to properly evaluate the characteristics of their shareholders and adjust their liquidity accordingly. We find that in crisis, the fund managers foresee the expected redemption patterns and increase the liquidity levels of funds as a precautionary measure.

The chapter 4, in a manner like that of Cipriani et al. (2017), we investigate the impact of 2016 Amendments to rule 2a-7 which mandated liquidity fee and redemption gates for all non-government MMFs and use of floating NAV for all non-government institutional MMFs. We observe that in response to the new rules, the majority of riskier sector (prime funds) have migrated to government funds. The institutional prime funds belonging to larger fund families were less likely to migrate possibly because if in danger of breaching regulatory threshold, they can obtain financial help from their sponsors to avoid charging liquidity fee or suspend redemptions (Baba et al. 2009; McCabe 2010; Brady et al. 2012; Kacperczyk and Schnabl 2013), whereas the MMFs with higher credit risk were more likely to convert to government funds. We show that institutional MMFs that remain prime try to completely avoid redemption gates and liquidity fees by hoarding liquidity and by dynamically changing liquidity with any increases in credit risk which is the opposite behaviour to that before the introduction of the new rules. We show that the loss of attractive money-like features and higher investor concentration have led to greater price competition among institutional funds as they seek to boost yields to attract investors. Finally, we document that retail prime MMFs tend to stay prime funds to benefit from the complete segregation of retail prime MMFs from institutional prime MMFs and this has left these funds with a more stable shareholder base, which allows such funds to aggressively engage in yield seeking behaviour. This aspect has not been studied before.

Chapter 5 aims to evaluate the response of institutional MMFs and their shareholders to the floating NAV mandated by 2016 Amendments. Unlike previous papers who study floating NAV (Gordon and Gandia 2014; Hanson et al. 2015; Witmer 2016), we conduct empirical analysis using actual floating NAV data of institutional prime MMFs reported on N-MFP forms since October 2016, to investigate the drivers of floating NAV, performance-flow relationship using floating NAV as an indicator of performance and the impact of floating NAV on the risk-taking of MMFs. This analysis fills a gap in the literature because, to the best of my knowledge, this aspect has not been investigated using the actual floating NAV data of the MMFs. We contribute to literature and show that the MMFs with higher floating NAV, and therefore higher opportunity for capital gains, attract more inflows. This gives the MMFs incentive to boost their NAV. Earlier performance-flow studies like Sirri and Tufano (1998), Koppenhaver and Sapp (2005), Chernenko and Sunderam (2014) focus on net yields of MMFs. Together with the findings that the MMFs that hold less liquidity, higher maturity riskier securities have higher NAV, indicates that a fund must hold risker portfolio to offer higher capital gains and attract shareholders. Furthermore, the study of the impact of floating NAV on risk-taking of funds reveals that it has two opposite effects. A fund must increase risk to boost capital gains, whereas, to retain investors, it must ensure less volatility in NAV because investors run from the funds that have higher fluctuations in NAV. We observe similar behaviour in retail funds and show that the shareholders in constant NAV funds actively track shadow NAV of the funds and tend to withdraw from funds whose NAV fluctuates excessively because such funds have a higher risk of breaching the 50 basis points threshold that would require a fund to trade at a lower than $1.00 share price resulting in loss of principal. This implies that the constant NAV MMFs (which now serve a more stable retail shareholder base only) after complete segregation from institutional MMFs may still be subject to runs when in distress.

In summary, the examination of the impact of recent reforms in US MMF industry shows that some new rules have made MMFs safer and more resilient to distress and has motivated funds to rein-in their portfolio risks. While the imposition of other rules (like floating NAV) produces countervailing effects and thus the impact of such rules remains unclear.

Chapter 2 Background and Literature Review

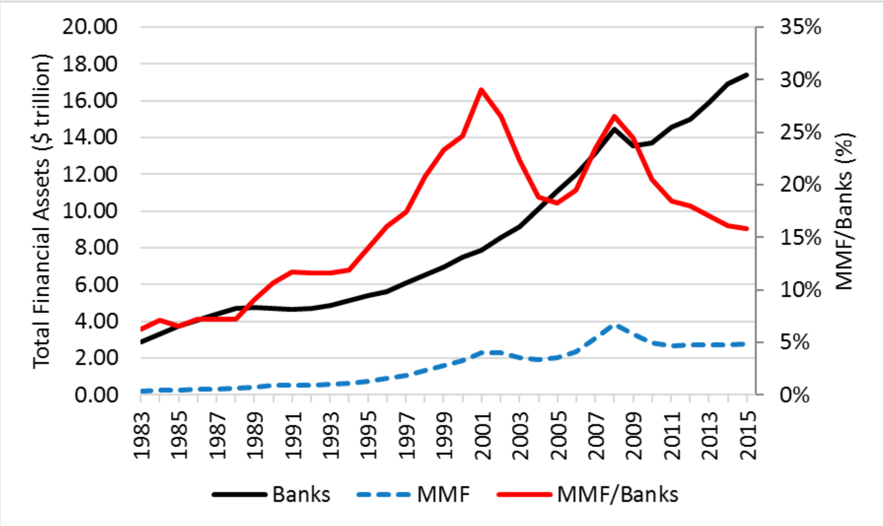
This thesis relates to several strands of literature. Specifically, we contribute to performance-flow relationship in MMFs, financial stability of the MMFs, the impact of financial regulation on their risk-taking and run risk. In this section, we discuss the main themes that are discussed in this dissertation. In section 2.1, we provide a short background of shadow banks and MMFs. In section 2.2, we explore studies on performance-flow relationship that exists in the MMF industry and risk-taking incentives that arise from it. In section 2.3, we discuss systemic risk arising from excessive risk-taking of MMFs and its consequences. In section 2.4, we specifically discuss studies on the impact of MMF regulation.

2.1 Shadow Banking

The term “shadow banking” was coined by McCulley (2007) to collectively describe levered non-bank investment conduits, vehicles and structures. Since the onset of the global financial crisis, academics and policymakers have adopted the term. Pozsar et al. (2010) broadly define shadow banks as financial intermediaries that conduct maturity, credit, and liquidity transformation without access to central bank liquidity or public sector credit guarantees. Examples of shadow banks include finance companies, asset-backed commercial paper conduits, limited-purpose finance companies, structured investment vehicles, credit hedge funds, money market funds, securities lenders, and government-sponsored enterprises. The shadow banking system has grown manifold in recent years. Figure 2.1 shows the evolution of shadow banks and traditional banks. In 2015, shadow banks and banks were similar in size with total financial assets of 16.89 trillion dollars and 17.37 trillion dollars respectively. The expansion in the shadow banking sector is attributable to genuine demand (Sunderam 2015), financial innovation, regulatory arbitrage, and agency problems that exist in the financial markets (Pozsar et al. 2012).

Figure 2.2: Total Financial Assets, US data

This figure shows the total financial assets of US MMFs and US banks. Banks include the total financial assets of private depository institutions. (Source: Board of Governors of the Federal Reserve: Financial Accounts of the United States, the author's own calculations).



Shadow banks raise funds through deposit-like liabilities which are then transformed into assets such as loans and mortgages and other long-term assets, just like banks provide maturity/liquidity transformation in credit intermediation activities. Although such short-term instruments are highly liquid imitating bank deposits, the risk profile of investors is different because these are not backed by official backstops and guarantees, and lack regulatory supervision. Maturity and liquidity transformation in combination with leverage gives rise to concerns because of the increased risk that short-term funding if undertaken in large quantities is susceptible to bank-like runs and hence can undermine the health of the wider financial system (FSB 2011).

The shadow banking system is highly interlinked with the regular banking system. For instance, banks compose shadow banking chains, explicitly sponsor shadow banks, and facilitate shadow banking activities, and directly invest in the financial products issued by the shadow banks. These linkages raise systemic concerns. Such interconnectedness can magnify market reactions in times of low liquidity in the financial markets and can intensify loss of liquidity in the shadow banking sector as well as the banking sector through negative spill-over effects. This became evident during the global financial crisis when major investment banks failed, others were acquired by banks and became bank holding companies. ABCP conduits and money market funds suffered runs, securitization activity collapsed, a lot of shadow banks including specialized investment vehicles and collateralized debt obligations became non-existent. Adrian and Ashcraft (2012) point out that such issues arose from both the asset and liability side. Issues related to the asset side were the underwriting standards, and on the liability side the fragility of wholesale funding seemed to be the problem. In response to these fragilities, governments set up both liquidity and solvency guarantees because distress to such institutions had potential to spill over to other institutions and damage the real economy. A necessary pre-requisite to counter such risk is to have reliable and relevant information about vulnerable areas of the financial system, especially focus is needed to be placed on elements where systemic risks are more likely to materialize. There are several papers which provide a comprehensive overview of the shadow banking system, the related regulatory landscape and financial stability. See Pozsar (2008), Adrian and Shin (2009), Pozsar et al. (2010), Acharya et al. (2013), Adrian and Ashcraft (2012), Gorton and Metrick (2012), and Gennaioli et al. (2013). We focus on money market funds, a sizeable and important part of the shadow banking sector which has proved risky in both the global financial crisis and the sovereign debt crisis.

Money market funds invest in short-term money market instruments. Depending upon the investment objective, a money market fund can be categorized as a government fund (if it invests at least 99.5 percent of its portfolio in government securities), a municipal fund (holding non-taxable municipal securities) and a prime fund (focusing primarily on corporate debt securities). Furthermore, based on the characteristics of a fund's shareholder base, a fund is considered either a retail fund when the shareholder base consists of natural persons, or an institutional fund in which shareholders are corporations and institutions. These funds serve two main purposes. First, these are very important suppliers of short-term funding and hold large amounts of debt instruments issued by financial and non-financial institutions. The global MMF industry amounted to 4.7 trillion dollars, of which US MMFs account for 2.7 trillion dollars, which was 58 percent of the global money market fund industry in 2017. Second, they serve as a valuable cash management apparatus for individuals, firms, institutions and governments.

In the US, MMFs are registered under the Investment Company Act of 1940 and regulated by the SEC under Rule 2a-7. This rule imposes liquidity and diversification requirements, maturity limits, portfolio quality restrictions, enhanced disclosure and stress testing requirements. Money market funds were established to counter limits on the interest payable on bank deposits and limits on the amount of deposits insured. They offered higher interest rates and, by using collateral based overnight repurchase agreements, they created new instruments that closely resemble insured deposits, but without restrictions on the insured amount. Some researchers see MMFs as "narrow banks" that are reliable liquidity providers even in times of crisis (Miles 2001; Pennacchi 2006). Indeed, from 1983, when SEC rule 2a-7 was first introduced, until September 2008 when the Reserve Primary Fund lowered its share price below $1 due to its exposure to Lehman Brothers, only one fund "broke the buck" in 1994.

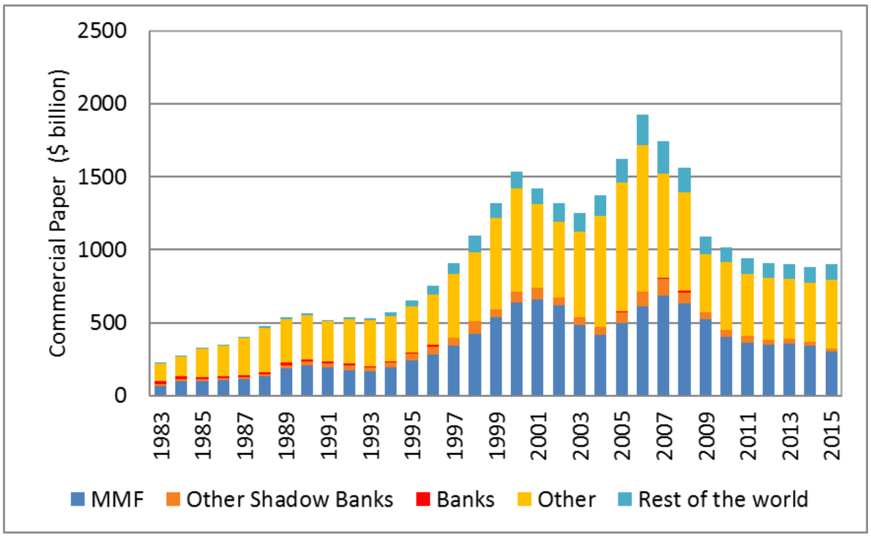
In this thesis, we specifically investigate US prime MMFs. These funds are important suppliers of credit to short-term credit markets, particularly because they are not restricted to invest solely in government securities. Their assets also include repurchase agreements, certificates of deposit, ABCP, commercial paper, bank notes, and corporate notes with remaining maturity of no more than 397 days. Figure 2.2 illustrates the importance of prime MMFs relative to other financial institutions in the commercial paper market. Previous crisis episodes have shown that distress in prime MMFs cause disruptions in the short-term credit markets, which are not completely offset by other credit suppliers (Chernenko and Sunderam 2014). As a result, prime MMFs were the primary focus of recent financial regulation. This dissertation investigates the impact of 2010 and 2016 Amendments to rule 2a-7 on prime MMFs.

Notable examples of recent contributions on money market funds include Christoffersen (2001), Christoffersen and Musto (2002), Baba et al. (2009), McCabe (2010), Di Maggio (2016), Duygan-Bump et al. (2013), Bengtsson (2013), Kacperczyk and Schnabl (2013), Chernenko and Sunderam (2014), Gallagher et al.

(2015), Strahan and Tanyeri (2015), Collins and Gallagher (2016), Pellegrini et al. (2017) and Di Maggio and Kacperczyk (2017).

Figure 2.2: Commercial Paper Holdings, US Data

This figure shows the amount of Commercial Paper held by various types of institutions. MMF represents money market funds. Other shadow banks include total financial assets of ABS issuers, Security brokers and dealers, finance companies, Government Sponsored Enterprises and Agency and GSE- backed mortgage pools. Banks include the total financial assets of private depository institutions. Other includes non-profits, retirement and pension funds, life insurance companies and mutual funds. Rest of the world represents holdings of non-US investors. (Source: Board of Governors of the Federal Reserve: Financial Accounts of the United States, the author's own calculations).



2.2 Performance-Flow and Risk-Taking

Money market funds are valuable cash management apparatus for individuals, firms and governments. They have been understood to be deposit-like investments that provide higher returns than regular deposit-taking banks. Christofferson and Musto (2002) find that these returns are highly persistent and are almost entirely driven by relative fee charged by funds. Domian and Reichenstein (1998) agree that this persistence in returns is because of the lower expense ratios charged by the funds and show that 87 percent of variation in net returns can be explained by the expense ratio and a dummy variable representing whether a fund exclusively invests in government securities. Di Maggio and Kacperczyk (2017) adds that the monetary policy regime also determines the returns of funds. They reveal that the returns of MMFs are heavily influenced by short-term interest rates and show that the performance of MMFs improve in high interest rate periods. Koppenhaver (1999) finds that returns are also affected by the portfolio characteristics of funds, and therefore influence the performance of the funds. For instance, increasing the share of commercial papers, which have considerably more credit risk than government securities could increase the return. Also, investing in longer maturities could also increase the performance of the funds. The knowledge of factors influencing a fund's returns matters because studies show that superior performance brings higher fund flows.[4]

My work is related to performance-flow relationship and risk-taking incentives in money market funds. Kacperczyk and Schnabl (2013) show that the fund flows are extremely sensitive to changes in yields, which indicates that funds have a strong incentive to invest in risky assets because such instruments offer higher yields, to attract yield-chasing depositors. Moreover, they give account of increase in yields of riskier instruments showing that asset risk of MMFs changed in relation to safer instruments in the period from August 2007 to March 2008, providing unprecedented

[4] The relationship between fund performance and fund inflows is the subject of an extensive literature that investigates mutual funds (Friend et al.1970; Smith 1978; Ippolito 1992; Chevalier and Ellison 1997; Sirri and Tufano 1998; Del Guercio and Tkac 2002).

expansion in opportunities for MMFs to invest in riskier assets. Similarly, Christoffersen (2001) argues that fund flows increase sharply with increase in net performance of the fund. Sirri and Tufano (1998) study equity mutual funds and find that investors consider historical performance in making their investment decisions and tend to invest disproportionately more in funds that perform better than others. These results are in line with the findings of Jank and Wedow (2015) and Koppenhaver and Sapp (2005) that investors base their investment decisions on performance of the funds, which fosters fierce competition, creating incentive for managers to invest in riskier assets to increase performance of the funds and attract more inflows and build asset size. This performance-flow relationship is twice as strong when the interest rates are low than they are in normal times, so funds respond by adjusting their portfolio risk upwards (Di Maggio and Kacperczyk 2017). During crisis this relationship might invert. Chernenko and Sunderam (2014) find evidence that during the sovereign debt crisis, from June to August 2011, the relationship between net yield and fund inflows became negative, possibly because shareholders turn to safer funds during a crisis. These studies imply that funds have incentive to boost performance to attract shareholders, which in turn encourages MMFs to take on more risk to earn higher portfolio yields to be able to offer higher net yields.

The extent to which funds engage in risk-taking depends on several other factors. Stiglitz and Weiss (1983) and Diamond (1989) provide evidence that borrowers that have reputational concerns tend to refrain from taking excessive risk. Kacperczyk and Schnabl (2013) agree that a fund sponsor's reputational concerns and its financial strength are important determinants of risk taking by money market funds.

They show that the funds with sponsors with higher reputational concerns engage in constrained risk-taking, while the funds with financially strong sponsors take on more risk. Further, during high systemic risk periods, stand-alone funds increase their risk relatively more, while in low systemic risk periods, the funds that are a part of conglomerates boost their risk-taking more. Similarly, Brady et al. (2012) argue that most of MMFs are backed by a sponsor, who are usually willing to provide financial support if a fund faces financial difficulties, makes funds act less cautious in choosing individual portfolio holdings. Often sponsors provide the needed support to avoid incurring huge reputational cost if their MMF fails. For instance, a failure could induce outflows in other funds managed by the same sponsor or damage their investment banking or commercial banking business both financially and in terms of reputation.

Risk-taking of funds also depends upon the type of their shareholder base. Strahan and Tanyeri (2015) observe that fund managers not only observed the factors driving cross-sectional variation in fund flows but also respond by reallocating their portfolios according to the investor preferences. Gallagher et al. (2015) use a unique and granular database to investigate the impact of investor characteristics on competition for assets across prime MMFs and show that funds with a higher proportion of institutional investors have more incentive to differentiate on yield and consequently take on more risk.

Other risk-taking incentives for MMFs include the following: The MMFs compete with other short-term markets like repurchase agreements. So, they must offer higher yields than other markets to stay competitive otherwise investors flee to alternative investments. For instance, Gallagher et al. (2015) find evidence that, investors quickly move their investments from MMFs to repo markets if the latter offers higher relative yields. Furthermore, MMFs could be motivated to take on more risk to earn higher fee revenue because Jank and Wedow (2015) show that higher risk boosts an MMF's expected fee revenue. Finally, lower interest rate environment could induce fund managers to engage in yield-seeking behaviour. For instance, Di Maggio and Kacperczyk (2017) study incentives of asset managers to chase yield by examining the response of money market fund managers to the zero lower bound interest rate policy and provide evidence that fund managers increased their portfolio risk by investing in riskier asset classes, to provide positive returns to their investors.

In chapters 3 and 4, part of the analysis assesses the impact of regulation on funds' performance and risk-taking behaviour. In chapter 5, we add a new perspective to MMF performance-flow literature by assessing the relationship between a fund's ability to provide capital gains and the fund inflows. We assess the response of institutional shareholders to newly introduced rule which requires institutional MMFs to price their shares using floating NAV.

2.3 Run Risk and Financial Stability

Money market funds have been understood to be safe. Some researchers saw them as "narrow banks" that are excellent liquidity providers even in times of crisis and pointed that the runs on the funds should be unlikely (Gorton and Pennacchi 1993; Miles 2001; Pennacchi 2006). This is because these funds have kept true to the promise of price stability in the past. From 1983, when rules 2a-7 were first introduced, until September 2008 when Reserve Primary Fund lost money due to the Lehman bankruptcy, only one fund broke the buck in 1994. It was a small fund, so the loss went unnoticed.

Domain and Reichenstein (1998) emphasized that money market funds are essentially commodities with no meaningful differentiation in portfolios and did not recognize the risk and return dynamics in these funds. Historically, MMFs usually attracted inflows during crisis, so run risk never appeared to be a concern. For instance, Miles (2001) showed that MMFs attracted inflows and increased lending to borrowers during monetary policy shocks and concluded that MMFs are safer than depository institutions. Similarly, Pennacchi (2006) showed that MMFs received inflows during liquidity shocks when spread between commercial paper and treasury bills increased and suggested that insurance of shares of MMFs might prove more effective in improving market liquidity.

During the global financial crisis and the European sovereign debt crisis, MMFs susceptibility to runs became clearer. This was evident in September 2008, when Reserve Management Company "broke the buck" and decided to liquidate Primary Fund's entire portfolio, because of the failure of Lehman Brothers, which worsened already weak investor confidence in short-term credit markets. This triggered large scale investor redemptions in other MMFs. These massive outflows shrank short-term funding markets considerably and credit supply contracted (Fed Board 2009; SEC 2009; PWG 2010; Kacperczyk and Schnabl 2010). The damage caused by runs led to government interventions to support MMFs to stop outflows and restore investor confidence.

This episode was repeated during the sovereign debt crisis. In June 2011, as the Eurozone crisis worsened, concerns about substantial Eurozone bank exposures of US MMFs increased, which led shareholders of the funds to withdraw approximately $162 billion over the period of June to August 2011. The substantial outflows in prime MMFs with high Eurozone bank exposures strained US money markets (FSOC 2011). These redemptions squeezed short-term markets, leading to reduced lending to creditworthy non-European issuers Chernenko and Sunderam (2014). McCabe et al. (2013) contend that redemptions from prime MMFs caused a decrease in the supply of lending to US non-financial firms, hence adversely affecting the US economy.

Many studies endeavour to provide reasons for such runs. Morris and Shin (1998) argue that while weak fundamentals might trigger a run, it is investors' irrational beliefs that magnify the crisis leading to a self-fulfilling crisis. The initial redemptions induce worse-informed investors to believe that other investors have received a negative signal about the associated risk of an investment, which creates a deteriorating outlook, hence stimulating a run (Chari and Jagannathan 1988). Similarly, Schmidt et al. (2016) examine MMF flows during the 2008 crisis and study investor and portfolio characteristics that contribute to run risk and agree that the strategic complementarities i.e. the self-fulfilling expectations that other investors will run leads to more outflows.

The intensity of such withdrawals also depends upon portfolio characteristics of funds (Koppenhaver 1999). MMFs that increase their returns (therefore increasing risk) by diversifying into a wider portfolio structure are more likely to encounter large withdrawals (Jank and Wedow 2015). Indeed, investor redemptions from MMFs during the sovereign debt crisis were concentrated among risky funds, indicating that investors were aware of the portfolio quality of the funds and made their decisions to redeem investments accordingly (McCabe 2010; Schmidt et al. 2016; Strahan and Tanyeri 2015). The investors have risk preferences for their portfolio holdings, so they rebalance their portfolios when these risk characteristics change (Jacklin and Bhattacharya 1988). Therefore, even extremely small changes in the fundamentals could lead to amplification of negative outcomes (Angeletos et al. 2007).

Studies suggest that the extent of redemption pressure also depends upon characteristics of shareholder base of a fund. For instance, Wermers (2011) examines the crisis in the US MMF industry and finds that redemptions were larger for funds that were catering to institutional investors. McCabe (2010), Schmidt et al. (2016) and Chernenko and Sunderam (2014) concede that institutional investors were driving runs on the MMFs, because funds that were financed by money from institutions suffered more outflows. Gallagher et al. (2015) empirically analyse the behaviour of institutional investors during the global financial crisis, the sovereign debt crisis and the US debt ceiling impasse and demonstrate that institutional investors consistently withdraw more fervently in all three episodes. This could be attributed to the fact that such institutional investors have deeper understanding of the negative externalities that their actions pose on other investors (FSOC 2012; IOSCO 2012). In addition, such investors have higher capital at risk which motivates them to track the performance of MMFs as well as assess the risk inherent in the portfolio holdings of such funds (Schapiro 2012). Furthermore, Schmidt et al. (2016) observe that the presence of retail investors in the fund has a significant relationship with the way institutional investors react during stress. They observe that institutional investors restrain their run-behaviour if a fund has a large proportion of retail investors in their shareholder mix.

Some studies claim constant NAV funds are more prone to runs than floating NAV funds. Witmer (2016) examines both type of funds from US and Europe and concludes that constant NAV funds are more susceptible to runs. Hanson et al. (2015) agree that the use of floating NAV successfully removes strategic motives to run. On the other hand, Jank and Wedow (2015) assert that large withdrawals are possible for floating NAV funds as well because risky portfolio holdings of funds could cause investors to withdraw money in case of trouble because they still have potential to lose value. Gordon and Gandia (2014) agree that the use of floating NAV does not eliminate run-like behaviour.

Literature provides evidence that the sponsor support can thwart runs in money market funds. For instance, McCabe (2010) analyses portfolio risk, sponsor risk and investor risk that a fund is subjected to and finds out that the sponsor support absorbed losses which increased investor confidence in 2007 during the ABCP crisis. Even though some of these funds suffered capital losses, the investors did not respond by withdrawing their funds, because they believed the sponsors would absorb the losses. They were correct to assume so. Brady et. al (2012) investigate sponsor support that prime money market funds received from 2007 to 2011 and find that sponsor support during this period was frequent and significant saved at least 31 prime funds from breaking the buck at multiple instances during the global financial crisis. Without the sponsor support the funds would have faced increased redemption pressure possibly resulting in lower net assets and higher losses for remaining investors.

Higher portfolio liquidity can boost investor confidence in MMFs ability to service redemptions (SEC 2014). Wermers (2011) examines crisis in the US MMF industry and finds that redemptions were larger for funds that had invested less in liquid assets. These results are corroborated by Jank and Wedow (2015) who study German money market funds and show that the funds with higher liquidity during good times have lower inflows, while such funds have lower outflows in the bad times. In other words, the liquid funds are unattractive to investors in times of high market liquidity but become attractive when the market illiquidity is high. We contribute to this literature by assessing the role of liquidity in restraining run risk on funds. More specifically, in chapter 3, we examine the response of shareholders of MMFs to the funds that hold higher liquidity in combination with higher credit risk, during crisis.

Runs have negative consequences for its investors as well as borrowers, leading to wider financial instability. Such heavy outflows in a fund could have negative effects on remaining investors (Edelen 1999; Nanda et al. 2000). During heavy redemption periods the funds could take a few days before their cash balances are fully restored, which may affect the investors who remain in the fund, because the funds become riskier. Strahan and Tanyeri (2015) who study MMFs' response to investors withdrawals during the 2008 crisis and show that the funds with heavy outflows relative to portfolio liquidity became temporarily riskier because they were forced to sell liquid securities to service redemptions. Moreover, heavy redemptions impose costs on funds by forcing them to sell assets at fire sale prices (Nanda et al. 2000; Chen et al. 2010). Such flow-induced trading can significantly affect individual stock returns and can have adverse price pressure on stock prices, driving prices away from fundamentals and information-efficient benchmarks (Coval and Stafford 2007). This could result in loss of principal invested by shareholders. Furthermore, this could transmit distress from one part of the financial system to other connected parts.

Ben-David et al. (2012) and Anand et al. (2012) show that during the global financial crisis, institutions sold more liquid assets instead of the "toxic" assets which adversely effected related asset prices, thereby propagating the crisis from illiquid asset markets to liquid asset markets. Greenwood and Thesmar (2011) add that flow-driven trades in mutual funds by an investor could give rise to contagion risk, especially if investors have correlated liquidity shocks, because flows can exert pressure on prices which causes portfolio values of other investors to fluctuate as well. Other related studies that aim to measure negative spill-over effects in terms of price impacts include Boyson et al. (2013), Aragon and Strahan (2012), and Lou (2012).

Runs lead to capital constraints at a financial intermediary which could result in a credit crunch. For instance, default from one firm can impair a bank's accounts, constraining the supply of the credit to other firms (Bernanke and Blinder 1988; Holmstrom and Tirole 1997; Khwaja and Mian 2008; Chava and Purnanandam 2011;

Schnabl 2012). Chernenko and Sunderam (2014) investigate runs on US money market funds during sovereign debt crisis and show the negative spill overs of US MMFs risk-taking on non-European issuers (borrowers). They find that MMFs with greater exposure to Eurozone banks suffered more withdrawals between June and August 2011. Investors were more concerned about investments of MMFs in Eurozone banks, therefore, such MMFs suffered more. As a result, these MMFs had liquidity problems and were capital constrained which affected their ability to supply money to the non-European issuers. In other words, in the wake of the crisis in Eurozone countries, creditworthy non-European issuers were unable to raise capital from MMFs. Such a dynamic was more pronounced for MMFs with larger exposure to Eurozone banks. They show that relationships in short-term credit markets are important, which create a channel that could lead to transmission of distress to the broader economy. Because of the presence of such lending frictions, fragility in MMFs funding could lead to disruptions in credit supply to large, highly rated firms. These results are corroborated by Correa et al. (2016) who study the interaction between MMFs and global banks in the US and establish that MMFs were primary transmission vehicles of spill-over effects from the sovereign debt crisis to US credit markets. They show that MMFs decreased lending to US branches of the banks that were affiliated with euro-area parent banks, and in turn such banks decreased lending to US firms. Ivashina et al. (2016) agree and document that US MMFs reduced their exposure to European banks sharply when the sovereign debt crisis escalated. This caused a reduction in dollar lending by European banks relative to euro lending, which in turn constrained the funding available to the firms that were more reliant on Eurozone banks.

Gallagher (2015) challenges the narrative and argues that there is little evidence to support the claims about the presence of MMFs lending channel during the sovereign debt crisis. Collins and Gallagher (2016), show that of the $162 billion withdrawn from prime MMFs during the sovereign debt crisis between June-August 2011, less than half of these outflows could be attributed to the MMFs' exposure to Eurozone banks. Furthermore, they show that the outflows due to Eurozone holdings concerns were concentrated in June 2011. The outflows in July to early August 2011, were primarily due to the legislative impasse on the federal debt ceiling which raised concerns. Gallagher (2015) observes that the funds seem to have met redemptions by decreasing their financing to European banks and claims that these reductions were more than the total outflows during June 2011. However, Gallagher concedes that the issuers financed by funds with greater Eurozone holdings experienced a similar reduction in their short-term debt, but they decreased their short-term financing from other short-term sources while increasing their long-term debt, which indicates that the reduction was because of decrease in demand for short-term credit. Gallagher provides evidence that MMFs with higher exposure to Eurozone banks actually increased their lending to North American non-financial firms because these firms were safer investments.

This dissertation contributes to run risk and financial stability literature by examining the role of money market fund regulation in reducing the runs on MMFs and promoting industry stability. In chapter 3, we study the role of minimum liquidity requirements on restraining the runs on MMFs during crisis. In chapter 4, part of the analysis examines how 2016 Amendments have changed the liquidity and risk management of both institutional and retail MMFs to foster stability. In chapter 5, we investigate whether floating NAV induces financial stability by restricting risk-taking incentives.

2.4 MMF Regulation and its Impact

Because of their systemic importance, MMFs have been subject to regulatory reforms in the US. In response to MMFs' run episode during global financial, the Securities and Exchange Commission introduced reforms in May 2010, sought to improve the resilience and transparency of MMFs. It was aimed at increasing liquidity, decreasing average portfolio maturity, requiring fund managers to understand the behaviour of the funds' investors, introducing stress testing procedures, and requiring funds to report detailed portfolio holdings data every month which were made available to the public after 60 days.

During the European debt crisis which saw large increases in sovereign credit spreads, MMFs faced heavy redemptions that squeezed short-term credit markets. This motivated introduction of 2016 Amendments. The new regulations, which became effective in October 2016, enable MMFs to impose liquidity fees or completely stop outflows through redemption gates when liquidity falls below a designated regulatory threshold. The rules also require all non-government institutional funds to use floating net asset values which explicitly exposes investors to capital losses. These reforms have induced a structural shift in the MMF industry.[5]

[5]The European MMFs have also been subject to similar systemic risk concerns and consequential regulation. The European Commission has proposed stable NAV funds to either convert to floating NAV funds or hold a 3 percent capital buffer and prohibits sponsor support unless it is approved by the appropriate regulator.

The focus of this thesis is to assess the impact of both MMF reforms and the response of investors to the new rules. There are several studies that discuss MMF reforms proposals (Birdthistle 2010; McCabe et al. 2012; Fisch and Roiter 2012; Fisch 2015; Hanson et al. 2015). However, the literature that empirically studies the post-reform impact of these regulations is limited. This section particularly discusses recent studies that discuss the potential effect of the MMF reforms.

Gallagher et al. (2015) study the effect of enhanced portfolio disclosure mandated in 2010 Amendments by examining shareholder redemption behaviour and portfolio risk adjustments of MMFs during the sovereign debt crisis. They conclude that greater transparency has two opposing effects: On the one hand, it enables investors to properly monitor the portfolios of funds which encourages managers to restrain portfolio risks. Furthermore, this discipline imposed by sophisticated investors (institutional investors) benefits unsophisticated investors (retail investors) and restricts the fund managers to window-dress their portfolios to make them appear safer near disclosure dates (Morey and O’Neal 2006; Ortiz et al. 2012). On the other hand, availability of real time transparent information about fund portfolio can lead to pre-emptive runs during distress leading to increased frequency of negative feedback loops. The disclosure of detailed information in MMFs exacerbated the funding shock to euro-area banks during the sovereign debt crisis (Correa et al. 2016). Aragon et al. (2013) and Shive and Yun (2013) agree that enhanced disclosure could lead to front-running in mutual funds. Furthermore, Villatoro (2009) and Verbeek and Wang (2013) find that it could also lead to herding behaviour because institutions might imitate each other’s portfolios.

Parlatore (2016) studies the consequences of MMF regulation including the prohibition of sponsor support, the adoption of a floating NAV and the imposition of capital buffers. Parlatore concludes that lack of sponsor support incentivizes funds to reduce risk to avoid fund liquidation, which in turn could result in fewer asset fire sales and more stable asset price and greater financial stability. The paper argues that capital buffers can have two opposing effects. On the one hand, they could raise cost of intermediation services, thereby decreasing the net returns for shareholders and the provision of liquidity by MMFs. On the other hand, capital buffers provide funds with the ability to absorb losses which would increase expected return, lower the probability of liquidation, make asset prices less volatile and reduce the risk of investment in MMFs which, together, could increase the total supply of liquidity. In addition, the paper concludes that adopting floating NAV for the whole industry could also boost the total supply of liquidity because investors would be attracted to MMFs as they can earn returns from floating NAV, but the risk should be kept low by restraining asset price volatility. Our paper is closely related to this. We empirically test the effect of floating NAV on MMF performance-flow relationship and risk-taking and find that funds with higher floating NAV attract more inflows and therefore have incentive to invest in riskier securities.

Lenkey and Song (2017) investigate the effect of liquidity fee on runs on financial institutions when shareholders are asymmetrically informed about the fundamentals of the institutions. They find that fee reduces informed investors' propensity to run, because it eliminates the first mover advantage. But it could also lead uniformed investors to become more cautious about the fundamentals of a firm and can cause them to run. Taken together, these results make impact of fee on runs unclear. Also, fee could induce last-mover advantage transferring wealth from uninformed investors to the informed investors. Zeng (2017) contends that redemption fees in mutual funds curtail runs, whereas, Hanson et al. (2015) and Cipriani et al. (2017) claim that the imposition of a liquidity fee would encourage pre-emptive runs.

Cipriani et al. (2017) is the only study that empirically investigates the post-reform impact of 2016 Amendments on US money market funds. They show that money has flowed out of the MMFs that are subject to redemption gates and liquidity fee (i.e. institutional prime and municipal MMFs) to funds which do not have such requirements (i.e. government funds) because of the reforms, which indicates that shareholders are concerned about the deposit-like attributes of their investments. They also show that the strength of the outflows was higher for institutional investors because they are more information sensitive. Also, consistent with risk-appetite of prime MMFs, this money has flowed to the government agency MMFs which is a relatively riskier segment.

Witmer (2018) studies whether funds hold excess liquidity to guard against shareholder redemptions. The paper finds that there is wide variation in the level of liquidity across MMFs. Funds with more volatile shareholder base, institutional shareholders and longer maturity assets hold higher liquidity to avoid runs and reduce transaction costs associated with investor redemptions. Moreover, external prime funds (i.e. those with retail or institutional shareholders) hold more liquidity than internal prime funds (i.e. those where the shareholders are the funds owned by the same sponsor) because the former are more vulnerable to runs. Finally, the paper argues that funds with higher liquidity have lower redemptions during a crisis.

This dissertation contributes to above literature by comprehensively studying the impact of MMF reforms. In chapter 3, we assess whether minimum liquidity requirements imposed by 2010 Amendments have made the funds more resilient to redemptions. In chapter 4, we examine the response of MMFs and investors to 2016 Amendments. In chapter 5, we investigate the post-reform impact of floating NAV requirement mandated by 2016 Amendments on the behaviour of funds as well as investors.

Chapter 3 Liquidity Management of Money Market Funds

3.1 Introduction

In this chapter, we investigate the changes in MMFs after the introduction of the 2010 Amendments especially focusing on the rules targeted at improving portfolio liquidity: (1) A minimum liquidity requirement, which endeavours to increase liquidity holdings of prime MMFs by imposing a floor on daily and weekly liquidity levels. Prime MMFs are expected to hold at least 10 percent of total net assets in daily liquid assets and 30 percent of total net assets in weekly liquid assets[6]; (2) A "know your investor" requirement, which urges MMFs to assess the characteristics of their investors in order to determine their redemption behaviour and adjust the liquidity levels above the minimum requirements accordingly. It is of great interest to know whether these reforms have proved effective at reducing the instability of prime money market funds.

Our contributions to the existing literature are as follows. First, we collate a unique dataset, which includes detailed portfolio holdings of MMFs before and after the 2010 Amendments. To the best of our knowledge, this is the first paper to assess changes in MMF behaviour after reforms using detailed pre- and post-reform data. We find that those funds for which the new liquidity requirements were binding (constrained funds) reallocated capital initially invested in riskier, longer maturity securities to either very short-term securities and/or in government securities. This

[6] See appendix A1 for definitions of weekly and daily liquidity.

leads to a safer asset mix and positions funds to be more resilient to unexpected outflows. In addition, following the reform we find that portfolio risk declined with a negative impact on the funds' profitability.

Second, with our pre-reform data we are able to do a counterfactual analysis to show how MMFs adjust their excess liquidity during the sovereign debt crisis, after reforms. We evaluate changes in daily and weekly excess liquidity and find that constrained funds increase daily excess liquidity twice as much as unconstrained funds and weekly excess liquidity more than three times as much. As a result, the daily and weekly excess liquidity profile of constrained and unconstrained funds has become similar. Interestingly, unconstrained funds increase excess liquidity even though they already hold much higher liquidity levels than constrained funds post reform. In this respect, unconstrained funds appear to aim to preserve their distinctive features (i.e. higher safety/liquidity) as a way to differentiate themselves from constrained competitors. We conjecture that this may be a strategy to attract wealthy and risk averse institutional investors.

Third, we investigate whether fund managers understand the redemption behaviour of their investor base. The 2010 Amendments impose a "know your investor" requirement which requires funds to adjust their liquidity levels according to the expected behaviour of their shareholders. We extend previous studies by investigating the impact of *expected* outflows, as opposed to observed outflows. We show that higher expected outflows lead funds to keep higher liquidity as a precautionary measure which indicates that MMFs know their investors and respond accordingly.

Fourth, we extend the analysis of Jank and Wedow (2015), who look at liquidity and inflows for German funds in a crisis. With our sample of US prime MMFs we evaluate the role of daily and weekly liquidity in mitigating outflows if the portfolio is perceived to carry considerable credit risk. In the context of the sovereign debt crisis, we use the level of Eurozone bank holdings as a credit risk proxy. When the sovereign debt crisis worsened in 2011, credit default spreads of Eurozone banks started to increase sharply. This caused concerns about the solvency of Eurozone banks, which led to massive withdrawals from exposed funds. We find that higher daily and weekly liquidity does not compensate for higher credit risk in a crisis. In this sense, investors appear to have over-riding concerns about the preservation of capital even when the funds are better able to meet redemptions.

Fifth, by analysing daily and weekly liquidity separately, we can investigate their distinctive features. The SEC introduced daily and weekly liquidity requirements to enable MMFs to survive severe illiquidity scenarios like the one that occurred after Lehman's collapse. Under such circumstances, MMFs may not be able to rely on the secondary or dealer market for funding. Then, only a liquid asset base could help them to meet redemptions (SEC 2010, p. 57). A weekly liquidity requirement is added to a minimum daily liquidity as sustained redemptions can persist for several days. We find that larger funds tend to hold lower levels of weekly liquidity in tranquil periods. This may be because their wider reach among investors enables them to diversify the risk of redemptions with higher subscriptions. However, whether fund size can have an impact on weekly liquidity in a crisis is less clear as such diversification opportunities could disappear. Daily liquidity, on the other hand, appears to be treated more conservatively by larger funds that do not seem to behave differently from smaller funds in both tranquil and crisis periods. Furthermore, we find that while MMFs with higher portfolio risk tend to hold higher weekly liquidity, the same relationship with portfolio risk is not found for daily liquidity. This is plausible because daily liquidity is more costly, i.e. less profitable, than weekly liquidity. Therefore, funds may prefer to adjust weekly liquid assets which have a longer maturity and, as a result, a higher yield.

The rest of the paper is organized as follows. In section 3.2, we provide a description of the data. The empirical analysis and results are presented in section 3.3. Section 3.4 concludes.

3.2 Data Description

The paper utilizes detailed portfolio holding reports of money market funds which are filed with the Securities and Exchange Commission monthly (N-MFP), quarterly (N-Q), semi-annually (N-CSRS) and annually (N-CSR). These forms are publicly available from the SEC EDGAR database.

The 2010 Amendments require MMFs to file a monthly report on form N-MFP, which includes a detailed schedule of portfolio holdings of money funds, starting from November 2010. This form provides information about fund-level variables like total net assets, assets of share classes, gross yield, and monthly shareholders subscriptions and redemptions. In addition, for each security held, it reports issuer name, amount of principal, yield, legal maturity date, and the CUSIP number. Before November 2010, portfolio holdings are available with quarterly frequency. The funds' management companies were required to report portfolio holdings on the N-Q form in the first and third quarter and on the N-CSRS form in the second and fourth quarter. We use three different forms N-Q, N-CSRS and N-CSR reports filed by the funds to build a pre-reform dataset which gives us snapshots of portfolio data in each quarter from January to December 2009.[7] The reporting on these forms, unlike N-MFP, is not standardized, and therefore partly required manual extraction. Then we used an algorithm to create a standardized dataset. Restrictions on weighted average life (WAL) and daily/weekly liquidity did not exist before the SEC amendments to Rule 2a-7 in May 2010. As a result, they are not reported on the forms. Therefore, we calculate these variables ourselves (see appendix A1).

To be able to measure the exposure of prime MMFs to Eurozone banks, which were the main source of instability in the summer of 2011 during the sovereign debt crisis, we aggregate issuer-level variables to the parent level. Then we assign a country to the parent and determine if the overall exposure to the parent firm is within the Eurozone. For instance, the securities issued by Bank of the West, Fortis funding LLC, Scaldis Capital LLC, Starbird funding corporation, as well the debt issued by BNP Paribas SA are all aggregated under the parent company BNP Paribas SA which is then associated with France and treated as a Eurozone exposure.[8]

Our final dataset spans from January 2009 to December 2012. We divide the data into pre-reform (January 2009-December 2009)[9,10] and post-reform (February 2011-

[7] N-Q, N-CSRS and N-CSR contain information about multiple funds managed by the same management company. We make sure to extract only the relevant data for prime money market funds.
[8] The N-MFP form does not specify the country and industry sector of the issuers, nor their parent company. We collect this information from a variety of other datasets. Since the CUSIP number of the issuers is given, we use it to link the data extracted from the N-MFP forms with other datasets. These include Amadeus, Bankscope, Osiris, and Bloomberg as well as the WRDS database for the CUSIP master file.
[9] In this period, only quarterly observations are available for each fund. In each quarter, the snapshot of portfolio holdings is provided for the reporting date. For consistency, other periods are also divided into four-month period.
[10] We choose this period for two reasons. First, before Q1 2009 in Q3-Q4 2008, during the time of Lehman's bankruptcy, the funds were in distress. As we want to determine the characteristics of the

September 2011). Post reform is further divided into "Calm" (February 2011-May 2011) and "Crisis" (June 2011 – September 2011) periods.[11] See Figure 3.1 for a graphical timeline. Our final dataset excludes feeder funds (i.e. funds that invest in other funds), internal funds, municipal funds, and variable annuities[12] which gives us a total of 186 prime funds in the post-reform period managing 1.3 trillion dollars in assets.

We have done extensive sanitation checks and used alternative sources to correct data entry errors. For instance, the net yield of the funds provided on form N-MFP is occasionally incorrectly reported. We obtain the correct values for such funds from Bloomberg. US Treasury bill yields are sourced from the Federal Reserve Economic Data (FRED) database.

3.3 Empirical Analysis

3.3.1 Portfolio Composition Before and After the 2010 Amendments

The 2010 Amendments mandated prime funds to hold at least 30 percent of total assets in weekly liquid securities, 10 percent of total assets in daily liquid assets and capped the weighted average life (WAL) of the portfolio to 120 days. Before these reforms, no such requirements were in place. To meet these constraints, the funds

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funds in normal pre-reform times we do not consider 2008. Second, we do not use the observations in Q1 2010 because the SEC reform was issued in February 2010. Although it became binding in May 2010 it is possible that the funds brought their level of liquidity and WAL in line with the new requirements before then. So, including this period in the analysis could distort the results.

[11] Large MMFs redemptions started in June 2011 and continued until September 2011. See Figure 3.5.

[12] The funds report their type in item 10 of the N-MFP form. We keep the fund in the data if it reports itself as "prime" fund. Item 7 reports if it is a feeder fund. Variable annuities are reported in item 9. We also exclude two funds that hold only cash over the period from February to September 2011. If a fund invests more than 95 percent in municipal securities, it is dropped from the final dataset.

had to make considerable changes in their portfolios. The liquidity floor seeks to enable prime funds to comfortably meet redemptions in the periods of distress. The WAL ceiling protects the fund against interest rate risk and spreads risk during high market volatility. In this section, we assess the extent of the changes in MMF portfolios after the 2010 Amendments and how such changes have influenced the liquidity and risk profile of the funds. In doing so one must keep in mind that during this period there were several other changes in the financial markets (for instance the introduction of the new Basel III regulations for banks) that might have impacted MMF portfolios. However, we still believe that the majority of the changes that we observe in liquidity and related measures is due to the minimum liquidity requirements in the 2010 Amendment because they placed direct demand on MMFs to change their liquidity to a certain level (for instance, increase weekly liquidity from 0% to 30%) and were binding.

In our sample, there is a large cross-sectional variation in the pre-reform liquidity levels of the prime funds. Figures 3.2, 3.3 and 3.4 show the distribution of WAL, daily liquidity and weekly liquidity respectively, before and after the amendments. The funds are assigned to the "Unconstrained" group if the pre-reform average weekly liquidity is greater than the required minimum of 30 percent. Otherwise, they are classified as "Constrained". We use weekly liquidity for the classification because it is the most stringent requirement.[13] We have 70 constrained funds, and 30 unconstrained funds.

[13] Among the funds that already meet the weekly liquidity requirement in the pre-reform period, aall but one also meet the daily requirement. On the other hand, more than 50 percent of the funds that meet daily liquidity requirements in the pre-reform period do not meet the weekly requirement. Finally, most pre-reform funds meet the WAL requirement.

We examine the extent of changes in daily and weekly liquidity and WAL_{ft} of funds after the reforms. Daily liquid assets, $DLiq_{ft}$, include US Treasury securities of any maturity and any security that can be liquidated within one business day (SEC 2010, p.64). Weekly liquid assets, $WLiq_{ft}$, include any security that can be liquidated within five business days as well as US Treasury securities of any maturity and US government agency securities maturing within 60 days. Our $DLiq_{ft}$ and $WLiq_{ft}$ are conservative measures of liquidity because they do not take into account the cash holdings of the funds, as they are unavailable. In robustness tests we redefine $DLiq_{ft}$ and $WLiq_{ft}$ to include "other assets" as a proxy for cash.[14] Our findings remain mostly unchanged. We expect $DLiq_{ft}$ and $WLiq_{ft}$ to increase, and WAL_{ft} to decrease after the reforms, in response to the required liquidity floor and WAL_{ft} ceiling for constrained funds. We decompose weekly liquidity holdings into US Treasury securities, $Treasury_{ft}$, agency securities that mature within 60 days, $AgcyLiq_{ft}$, and liquid assets in the form of short-term securities that can be liquidated within five business days, $NonGovLiq_{ft}$. We do this to determine the type of instruments that the funds prefer to hold, as these may have consequences for the demand of such instruments.

Table 3.1 reports the averages and statistical significance of liquidity and other variables that describe the composition of MMF portfolios. Results are shown for both the "constrained" and "unconstrained" funds before and after reforms. On average, the constrained funds have increased their post-reform weekly liquidity by 22.4% of net assets, half of which is achieved by larger holdings of daily liquid assets

[14] "Other Assets" are reported in Item 14 on the N-MFP form. It includes cash, receivables from brokers, receivables for fund shares sold, receivable for interest, and prepaid expenses.

(11.7%). The funds have adjusted to higher liquidity by holding more treasury securities (+2.8%) but mostly more short-term non-government securities (+21%) due to their higher yield.

Before reforms, the average WAL_{ft} is approximately 85 days, which is already less than 120 days. This is because, even in the absence of the requirements, the fund managers were using weighted average life limits to reduce portfolio risk (SEC 2010). However, there are several funds that had $WAL_{ft.}$ higher than 120 days. The constrained funds have decreased their WAL_{ft} by approximately 19 days. They have also considerably increased their investments (+19.3%) in short-term securities maturing within three months, $OA_{0\text{-}3m,ft}$, which is consistent with the large liquidity gains reported above. To the same effect, MMFs have decreased investments (-6.8%) in securities that mature from 9 to 13 months, $OA_{9\text{-}13m,ft}$.

An increase in liquid assets is expected to translate into lower portfolio yields. Thus, we examine the impact on the average excess yield of the constrained funds after the reforms. As expected, the funds are earning less excess yield on their short-term investments $Spread_{0\text{-}3m,ft}$. In response to such a decrease, it is possible that the funds increased investment in higher yielding securities, to compensate for the drop in the earnings. We test this hypothesis and find some evidence that the funds, on average, earn 37 bps higher excess yield from the investments in longer dated securities, $Spread_{9\text{-}13m,ft}$, after the reforms. However, overall $PortRisk_{ft}$ calculated as the difference between the gross yield of the fund's assets and the 1-month Treasury bill rate has fallen. This indicates that the regulatory changes have indeed put pressure on the funds' profitability. To test whether investors have withdrawn from prime funds because of the lower yields, we look at the variation in the funds' net assets following the reform. We find that the change is slightly negative but not statistically significant.

We now turn to unconstrained funds. We observe that their weekly liquidity also increased but significantly less than for constrained funds. They seem to do so by holding higher daily liquidity and substituting agency securities with short-term non-government securities which, again, is probably motivated by the higher yield of the latter. The increase in liquidity in unconstrained funds beyond the levels required by the new rules, suggests that those funds have a higher degree of risk-aversion. This is possibly to differentiate themselves from other riskier prime funds in order to be able to attract risk-averse shareholders who may use MMFs for safe cash parking rather than as investment vehicles. Unconstrained funds on average increase the WAL_{ft}, but the average remains lower than that of the constrained funds. No major differences are found relative to constrained funds on the other portfolio characteristics. Column 8 shows the extent to which constrained and unconstrained funds have become (dis)similar, after the reforms. The overall message is that the two groups have moved towards similar liquidity levels and risk profile in the post-reform period.

In summary, we find that there have been considerable changes in the portfolio composition of MMFs. These changes have resulted in increased liquidity and have positioned funds to be more resilient in times of heavy outflows. This, however, has come to the cost of substantially lower portfolio yields.

3.3.2 Impact on the Resilience of MMFs

In the summer of 2011, the sovereign debt crisis worsened and began to spread from Greece, Ireland and Portugal to other Euro area countries. Credit default spreads of Eurozone banks increased sharply amidst concerns over their solvency. Consequently, investors started withdrawing from MMFs due to their holdings of bank assets. Chernenko and Sunderam (2014) find that MMFs with greater exposure to Eurozone banks suffered more outflows. As a result, these funds experienced liquidity problems. This affected their ability to provide short term funding to non-European issuers, which were affected by a credit crunch. This crisis period provides a setting to test the resilience of MMFs after reforms. As investors' withdrawals were most prominent in the period from June to September 2011 (Figure 3.5), we focus on this period for our counterfactual analysis. We construct a counterfactual excess liquidity measure, C_ExWLiq_{ft} (C_ExDLiq_{ft}) which is defined as the lagged average weekly (daily) liquidity in excess of outflows. This variable captures the amount of excess liquidity that the funds would have maintained during the crisis, had they continued to hold the same level of weekly (daily) liquidity as before the reforms. We also calculate the actual excess weekly (daily) liquidity, $ExWLiq_{ft}$ ($ExDLiq_{ft}$) which is the difference between the outflows and lagged weekly (daily) liquidity. We employ these to analyse the extent to which constrained and unconstrained funds have become more stable compared to the pre-reform period.

Table 3.2 presents our results. Columns 1-3 show that, after the reforms, the constrained funds have 41 percent weekly excess liquidity after servicing redemptions. This would have been only 17 percent if the pre-reform level of liquidity had been maintained, which points to a considerable increase of 24 percent in the liquidity cushion of prime MMFs. Daily excess liquidity has also increased by a substantial 13.5 percent to 22.3 percent. Columns 4-6 show that the unconstrained funds have increased both daily and weekly excess liquidity as well. But their adjustments are lower in magnitude. Post-reform, these funds continue to have higher excess liquidity than constrained funds. These results confirm that both groups are more resilient when under sustained pressure from high redemptions, as compared to their pre-reform condition.

On average, as columns 2 and 5 suggest, most funds, even in the absence of reforms held enough liquidity to service their redemption requests comfortably. However, it should be noted that the liquidity requirements are set in response to the redemption behaviour of investors during the global financial crisis, a time when the funds experienced much higher distress than the episode under study. However, when we look at the distribution of excess liquidity across all funds, instead of the average fund, we observe that at least 18 (9) funds with higher proportion of assets invested in Eurozone banks would have had a shortfall in daily (weekly) liquidity after servicing redemptions, had they kept pre-reform liquidity levels. But these marginal funds managed to have positive actual excess daily and weekly liquidity which could largely be attributed to the 2010 Amendments because of their binding minimum liquidity requirements.

3.3.3 Factors Influencing MMF Liquidity Holdings

The 2010 Amendments have a general liquidity requirement which requires that the fund management and board of directors consider the redemption behaviour of their investors. This is called the "know your investors" rule. Depending upon the volatility of shareholder redemptions, a fund must hold greater liquidity than that required by the daily and weekly minimum levels mandated by the 2010 Amendments. Consistent with this requirement, most funds in our sample hold more liquidity than the regulatory minimum.

In this section, we assess the factors that influence the funds' decision to hold higher liquidity than required with the following monthly fixed effects model,

$$WLiq_{ft} = \alpha_f + \beta_1 FlowVol_{ft-1} + \beta_2 ExpOutflows_{ft-1} + \beta_3 ExpInflows_{ft-1} + \beta_4 PortVol_{ft-1} + \beta_5 InstShare_{ft-1} + \beta_6 Size_{ft-1} + \varepsilon_{ft} \qquad eq.\ (1)$$

The dependent variable is weekly liquidity, $WLiq_{ft}$ measured as before. The main explanatory variables include $FlowVol_{ft}$, which measures the risk the funds face due to shareholders' behaviour (uncertainty of inflows/outflows) and $PortVol_{ft}$, which measures the extent to which a fund's excess yield changes from month to month. Since we expect those funds that anticipate higher outflows to hold more liquidity we also employ $ExpOutflows_{ft}$ to capture a fund's expected redemption levels. In addition, we analyse how the funds adjust their liquidity levels if they expect more subscriptions, $ExpInflows_{ft}$.

The literature argues that investors respond differently in tranquil and crisis times (Jacklin and Bhattacharya 1988; Jank and Wedow 2015). Therefore, we divide our sample into "Calm" (September-December 2012)[15] and "Crisis" (June-September 2011) periods. We assess how the above-mentioned factors influence the weekly and

[15] Ideally, we would like to analyze the period from February to May 2011 as the "Calm" period, as we later would in the rest of paper, it is not possible to do so here because we use November 2010 to May 2011 to calculate the explanatory variables used in the regression analysis. Therefore, instead we use September to December 2012 for the "Calm" period.

daily liquidity of the funds. In all regressions, we control for fund size, $Size_{ft}$ and institutional share, $InstShare_{ft}$.

Table 3.3 displays our results for weekly liquidity. We estimate eq. (1) first using fund fixed effects (columns 1 and 3) and then with fund and time fixed effects (columns 2 and 4) for both crisis and calm periods. We find that during the crisis prime MMFs with riskier portfolios and higher expected outflows increase their weekly liquidity levels. This is in line with Witmer (2018) who finds that funds that are more vulnerable to runs hold more liquidity.

This demonstrates that funds with higher portfolio risk and redemption risk have a more cautious attitude in stressful times and respond by actively adjusting their liquidity levels. Interestingly, the funds with higher flow volatility have lower liquidity levels, which is counterintuitive. A possible explanation is that the funds that have witnessed larger changes in net inflows in the past are those who faced larger redemptions which left them with lower liquidity.

Next, we look at the "Calm" period. We choose this to be between September and December 2012 because we need several months of data to compute portfolio volatility and we aim to avoid any overlap between the crisis and calm periods. Similar to the crisis period, funds that expect higher outflows hold more liquidity to meet redemptions. However, differently from the crisis period, the coefficient of $PortVol_{ft}$ is now negative, probably indicating that portfolio risk is not believed to pose serious liquidity shortages. The funds that serve investors with highly unpredictable investment behaviour are left with lower liquidity during calm periods as well. The coefficients of $Size_{ft}$ and $InstShare_{ft}$ are insignificant.

In Table 3.4 we repeat the analysis for daily liquidity. Results are similar to those for weekly liquidity with a few exceptions. During crises, consistent with previous findings, funds keep more daily liquid assets if they expect higher outflows and hold a riskier portfolio. The funds serving a more volatile shareholder base tend to have lower daily liquidity. Finally, we find some evidence that funds with bigger size seem to have more liquidity, but it disappears when we control for time fixed effects.

Our results are robust to an alternative definition of weekly and daily liquidity which includes cash (see appendix A2 and A3) and to the addition of a lagged dependent variable among the regressors to control for possible persistence in liquidity levels (see appendix A4 and A5). In addition, because we estimate the variables $ExpOutflows_{ft}$ and $ExpInflows_{ft}$ using a regression, our results might suffer from generated regressor bias (Pagan 1984). We correct for this by calculating standard errors using the bootstrap procedure to address the uncertainty related to the first-stage regression and find that our results are robust (see appendix A6 and A7).

3.3.4 Investors' Response to Liquidity

In this section, we examine the redemption behaviour of MMF shareholders in response to the level of fund liquidity. We investigate whether higher liquidity signals health, boosting investor confidence in the fund and providing protection against panic-driven runs.

There is abundant literature on the negative effects of outflows on remaining investors in the fund (Edelen 1999; Nanda et al. 2000). Therefore, there is an incentive to withdraw earlier than others which leads to "self-fulfilling runs". Jank and Wedow (2015), with a sample of German money funds, show that the funds with lower liquidity have lower outflows in bad times, but also experience lower inflows during good times. In other words, liquidity, which may come at the cost of lower yields, may or may not be attractive to investors depending on market conditions. However, Jank and Wedow (2015) do not differentiate between low risk and high risk funds. It is plausible to expect that investors may respond differently to liquidity when the fund is riskier. We extend their analysis by studying the role of fund liquidity in tandem with the level of credit risk in the funds. We estimate the following monthly panel fixed effects,

$$NetInflows_{ft} = \alpha_f + \beta_1 WLiq_{ft-1} + \beta_2 EZB_{ft-1} + \beta_3 Low\ EZB_f * WLiq_{ft-1} + \beta_4 High\ EZB_f * WLiq_{ft-1} + \beta_5 WAL_{ft-1} + \beta_6 InstShare_{ft-1} + \beta_7 NetYield_{ft-1} + \beta_8 ExRatio_{ft-1} + \beta_9 NetInflows_{ft-1} + \varepsilon_{ft} \qquad eq.\ (2)$$

The dependent variable across all regressions is $NetInflows_{ft}$. All other variables are defined as before. Table 3.5 shows the results. We estimate eq. (2) using fund fixed effects in columns 1 and 3 and add time fixed effects as well in columns 2 and 4 for both crisis and calm periods. We find that during tranquil times (columns 1 and 2) fund liquidity and net inflows have a negative but not statistically significant relationship. We use Eurozone bank exposure, EZB_{ft} as a measure of portfolio credit risk. Consistent with the results of Chernenko and Sunderam (2014) the funds with higher EZB_{ft} share in their portfolio, attract more investors in good times as this would generate higher yields. We also interact the fund's liquidity with dummies that identify low and high exposure to Eurozone banks. We do so to test whether investors' response to liquidity varies depending on the level of credit risk. However, the coefficient of both interaction terms is not statistically significant. Consistent with the performance-flow relationship documented in the literature,[16] we observe that a fund receives higher inflows if it has invested in longer term securities, as measured by the weighted average life (WAL_{ft}) of the fund. Furthermore, the proportion of institutional investors among the fund's shareholders is negative and highly significant. A possible explanation is that such investors use these funds for temporary cash management, and hence withdraw more frequently than other investors to meet short-term liquidity needs.

We repeat the analysis between June and September 2011 when the sovereign debt crisis worsened. In line with the findings of Jank and Wedow (2015) and Witmer (2018) the coefficient of liquidity is negative in calm periods and positive in a crisis (model 3 and 4). This suggests that, in a crisis, liquidity helps contain redemptions while this is not the case in normal market conditions. However, although the sign of the liquidity coefficient is as expected, in our analysis it is not statistically significant probably due to our smaller sample size.

The exposure to Eurozone banks now turns negative and significant, which shows that funds with higher credit risk consistently face higher redemption pressure during the crisis. Moreover, higher liquidity does not appear to reduce outflows when the exposure to Eurozone banks is high. In fact, the coefficient of the interaction term High EZB*WLiq is negative and significant. But when we look at the overall effect of liquidity in high credit risk funds through a Wald test on WLiq*(1+ EZB) we confirm that net inflows do not appear to be related to liquidity

[16] See, for instance, Chernenko and Sunderam (2014), Christoffersen (2001), Christoffersen and Musto (2002), Kacperczyk and Schnabl (2013), Jank and Wedow (2015) and Collins and Gallagher (2016).

(see appendix A10). More specifically, if the source of risk is fund-specific, higher liquidity does not help to contain redemptions.

In addition, we look at how net inflows are affected by management fees, as proxied by the funds' expense ratio. We find the expense ratio to influence net inflows positively during the crisis. This may be because higher fees identify actively managed funds which may give more confidence to investors about the funds' ability to outperform their peers under uncertain market conditions (Morningstar 2015).

We repeat the above analysis with daily liquidity. Results are reported in table 3.6 and are in line with those obtained with weekly liquidity. An exception is the negative and significant coefficient of daily liquidity in the calm period. This suggests that daily liquidity is not regarded positively by investors when the markets are stable. Higher liquidity leads to lower returns and investors seek riskier investments to boost yields. However, the result is not confirmed in our robustness tests. These are based on revised liquidity measures that include cash holdings. All the other main results are confirmed (see appendix A8 and A9).

The design of the model is so that one might argue that the sub-sample periods (Calm and Crisis) have been defined based on the dependent variable so that in one period we mainly explain inflows and in the other we mainly explain outflows (see Figure 3.5). So, the distribution of the left-hand-side variable across the sub-sample periods may not be comparable. To alleviate this concern, we plot the distribution of $NetInflows_{ft}$ (see appendix A11) and find that the distribution of net inflows is evenly distributed (bell-shaped) in both Calm and Crisis period. This is because NetInflows in Figure 3.5 are not relative to fund size but are stated in aggregate dollar terms. However, the dependent variable used here is calculated relative to the lagged net assets of the funds. Therefore, the dependent variable in this setting is fit for purpose. However, to be cautious we conduct further robustness tests using a nested model instead of considering sub-sample periods separately and find that the our results are confirmed (see appendix A12 and A13).

3.4 Conclusion

This paper explores the changes in the behaviour of MMFs after the introduction of new liquidity requirements that are designed to improve the stability of money market funds. We see substantial changes in the composition of the funds' portfolios, after reforms. As expected, portfolio liquidity has increased while asset maturity has declined. This has led to a safer asset mix and equipped funds to withstand high redemption pressure. The finding is corroborated by our counterfactual analysis that explores what would have happened if the funds had maintained the same level of liquidity they had before the reforms. We observe that during the sovereign debt crisis MMFs met redemption pressure easily and had excess liquidity left unused. However, the liquidity shocks during the sovereign debt crisis were mild in comparison with the post-Lehman events in 2008. So, whether MMFs could withstand harsh scenarios remains to be tested. In addition to this, even though higher liquidity has reduced portfolio risk it has also put a downward pressure on portfolio returns which reduces the overall profitability of MMFs. This may have consequences for their ability to survive especially in an environment with near zero interest rates.

We also see that MMFs seem to be relatively acquainted with the redemption behaviour of their shareholder base and keep higher liquidity when expecting higher redemption pressure. On the other hand, when we investigate the response of investors to higher fund liquidity, we find it to be neutral. Instead investors respond to the fund's credit risk. This suggests that investors' behaviour may be driven more by their concerns about the preservation of capital rather than the funds' ability to meet redemptions.

Figures

Figure 3.1: Timeline (Jan 2009 – Dec 2012)

Before reform period includes January to December 2009. Reform period starts from the announcement of reforms in February 2010 to full implementation in November 2010. After reform period starts in November 2010, when the N-MFP form data become available, and ends in December 2012.

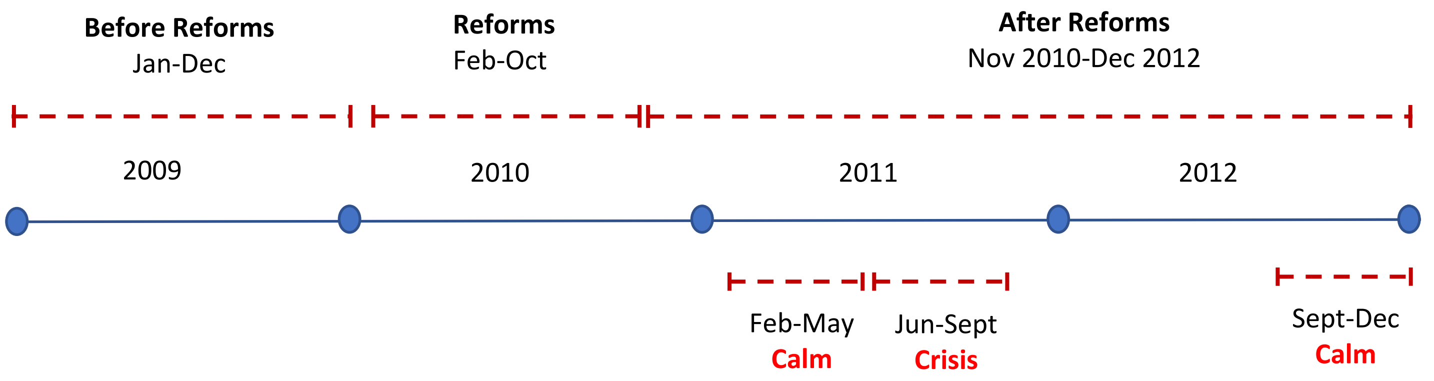


Figure 3.2: Distribution of Weighted Average Life (WAL) Before and After the 2010 Amendments

This figure shows box-and-whisker plots of WAL_{ft} across funds by each quarter during Before Reform period (January–December2009), and by monthly frequency for a subsample (February – September 2011) during After Reform period. Rectangles show the interquartile range (IQR), which represent the 25th to 75th percentile, and the horizontal line in the middle of the rectangle is median. The ends of the lines below and above the rectangle represent the minimum and maximum values from Q1 − 1.5 * IQR to Q1 and from Q3 to Q3 + 1.5 * IQR, respectively. The observations falling outside of this range, are outliers denoted with a dot. (Source: N-Q, N-CSR, N-CSRS, and N-MFP forms data, authors' own calculations.)

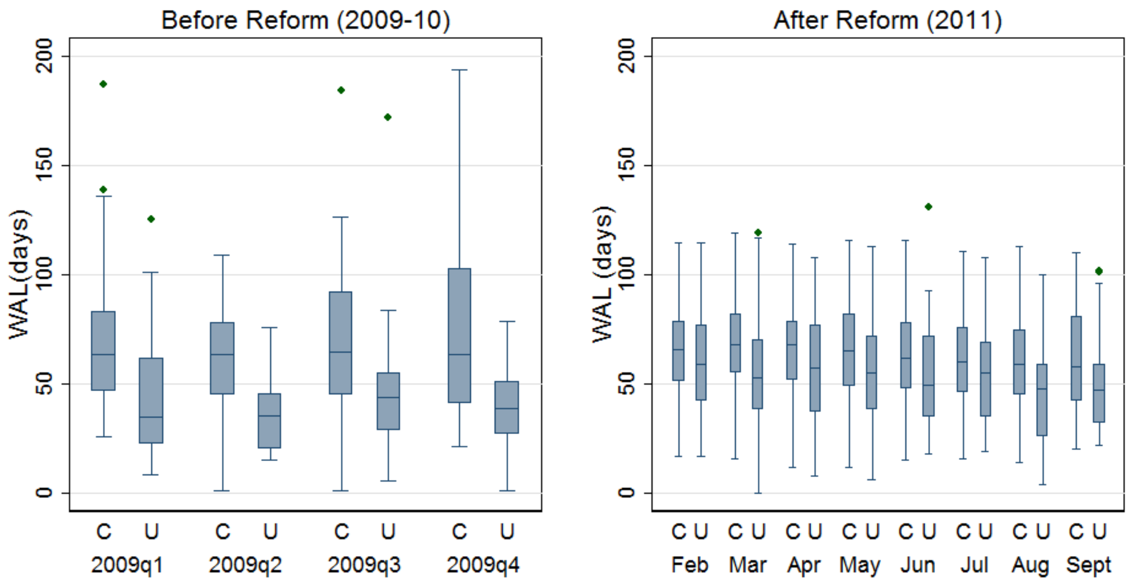


Figure 3.3: Distribution of Daily Liquidity Before and After the 2010 Amendments

This figure shows box-and-whisker plots of Daily Liquidity ($DLiq_{ft}$) across funds by each quarter during Before Reform period (January–December2009), and by monthly frequency for a subsample (February – September 2011) during After Reform period. Rectangles show the interquartile range (IQR), which represent the 25th to 75th percentile, and the horizontal line in the middle of the rectangle is the median. The ends of the lines below and above the rectangle represent the minimum and maximum values from Q1 − 1.5 * IQR to Q1 and from Q3 to Q3 + 1.5 * IQR, respectively. The observations falling outside of this range, are outliers denoted with a dot. (Source: N-Q, N-CSR, N-CSRS, and N-MFP forms data, authors' own calculations.)

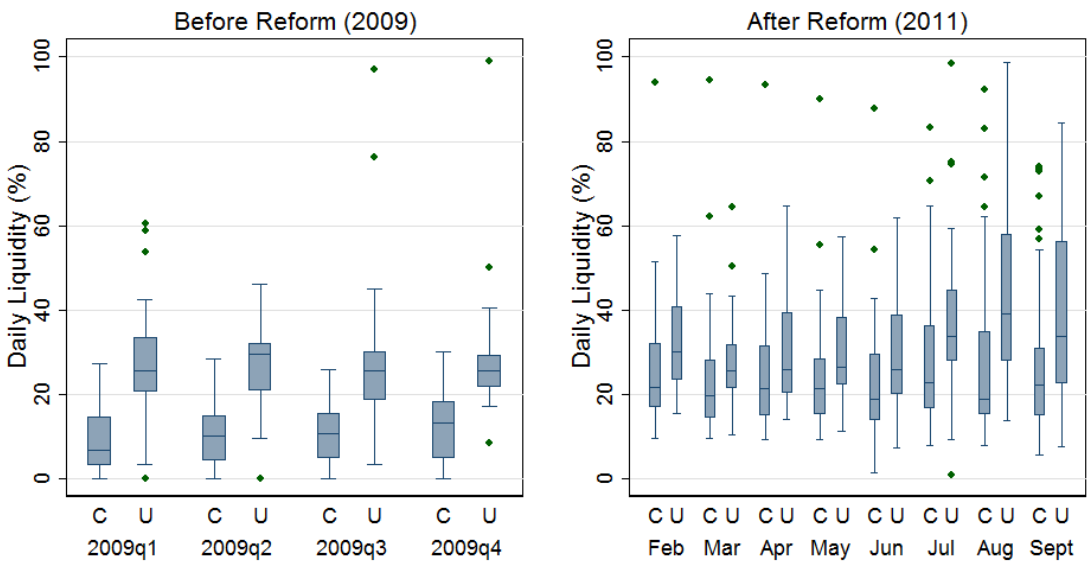
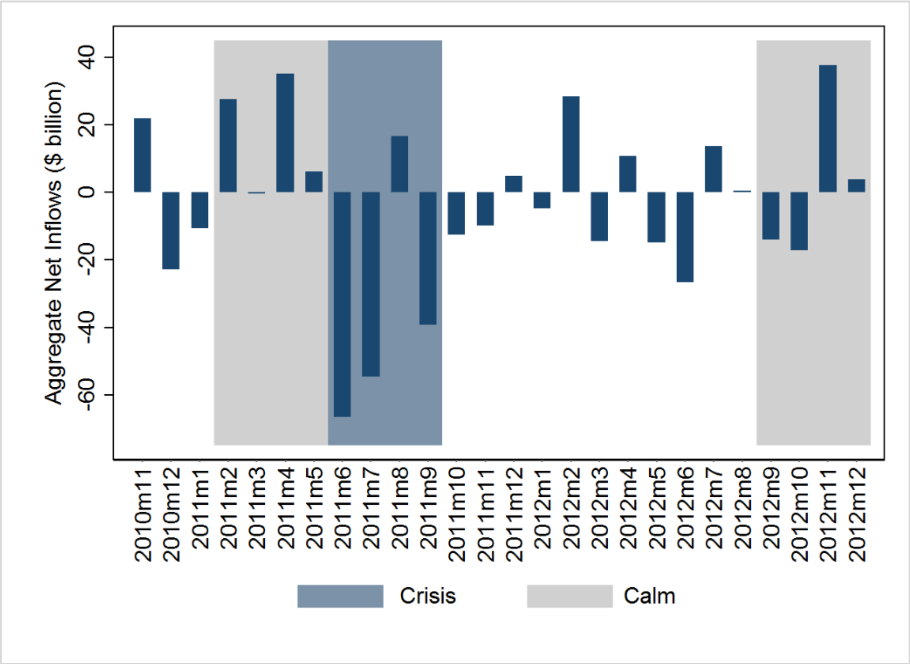


Figure 3.4: Distribution of Weekly Liquidity Before and After the 2010 Amendments

This figure shows box-and-whisker plots of Weekly Liquidity ($WLiq_{ft)}$ across funds by each quarter during Before Reform period (January – December2009), and by monthly frequency for a subsample (February – September 2011) during After Reform period. Rectangles show the interquartile range (IQR), which represent the 25th to 75th percentile, and the horizontal line in the middle of the rectangle is the median. The ends of the lines below and above the rectangle represent the minimum and maximum values from Q1 − 1.5 * IQR to Q1 and from Q3 to Q3 + 1.5 * IQR, respectively. The observations falling outside of this range, are outliers denoted with a dot. (Source: N-Q, N-CSR, N-CSRS, and N-MFP forms data, authors' own calculations.)

Figure 3.5: Aggregate Net Inflows of the US MMFs (Nov 2010 – Dec 2012)

This figure demonstrates aggregate net inflows of money market funds during the sovereign debt crisis (June-September 2011) and two calm periods used in this paper (February-May 2011 and September-December 2012). Aggregate Net Inflows are the sum of money market funds' net inflows each month. (Source: N-MFP forms data, authors' own calculations).



Tables

Table 3.1: Portfolio Characteristics Before and After 2010 Amendments

The table presents averages of the variables before reforms ("Before" is the period from January-December 2009 with quarterly reported data compiled from the forms N-Q, N-CSRS and N-CSR filed with SEC), and after reforms ("After" is the period from February-May 2011 with monthly data compiled from the form N-MFP filed with SEC). Constrained funds are the funds that held less than 30 percent average weekly liquidity before reforms. Unconstrained funds represent the funds that held more than or equal to 30 percent average weekly liquidity before reforms. "C-U" represents the difference between the "Constrained" and "Unconstrained" group. Diff is the difference between "After" and "Before" reform variables. . $DLiq_{ft}$ represents daily liquid assets of a fund as a percentage of its net assets. It includes any security that matures or have a demand feature that allows it to be converted to cash within one business day and US Treasury securities of any maturity. $WLiq_{ft}$ represents weekly liquid assets of a fund as a percentage of its net assets. It includes (1) any security that matures or has a demand feature that allows it to be converted to cash within five business days, $NonGovLiq_{ft}$ (2) US government agency securities that matures within sixty days, $AgcyLiq_{ft}$, (3) US Treasury securities of any maturity, $Treasury_{ft}$. WAL_{ft} is Weighted Average Life calculated as average days to maturity weighted by the investment weight of each security. $OA_{0\text{-}3m,ft}$ and $OA_{9\text{-}13m,ft}$ measure the aggregate investment weight of portfolio securities maturing within 0-3 months maturities and 9-13 months, respectively. $Spread_{0\text{-}3m,ft}$ measures the difference between weighted issuer yield of securities maturing within 3 months, and 3-month treasury bill. $Spread_{9\text{-}13m,ft}$ measures difference between weighted issuer yield of securities maturing within 9-13 months and 12-month treasury bill. $PortRisk_{ft}$ measures difference between gross yield of the fund portfolio and 1-month Treasury bill. $NetAssets_{ft}$ is the value of net assets reported on monthly and quarterly forms. It is equal to the total value of the fund's securities plus other assets less liabilities. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Constrained Funds (C)			Unconstrained Funds (U)			"C-U"		
	Before	After	Diff	Before	After	Diff	Before	After	Diff
Mean	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$DLiq_{ft}$ %	11.51***	23.21***	11.70***	25.94***	32.14***	6.203**	-14.43***	-8.925***	5.502*
$WLiq_{ft}$ %	19.11***	41.53***	22.42***	39.17***	45.45***	6.280**	-20.06***	-3.918	16.14***
$Treasury_{ft}$ %	2.317***	5.164***	2.848***	3.024***	2.959***	-0.0644	-0.707	2.205	2.912*
$AgcyLiq_{ft}$ %	3.921***	2.597***	-1.324	11.34***	6.034***	-5.305**	-7.418***	-3.437***	3.980**
$NonGovLiq_{ft}$ %	12.87***	33.84***	20.97***	24.48***	35.51***	11.03***	-11.60***	-1.664	9.941***
WAL_{ft} (days)	84.60***	65.95***	-18.65**	44.08***	60.57***	16.49***	40.51***	5.380	-35.13***
$OA_{0\text{-}3m,ft}$ %	67.43***	86.77***	19.34***	81.98***	88.96***	6.984***	-14.55***	-2.194*	12.35**
$OA_{9\text{-}13m,ft}$ %	9.190***	2.342***	-6.848***	10.40*	3.313***	-7.086	-1.209	-0.971**	0.238
$Spread_{0\text{-}3m,ft}$ (bps)	43.13***	21.42***	-21.71***	35.03***	19.95***	-15.07***	8.102	1.467	-6.635
$Spread_{9\text{-}13m,ft}$ (bps)	58.46***	95.07***	36.61*	37.93***	81.85**	43.92	20.53	13.22	-7.306
$PortRisk_{ft}$ (bps)	53.13***	28.02***	-25.12***	43.55***	25.31***	-18.25***	9.578	2.707	-6.871
$NetAssets_{ft}$ ($ bn)	5.389***	5.359***	-0.0306	3.914***	4.572***	0.658	1.475	0.787	-0.688
No of funds	70	70	70	30	30	30	100	100	100

Table 3.2: Excess Liquidity During the Sovereign Debt Crisis – Counterfactual Analysis

The table shows averages of the stated variables during the sovereign debt crisis (June-September 2011). $ExDLiq_{ft}$ is the excess daily liquidity calculated as the difference between lagged daily liquidity and $Outflows_{ft}$. C_ExDLiq_{ft} is counterfactual excess daily liquidity calculated as the difference between average pre-reform daily liquidity and $Outflows_{ft}$. $ExWLiq_{ft}$ is the excess weekly liquidity calculated as difference between lagged weekly liquidity and $Outflows_{ft}$. $Outflows_{ft}$ are the negative net inflows during the crisis period. C_ExWLiq_{ft} is counterfactual excess weekly liquidity which the funds would have had in the absence of reforms. It is calculated as the difference between average pre-reform weekly liquidity and $Outflows_{ft}$. "C-U" represents difference between the constrained and unconstrained group. Diff is the difference between excess liquidity and counterfactual liquidity. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Constrained Funds (C)			**Unconstrained Funds (U)**			**"C-U"**		
	$ExDLiq_{ft}$	**C_ExDLiq_{ft}**	**Diff**	**$ExDLiq_{ft}$**	**C_ExDLiq_{ft}**	**Diff**	**$ExDLiq_{ft}$**	**C_ExDLiq_{ft}**	**Diff**
Mean	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Daily %	22.34***	8.985***	13.46***	31.58***	25.31***	6.365**	-9.233***	-16.33***	7.095**
	(1.452)	(0.878)	(1.649)	(2.390)	(2.174)	(3.061)	(2.694)	(1.955)	(3.201)
	$ExWLiq_{ft}$	C_ExWLiq_{ft}	Diff	$ExWLiq_{ft}$	C_ExWLiq_{ft}	Diff	$ExWLiq_{ft}$	C_ExWLiq_{ft}	Diff
Weekly %	40.53***	16.58***	24.05***	47.39***	39.91***	7.580**	-6.858***	-23.32***	16.47***
	(1.318)	(1.365)	(1.978)	(2.344)	(3.126)	(3.378)	(2.515)	(2.916)	(3.717)
No of funds	70	70	70	30	30	30	100	100	100

Table 3.3: Know Your Investor (Weekly Liquidity)

This table presents results for panel regressions. We include time fixed effects in Columns 1 and 3, we additionally control for fund fixed effects in Columns 2 and 4. The analysis is divided into "Crisis" (June- September 2011) and "Calm" (September-December 2012) period. Ideally, we would like to analyse the period from February-May 2011 for "Calm" period, as we later would in the rest of paper, it is not possible to do it here because we use November 2010 – May 2011 to calculate the explanatory variables used in the regressions. The dependent variable is $WLiq_{ft}$. It represents weekly liquid assets of a fund as a percentage of its net assets. It includes any security that matures or has a demand feature that allows it to be converted to cash within five business days, US government agency securities that mature within sixty days, and US Treasury securities of any maturity. $FlowVol_{ft}$ is rolling standard deviation of $NetInflows_{ft}$ of a fund with fixed window of seven months (window starts from November 2010). $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets. The $ExpOutflows_{ft}$ are the forecasted outflows. $ExpInflows_{ft}$ are forecasted inflows. $PortVol_{ft}$ is rolling standard deviation of $PortRisk_{ft}$ of a fund with fixed window of seven months. $Size_{ft}$ is log of net assets. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. All variables except $WLiq_{ft}$ and $Size_{ft}$ are winsorized at 1st and 99th percentile. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1

	Crisis (June-Sept 2011)		**Calm (Sept-Dec 2012**	
DEP VAR: $WLiq_{ft}$	(1)	(2)	(3)	(4)
$FlowVol_{ft-1}$	-0.4587**	-0.8166***	-0.2015*	-0.1852*
	(0.1942)	(0.2114)	(0.1071)	(0.1110)
$ExpOutflows_{ft-1}$	3.0549***	1.5903*	3.0788**	2.9516**
	(0.9795)	(0.9169)	(1.3818)	(1.3990)
$ExpInflows_{ft-1}$	1.6272	1.7885	6.8922	7.1770
	(1.2483)	(1.1559)	(4.9981)	(4.6476)
$PortVol_{ft-1}$	0.8089	1.4093***	-0.8091*	-1.0770*
	(0.5616)	(0.5130)	(0.4766)	(0.5655)
$InstShare_{ft-1}$	-0.4703	-0.1653	0.1186	0.1571
	(0.2873)	(0.2883)	(0.2311)	(0.2345)
$Size_{ft-1}$	9.9034	6.4598	-1.5892	-2.0843
	(6.2114)	(5.7791)	(6.0458)	(6.4534)
Constant	-127.1064	-78.7742	80.8676	88.5106
	(128.8224)	(118.7510)	(124.1131)	(133.1175)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.8334	0.8468	0.8960	0.8995
N	560	560	560	560

Table 3.4: Know Your Investor (Daily Liquidity)

This table presents results for panel regressions. We include time fixed effects in Columns 1 and 3, we additionally control for fund fixed effects in Columns 2 and 4. In some regressions, we add time fixed effects to control for global risks. The analysis is divided into "Crisis" (June- September 2011) and "Calm" (September-December 2012) period. Ideally, we would like to analyse the period from February-May 2011 for "Calm" period, as we later would in the rest of paper, it is not possible to do it here because we use November 2010 – May 2011 to calculate the explanatory variables use in the regressions. Therefore, instead we use September-December 2012 for "Calm" period. The dependent variable is $DLiq_{ft}$. It represents daily liquid assets of a fund as a percentage of its net assets. It includes any security that matures or has a demand feature that allows it to be converted to cash within one business day and US Treasury securities of any maturity. $FlowVol_{ft}$ is rolling standard deviation of $NetInflows_{ft}$ of a fund with fixed window of seven months (window starts from November 2010). $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets.The $ExpOutflows_{ft}$ are the forecasted outflows. $ExpInflows_{ft}$ are forecasted inflows. $PortVol_{ft}$ is rolling standard deviation of $PortRisk_{ft}$ of a fund with a fixed window of seven months. $PortRisk_{ft}$ measures difference between gross yield of the fund portfolio and 1-month Treasury bill. $Size_{ft}$ is log of net assets. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. All variables except $DLiq_{ft}$ and $Size_{ft}$ are winsorized at 1st and 99th percentile. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Crisis (June-Sept 2011)		**Calm (Sept-Dec 2012**	
DEP VAR: $DLiq_{ft}$	(1)	(2)	(3)	(4)
$FlowVol_{ft-1}$	-0.2548	-0.5220***	-0.2066*	-0.2032*
	(0.1949)	(0.1975)	(0.1235)	(0.1166)
$ExpOutflows_{ft-1}$	2.3594***	1.3401*	0.3974	0.1220
	(0.8891)	(0.7990)	(1.1097)	(1.1336)
$ExpInflows_{ft-1}$	0.9645	0.4171	2.0704	1.8162
	(0.9145)	(0.8803)	(1.3019)	(1.4208)
$PortVol_{ft-1}$	0.8473	1.2535**	-0.5932	-0.9368*
	(0.5244)	(0.5859)	(0.4074)	(0.5497)
$InstShare_{ft-1}$	-0.0077	0.1061	0.2767	0.3359**
	(0.2957)	(0.2643)	(0.1740)	(0.1655)
$Size_{ft-1}$	10.4631*	9.3625	7.0843*	6.3957
	(6.0377)	(5.7108)	(3.8627)	(4.2376)
Constant	-192.2726	-180.4398	-135.3105*	-125.1017
	(124.0374)	(116.3412)	(78.4758)	(86.4692)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.791	0.808	0.848	0.851
N	560	560	560	560

Table 3.5: Investor Response to Weekly Liquidity

The table presents results of panel regressions. We include fund fixed effects in Columns 1 and 3, we additionally control for time fixed effects in Columns 2 and 4. The analysis is divided into "Calm" (February-May 2011) and "Crisis" (June- September 2011) period. The dependent variable is $NetInflows_{ft}$. $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets. $WLiq_{ft}$ represents weekly liquid assets of a fund as a percentage of its net assets. It includes any security that matures or has a demand feature that allows it to be converted to cash within five business days, US government agency securities that mature within sixty days, and US Treasury securities of any maturity. EZB_{ft} is share of a fund's portfolio invested in Eurozone banks that were part of 2011 stress tests. We divide the funds into low, medium and high terciles based on fund portfolio invested in Eurozone banks, Low EZB_f and High EZB_f represent funds with lowest and highest EZB_{ft} tercile, respectively. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. WAL_{ft} is Weighted Average Life calculated as remaining time to maturity of the investment, weighted by its investment weight in fund portfolio. $NetYield_{ft}$ is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP forms. $ExRatio_{ft}$ is the expense ratio of funds, calculated as a difference between gross yield and net yield. GrossYield is the value-weighted average of issuer yields. $NetInflows_{ft}$, $NetYield_{ft}$ and $ExRatio_{ft}$ are winsorized at 1st and 99th percentile to remove outliers. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Calm (Feb-May 2011)		Crisis (Jun-Sept 2011)	
DEP VAR: $NetInflows_{ft}$	(1)	(2)	(3)	(4)
$WLiq_{ft-1}$	-0.0392	-0.0523	0.0215	0.0497
	(0.0652)	(0.0666)	(0.0645)	(0.0622)
EZB_{ft-1}	0.2493***	0.2336**	-0.2800*	-0.3114*
	(0.0887)	(0.0952)	(0.1456)	(0.1633)
Low EZB_f * $WLiq_{ft-1}$	0.0537	0.0571	-0.0260	-0.0175
	(0.0483)	(0.0471)	(0.0269)	(0.0243)
High EZB_f * $WLiq_{ft-1}$	-0.0323	-0.0344	-0.0432***	-0.0345**
	(0.0283)	(0.0280)	(0.0156)	(0.0158)
WAL_{ft-1}	0.0770**	0.0728**	0.0346	0.0207
	(0.0376)	(0.0365)	(0.0608)	(0.0593)
$InstShare_{ft-1}$	-1.3844***	-1.3876***	-1.2073**	-1.0699**
	(0.1977)	(0.1985)	(0.5210)	(0.5105)
$NetYield_{ft-1}$	0.2184	0.2227	-0.2985	0.1172
	(0.3087)	(0.3192)	(0.4043)	(0.4204)
$ExRatio_{ft-1}$	0.1612	0.1761	0.3114**	0.5058***
	(0.1288)	(0.1365)	(0.1526)	(0.1528)
$NetInflows_{ft-1}$	-0.1096	-0.1280*	0.0917	0.0587
	(0.0729)	(0.0721)	(0.0829)	(0.0764)
Constant	79.2503***	80.3660***	77.6241**	61.1075*
	(13.6314)	(13.8027)	(35.4433)	(34.6894)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.0770	0.0863	0.0882	0.131
N	639	639	654	654

Table 3.6: Investor Response to Daily Liquidity

The table presents results of panel regressions. We include fund fixed effects in Columns 1 and 3, we additionally control for time fixed effects in Columns 2 and 4. The analysis is divided into "Calm" (February-May 2011) and "Crisis" (June- September 2011) period. The dependent variable is $NetInflows_{ft}$. $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets. $DLiq_{ft}$ represents daily liquid assets of a fund as a percentage of its net assets. It includes (1) any security that matures or has a demand feature that allows it to be converted to cash within one business day (2) US Treasury securities of any maturity. EZB_{ft} is share of a fund's portfolio invested in Eurozone banks that were part of 2011 stress tests. We divide the funds into low, medium and high terciles based on fund portfolio invested in Eurozone banks, Low EZB_f and High EZB_f represent funds with lowest and highest EZB_{ft} tercile, respectively. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. WAL_{ft} is Weighted Average Life calculated as remaining time to maturity of the investment, weighted by its investment weight in fund portfolio. $NetYield_{ft}$ is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP forms. $ExRatio_{ft}$ is the expense ratio of funds, calculated as the difference between gross yield and net yield. GrossYield is the value-weighted average of issuer yields. $NetInflows_{ft}$, $NetYield_{ft}$ and $ExRatio_{ft}$ are winsorized at 1st and 99th percentile to remove outliers. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Calm (Feb-May 2011)		**Crisis (Jun-Sept 2011)**	
DEP VAR: $NetInflows_{ft}$	(1)	(2)	(3)	(4)
$DLiq_{ft-1}$	-0.2424**	-0.2303**	0.0540	0.0703
	(0.1050)	(0.1062)	(0.0582)	(0.0574)
EZB_{ft-1}	0.2423***	0.2060**	-0.2623*	-0.2975*
	(0.0852)	(0.0916)	(0.1462)	(0.1608)
Low EZB_f * $DLiq_{ft-1}$	0.0863	0.0881	-0.0275	-0.0165
	(0.0697)	(0.0681)	(0.0430)	(0.0384)
High EZB_f * $DLiq_{ft-1}$	-0.0567	-0.0566	-0.0606***	-0.0536**
	(0.0496)	(0.0477)	(0.0214)	(0.0218)
WAL_{ft-1}	0.0565	0.0588	0.0420	0.0205
	(0.0383)	(0.0368)	(0.0581)	(0.0562)
$InstShare_{ft-1}$	-1.3043***	-1.2984***	-1.1913**	-1.0491**
	(0.2077)	(0.2118)	(0.5252)	(0.5152)
$NetYield_{ft-1}$	0.1918	0.1877	-0.2633	0.1715
	(0.3211)	(0.3260)	(0.3957)	(0.4155)
$ExRatio_{ft-1}$	0.2017	0.2034	0.3231**	0.5326***
	(0.1347)	(0.1367)	(0.1513)	(0.1554)
$NetInflows_{ft-1}$	-0.1179	-0.1277*	0.0941	0.0596
	(0.0729)	(0.0722)	(0.0826)	(0.0761)
Constant	79.5386***	79.6795***	74.7206**	58.8725
	(14.3400)	(14.8374)	(36.2219)	(35.6690)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.103	0.107	0.0879	0.133
N	639	639	654	654

Appendix A

A1. Variables Definitions

VARIABLE	DEFINITION
$AgcyLiq_{ft}$ (%)	The percentage of net assets invested in US government agency securities maturing within sixty days.
C_ExDLiq_{ft} (%)	$= \frac{\overline{DailyLiquidAssets_{f,pre-reform}}}{NetAssets_{f,pre-reform}} - \frac{Outflows_{f,t}}{NetAssets_{f,t-1}}$. $DailyLiquidAssets_{ft}$ include any security that matures or has a demand feature that allows it to be converted to cash within one business days and US Treasury securities of any maturity.
C_ExWLiq_{ft} (%)	$= \frac{\overline{WeeklyLiquidAssets_{f,pre-reform}}}{NetAssets_{f,pre-reform}} - \frac{Outflows_{f,t}}{NetAssets_{f,t-1}}$. $WeeklyLiquidAssets_{ft}$ include any security that matures or has a demand feature that allows it to be converted to cash within five business days, US government agency securities that mature within sixty days, and US Treasury securities of any maturity.
$ExRatio_{ft}$ (bps)	$= GrossYield_{ft} - NetYield_{ft}$
$ExDLiq_{ft}$ (%)	$= \frac{DailyLiquidAssets_{f,t-1}}{netassets_{f,t-1}} - \frac{Outflows_{f,t}}{netassets_{f,t-1}}$. $DailyLiquidAssets_{ft}$ include any security that matures or has a demand feature that allows it to be converted to cash within one business days and US Treasury securities of any maturity.
$ExWLiq_{ft}$ (%)	$= \frac{WeeklyLiquidAssets_{f,t-1}}{NetAssets_{f,t-1}} - \frac{Outflows_{f,t}}{NetAssets_{f,t-1}}$. $WeeklyLiquidAssets_{ft}$ include any security that matures or has a demand feature that allows it to be converted to cash within five business days, US government agency securities that mature within sixty days, and US Treasury securities of any maturity.
$ExpInflows_{ft}$ (%)	$= FORECASTED\ NetInflows_{ft}$ if $NetInflows_{ft} \geq 0$ $FORECASTED\ NetInflows_{ft} = \alpha + \sum_{n=1}^{N=7} \beta_1\ NetInflows_{f,t-n} + \sum_{n=1}^{N=7} \beta_2\ IssuerYield_{f,t-n}$

ExpOutflows_{ft} (%)	$= \lvert \text{FORECASTED NetInflows}_{ft} \rvert \quad \text{if NetInflows}_{ft} < 0$ $\text{FORECASTED NetInflows}_{ft} = \alpha + \sum_{n=1}^{N=7} \beta_1 \text{ NetInflows}_{f,t-n} + \sum_{n=1}^{N=7} \beta_2 \text{ IssuerYield}_{f,t-n}$
EZB_{ft} (%)	$= \frac{\sum_{i \in EZB} \text{OutstandingAmount}_{fi\,t}}{\sum_{i} \text{OutstandingAmount}_{fit}}$, $\text{EZB} =$ Eurozone Bank Share, this includes banks that were part of July 2011 stress tests.
FlowVol_{ft} (%)	= Rolling Standard deviation of NetInflows_{ft} , calculated as fixed window of past 7-month observations.
GrossYield_{ft} (bps)	Gross yield is the value-weighted average of issuer yields. $= \frac{\sum_{i=1}^{n} \text{IssuerYield}_{it} \times \text{OutstandingAmount}_{it}}{\sum_{i=1}^{n} \text{OutstandingAmount}_{it}}$
InstShare_{ft} (%)	The share of fund's assets in institutional share classes. We define institutional share class as the share classes that have minimum investment of $ 1,000,000 or that have "institutional" in the name of the class.
IssuerYield_{it} (bps)	The yield of invested security as reported on the form N-MFP filed with SEC.
DLiq_{ft} (%)	It represents daily liquid assets of the fund as a percentage of total assets. $\text{DailyLiquidAssets}_{ft}$ include any security that matures or haa a demand feature that allows it to be converted to cash within one business days and US Treasury securities of any maturity.
WLiq_{ft} (%)	It represents weekly liquid assets of the fund as a percentage of total assets. $\text{WeeklyLiquidAssets}_{ft}$ include any security that matures or has a demand feature that allows it to be converted to cash within five business days, US government agency securities that mature within sixty days, and US Treasury securities of any maturity.
NetAssets_{ft} ($)	NetAssets_{ft} is the value of net assets reported on N-MFP form. It is the total value of the fund's securities and other assets less liabilities.
NetInflows_{ft} (%)	$= \frac{(\text{Subscriptions}_{ft} - \text{Redemptions}_{ft}) * 100}{\text{NetAssets}_{ft-1}}$
NetYield_{ft} (bp)	NetYield_{ft} is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP forms
NonGovLiq_{ft} (%)	It includes percentage of net assets invested in securities maturing within 5 days excluding government and agency securities.

$OA_{0-3m,ft}$ (%)	The percentage of net assets invested in securities with maturities, M≤90days
$OA_{9-13m,ft}$ (%)	The percentage of net assets invested in securities with maturities ranging, 270 ≤ M ≤397 days
$PortRisk_{ft}$ (bps)	$= GrossYield_{ft} - TBILL_t$ ($TBILL_t$ = 4-Week Treasury Bill: Secondary Market Rate, Percent, Monthly)
$PortVol_{ft}$ (%)	= Rolling Standard deviation of $PortRisk_{ft}$, calculated as fixed window of past 7-month observations.
$Size_{ft}$	$= \log(NetAssets_{ft})$
$Spread_{0-3m,ft}$(bps)	$Spread_{0-3m,ft}$ measures the difference between weighted issuer yield of securities maturing within 3 months and 3-month treasury bill.
$Spread_{9-13m,ft}$	$Spread_{9-13m,ft}$ measures the difference between weighted issuer yield of securities maturing within 3 months and 12-month treasury bill.
$Treasury_{ft}$ (%)	The percentage of assets invested in US Treasury securities of any maturity.
WAL_{ft} (days)	$= \frac{\sum_i AmortizedCost_{it} \times TTM_{it}}{\sum_i AmortizedCost_{it}}$

A2: Know Your Investor (Weekly Liquidity with Cash)

This table presents results for panel regressions. We include time fixed effects in Columns 1 and 3, we additionally control for fund fixed effects in Columns 2 and 4. In some regressions, we add time fixed effects to control for global risks. The analysis is divided into "Crisis" (June- September 2011) and "Calm" (September-December 2012) period. Ideally, we would like to analyse the period from February-May 2011 for "Calm" period, as we later would in the rest of paper, it is not possible to do it here because we use November 2010 – May 2011 to calculate the explanatory variables use in the regressions. Therefore, instead we use September-December 2012 for "Calm" period. The dependent variable is $DLiq_{ft}$. It represents daily liquid assets of a fund as a percentage of its net assets. It includes any security that matures or has a demand feature that allows it to be converted to cash within one business day and US Treasury securities of any maturity. $FlowVol_{ft}$ is rolling standard deviation of $NetInflows_{ft}$ of a fund with fixed window of seven months (window starts from November 2010). $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets.The $ExpOutflows_{ft}$ are the forecasted outflows. $ExpInflows_{ft}$ are forecasted inflows. $PortVol_{ft}$ is rolling standard deviation of $PortRisk_{ft}$ of a fund with a fixed window of seven months. $PortRisk_{ft}$ measures difference between gross yield of the fund portfolio and 1-month Treasury bill. $Size_{ft}$ is log of net assets. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. All variables except $DLiq_{ft}$ and $Size_{ft}$ are winsorized at 1st and 99th percentile. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Crisis (June-Sept 2011)		Calm (Sept-Dec 2012	
DEP VAR: $WLiq_{ft}$	(1)	(2)	(3)	(4)
$FlowVol_{ft-1}$	-0.1234	-0.4300**	-0.2684**	-0.2473**
	(0.1722)	(0.1842)	(0.1127)	(0.1153)
$ExpOutflows_{ft-1}$	2.4292**	1.2389	0.6875	0.7092
	(0.9445)	(0.9013)	(1.1987)	(1.2223)
$ExpInflows_{ft-1}$	1.5513	1.5744	3.4031**	3.1342**
	(1.1539)	(1.1178)	(1.3268)	(1.2190)
$PortVol_{ft-1}$	0.6323	1.1854**	-0.6544	-1.0110*
	(0.5621)	(0.5329)	(0.4689)	(0.5567)
$InstShare_{ft-1}$	-0.1131	0.0931	0.0198	0.0436
	(0.2493)	(0.2598)	(0.2017)	(0.2179)
$Size_{ft-1}$	8.3473	6.0762	0.9405	0.2342
	(5.6484)	(5.3510)	(6.3267)	(6.5294)
Constant	-118.7629	-88.2366	33.3392	47.1712
	(117.7341)	(111.0752)	(129.9848)	(134.9401)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.802	0.812	0.87	0.873
N	560	560	560	560

A3: Know Your Investor (Daily Liquidity with Cash)

This table presents results for panel regressions. We include time fixed effects in Columns 1 and 3, we additionally control for fund fixed effects in Columns 2 and 4. In some regressions, we add time fixed effects to control for global risks. The analysis is divided into "Crisis" (June- September 2011) and "Calm" (September-December 2012) period. Ideally, we would like to analyse the period from February-May 2011 for "Calm" period, as we later would in the rest of paper, it is not possible to do it here because we use November 2010 – May 2011 to calculate the explanatory variables use in the regressions. Therefore, instead we use September-December 2012 for "Calm" period. The dependent variable is $DLiq_{ft}$. It represents daily liquid assets of a fund as a percentage of its net assets. It includes any security that matures or has a demand feature that allows it to be converted to cash within one business day and US Treasury securities of any maturity. $FlowVol_{ft}$ is rolling standard deviation of $NetInflows_{ft}$ of a fund with fixed window of seven months (window starts from November 2010). $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets.The $ExpOutflows_{ft}$ are the forecasted outflows. $ExpInflows_{ft}$ are forecasted inflows. $PortVol_{ft}$ is rolling standard deviation of $PortRisk_{ft}$ of a fund with a fixed window of seven months. $PortRisk_{ft}$ measures difference between gross yield of the fund portfolio and 1-month Treasury bill. $Size_{ft}$ is log of net assets. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. All variables except $DLiq_{ft}$ and $Size_{ft}$ are winsorized at 1st and 99th percentile. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Crisis (June-Sept 2011)		**Calm (Sept-Dec 2012**	
DEP VAR: $DLiq_{ft}$	(1)	(2)	(3)	(4)
$FlowVol_{ft-1}$	-0.1505	-0.4444**	-0.2085	-0.1974
	(0.1855)	(0.1896)	(0.1511)	(0.1393)
$ExpOutflows_{ft-1}$	1.6813**	1.5438**	-3.1208*	-3.0298*
	(0.7240)	(0.7444)	(1.6063)	(1.6658)
$ExpInflows_{ft-1}$	1.7225*	1.2963	4.2692*	3.8854
	(0.9154)	(0.9900)	(2.4975)	(2.5031)
$PortVol_{ft-1}$	0.4385	0.9679*	-0.5202	-1.0664*
	(0.5436)	(0.5821)	(0.4604)	(0.6001)
$InstShare_{ft-1}$	-0.0607	0.0488	0.2205	0.2739
	(0.3213)	(0.2959)	(0.2333)	(0.2309)
$Size_{ft-1}$	11.5545*	11.5018*	10.0191**	8.8662**
	(6.3570)	(5.8398)	(4.2732)	(4.4671)
Constant	-212.0374	-221.7516*	-191.2327**	-169.9666*
	(131.3038)	(121.0897)	(87.5544)	(92.3198)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.832	0.847	0.862	0.865
N	560	560	560	560

A4: Know Your Investor (Weekly Liquidity with lagged dependent variable)

This table presents results for panel regressions. We include time fixed effects to control for global risks. The analysis is divided into "Crisis" (June- September 2011) and "Calm" (September-December 2012) period. Ideally, we would like to analyse the period from February-May 2011 for "Calm" period, as we later would in the rest of paper, it is not possible to do it here because we use November 2010 – May 2011 to calculate the explanatory variables use in the regressions. Therefore, instead we use September-December 2012 for "Calm" period. The dependent variable is $WLiqC_{ft}$. It represents weekly liquid assets of a fund as a percentage of its net assets. It includes cash (proxied by "other assets" reported on N-MFP) any security that matures or has a demand feature that allows it to be converted to cash within five business days, US government agency securities that mature within sixty days, and US Treasury securities of any maturity. $FlowVol_{ft}$ is rolling standard deviation of $NetInflows_{ft}$ of a fund with fixed window of seven months (window starts from November 2010). $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets. The $ExpOutflows_{ft}$ are the forecasted outflows. $ExpInflows_{ft}$ are forecasted inflows. $PortVol_{ft}$ is rolling standard deviation of $PortRisk_{ft}$ of a fund with a fixed window of seven months. $Size_{ft}$ is log of net assets. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. All variables except $WLiqC_{ft}$ and $Size_{ft}$ are winsorized at 1st and 99th percentile. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

	Crisis (June-Sept 2011)		**Calm (Sept-Dec 2012**	
DEP VAR: $WLiq_{ft}$	(1)	(2)	(3)	(4)
$ExpOutflows_{ft-1}$	2.8361***	1.5561*	3.4643**	3.2422**
	(0.9790)	(0.9189)	(1.5728)	(1.5739)
$ExpInflows_{ft-1}$	1.7722	1.8241	6.8265	7.1818
	(1.2831)	(1.1740)	(5.4541)	(4.9796)
$PortVol_{ft-1}$	0.7382	1.3581**	-0.8110	-1.0530*
	(0.5326)	(0.5203)	(0.4936)	(0.5823)
$FlowVol_{ft-1}$	-0.4692**	-0.8099***	-0.2319**	-0.2118**
	(0.1835)	(0.2077)	(0.0985)	(0.1040)
$InstShare_{ft-1}$	-0.4506	-0.1620	0.1563	0.1877
	(0.2803)	(0.2864)	(0.2232)	(0.2267)
$Size_{ft-1}$	9.8840	6.4992	-2.0922	-2.4330
	(6.1215)	(5.7578)	(6.2232)	(6.6082)
$WLiq_{ft-1}$	0.0808	0.0270	-0.1329	-0.1057
	(0.0645)	(0.0578)	(0.0806)	(0.0831)
Constant	-131.6863	-80.9322	95.9732	99.3015
	(127.1301)	(118.6495)	(128.0355)	(136.4441)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.776	0.791	0.861	0.864
N	560	560	560	560

A5: Know Your Investor (Daily Liquidity with lagged dependent variable)

This table presents results for panel regressions. We include time fixed effects to control for global risks. The analysis is divided into "Crisis" (June- September 2011) and "Calm" (September-December 2012) period. Ideally, we would like to analyse the period from February-May 2011 for "Calm" period, as we later would in the rest of paper, it is not possible to do it here because we use November 2010 – May 2011 to calculate the explanatory variables use in the regressions. Therefore, instead we use September-December 2012 for "Calm" period. The dependent variable is $DLiqC_{ft}$. It represents daily liquid assets of a fund as a percentage of its net assets. It includes cash cash (proxied by "other assets" reported on N-MFP) any security that matures or has a demand feature that allows it to be converted to cash within one business day and US Treasury securities of any maturity. $FlowVol_{ft}$ is rolling standard deviation of $NetInflows_{ft}$ of a fund with fixed window of seven months (window starts from November 2010). $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets.The $ExpOutflows_{ft}$ are the forecasted outflows. $ExpInflows_{ft}$ are forecasted inflows. $PortVol_{ft}$ is rolling standard deviation of $PortRisk_{ft}$ of a fund with a fixed window of seven months. $Size_{ft}$ is log of net assets. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. All variables except $DLiqC_{ft}$ and $Size_{ft}$ are winsorized at 1^{st} and 99^{th} percentile. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Crisis (June-Sept 2011)		Calm (Sept-Dec 2012	
DEP VAR: $DLiq_{ft}$	(1)	(2)	(3)	(4)
$ExpOutflows_{ft-1}$	2.2192**	1.3335*	0.6146	0.5028
	(0.8663)	(0.7918)	(1.0886)	(1.1976)
$ExpInflows_{ft-1}$	1.0702	0.4555	0.3102	1.7682
	(0.9446)	(0.8976)	(2.7633)	(3.1352)
$PortVol_{ft-1}$	0.7516	1.1555*	-0.6716	-0.9741*
	(0.5210)	(0.5872)	(0.4059)	(0.5548)
$FlowVol_{ft-1}$	-0.2686	-0.5109***	-0.2089*	-0.2030*
	(0.1795)	(0.1876)	(0.1255)	(0.1189)
$InstShare_{ft-1}$	0.0647	0.1324	0.3063**	0.3269*
	(0.3090)	(0.2739)	(0.1485)	(0.1780)
$Size_{ft-1}$	9.7080	9.1100	7.2334*	6.2485
	(5.9402)	(5.6667)	(4.1998)	(4.3881)
$DLiq_{ft-1}$	0.0981	0.0614	0.0425**	-0.0242
	(0.0829)	(0.0760)	(0.0210)	(0.0317)
Constant	-183.5320	-178.1567	-140.9185*	-120.8194
	(121.0716)	(114.8052)	(84.9440)	(89.9820)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.791	0.807	0.850	0.851
N	560	560	560	560

A6: Know Your Investor (Weekly Liquidity with bootstrapped errors)

This table presents results for panel regressions. We include time fixed effects in Columns 1 and 3, we additionally control for fund fixed effects in Columns 2 and 4. In some regressions, we add time fixed effects to control for global risks. The analysis is divided into "Crisis" (June- September 2011) and "Calm" (September-December 2012) period. Ideally, we would like to analyse the period from February-May 2011 for "Calm" period, as we later would in the rest of paper, it is not possible to do it here because we use November 2010 – May 2011 to calculate the explanatory variables use in the regressions. Therefore, instead we use September-December 2012 for "Calm" period. The dependent variable is $DLiq_{ft}$. It represents daily liquid assets of a fund as a percentage of its net assets. It includes any security that matures or has a demand feature that allows it to be converted to cash within one business day and US Treasury securities of any maturity. $FlowVol_{ft}$ is rolling standard deviation of $NetInflows_{ft}$ of a fund with fixed window of seven months (window starts from November 2010). $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets.The $ExpOutflows_{ft}$ are the forecasted outflows. $ExpInflows_{ft}$ are forecasted inflows. $PortVol_{ft}$ is rolling standard deviation of $PortRisk_{ft}$ of a fund with a fixed window of seven months. $PortRisk_{ft}$ measures difference between gross yield of the fund portfolio and 1-month Treasury bill. $Size_{ft}$ is log of net assets. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. All variables except $DLiq_{ft}$ and $Size_{ft}$ are winsorized at 1^{st} and 99^{th} percentile. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

	Crisis (June-Sept 2011)		**Calm (Sept-Dec 2012**	
DEP VAR: $WLiq_{ft}$	(1)	(2)	(3)	(4)
$FlowVol_{ft-1}$	-0.4587**	-0.8166***	-0.2015	-0.1852
	(0.2019)	(0.2203)	(0.1277)	(0.1387)
$ExpOutflows_{ft-1}$	3.0549***	1.5903*	3.0788*	2.9516*
	(0.9627)	(0.8764)	(1.6450)	(1.6640)
$ExpInflows_{ft-1}$	1.6272	1.7885	6.8922	7.1770
	(1.2230)	(1.0887)	(5.5552)	(5.1944)
$PortVol_{ft-1}$	0.8089	1.4093**	-0.8091	-1.0770*
	(0.5556)	(0.5499)	(0.5003)	(0.6009)
$InstShare_{ft-1}$	-0.4703	-0.1653	0.1186	0.1571
	(0.2921)	(0.2980)	(0.2355)	(0.2348)
$Size_{ft-1}$	9.9034	6.4598	-1.5892	-2.0843
	(6.8426)	(6.3189)	(5.9232)	(6.4304)
Constant	-127.1064	-78.7742	80.8676	88.5106
	(138.4347)	(124.4361)	(121.1377)	(133.3507)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.8334	0.8468	0.8960	0.8995
N	560	560	560	560

A7: Know Your Investor (Daily Liquidity with bootstrapped errors)

This table presents results for panel regressions. We include time fixed effects in Columns 1 and 3, we additionally control for fund fixed effects in Columns 2 and 4. In some regressions, we add time fixed effects to control for global risks. The analysis is divided into "Crisis" (June- September 2011) and "Calm" (September-December 2012) period. Ideally, we would like to analyse the period from February-May 2011 for "Calm" period, as we later would in the rest of paper, it is not possible to do it here because we use November 2010 – May 2011 to calculate the explanatory variables use in the regressions. Therefore, instead we use September-December 2012 for "Calm" period. The dependent variable is $DLiq_{ft}$. It represents daily liquid assets of a fund as a percentage of its net assets. It includes any security that matures or has a demand feature that allows it to be converted to cash within one business day and US Treasury securities of any maturity. $FlowVol_{ft}$ is rolling standard deviation of $NetInflows_{ft}$ of a fund with fixed window of seven months (window starts from November 2010). $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets.The $ExpOutflows_{ft}$ are the forecasted outflows. $ExpInflows_{ft}$ are forecasted inflows. $PortVol_{ft}$ is rolling standard deviation of $PortRisk_{ft}$ of a fund with a fixed window of seven months. $PortRisk_{ft}$ measures difference between gross yield of the fund portfolio and 1-month Treasury bill. $Size_{ft}$ is log of net assets. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. All variables except $DLiq_{ft}$ and $Size_{ft}$ are winsorized at 1st and 99th percentile. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Crisis (June-Sept 2011)		Calm (Sept-Dec 2012	
DEP VAR: $DLiq_{ft}$	(1)	(2)	(3)	(4)
$FlowVol_{ft-1}$	-0.2548	-0.5220**	-0.2066	-0.2032
	(0.1911)	(0.2123)	(0.1632)	(0.1560)
$ExpOutflows_{ft-1}$	2.3594***	1.3401*	0.3974	0.1220
	(0.7540)	(0.7088)	(1.1273)	(1.1501)
$ExpInflows_{ft-1}$	0.9645	0.4171	2.0704	1.8162
	(0.8447)	(0.8037)	(1.4017)	(1.4559)
$PortVol_{ft-1}$	0.8473*	1.2535**	-0.5932	-0.9368*
	(0.4916)	(0.5745)	(0.4443)	(0.5652)
$InstShare_{ft-1}$	-0.0077	0.1061	0.2767*	0.3359**
	(0.3497)	(0.3237)	(0.1675)	(0.1619)
$Size_{ft-1}$	10.4631	9.3625	7.0843*	6.3957
	(6.9788)	(6.6223)	(3.7143)	(4.0986)
Constant	-192.2726	-180.4398	-135.3105*	-125.1017
	(147.1772)	(135.4477)	(77.5191)	(86.7373)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.791	0.808	0.848	0.851
N	560	560	560	560

A8: Investor Response to Weekly Liquidity (with cash)

The table presents results of panel regressions. We include fund fixed effects in Columns 1 and 3, we additionally control for time fixed effects in Columns 2 and 4. The analysis is divided into "Calm" (February-May 2011) and "Crisis" (June- September 2011) period. The dependent variable is $NetInflows_{ft}$. $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets. $WLiqC_{ft}$ represents weekly liquid assets of a fund as a percentage of its net assets. It represents weekly liquid assets of a fund as a percentage of its net assets. It includes cash (proxied by "other assets" reported on N-MFP) any security that matures or has a demand feature that allows it to be converted to cash within five business days, US government agency securities that mature within sixty days, and US Treasury securities of any maturity. EZB_{ft} is share of a fund's portfolio invested in Eurozone banks that were part of 2011 stress tests. We divide the funds into low, medium and high terciles based on fund portfolio invested in Eurozone banks, Low EZB_f and High EZB_f represent funds with lowest and highest EZB_{ft} tercile, respectively. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. WAL_{ft} is Weighted Average Life calculated as remaining time to maturity, TTM_{it} of the investment, weighted by its investment weight in fund portfolio. $NetYield_{ft}$ is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP forms. $ExRatio_{ft}$ is the expense ratio of funds, calculated as a difference between gross yield and net yield. GrossYieldis the value-weighted average of issuer yields. $NetInflows_{ft}$, $NetYield_{ft}$ and $ExRatio_{ft}$ are winsorized at 1st and 99th percentile to remove outliers. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Calm (Feb-May 2011)		**Crisis (Jun-Sept 2011)**	
DEP VAR: $NetInflows_{ft}$	(1)	(2)	(3)	(4)
$WLiqC_{ft-1}$	-0.0146	-0.0272	0.0276	0.0378
	(0.0661)	(0.0681)	(0.0698)	(0.0681)
EZB_{ft-1}	0.2465***	0.2355**	-0.2768*	-0.3182*
	(0.0898)	(0.0964)	(0.1457)	(0.1654)
Low EZB_f * $WLiqC_{ft-1}$	0.0461	0.0496	-0.0272	-0.0174
	(0.0472)	(0.0461)	(0.0240)	(0.0222)
High EZB_f * $WLiqC_{ft-1}$	-0.0324	-0.0336	-0.0431***	-0.0356**
	(0.0278)	(0.0272)	(0.0149)	(0.0157)
WAL_{ft-1}	0.0822**	0.0784**	0.0367	0.0160
	(0.0356)	(0.0343)	(0.0595)	(0.0598)
$InstShare_{ft-1}$	-1.3836***	-1.3897***	-1.2075**	-1.0754**
	(0.2006)	(0.1992)	(0.5205)	(0.5098)
$NetYield_{ft-1}$	0.2294	0.2418	-0.2964	0.1070
	(0.3069)	(0.3169)	(0.4108)	(0.4295)
$ExRatio_{ft-1}$	0.1679	0.1915	0.3162**	0.5046***
	(0.1310)	(0.1398)	(0.1558)	(0.1564)
$NetInflows_{ft-1}$	-0.1088	-0.1277*	0.0916	0.0587
	(0.0735)	(0.0727)	(0.0823)	(0.0761)
Constant	77.7502***	78.6178***	77.1016**	62.4855*
	(13.6779)	(13.7316)	(34.4413)	(33.7645)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.0755	0.0844	0.0889	0.131
N	639	639	654	654

A9: Investor Response to Daily Liquidity (with cash)

The table presents results of panel regressions. We include fund fixed effects in Columns 1 and 3, we additionally control for time fixed effects in Columns 2 and 4. The analysis is divided into "Calm" (February-May 2011) and "Crisis" (June- September 2011) period. The dependent variable is $NetInflows_{ft}$. $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets. $DLiqC_{ft}$ represents daily liquid assets of a fund as a percentage of its net assets. It represents daily liquid assets of a fund as a percentage of its net assets. It includes cash cash (proxied by "other assets" reported on N-MFP) any security that matures or has a demand feature that allows it to be converted to cash within one business day and US Treasury securities of any maturity. EZB_{ft} is share of a fund's portfolio invested in Eurozone banks that were part of 2011 stress tests. We divide the funds into low, medium and high terciles based on fund portfolio invested in Eurozone banks, Low EZB_f and High EZB_f represent funds with lowest and highest EZB_{ft} tercile, respectively. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. WAL_{ft} is Weighted Average Life calculated as remaining time to maturity of the investment, weighted by its investment weight in fund portfolio. $NetYield_{ft}$ is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP forms. $ExRatio_{ft}$ is the expense ratio of funds, calculated as a difference between gross yield and net yield. $GrossYield_{ft}$ is the value-weighted average of issuer yields. $NetInflows_{ft}$, $NetYield_{ft}$ and $ExRatio_{ft}$ are winsorized at 1^{st} and 99^{th} percentile to remove outliers. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Calm (Feb-May 2011)		**Crisis (Jun-Sept 2011)**	
DEP VAR: $NetInflows_{ft}$	(1)	(2)	(3)	(4)
$DLiqC_{ft-1}$	-0.0993	-0.0907	0.0695	0.0568
	(0.0872)	(0.0888)	(0.0667)	(0.0647)
EZB_{ft-1}	0.2485***	0.2307**	-0.2644*	-0.3112*
	(0.0889)	(0.0963)	(0.1443)	(0.1609)
Low EZB_f * $DLiqC_{ft-1}$	0.0714	0.0724	-0.0353	-0.0217
	(0.0689)	(0.0674)	(0.0349)	(0.0318)
High EZB_f * $DLiqC_{ft-1}$	-0.0588	-0.0579	-0.0615***	-0.0564***
	(0.0415)	(0.0399)	(0.0202)	(0.0213)
WAL_{ft-1}	0.0773**	0.0764**	0.0450	0.0172
	(0.0359)	(0.0342)	(0.0574)	(0.0566)
$InstShare_{ft-1}$	-1.3534***	-1.3574***	-1.1931**	-1.0595**
	(0.2064)	(0.2068)	(0.5189)	(0.5081)
$NetYield_{ft-1}$	0.2195	0.2272	-0.2583	0.1432
	(0.3094)	(0.3173)	(0.4084)	(0.4243)
$ExRatio_{ft-1}$	0.2072	0.2160	0.3339**	0.5226***
	(0.1378)	(0.1422)	(0.1573)	(0.1574)
$NetInflows_{ft-1}$	-0.1112	-0.1265*	0.0938	0.0598
	(0.0742)	(0.0728)	(0.0822)	(0.0758)
Constant	77.5022***	77.7979***	74.0685**	60.7504*
	(14.2345)	(14.3789)	(34.5257)	(33.7875)
Fund Fixed Effects	Y	Y	Y	Y
Time Fixed Effects	N	Y	N	Y
Adjusted R^2	0.0836	0.0901	0.0894	0.132
N	639	639	654	654

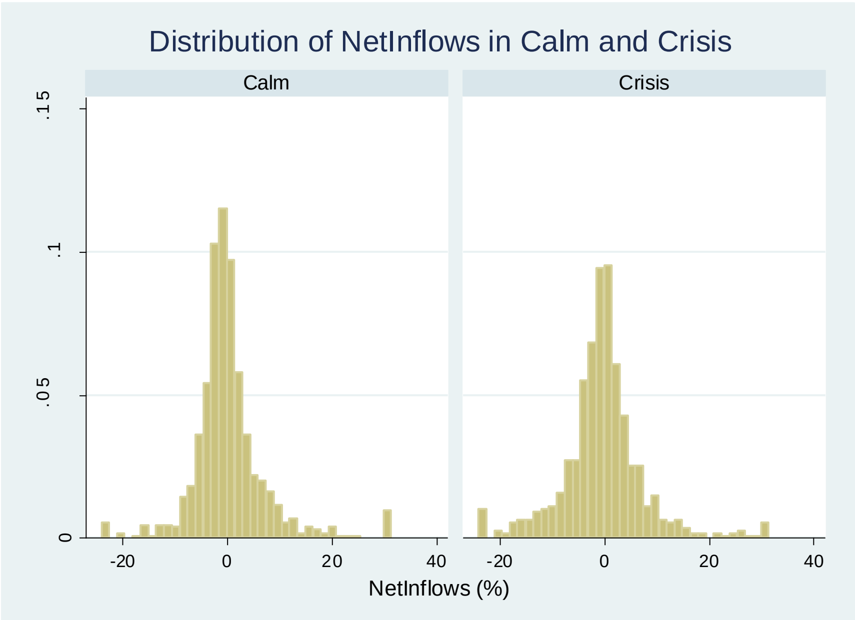
A10: Wald Tests

The table presents p-values for Wald tests conducted for the sum of coefficients of daily/weekly liquidity and their interactions with Low and High Eurozone bank share, EZB_{ft} tercile reported in table 3.5 and 3.6 in section 3.3.4, for models with only fund fixed effects and with both fund and time fixed effects.

Wald test	**Fund FE only**	**Fund /Time FE**
Daily Liquidity		
$DLiq_{ft-1}$ + [Low EZB_{f} * $DLiq_{ft-1}$]	0.3777	0.2742
$DLiq_{ft-1}$ + [High EZB_{f} * $DLiq_{ft-1}$]	0.4030	0.2731
Weekly Liquidity		
$WLiq_{ft-1}$ + [Low EZB_{f} * $WLiq_{ft-1}$]	0.8682	0.42
$WLiq_{ft-1}$ + [High EZB_{f} * $WLiq_{ft-1}$]	0.9703	0.5194

A11: Distribution of Net Inflows in Calm and Crisis

The figure presents the distribution of $NetInflows_{ft}$. The left-hand panel shows distribution for "Calm" period (February-May 2011) and the right-hand panel shows distribution for "Crisis" period (June-September 2011). $NetInflows_{ft}$ is defined as the difference between monthly subscriptions and redemptions scaled by lagged net assets.



A12. Investor Response to Weekly Liquidity (Nested Model)

The table presents results of panel regressions. The dependent variable is $NetInflows_{ft}$. $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets. $CRISIS_t$ dummy takes the value of 0 from February-May 2011 for "Calm" period, and 1 from June- September 2011 for crisis period. EZB_{ft} is share of a fund's portfolio invested in Eurozone banks that were part of 2011 stress tests. We divide the funds into low, medium and high terciles based on fund portfolio invested in Eurozone banks, Low EZB_{ft} and High EZB_{ft} represent funds with lowest and highest EZB_{ft} tercile, respectively. $WLiq_{ft-1}$ represents weekly liquid assets of a fund as a percentage of its net assets. It includes any security that matures or has a demand feature that allows it to be converted to cash within five business days, US government agency securities that mature within sixty days, and US Treasury securities of any maturity. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. WAL_{ft} is Weighted Average Life calculated as remaining time to maturity of the investment, weighted by its investment weight in fund portfolio. $NetYield_{ft-1}$ is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP forms. $ExRatio_{ft-1}$ is the expense ratio of funds, calculated as a difference between gross yield and net yield. GrossYield is the value-weighted average of issuer yields. All variables are winsorized at 1st and 99th percentile to remove outliers. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

DEP VAR: $NetInflows_{ft}$	(1)	(2)
EZB_{ft-1}	0.1507**	0.142*
	(0.0713)	(0.0811)
EZB_{ft-1}* $CRISIS_t$	-0.3274***	-0.323**
	(0.1253)	(0.131)
$WLiq_{ft-1}$	0.0062	-0.00294
	(0.0514)	(0.0519)
$WLiq_{ft-1}$* $CRISIS_t$	0.0148	0.0363
	(0.0588)	(0.0582)
Low EZB_{ft} * $WLiq_{ft-1}$ * $CRISIS_t$	0.0067	0.00803
	(0.0226)	(0.0223)
High EZB_{ft} * $WLiq_{ft-1}$ * $CRISIS_t$	-0.1078**	-0.0917**
	(0.0478)	(0.0429)
$NetYield_{ft-1}$	0.2481	0.318*
	(0.1593)	(0.165)
$NetYield_{ft-1}$* $CRISIS_t$	-0.3003**	-0.226*
	(0.1237)	(0.123)
$ExRatio_{ft-1}$	-0.0035	0.0138
	(0.0672)	(0.0726)
$ExRatio_{ft-1}$* $CRISIS_t$	0.1497**	0.189***
	(0.0709)	(0.0708)
WAL_{ft-1}	-0.0063	-0.00255
	(0.0307)	(0.0311)
$InstShare_{ft-1}$	-0.6247**	-0.603**
	(0.2666)	(0.275)
$NetInflows_{ft-1}$	-0.2123***	-0.198***
	(0.0397)	(0.0399)
$CRISIS_t$	1.9064	-1.149
	(3.5139)	(3.628)
Constant	41.5019**	39.01**
	(18.4921)	(18.90)
Fund Fixed Effects	Y	Y
Time Fixed Effects	N	Y
Adj R-squared	0.0950	0.112
Observations	1,293	1,293

A13. Investor Response to Daily Liquidity (Nested Model)

The table presents results of panel regressions. The dependent variable is $NetInflows_{ft}$. $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions scaled by lagged net assets. $CRISIS_t$ dummy takes the value of 0 from February-May 2011 for "Calm" period, and 1 from June- September 2011 for crisis period. EZB_{ft} is share of a fund's portfolio invested in Eurozone banks that were part of 2011 stress tests. We divide the funds into low, medium and high terciles based on fund portfolio invested in Eurozone banks, Low EZB_{ft} and High EZB_{ft} represent funds with lowest and highest EZB_{ft} tercile, respectively. $DLiq_{ft}$ represents daily liquid assets of a fund as a percentage of its net assets. It includes (1) any security that matures or have a demand feature that allows it to be converted to cash within one business day (2) US treasury securities of any maturity. $InstShare_{ft}$ is the percentage of a fund's net assets held by institutional shareholders. WAL_{ft} is Weighted Average Life calculated as remaining time to maturity of the investment, weighted by its investment weight in fund portfolio. $NetYield_{ft-1}$ is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP forms. $ExRatio_{ft-1}$ is the expense ratio of funds, calculated as a difference between gross yield and net yield. GrossYield is the value-weighted average of issuer yields. All variables are winsorized at 1^{st} and 99^{th} percentile to remove outliers. In all regressions, the standard errors are clustered by funds. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

DEP VAR: $NetInflows_{ft}$	(1)	(2)
EZB_{ft-1}	0.1575**	0.145*
	(0.0641)	(0.0744)
EZB_{ft-1}* $CRISIS_t$	-0.3447***	-0.342***
	(0.1017)	(0.106)
$DLiq_{ft-1}$	-0.0745	-0.0652
	(0.0928)	(0.0918)
$DLiq_{ft-1}$* $CRISIS_t$	0.1444	0.123
	(0.0932)	(0.0918)
Low EZB_{ft} * $DLiq_{ft-1}$ * $CRISIS_t$	0.0232	0.0205
	(0.0296)	(0.0295)
High EZB_{ft} * $DLiq_{ft-1}$ * $CRISIS_t$	-0.2260***	-0.169**
	(0.0679)	(0.0660)
$NetYield_{ft-1}$	0.2653	0.327*
	(0.1649)	(0.171)
$NetYield_{ft-1}$* $CRISIS_t$	-0.2758**	-0.209
	(0.1265)	(0.127)
$ExRatio_{ft-1}$	0.0122	0.0253
	(0.0695)	(0.0746)
$ExRatio_{ft-1}$* $CRISIS_t$	0.1568**	0.198**
	(0.0746)	(0.0763)
WAL_{ft-1}	-0.0037	-0.00194
	(0.0313)	(0.0317)
$InstShare_{ft-1}$	-0.6094**	-0.589**
	(0.2711)	(0.275)
$NetInflows_{ft-1}$	-0.2063***	-0.193***
	(0.0416)	(0.0416)
$CRISIS_t$	3.0579	0.0410
	(2.6254)	(2.946)
Constant	39.1510**	37.06*
	(18.6064)	(18.81)
Fund Fixed Effects	Y	Y
Time Fixed Effects	N	Y
Adj R-squared	0.102	0.115
Observations	1,293	1,293

Chapter 4 Response of MMF Industry to the Loss of its Cash-like Nature

4.1 Introduction

In this chapter, we focus on assessing the response of MMFs and their shareholders to 2016 Amendments. The most notable rules include: (1) the imposition of liquidity fee and redemption gates, which allows MMFs to charge a redemption fee or suspend redemptions entirely if the liquidity level of a fund drops below a certain threshold; (2) Segregation of institutional MMFs from retail MMFs; (3) and introduction of floating net asset value for institutional MMFs. To the best of our knowledge, this is the first paper that comprehensively evaluates the impact of the 2016 Amendments on the MMF industry.

Our contributions to the existing literature are as follows: First, we show that in the transition period before the new reforms became effective (November 2015 to October 2016), the migration of total net assets (TNA) from non-government funds to government funds, also documented in Cipriani et al. (2017), is concentrated within the sector that has historically proven risky i.e. the prime funds. We do not observe significant outflows from municipal MMFs.

Second, we investigate the characteristics that influence the decision to convert to a government fund. This has not been studied before. We document that the institutional prime funds that belonged to larger fund families were less likely to convert possibly because they can obtain financial backing from their sponsors (Baba et al. 2009; McCabe 2010; Kacperczyk and Schnabl 2013; Brady et al. 2012).

Specifically, a sponsor can inject liquidity into the fund if a possible breach in the regulatory liquidity threshold is anticipated. This would help a fund avoid charging a liquidity fee or suspending redemptions which can adversely impact the reputation of the sponsor. In addition, we show that funds with higher credit risk were more likely to convert as they face a higher probability of outflows (Chari and Jagannathan 1988; Jacklin and Bhattacharya 1988; Chernenko and Sunderam 2014). This would lower the fund's liquidity reserves and increase the likelihood of eliciting liquidity fees and redemption gates. Interestingly, we find that retail prime funds with higher risk tend to stay prime funds possibly because retail investors are significantly less likely to run during market distress (Gallagher et al. 2015) so such funds are more likely to engage in yield seeking behaviour. Furthermore, the complete segregation from institutional investors, now required of retail prime funds, will allow such funds to reach for yield as their investor base is more stable.

Third, we examine the response of money market funds to liquidity fees and redemption gates. Previous literature explores the impact of liquidity fees on the run-behaviour of MMF investors. Cipriani et al. (2014) suggest that liquidity fees make MMFs more fragile and vulnerable to pre-emptive runs. On the contrary, Lenkey and Song (2017) find that liquidity fees strengthen informed investors' incentives to remain invested until maturity. We add new perspective to the debate by providing empirical evidence of the efforts of institutional MMFs to completely avoid redemption gates and liquidity fees by hoarding liquidity and by actively adjusting liquidity in tandem with any increases in credit risk. We contrast this with the period before the reforms and observe the opposite behaviour. In the pre-reform period, MMFs decreased their liquidity simultaneously with an increase in the expected loss.

Fourth, this is the first paper that observes that after complete segregation of institutional and retail funds there is greater heterogeneity in portfolio composition in each type of fund. In addition, we observe distinct fund strategies to guard against credit risk and heightened institutional fund competition. Gallagher et al. (2015) suggest that greater concentration of institutional investors will result in increased demand for liquidity in such funds. We confirm this and show that, as compared to retail prime MMFs, institutional prime MMFs hold more liquid portfolios. This leads to a safer asset mix and positions funds to be more resilient to unexpected outflows. However, this has a negative impact on the institutional funds' profitability. Further, Christoffersen (2001) suggests that institutional funds have stronger price competition than retail funds. We see that, within the MMF industry, greater investor concentration and the loss of previously attractive money-like features have strengthened price competition among institutional funds. This occurs as they endeavour to differentiate themselves by offering higher yields to attract investors.

The rest of the paper proceeds as follows: Section 4.2 provides an overview of the new regulatory landscape. Section 4.3 describes the data. Section 4.4 presents the empirical analysis and results. Section 4.5 concludes.

4.2 Regulatory Landscape

MMFs are regulated under rule 2a-7 of the Investment Company Act of 1940, which restricts funds' investments to short-term, high-quality debt securities. On July 23, 2014, the SEC announced amendments to rule 2a-7 that governs money market funds. These amendments have introduced significant structural and operational changes. The SEC built these changes upon the reforms of March 2010 that dealt with credit, liquidity and interest rate risks. The new reforms provided a two-year transition period to allow funds to operationally adapt to the new structure whilst also giving investors time to evaluate their investment options. The compliance date for the funds was October 14, 2016.

MMFs are primarily divided into three types of funds based on the type of portfolio securities held. Prime MMFs invest in a variety of corporate debt securities including certificates of deposit, commercial paper, repurchase agreements and banker's acceptances. A government MMF invests at least 99.5 percent (formerly 80 percent) of its total assets in cash, government securities and/or repurchase agreements that are fully collateralized by cash or government securities. A tax-exempt (also known as municipal) MMF holds non-taxable municipal securities that are not taxed by the federal government, nor, in some cases, state and municipalities. Depending upon risk characteristics, the new rules apply to each MMF sector differently (Table 4.1). Prime and municipal MMFs have structurally changed and must comply with several new rules while government MMFs are not significantly affected by the reforms.

The new rules have introduced investor differentiation and floating NAV liquidity fee and redemptions gates, enhanced disclosure requirements and enhanced stress testing. Institutional funds have been the focus of the stricter regulations. Before October 2016, a management company could offer retail and institutional share classes for the same portfolio. However, the new reforms have fully segregated institutional funds from retail funds, which means that for one portfolio, a management company can offer shares to either retail[17] shareholders or institutional shareholders, but not both. Furthermore, institutional prime and municipal/tax-exempt funds are required to transact at floating NAV. This means that a fund must use market-based values of their securities to value their portfolio so that the daily share prices of the funds now fluctuate with the market. This change addresses the first-mover advantage that institutional investors usually gain at the expense of retail investors, during a time of crisis. Before the reforms, these funds used the penny rounding method and a stable NAV of $1.00. Under the new rules, funds must now use basis point rounding with $1.0000 share price. Government and retail money market funds continue to use the amortized cost method and/or penny rounding method of pricing to maintain a stable NAV.

In addition, the prime and municipal funds now have the ability to impose liquidity fees and redemption gates if certain liquidity thresholds are not met. The SEC explains that fees and gates are intended to enhance an MMF's ability to manage heavy redemptions and make redeeming investors pay their share of the cost of the liquidity that they receive. Liquidity fee and redemptions gates apply to all non-government funds, although government funds can also use these tools at their discretion if they have already announced it in their prospectus. If the fund board deems it advisable, a money market fund can impose a liquidity fee of up to 2 percent of redemption amount when a fund's weekly liquid assets[18] fall below 30 percent of

[17] A retail money market fund, under SEC 2016 new rules, is defined as a fund that has policies and procedures which would limit beneficial investors of the fund to natural persons (SEC 2014).
[18] Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days.

its total assets. If the fund's weekly liquid assets fall below 10 percent, then a fund is required to charge a one percent fee on all redemptions. However, if the fund board determines that charging a liquidity fee is not in the best interests of the fund or that a lower or a higher fee (up to 2 percent) is more effective in alleviating the situation, then it can choose to do so. Alternatively, the fund can suspend redemptions for up to 10 business days in a 90-day period if a fund's weekly liquid assets fall below 30 percent, at the discretion of the fund's board. Any fee or gate must be lifted automatically after weekly liquid assets rise to or above 30 percent, but it can be lifted any time before then if the board deems that such a liquidity fee or gate is no longer in the best interests of the fund. A gate must be lifted within 10 business days.

Additionally, the funds are required to provide daily disclosure on their website about the fund's liquidity levels, shareholder inflows and outflows, market-based net asset values, use of liquidity fee, redemption gates and sponsor support. The funds must also report additional information relevant to assessing money market fund risk on the N-MFP2 form. They must also adhere to stronger diversification requirements, conduct stress tests to maintain at least 10 percent of weekly liquid assets and ensure minimal principal volatility.

These amendments provide MMFs the tools to deal with heavy redemptions in times of distress, alleviate first mover advantage, and improve transparency of their risks. The extent to which the regulators have been successful in achieving this remains to be seen and is the focus of this paper. We aim to investigate the impact of the regulation by assessing the response of money market funds and their investors after the reforms.

4.3 Data Description

We create a unique dataset comprising detailed portfolio holdings of US money market funds which are filed monthly with the SEC monthly over the period from January 2014 to March 2017. These filings are publicly available from the SEC EDGAR database. We use several other databases to link the issuers of the MMF portfolio securities with their parent issuers, countries of domicile and their annualized expected loss.

The amendments to rule 2a-7 that were introduced in May 2010 require MMFs to file a monthly report on N-MFP form [19], which includes a detailed schedule of portfolio holdings of money market funds, starting from November 2010. Since April 2016, the compliance date for reporting requirements, the reporting of additional information is required under the new version of the form (N-MFP2).[20] Our sample includes information from both versions of the form. We calculate the variables that were not reported on N-MFP form ourselves, and use the information reported on the N-MFP2 form for the same variable, after the reforms. For instance, weekly liquidity of a fund is reported on the N-MFP2 form from May 2016 onwards. Before this, levels were not required to be reported on the N-MFP form. We calculate the weekly liquidity[21] ourselves before that period.

[19]This form provides information about fund-level variables like total net assets, gross yield, net yield and monthly shareholders subscriptions and redemptions. In addition, for each security held, it reports issuer name, amount of principal, yield, legal maturity date, and the CUSIP number.

[20] The additional information includes cash held, daily and weekly liquidity, floating net asset value, and identifiers of the security issuers and more.

[21]Weekly liquidity represents weekly liquid assets of a fund as a percentage of its total assets.

For our analysis, we aggregate issuer-level variables to the parent level. Then, we assign a country to the parent. For instance, the securities issued by Bank of the West, Fortis Funding LLC, Scaldis Capital LLC, Starbird Funding Corporation, as well the debt issued by BNP Paribas SA are all aggregated under the parent company BNP Paribas SA. The N-MFP form does not specify the parent company and country of incorporation of the issuers. We collect this information from a variety of other datasets[22]. We use identifiers of the issuers reported on the forms to link them to other datasets. For the securities for which identifiers are missing, we use the names of the issuers to merge them with external databases. Using the name of a company to link different databases can be tricky. The name of a company in one database often differs from the name used in the other. We employ the "fuzzy string matching" approach to join the databases. Fuzzy matching allows for non-exact matches to be joined. To accomplish this, we use the "n-gram" procedure which decomposes the text string into elements of *n* characters (grams) using a moving window. The n-gram algorithm is effective for data with misspellings and large string permutations. One caveat of fuzzy matching is the "false positive" challenge. The algorithm tends to match names from one database to another database even when the match is not completely accurate. To mitigate this concern, we check the matched data line by line, by hand, to ensure complete accuracy of the matched observations. We are able

[22]We procure information about global ultimate owners (GUO) of issuers from Wharton Research Data Services (WRDS), Bloomberg, and Bureau van Dijk's databases including Amadeus, Bankscope, Orbis Bank Focus and Osiris. Also, we obtain business card information from the Global Legal Entity Identifier Foundation (GLEIF). GLEIF maintains key reference information that clearly identifies legal entities participating in financial transactions. It provides "Level 1" data that has information on 'who is who', and "Level 2" data that describes 'who owns whom'. After linking the issuers of MMF securities with Level 1 and Level 2 data, we have some issuers for which the information is still missing.

to obtain information about parents and country of incorporation for the majority of the issuers.

Next, following Collins and Gallagher (2016) we calculate expected loss to maturity (ELM) using the default probabilities of issuers obtained from the Risk Management Institute (RMI) of the National University of Singapore (see appendix B1). The funds for which less than 75 percent of portfolio securities could be matched with the default probabilities are removed from the analysis. These represent only 5 percent of the funds. On average, 92 percent of the total net assets of the prime funds in our sample are matched with default probabilities. To calculate the yield spread of money market funds we use US Treasury bill yields which are collected from the Federal Reserve Economic Data (FRED) database. We have performed extensive checks and used alternative sources to correct data entry errors. For instance, the net yield of the funds provided on the N-MFP form is occasionally incorrectly reported. We obtain the correct values for such funds from Bloomberg.

Our final dataset spans from January 2014 to March 2017. The nature of the analysis requires the sample to be divided into several periods (Figure 4.1) depending upon the type of analysis done. We divide the data into before-reform (January 2014 – June 2014) and after-reform (October 2016 – March 2017) to compare fund portfolio composition of the funds, the fund liquidity management and shareholder response to the new rules. The before-reform period covers the six months immediately before the approval of the reforms in July 2014. We select this period which is more than two years before the after-reform period to make sure it is not affected by the changes that funds undergo during the transition period to comply with the new rules. The after-reform period includes the six months from the final compliance month i.e. October 2016 to March 2016. After the announcement of the reforms on July 23, 2014 there is approximately a two-year window for the funds to make the required changes by the compliance date. We divide this into pre-transition and transition periods. Based on graphical evidence (Figure 4.2), the transition period consists of one year from November 2015 to October 2016 when the fund industry was making the required structural changes. We select six months before this to be the pre-transition period (May 2015 to October 2015). This is utilized to test the characteristics of the funds that decide to change status from prime to government.

4.4 Empirical Analysis

The primary aim of this paper is to study the response of MMFs and their investors to the 2016 Amendments. The regulation is believed to have fundamentally altered the basic features that attracted short-term investors to MMFs i.e. intra-day liquidity and preservation of capital coupled with higher yield. The possibility of losing these qualities and the uncertainty surrounding the impact of the reforms have caused massive outflows from the non-government money market funds (Cipriani et al. 2017). Most of these assets have migrated to government money market funds. Figure 4.2 and Table 4.2 show that from January 2014 to March 2017, the TNA of the MMF industry remain constant at around $3 trillion. The TNA within the different types of MMFs have, however, changed dramatically. The TNA of prime money market funds have decreased by 67 percent from $1,794 billion to $599 billion. The share of prime fund TNA has dropped by 39 percent down to only 20 percent of industry TNA in March 2017. Municipal funds have dropped by 52 percent to $135 billion. Government funds have increased dramatically to $1,226 billion, a 127 percent rise in March 2017. The market share of the government funds has increased by 43 percent to 75 percent of the industry TNA. This reduction in the TNA of prime funds and increase in government funds shows investors' preference for liquidity and preservation of capital. Figure 4.3 shows the number of each type of fund from January 2014 to March 2017. Prime funds and municipal funds have decreased while the number of government funds have increased significantly. This indicates that the migration of TNA from non-government MMFs is not only because of investors moving their money from prime funds to the existing government funds but also because of the funds' decision to convert to government funds. In section 4.4.1, we empirically test the statistical significance of the changes in the TNA of the funds.

4.4.1 Changes in Total Net Assets of MMFs

The 2016 Amendments to rule 2a-7 impose liquidity fee and redemption gates on all prime/municipal funds and floating NAV on institutional prime and municipal funds. However, these rules do not apply to government funds. Consequently, it appears that the non-government funds have transferred a massive amount of assets to government funds to evade the new rules which are presumed to thwart the ability of investors to make same day withdrawals or do so at a cost. Prime MMFs have been popular for providing same-day liquidity, preservation of capital, and higher yields. The possibility of losing these features has caused the industry to migrate from prime and municipal funds to government funds. An increase in the number of government funds (Figure 4.3) indicates that the funds have converted to this category. In this scenario, we expect that the funds would be converted within the same family[23]. Cipriani et al. (2017) also find that most of this transfer is concentrated within the same fund family. To account for this, we conduct the analysis at a fund family level.

We investigate the changes in the TNA of the funds after the 2016 Amendments using the following panel fixed effects model:

$$Y_{fft} = \alpha_{ff} + \beta_1 Reform_t + \mu_t + \varepsilon_{fft} \qquad eq.\ (1)$$

where Y_{fft} represents a fund family's TNA calculated separately for each category of fund and the shareholder type it serves. For instance, we aggregate the TNA of all retail prime funds of a fund family separately from all institutional prime funds of the family and repeat the process for municipal and government funds of the family aggregating the TNA by either retail or institutional fund. So, Y_{fft} represents six variables: $NAPrimeI_{fft}$ and $NAPrimeR_{fft}$ which are calculated as a sum of TNA of a fund family "ff" invested in all institutional prime funds and all retail prime fund, respectively; $NAMuniI_{fft}$, $NAMuniR_{fft}$, $NAGovtI_{fft}$, $NAGovtR_{fft}$ calculated as a sum of TNA of a fund family "ff" invested in all institutional municipal funds, all retail municipal funds, all institutional government funds and all retail government funds, respectively. Before reforms, a fund with an institutional share greater than 99 percent is identified as an institutional fund, otherwise it is a retail fund. Institutional share is the share of a fund's ownership in institutional share classes. Following Chernenko and Sundaram (2014), a share class is considered institutional if it has a minimum investment of $ 1,000,000 has "institutional" in the name of the class.

[23]A fund family is an investment company which invests in one or more money market funds. A fund family is identified by the CIK number of a fund manager as reported on the N-MFP form. Table 4.3 shows that, in our sample, there is a total of 282 fund families before reforms and 226 families after reforms.

After reforms, a fund is identified as retail or institutional on the N-MFP2 form, so we utilize that information. α_{ff} represents fund family fixed effects and enables with control for possible endogeneity that might result from a correlation of unobserved fund family-specific attributes with the explanatory variables. We add time fixed effects, μ_t, to control for global risks. $Reform_t$ takes the value of zero before reforms (January 2014 – June 2014), which is the six-month period immediately before the reforms were introduced. It takes the value of one from October 2016 to March 2017, a period that comprises the six months after the reforms became effective in October 2016. The industry becomes stable after the compliance date which makes it unnecessary to go beyond this six-month period. For consistency, both before- and after-reform periods are six months long. ε_{fft} is the error term clustered at the fund family level.

Table 4.4 presents the regression results. Columns (1-4) show that β_1 for both retail and institutional prime/municipal funds is negative and significant indicating that the TNA in these two types of funds has decreased significantly. Institutional prime and municipal funds' decrease in TNA indicates the desire to avoid the requirements such as redemption gates, liquidity fee and the imposition of floating NAV. A liquidity fee is a fee charged against the redemption amount and retained by the fund. It is intended to deter investors from withdrawing shares during stressful periods to avoid sudden heavy outflows, boost liquidity levels by injecting cash withheld from redemptions, and remove the first mover advantage. It results in a loss of capital and lower investor return. A redemption gate is a temporary suspension of the redemption of a fund's shares. It leads to a loss of liquidity and access to money.

While redemption gates and liquidity fees are mutually exclusive, the imposition of a liquidity fee can be followed by the imposition of redemption gates.

The decrease in TNA of institutional funds is consistent with the fact that institutional investors are active and tend to withdraw from funds if there is a risk of losing unhindered access to money and of loss of capital (Jacklin and Bhattacharya 1988; Chordia 1996; Greene et al. 2007). Anecdotal evidence suggests that this decrease has partially occurred because of the decision of funds to convert themselves into government funds without investors having to withdraw the money. This decision is because the institutional funds are serving a more active and volatile shareholder base and are expected to be more prone to runs during distress (Wermers 2011; Schmidt et al. 2016). Therefore, they will have a higher probability of imposing liquidity fees or redemption gates. This could taint the reputation of the fund family and fund sponsors. Unfortunately, we are not able to separate the impact of redemption gates and liquidity fees from the impact of floating NAV in institutional funds and other confounding effects. However, it can be observed clearly from the decrease in TNA of retail prime/municipal funds because these funds are not subject to floating NAV. Therefore, the reduction in TNA of retail funds could be interpreted as the response of investors to redemption gates and liquidity fees. However, one must keep in mind that other changes in financial markets such as bank reforms (Basel III) may have indirectly influenced the decision of investors to some extent. Retail investors have historically been inactive investors. Then, one would expect these funds to have less reason to worry about imposing a redemption gate or liquidity fee, and therefore have lower reputational risk. The reason for the decrease is possibly because the redemption gates/liquidity fees have changed the nature of money market funds. During calm periods, these funds can be treated as money-like, but in distress periods, the investors either cannot redeem, if redemptions are suspended, or can withdraw at will, albeit at a possible loss of principal if a liquidity fee is imposed.

Columns (5-6) show that both retail and institutional government funds have increased TNA, post reform. Government money market funds may, but are not required to, use liquidity fees and redemption gates. In addition, these funds are not required to float NAV and can continue to operate at stable NAV. These funds maintain the pre-reform nature of money market funds and hence seem to be more in-demand after the reforms. So, the transfer has occurred because of i) the investors' decision to move to government funds and ii) the funds' decision to change their type and portfolio composition to become government funds. Next, we empirically test whether the increase in the TNA of government funds is in fact due to migration of TNA from prime and municipal funds.

4.4.2 Migration of Total Net Assets of MMFs to Government Funds

In this section, we investigate the flows between different types of money market funds. We conduct the study using the changes in total net assets to capture both i) the withdrawals made by shareholders ii) the instances where a fund reclassifies itself from prime/municipal to government. Conversely, if we use redemptions and subscriptions we will miss out the transfer of TNA of a fund to government funds that was done by changing the category of funds through broker-dealers without requiring investors to withdraw their money. To capture this, the analysis is carried out at the fund family level. An increase in a fund family's government TNA and a decrease in prime and municipal net assets represents a fund reclassification. If the changes in the TNA of different types of MMFs is because of the reforms, then we would expect the migration of money to remain within the same fund family. This analysis is similar to Cipriani et al. (2017), but we extend the analysis by examining the migration of money from retail/institutional prime and municipal funds separately to discover which funds respond more sharply.

We run panel regressions including time and fund family fixed effects. Time-fixed effects are included to control for global risks. Fund family fixed effects are added to observe the within-fund family variation in the total net assets. We run the following model over the transition period from November 2015 to October 2016, the time when the industry was adjusting to comply with new regulations,

$$\Delta NAGovt_{fft} = \alpha_{ff} + \beta_1 \Delta NAPrimeI_{fft} + \beta_2 \Delta NAPrimeI_{fft-1} + \beta_3 \Delta NAPrimeR_{fft} + \beta_4 \Delta NAPrimeR_{fft-1} + \beta_5 \Delta NAMuniI_{fft} + \beta_6 \Delta NAMuniI_{fft-1} + \beta_7 \Delta NAMuniR_{fft} + \beta_8 \Delta NAMuniR_{fft-1} + \mu_t + \varepsilon_{fft} \qquad eq.\ (2)$$

The dependent variable, $\Delta NAGovt_{fft}$, is the monthly change in a fund family's TNA held in government funds. We calculate TNA of each type of fund held by each family separately to clearly identify which funds convert to government funds. $\Delta NAPrimeI_{fft}$ and $\Delta NAPrimeR_{fft}$ represent the first differences of a fund family's TNA invested in institutional prime and retail prime funds, respectively. $\Delta NAMuniI_{fft}$, and $\Delta NAMuniR_{fft}$, represent the first differences of a fund family's TNA invested in institutional municipal funds and retail municipal funds, respectively. We control for lagged changes in all variables to account for delayed transfers.

Table 4.5 displays the results for changes in TNA of government funds of a fund family in relation to changes in TNA of its prime and municipal funds. Column 1 shows that contemporaneous changes in TNA of institutional prime funds, $\Delta NAPrimeI_{fft,}$ is highly statistically significant and is negatively related to changes in government TNA of the fund family. This indicates that a fund family's decrease in institutional prime TNA had led to an increase in government TNA. This shows that the reforms have led to the migration of funds from prime to government fund. The coefficient of $\Delta NAPrimeI_{fft}$ is -0.78 which is very high showing that most of the increase in government funds is driven by a decrease in a family's institutional prime funds. Additionally, we control for its lagged changes, $\Delta NAPrimeI_{fft-1}$, to capture the variation in case there is a delay in transferring assets from one fund to another, i.e. the transfer is not contemporaneous. The coefficient is negative and significant, hence reinforcing the previous results. Next, the changes in retail prime total net assets, $\Delta NAPrimeR_{fft}$ show that retail funds are also transferring TNA from prime to government. The coefficient is -0.12 which is very small as compared to institutional prime funds, suggesting lower variation in $\Delta NAPrimeR_{fft}$ because of retail funds. The sum of the coefficients, $\beta_{1} + \beta_{2} + \beta_{3}$ is equal to -1.01, indicating almost one-to-one migration of assets from prime funds to government funds. Cipriani et al. (2017) find a similar relationship.

On the other hand, coefficients of municipal funds are insignificant. This is because municipal funds are inherently different from prime and government funds. First, these are not risky like prime funds because they only invest in municipal securities issued by local or state governments. Second, it is possibly harder for such funds to easily transfer to government funds because these must change status from tax-exempt to taxable funds, as well as change their entire portfolio to government securities. Third, the shareholder base of these funds has not proven to be a volatile one, so there does not seem to be much incentive to change to a different type of fund. The municipal funds seem to be safer than government funds as evidenced from the fact that the investors withdrew heavily from government funds during the US debt ceiling impasse of 2011. The municipal funds have never been in trouble, historically. Cipriani et al. (2017) find that non-government funds migrate their TNA to government funds, but we clarify that such migration is statistically significant only for prime money market funds.

It might be the case that a fund family's increase (decrease) in one type of fund always results in a decrease (increase) in the other type. Therefore, we run a placebo regression, before reforms from January 2014 – June 2014.[24] This is about two years before the SEC regulation compliance deadline and therefore is not influenced by the transition period. Column 2 shows that during this period, the slope coefficient on prime institutional funds' contemporaneous, changes, $\Delta NAPrimeI_{ff}$, and lagged changes, $\Delta NAPrimeI_{fft-1}$, is positive and highly significant. This indicates that, usually, an increase in government TNA is accompanied by an increase in the TNA of institutional prime funds of the same family. Therefore, it is only in the year before the compliance date that investors moved their assets from prime to government funds within the same family, which indicates that such migration is driven by the reforms. The analysis indicates that municipal funds have not changed dramatically after the reforms, so the rest of our paper focuses only on prime money market funds.

[24] A regression for a one-year sample also produces similar results.

4.4.3 Factors that Influenced Decision of Prime MMFs to Change Category

In this section, we attempt to understand the characteristics of the prime MMFs that predict a change to government funds, which has not been analysed before. We estimate a pooled probit model over the pre-transition period, from May 2015 – October 2015, the six months just before the funds started to make changes to comply with the new rules. We choose six months to be consistent with the choice of other periods in the paper.[25] We estimate the following regression separately for institutional and retail prime funds:

$$Change_f = \alpha + \beta_1\, NoOfFunds_{ft} + \beta_2\, Size_{ft} + \beta_3\, ELM_{ft} + \beta_4\, FlowVol_{ft} + \beta_5\, ExRatio_{ft} + \beta_6\, WLiq_{ft} + \varepsilon_{ft} \qquad eq.\ (3)$$

where $Change_f$ is a dummy variable which takes the value of 1 if a fund, "f" exits prime fund by the compliance deadline of October 2016, otherwise 0. $NoOfFunds_{ft}$ represents the size of a fund's family as measured by the number of MMFs a fund family manages. $Size_{ft}$ is the log of total net assets of a fund. ELM_{ft} is the expected loss at maturity which represents the credit risk of a fund (see appendix B1 for calculations). $WLiq_{ft}$ is the weekly liquidity which represents a fund's weekly liquid assets of the fund as a percentage of its total assets. $FlowVol_{ft}$ is the flow volatility, calculated as rolling standard deviation of a fund's $NetInflows_{ft}$ over a fixed window of the past six months, where $NetInflows_{ft}$ are calculated as the difference between subscriptions and redemptions. $ExRatio_{ft}$ is the expense ratio of a fund, which represents the difference between gross yield (a fund's portfolio yield) and net yield

[25]We conduct a robustness test on the period from July 2014 to October 2015 which includes the whole stretch of time from the approval of 2016 amendments to rule 2a-7 in July 2014 to October 2015 which is a month before transition period starting in November 2015. We find that the results are robust (see appendix B3).

(yield paid to a fund's investor). ε_{ft} is the error term. We cluster standard errors by fund. We run the regression separately for institutional and retail funds. Institutional prime funds are subject to stricter requirements than retail prime funds, so we expect them to behave differently than retail funds.

Table 4.6 summarizes the results.[26] Columns 1 and 2 represent the coefficients and marginal effects of the probit model in eq. (3), for institutional prime funds, respectively. In column 2, $NoOfFunds_{ft}$ is negative and highly significant. Institutional funds that belong to bigger fund families are less likely to change to government funds or quit. Such funds, when in distress, can acquire financial support from their sponsor. McCabe (2010) shows that sponsors' support slowed the investor withdrawals in 2007. Brady et al. (2012) find that at least 21 prime funds received support from their sponsors to avoid "breaking the buck" during the global financial crisis. A fund sponsor even though not contractually required to do so, often chooses to support an MMF to avoid reputational risk which can have a negative impact on the sponsor's other businesses. Post reforms, the institutional prime funds became obligated to use floating NAV so breaking the buck is no longer a concern. However, they must impose liquidity fees and redemption gates when liquidity levels drop below a certain threshold. However, a fund can avoid liquidity fees and redemption gates by obtaining financial support from its sponsors to increase liquidity levels.

The marginal effects of $Size_{ft}$ are negative and significant indicating that the bigger funds are less likely to change their category. Judging from the fact that bigger

[26]The results are robust to a specification including time-fixed effects (see appendix B2).

funds are managing more net assets, these funds have demonstrably higher capability to attract and retain investors. Therefore, they are possibly more confident in their ability to continue to do so in the post-reform era. Other reasons could be that bigger funds are slower to change and are better at managing relationships with their shareholders which would allow them to predict outflows more accurately and hence be able to manage their liquidity more effectively. Next, the coefficient of ELM_{ft} which is a fund's expected loss at maturity, a measure of portfolio credit risk, is positive and significant. Institutional prime funds with higher credit risk are more likely to change to government funds because funds with higher credit risk have a greater possibility to undergo distress (Chari and Jagannathan 1988; Jacklin and Bhattacharya 1988; Chernenko and Sunderam 2014), which could lead to higher outflows and lower liquidity with an increased likelihood of eliciting liquidity fees and redemption gates. Higher credit risk would also give rise to more volatility in a fund's floating NAV which could lead to investor withdrawals because of potential loss in the principal invested. Therefore, converting to a government fund would lead to a more stable fund with no requirement for floating NAV, redemption gates or liquidity fees. The marginal effects of the expense ratio, $ExRatio_{ft}$, weekly liquidity $WLiq_{ft}$, and flow volatility, $FlowVol_{ft}$, are insignificant, indicating that these do not play a part in a fund's decision to exit prime funds.

Columns 3 and 4 represent the coefficients and marginal effects for retail prime funds. In Column 4, the coefficient of $NoOfFunds_{ft}$ is insignificant indicating that, unlike with institutional funds, the size of a fund family is not a determining factor in the decision of a retail fund to change category. The coefficient on $Size_{ft}$ shows that the bigger retail funds do not change their category in response to the reforms.

This is possibly because such funds have demonstrably higher capacity to attract inflows, retain investors and have possibly better relationships with shareholders with greater ability to manage outflows and hence liquidity levels. Interestingly, the funds with higher ELM_{ft}, tend to stay prime funds. This could be because retail funds, unlike institutional funds, do not have a very volatile shareholder base. In previous episodes of crisis, retail investors remained significantly less likely to withdraw during market stress (Gallagher et al. 2015). This is because retail investors do not usually have resources to assess the quality of a fund's portfolio. Therefore, retail funds do not have the incentive to keep the credit risk of their portfolio low because they are managing slow money. Moreover, the new reforms prohibit institutional investors from investing in retail funds which means that the market discipline enforced by the institutional investors before reforms has been eliminated. Therefore, retail funds can invest in riskier assets without potentially adverse consequences. The marginal effects of $FlowVol_{ft}$ is positive and significant. Retail funds with higher flow volatility are more likely to change to government funds because higher flow volatility results in unpredictability of inflows/outflows and hence more volatility in liquidity levels. The marginal effects of $ExRatio_{ft}$ and $WLiq_{ft}$, are insignificant.

4.4.4 Changes in Retail vs Institutional Prime Funds

The requirement of redemption gates and liquidity fees means that after the reforms if a fund is subject to heavy withdrawals and its liquidity goes below a certain level it can restrict the redemptions for a maximum period of 10 days or charge a fee on redemptions. Several funds advertise that they do not plan to impose gates nor charge liquidity fees. Therefore, we expect funds to position themselves so that they can avoid scenarios where they might be forced to restrict redemptions. We document changes in retail and institutional prime funds' portfolio composition after the reforms. This is the first paper to engage in such analysis.

Table 4.7 reports the averages and statistical significance of the variables that describe the composition of MMF portfolios before reforms (BR) from January 2014 to June 2014 and after reforms (AR) from October 2016 to March 2017. "Diff" represents the difference between "AR" and "BR". Column 3 shows the differences between the averages of the reported variables before and after reforms. The average size of an institutional prime fund, $NetAssets_{ft}$ has not changed significantly.[27] The funds have increased their weekly liquidity, $WLiq_{ft}$ to 67 percent on average, to ensure that they do not the breach 30 percent threshold that could lead to imposition of redemption gates or liquidity fees. In addition, they have lowered weighted average life, WAL_{ft} which leads to lower average maturity and a more liquid portfolio. The assets with longer maturities have largely decreased. On average, the expected loss of a fund, ELM_{ft} has increased by 2.85 bp indicating that funds are taking more risk. Post-reform, the increase in the regulatory burden has increased the cost of operations. The new rules have stripped funds of features such as preservation of capital and money-like liquidity, making MMFs less attractive than before. To attract investors a fund must earn higher yield (Sirri and Tufano 1998; Koppenhaver and Sapp 2005), to cover the increased expenses and pay a competitive yield to shareholders. To earn higher yield, it must invest in riskier securities (Kacperczyk

[27]The total net assets of MMFs are known to be positively skewed, which would lead to a biased mean. As a robustness test, we calculate the significance of the differences between the median net assets, which is also insignificant (see appendix B4).

and Schnabl 2013). Next, $Spread_{ft}$ indicates that institutional funds have, in fact, increased the portfolio gross yield net of the average government fund gross yield. ($NetYield_{ft}$ - $\overline{GovtNY}_{ft}$) indicates that after accounting for the increases in the treasury yield during the period under analysis, the funds are paying a higher yield after the reforms (+12.26 bp). Also, the funds are charging higher management fees to meet the added cost of the new regulations, as seen from the increase in the expense ratios, $ExRatio_{ft}$.

Column 6 displays the differences in the averages of the variables for retail funds before and after the reforms. The retail funds have the similar response in sign and significance for all the variables, but the magnitude of the average values differ in most cases. Columns 7 and 8 compare these differences in institutional and retail funds before and after reforms. After reforms, institutional funds hold more $WLiq_{ft}$ (+15.55%) than retail funds which is five times more than the difference before reforms. These funds also have lower WAL_{ft} (-15.96 %) than their retail counterparts. There was no significant difference in WAL_{ft} of the funds earlier. The difference in the liquidity of these funds is understandable as these have different liquidity management goals because of structural differences in the post-reform era. Institutional funds serve a more volatile shareholder base and are subject to the floating NAV requirement. They must strive to keep the NAV stable which translates into maintaining lower risk and a more liquid portfolio. Because they manage hot money, they also need higher liquidity to withstand heavy redemption pressure. Figure 4.4 shows the average proportion of the total portfolio securities invested in each maturity range for institutional and retail funds. The institutional funds seem to have changed $WLiq_{ft}$ and WAL_{ft} by investing a higher proportion of assets in very short-term securities that mature within 5 days, and disinvesting in longer maturity securities. Conversely, retail funds decrease their short-term investments and invest more in securities with maturities >180 days (Figure 4.4) which explains the difference in liquidity and WAL_{ft}. The expected loss, ELM_{ft} is not significantly different for both types of funds. However, Figures 4.5 and 4.6 show that the source of the ELM_{ft} for both types of funds is different. Figure 4.5 shows that the ELM_{ft} of institutional MMFs has increased from all regions including Asia and Pacific, Europe, North America and Other. This could be interpreted as a more cautious risk management strategy where the funds have diversified the credit risk. Institutional MMFs (Figure 4.6) have very slightly increased their investments in Europe, but they keep investing roughly the same proportion of their assets in each region as compared to before the reforms. Retail MMFs have decreased the total proportion of securities invested in Asia and Pacific and Europe and increased their investment in North America.

Institutional funds are earning a lower yield spread, $Spread_{ft}$, (-8.56 bp) than retail funds, which is four times lower than the difference before reforms. However, they still pay a higher net yield to their investors, $NetYield_{ft}$ - $\overline{GovtNY_t}$. These funds are able to pay higher yields while earning lower $Spread_{ft}$ by charging lower fees than retail funds do. The expense ratio of institutional funds (-19.54 bp) is very low as compared to that of retail funds. Christoffersen (2001) demonstrates that 79 percent of institutional MMFs waive fees whereas only 55 percent of retail funds do so, implying that institutional funds have stronger price competition than retail funds.

The expense ratio of institutional funds is approximately seven times lower than the difference before reforms. Furthermore, retail funds have less incentive to charge lower fees because retail investors are less sensitive to fund performance and tend to remain invested in funds that charge higher fees (Christoffersen and Musto 2002). It seems that higher investor concentration, stricter rules and loss of the attractive features of MMFs have strengthened competition in institutional funds. However, other regulations such as those in Basel III and the Dodd-Frank Act might be affecting the analysed measures as well. Unfortunately, it is not possible to separate the impact of these regulations from the impact of SEC regulation.

In summary, we find that the institutional funds have changed their portfolio composition dramatically in the port-reform era. In addition to the structural changes imposed by the regulations, the two types of funds have become very different in their liquidity positions, maturity structure and competitiveness. Institutional funds are foregoing more management fee to pay higher yields to their investors and maintain their competitiveness.

4.4.5 Liquidity Management at MMFs After 2016 Amendments

In addition to the minimum regulations, in chapter 3, we show that portfolio composition and shareholder behaviour determine the levels of liquidity a fund holds. They document that higher flow volatility, expected outflows and riskier portfolios maintain higher liquidity suggesting that the funds keep a safety cushion if they have a higher chance of withdrawals. We extend the analysis by further investigating the relationship between contemporaneous changes in liquidity and credit risk of a fund. MMFs have several reasons to manage the weekly liquidity of their portfolio actively. First, they must have a regulatory minimum of 30 percent of their total assets in weekly liquid assets. Second, new rules require funds to charge liquidity fees or suspend redemptions if the weekly liquid assets fall below this regulatory minimum. Third, if it has higher risk it must maintain a safety cushion to meet redemptions comfortably because during market distress, runs are more severe for MMFs that have lower portfolio liquidity (Wermers 2011). We thus test whether the funds are managing their liquidity according to their risk profile. The empirical model is specified as follows:

$$\Delta WLiq_{ft} = \alpha_f + \beta_1 \Delta ELM_{ft} + \beta_2 ELM_{ft-1} + \beta_3 \Delta NetInflows_{ft} + \beta_4 NetInflows_{ft-1} + \varepsilon_{ft} \qquad eq.\ (4)$$

where $\Delta WLiq_{ft}$ is monthly change in weekly liquidity of fund "f". α_f represents fund fixed effects. We include the change in the expected loss of a portfolio, ΔELM_{ft}. This is the main regressor of interest. An increase in credit risk raises the likelihood of default, which could lead to heavy outflows and hence a higher need for liquid assets. Given that funds base their liquidity levels on the portfolio composition and redemption behaviour of their investors, we expect any increase in credit risk to be accompanied by a contemporaneous growth in liquidity, which should result in a positive β_1. We include ELM_{ft-1} to account for delayed adjustments in fund liquidity. A higher lagged credit risk should encourage funds to hold more liquid holdings. Therefore, we expect a positive β_2. We add contemporaneous changes in net inflows, $\Delta NetInflows_{ft}$ in the regression to capture variation in liquidity caused by changes in funds' net subscriptions. $NetInflows_{ft}$ is calculated as the difference between subscriptions and redemptions. Positive net inflows inject cash in the fund which would result in higher liquidity, while negative net inflows decrease liquidity because funds must sell their liquid assets to meet redemptions. We add lagged net inflows, $NetInflows_{ft-1}$ as a control variable to capture possible delays in rebalancing the portfolio to achieve the desired liquidity levels.

One caveat of including ΔELM_{ft} and $\Delta NetInflows_{ft}$ as regressors is that there might be reverse causality between changes in liquidity, expected loss and net inflows. To address this problem, we instrument these variables with their predicted values.[28] The analysis is conducted separately for institutional and retail funds. We further divide the sample into before-reform and after-reform to observe any changes in fund behaviour after the introduction of the new rules.

Table 4.8 presents the results of eq. (4). Column 1 shows regression results for institutional prime funds before reforms. The coefficient of ΔELM_{ft} is negative and significant indicating that an increase in expected loss results in a decrease of portfolio liquidity. In other words, a fund's liquidity decreases contemporaneously as credit risk increases. This is possibly because a fund invests a large proportion of its assets in longer maturity instruments to increase the expected loss, which leads to a lower proportion of assets invested in short-term liquid assets. It is well documented that the funds increase their credit risk to earn higher yields (Koppenhaver 1999; Chernenko and Sunderam 2014) to attract more inflows. The

[28]For $NetInflows_{ft}$, we estimate the following regression: $\Delta NetInflows_{f,t} = \alpha + \sum_{n=1}^{N=5} \beta_1 \Delta NetInflows_{f,t-n} + \Delta NetYield_{f,t-1} + \varepsilon_{f,t}$ where n is the number of lags. To obtain fitted values for ΔELM_{ft} the following model is estimated: $\Delta ELM_{f,t} = \alpha + \sum_{n=1}^{N=5} \beta_1 \Delta ELM_{f,t-n} + \Delta WAL_{f,t-1} + \varepsilon_{f,t}$. Using fitted values in eq. (4) helps address endogeneity concerns but could lead to biased coefficients. We conduct a robustness test by using bootstrapped standard errors and find that the results are robust (see appendix B5). Further, we employ a different lag specification to calculate the fitted values of the variables and show that the results are robust (see appendix B6).

liquid assets have inferior performance (Acharya and Pedersen 2005; Jank and Wedow 2015), so a decrease in liquidity boosts returns. MMFs endeavour to reach for yields because mutual fund investors react to performance (Sirri and Tufano 1998; Koppenhaver and Sapp 2005). The lagged expected loss, ELM_{ft-1} is insignificant. The control variable $\Delta NetInflows_{ft}$ has a positive sign because net inflows boost cash reserves resulting in higher liquidity. The lagged net inflows, $NetInflows_{ft-1}$ is insignificant. One explanation would be that the funds have already allocated their cash to assets which would no longer result in any changes in the liquidity of a fund.

In column 2, after reforms, the coefficient of ΔELM_{ft} becomes positive and significant. Institutional prime funds grow their liquidity as they raise the credit risk of their portfolio. This indicates a more cautious investment management strategy. As a fund amplifies its riskiness, it simultaneously boosts its liquidity levels to guard against possible distress which could lead to shareholder redemptions. Thus, higher liquidity levels show preparedness that would help funds meet redemptions easily and mitigate the reputational risk of having to suspend redemptions. The lagged credit risk, ELM_{ft-1} is also positive and significant, which reinforces the previous finding that funds are actively managing their liquidity in relation to the riskiness of their portfolio. Such a response is expected from funds that serve institutional investors because these funds are characterized by higher flow volatility (Gallagher et al. 2015) and higher likelihood of runs in distress (Schmidt et al. 2016), which results in higher demand for liquidity. To the best of our knowledge, this is the first paper to show such a contrast in behaviour of institutional MMFs after the introduction of redemption gates, liquidity fees and floating NAV. In addition, our results confirm the concern of Gallagher et al. (2015) that greater concentration of institutional investors will result in increased demand for liquidity in such funds.

Column 3 displays the results for eq. (4) for retail prime funds, before reforms. As the expected loss increases, retail funds increase their portfolio liquidity which is a cautious investment strategy to maintain safe liquidity levels. All control variables are insignificant. In column 4, after reforms, the contemporaneous change in expected loss, ΔELM_{ft} has an insignificant impact on the liquidity levels of the fund which is interesting. Unlike institutional funds, the retail funds do not seem to increase liquidity actively post reforms. This is possibly because the market discipline enforced by institutional shareholders is eliminated, because after reforms retail funds are only offered to “natural persons” who rebalance their portfolio less frequently. The control variables $\Delta NetInflows_{ft}$ and $NetInflows_{ft-1}$ are insignificant.

In summary, in the post-reform period, institutional prime funds have become more active in their management of credit risk. They adjust their liquidity levels upwards simultaneously with any increases in their credit risk resulting in increased safety to control for possible redemption pressure. On the other hand, retail funds have become more relaxed in their liquidity management.

4.4.6 Shareholders’ Response to New Rules

The new rules have consequences for investors in money market funds. They could lose access to capital if redemption gates are applied or incur costs if liquidity fees are imposed. So, post reform the institutional investors must be more cautious of the credit risk and liquidity levels of the portfolio investments in the MMFs. Historically, heavy redemption pressure occurs when the fund’s securities become riskier.[29] Many fund families have taken actions to limit the possibility of a redemption trigger or avoid it altogether by converting their funds into government money market funds, which have no such requirement.

In this section, we examine the response of each type of shareholder after reforms. We estimate the following panel fixed effects regression:

$$NetInflows_{ft} = \alpha_f + \beta_1 \Delta ELM_{ft} + \beta_2 ELM_{ft-1} + \beta_3 \Delta WLiq_{ft} + \beta_4 WLiq_{ft-} + \beta_5 C_{ft-1} + \varepsilon_{ft} \qquad eq.\ (5)$$

where the dependent variable $NetInflows_{ft}$ is calculated as a difference between monthly subscription and redemptions as a percentage of the lagged total net assets of fund "f". α_f represents fund fixed effects. ΔELM_{ft} is the predicted change in the expected loss at maturity of a fund's portfolio and is defined as before. $\Delta WLiq_{ft}$ is the predicted change in weekly liquidity. ELM_{ft-1} and $WLiq_{ft-1}$ are lagged expected loss and weekly liquidity, respectively. We include but do not show the following control variables represented by C_{ft-1} matrix that could influence the behaviour of a fund's shareholders: $NetYield_{ft-1}$, which is the yield earned by funds' shareholders, calculated as the value-weighted average of the 7-day net yields of the fund share classes as reported on N-MFP form; $Size_{ft}$, the log of total net assets of a fund; $ExRatio_{ft}$, the expense ratio of a fund calculated as the difference between the gross yield and the net yield of a fund. Standard errors are clustered by fund.

[29]For instance, the Lehman Brothers default in September 2008 triggered industry wide redemptions and the Reserve Primary funds "broke the buck". In June 2011, during the sovereign debt crisis, investors withdrew heavily from the MMFs with high Eurozone bank exposures because such banks were expected to default due to their large holdings of sovereign debt. Most of these withdrawals were made by institutional investors.

Table 4.9 presents the results.[30] Column 1 shows the results for institutional prime funds before reforms. All the main explanatory variables are insignificant. This is plausible because MMFs hold high quality short-term debt instruments and are governed by rule 2a-7 which ensures stable NAV and low-risk portfolios. This enabled MMFs to offer attractive features such as preserving capital, providing intraday liquidity coupled with higher yields before reform. With such features, investors were not very concerned about the portfolio composition before reforms during calm periods. This has changed after reforms. In column 2, we examine the response of investors to credit risk and liquidity of a fund portfolio, after reforms. We find that investors respond negatively to higher credit risk portfolios. This is expected because post-reform, in the event of distress, investors can lose access to capital if redemption gates are applied or redeem their money at a cost if a fund decides to charge a liquidity fee. Furthermore, we expect institutional investors to be watchful of the changing risk of a fund. We test this by using the contemporaneous changes in the expected loss of a fund as an additional regressor, ΔELM_{ft}. The coefficient is negative and highly significant. So, institutional investors tend to disinvest from funds with higher credit risk. The contemporaneous changes of net inflows with changes in expected losses points to the cautious attitude of institutional investors to the risk of a portfolio. This prudent behaviour of institutional investors is corroborated by Gallagher et al. (2015) who find that after controlling for net yields, institutional investors react negatively to increases in gross yield which

[30]The results presented in table are robust to regression bias (see appendix B7), persistence of net inflows (we run a dynamic regression) (see appendix B8) and different specification of contemporaneous variables (see appendix B9).

represents risk. The weekly liquidity of a fund has become a critical indicator of a fund's health and a determinant of whether a fund is at risk of suspension of redemptions. We find that the lagged weekly liquidity, $WLiq_{ft-1}$ is negative and highly significant which is consistent with previous studies (Jank and Wedow 2015) which find that MMFs with more liquid assets tend to have lower inflows. This is because higher liquidity results in lower portfolio yields and therefore reduced net yields.

Columns 3 and 4 shows regression results for retail prime funds. The coefficient of lagged expected loss is negative and significant indicating that before reforms investors are cautious of the credit risk of a fund's portfolio. However, ELM_{ft-1} becomes insignificant after the reforms. This is possibly because retail funds are deemed more stable after the reforms as institutional investors are completely prohibited from investing in such funds. Therefore, the "hot money" leading to the first mover advantage and a possible loss in value of NAV because of the higher unpredictability in inflows/outflows has been removed resulting in higher tolerance for risk. Weekly contemporaneous change in liquidity, $\Delta WLiq_{ft}$ and lagged weekly liquidity, $WLiq_{ft-1}$ remain insignificant indicating that retail investors do not take liquidity levels into account.

In summary, institutional investors are now more prudent about the credit risk of a fund portfolio. As a result, they withdraw from funds that take on more risk to try and avoid being squeezed by redemption gates and liquidity fees. Interestingly, we see that retail investors have become more liberal than before and do not respond negatively to the risk-taking of funds. This incentivizes retail funds to accumulate risk in order to gain higher yields. One must keep in mind that while the 2016

Amendments were the primary sources of regulatory restrictions on MMFs, other regulatory changes such as Basel III and the Dodd-Frank Act might also have indirectly affected MMF investors' decisions.

4.5 Conclusion

We utilize a unique dataset of detailed portfolio holdings of US money market funds filed monthly with the SEC from January 2014 to March 2017 to assess the response of MMFs and their investors to the amendments of rule 2a-7 which became effective on October 14, 2016. The most notable changes include the introduction of investor differentiation, floating net asset value, redemptions gates and liquidity fees. This paper investigates the changes in the MMF industry that have occurred after the 2016 Amendments. We assess the response of institutional and retail money market funds and their investors after the reforms. We empirically show that the total net assets from prime MMFs have migrated to government MMFs within the same fund family indicating the preference of investors for the bank-like function of MMFs. In addition, we show that the institutional funds that held more credit risk were more likely to migrate, while surprisingly, retail funds with more risk stayed prime funds. We also find that the institutional funds have changed their portfolio composition dramatically in the post-reform period. The two types of funds have become very different in their liquidity positions, maturity structure and competitiveness. Institutional funds are foregoing more management fee to pay higher yield to their investors to maintain their competitiveness. Moreover, institutional funds have become more active in their management of credit risk. As they increase their risk, they tend to increase their liquidity to increase the liquidity safety net for a possible redemption pressure. On the other hand, retail funds have become more relaxed in their liquidity management possibly because of the elimination of the market discipline that was enforced by the presence of institutional investors in their shareholder mix. We believe that these changes in the MMF industry could be attributed to the regulatory changes to rule 2a-7. However, based on the research design of this chapter it is not possible to clearly determine a causal effect between the regulatory changes and the observed changes due to multiple confounding effects that may have influenced the portfolio characteristics of funds and the response of investors to them.

An interesting question that remains unexplored in this chapter is the influence of floating NAV in mitigating risk-taking and runs and the reaction of shareholders to this change from previously stable NAV.

Figures

Figure 4.1: Timeline (Jan 2014 – Mar 2017)

This figure shows the timeline for various sample periods used in this paper. Our final dataset spans from January 2014 to March 2017. The before-reform (BR) period includes January 2014 to June 2014, a six-month period just before approval of the new rules in July 2014. The after-reform period (AR) includes the six months from the final compliance month October 2016 to March 2016. The transition period consists of a one-year interval from November 2015 to October 2016 when the MMF industry was making the required structural changes. The pre-transition period is the six months, from May 2015 to October 2015.

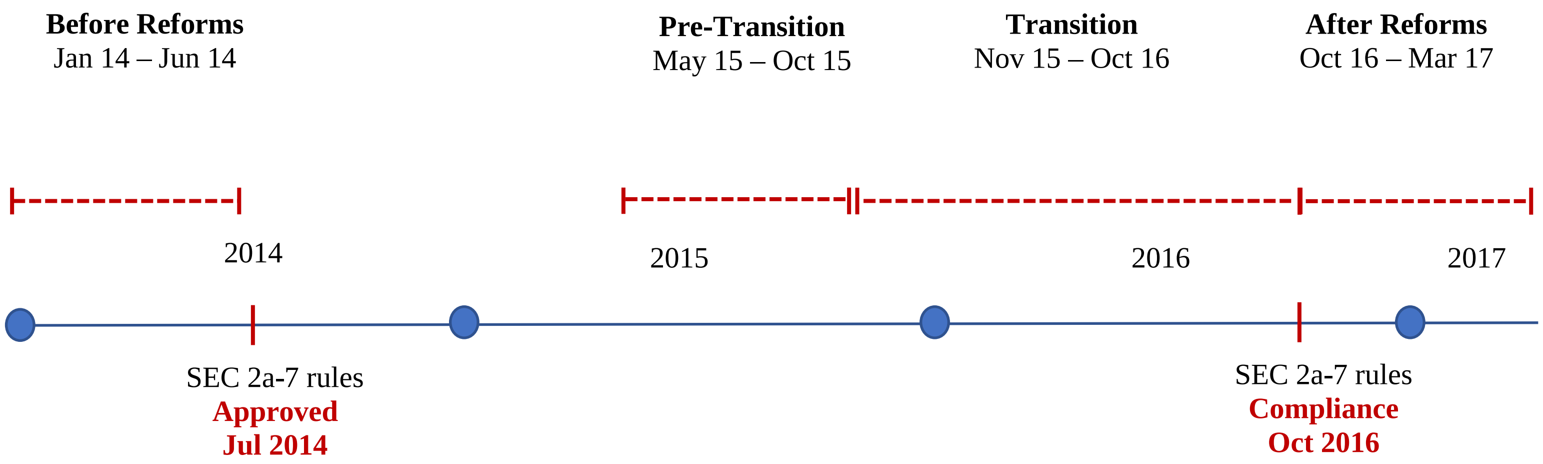


Figure 4.2: Aggregate Net Assets of the MMF Industry

This figure shows the evolution of aggregate net assets by the type of MMF over whole sample period from January 2014 to March 2017. Prime funds include those funds that report their category as "Prime" in item A.10 of the N-MFP form, Government funds includes treasury, government/agency and exempt government funds, municipal funds include single state and other tax-exempt funds as reported in item A.10 of the N-MFP form. (Source: N-MFP form data; authors' own calculations).

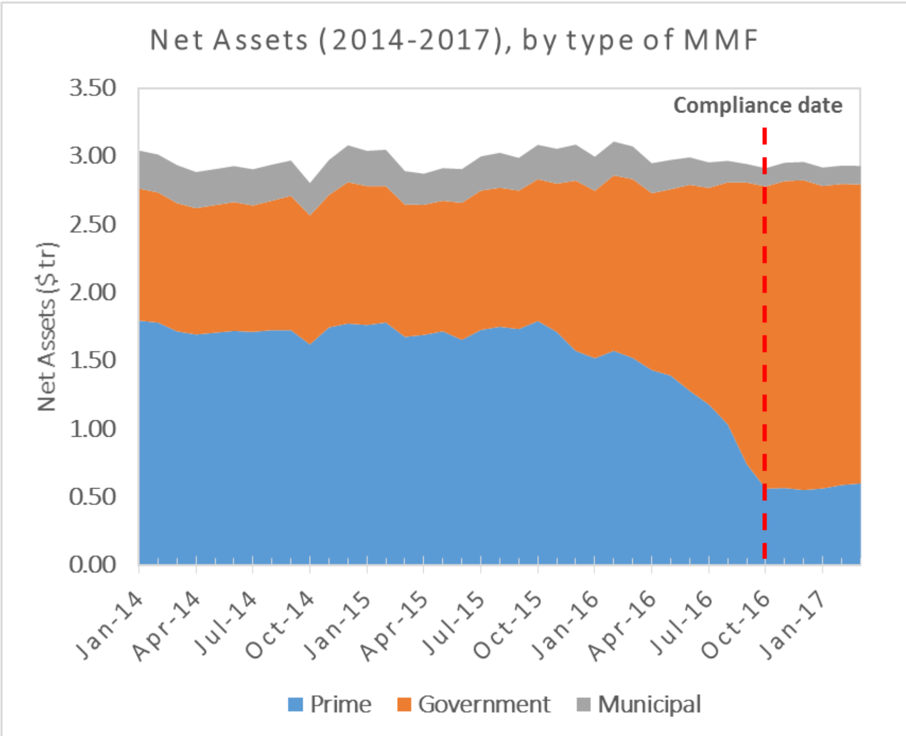


Figure 4.3: Number of Funds in the MMF Industry

This figure shows the evolution of the number of funds by the type of MMF over whole sample period from January 2014 to March 2017. Prime funds include those funds that report their category as "Prime" in item A.10 of the N-MFP form Government funds includes treasury, government/agency and exempt government funds, municipal funds include single state and other tax-exempt funds as reported in item A.10 of the N-MFP form. (Source: N-MFP form data; authors' own calculations).

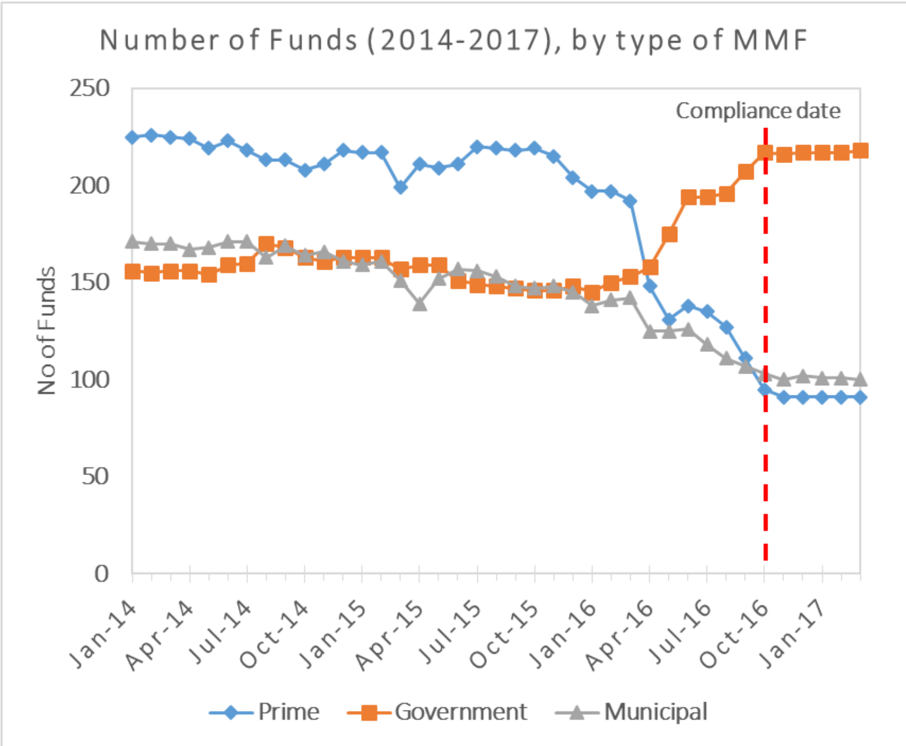


Figure 4.4: Prime MMFs' Portfolio Maturity Structure by Shareholder Type

This figure displays the average percentage of a fund's assets maturing within various time intervals by the shareholder type of prime MMF i.e. institutional vs retail. To arrive at this, we calculate the percentage of a fund's assets maturing within certain time intervals and calculate the average of this in the before-reform and after-reform periods. The before-reform (BR) period includes January 2014 to June 2014. The after-reform period (AR) includes six months from the final compliance month, October 2016, to March 2016. (Source: N-MFP form data; authors' own calculations).

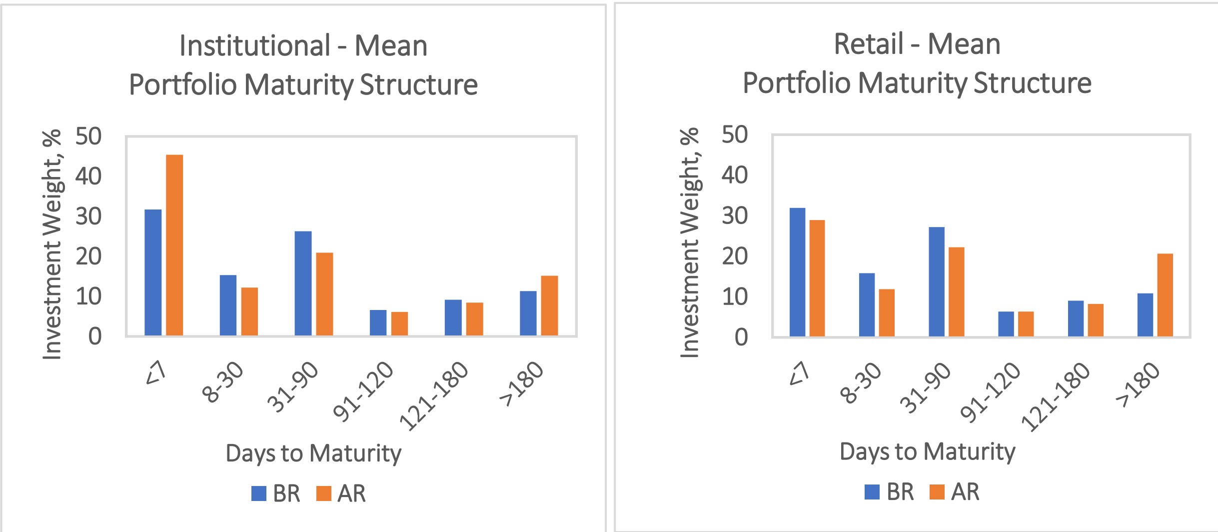
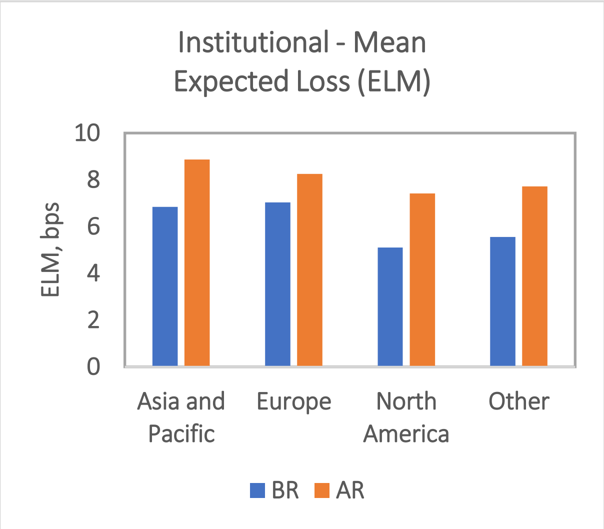


Figure 4.5: Expected Loss (ELM) by Region

This figure displays the average expected loss of the MMF industry within various regions for institutional and retail prime MMFs. To arrive at this, we calculate the ELM of a fund's portfolio from each region, then calculate the average of ELM across all funds within a region for the before-reform and after-reform periods. Asia and Pacific includes Austraila, Japan, New Zealand, China, Hong Kong, India, Singapore, South Korea and Sri Lanka. Europe includes Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxemburg, Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom. North America includes Canada and the United States. Other includes Mauritius, UAE and unclassified securities. The before-reform (BR) period includes January 2014 to June 2014. The after-reform period (AR) includes six months from the final compliance month, October 2016, to March 2016. (Source: N-MFP form data; authors' own calculations).



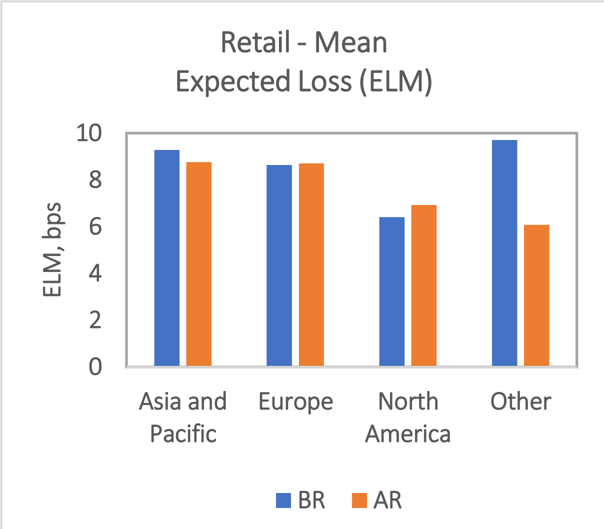
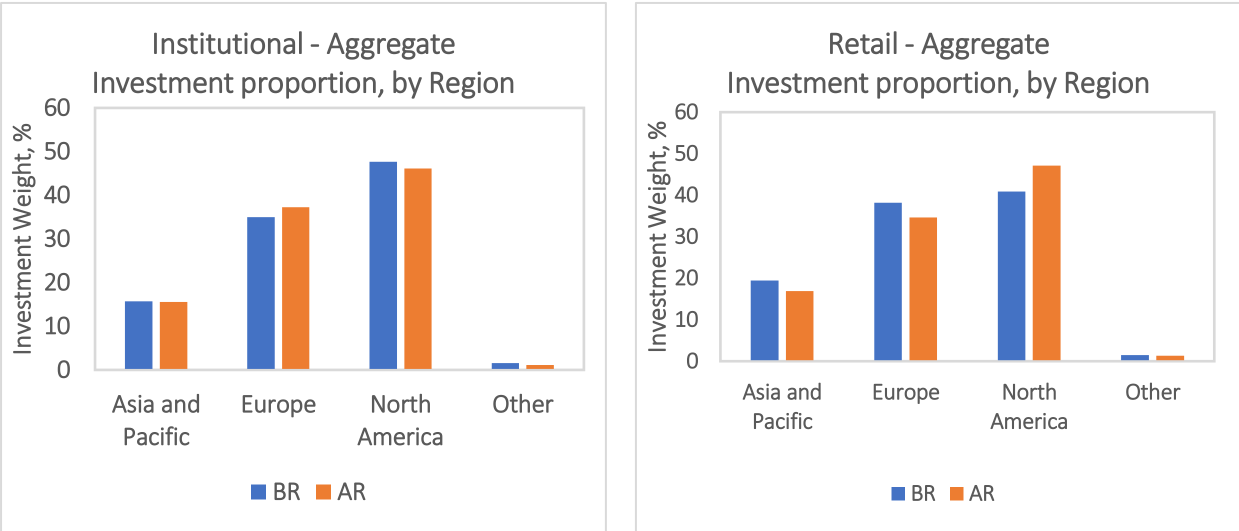


Figure 4.6: Investment Weight of MMFs' Assets by Region

This figure displays the aggregate assets holding proportion of MMFs invested in each region for institutional and retail prime MMFs. Asia and Pacific includes Austraila, Japan, New Zealand, China, Hong Kong, India, Singapore, South Korea and Sri Lanka. Europe includes Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Luxemburg, Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom. North America includes Canada and the United States. Other includes Mauritius, UAE and unclassified securities. The before-reform (BR) period includes January 2014 to June 2014. The after-reform period (AR) includes six months from the final compliance month, October 2016, to March 2016. (Source: N-MFP form data; authors' own calculations).



Tables

Table 4.1: 2016 Amendments by MMF Type

This table summarizes the impact of key amendments in Rule 2a-7, effective from October 2016. *Liquidity fee and redemption gates are applied when a fund's weekly liquid assets fall below the 30 percent of its total assets.

Fund Type	Investor Type	Liquidity Fee*	Redemption Gates*	Floating NAV
Prime Funds	Institutional	Up to 2%	Up to 10 business days	Floating
Municipal Funds	Retail	Up to 2%	Up to 10 business days	Stable at $1.00
Government Funds	Institutional	None	None	Stable at $1.00
	Retail			

*Liquidity fee and redemption gates are applied when a fund's weekly liquid assets fall below the 30 percent of its total assets.

Table 4.2: Total Net Assets and Market Share by MMF Type

This table presents aggregate net assets and market share of MMFs by fund type, before reforms in January 2014 (which is the start of our sample period) and after reforms in March 2017, the last month of the sample period. (Source: N-MFP form data; authors' own calculations).

	January 2014		**March 2017**		**Change**	
Total Net Assets	**$bn**	**% share**	**$bn**	**% share**	**$bn**	**% share**
Prime	1,794	59	599	20	-1,194	-39
Municipal	279	9	135	5	-144	-5
Government	969	32	2,195	75	1,226	+43
Total	3,042		2,930		-112	

Table 4.3: Number of Fund Families

This table shows the number of funds families in our sample. Panel A contains the total number of fund families in our sample. Panel B displays the number of fund families with at least one fund in each stated category. A fund family is identified by the CIK number of a fund manager reported on N-MFP form. Prime funds include those funds that report their category as “Prime” in item A.10 of the N-MFP form. Government funds includes treasury, government/agency and exempt government funds, municipal funds include single state and other tax-exempt funds as reported in item A.10 of N-MFP form. The before-reform (BR) period includes January 2014 to June 2014. The after-reform period (AR) includes six months from the final compliance month i.e. October 2016 to March 2016. (Source: N-MFP form data; authors’ own calculations).

Panel A: Total Number of Fund Families			
	BR	**AR**	**Diff**
Total Fund Families	282	226	-56

Panel B: Number of Fund Families with at least one Fund in Stated Category			
	BR	**AR**	**Diff**
Prime	189	69	-120
Municipal	88	55	-33
Government	100	161	+61

Table 4.4: Changes in Total Net Assets of MMFs

This table shows results of panel regressions including both fund family and time fixed effects. The dependent variable in each column represents the total net assets of a fund family invested in the respective category of fund and its type of shareholder base. $NAPrimeI_{fft}$ and $NAPrimeR_{fft}$ represent total net assets of a fund family "ff" invested in institutional prime and retail prime funds, respectively. $NAMuniI_{fft}$, $NAMuniR_{fft}$, $NAGovtI_{fft}$ and $NAGovtR_{fft}$ are total net assets of a fund family invested in institutional municipal funds, retail municipal funds, institutional government funds, and retail government funds, respectively. $Reform_t$ is a dummy variable which takes the value of zero before reforms (January – June 2014) and one in the after-reform period (October 2016 – March 2017). The standard errors are clustered by fund family. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Prime		**Municipal**		**Government**	
	Institutional	**Retail**	**Institutional**	**Retail**	**Institutional**	**Retail**
DepVar:	$NAPrimeI_{fft}$	$NAPrimeR_{fft}$	$NAMuniI_{fft}$	$NAMuniR_{fft}$	$NAGovtI_{fft}$	$NAGovtR_{fft}$
	(1)	(2)	(3)	(4)	(5)	(6)
$Reform_t$	-3.64***	-1.13***	-0.75**	-1.55***	4.29***	0.14**
	(0.75)	(0.18)	(0.30)	(0.46)	(1.27)	(0.06)
Constant	6.13***	1.78***	1.80***	2.53***	3.28***	0.38***
	(0.42)	(0.09)	(0.15)	(0.23)	(0.62)	(0.03)
Time FE	Y	Y	Y	Y	Y	Y
Family FE	Y	Y	Y	Y	Y	Y
Adjusted R^2	0.12	0.31	0.09	0.15	0.08	0.06
Observations	1,728	1,044	660	696	1,476	1,080

Table 4.5: Migration of Total Net Assets of MMFs to Government MMFs

This table shows results of panel fixed effects regressions including both fund family and time fixed effects. The dependent variable, $\Delta NAGovt_{fft}$ is the first difference of TNA of a fund family managed by its government funds. $\Delta NAPrimeI_{fft}$ and $\Delta NAPrimeR_{fft}$ represent the first differences of TNA of a fund family "ff" managed by its institutional prime and retail prime funds, respectively. $\Delta NAMuniI_{fft}$, and $\Delta NAMuniR_{fft}$, are the first differences of TNA of a fund family "ff" managed by its institutional municipal funds and retail municipal funds, respectively. We include lags of all variables in the regression. Column (1) shows results for the transition period starting from November 2015 to October 2016, which represents one year before the compliance date of the SEC 2016 reforms. Column (2) runs a placebo regression during before-reform period from January 2014 toJune 2014.The standard errors are clustered by fund family. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Transition Period (Nov 2015 – Oct 2016)	**Placebo Regression** BR (Jan 2014 – Jun 2014)
DepVar: $\Delta NAGovt_{fft}$	(1)	(2)
$\Delta NAPrimeI_{fft}$	**-0.78*****	**0.44*****
	(0.24)	(0.07)
$\Delta NAPrimeI_{fft-1}$	**-0.11***	**0.44*****
	(0.06)	(0.07)
$\Delta NAPrimeR_{fft}$	**-0.12****	0.03
	(0.05)	(0.03)
$\Delta NAPrimeR_{fft-1}$	-0.00	-0.03
	(0.01)	(0.03)
$\Delta NAMuniI_{fft}$	-0.42	0.11
	(0.47)	(0.12)
$\Delta NAMuniI_{fft-1}$	-0.05	-0.10
	(0.35)	(0.13)
$\Delta NAMuniR_{fft}$	0.32	0.38
	(0.56)	(0.27)
$\Delta NAMuniR_{fft-1}$	-0.21	0.22
	(0.42)	(0.19)
Constant	0.05	-0.03**
	(0.07)	(0.01)
Time FE	Y	Y
Family FE	Y	Y
Adjusted R^2	0.26	0.21
Observations	2,822	1652

Table 4.6: Factors that Influenced the Decision of Prime MMFs to Change Category

This table shows results of probit models over the pre-transition period from May 2015 to October 2015. The dependent variable, $Change_f$ is a dummy variable which takes the value of 1 if a fund changes its category from prime fund to government fund or quits the fund management industry, and 0 if the fund stays a prime fund. "Coef" represents the coefficients of the probit model. "Marginal" are the marginal effects of the probit model. $NoOfFunds_{ft}$ represents the number of funds managed by the fund family of the fund. $Size_{ft}$ is the log of total net assets of a fund. ELM_{ft} is the expected loss of a fund portfolio and is a proxy for credit risk (see appendix B1 for calculation). $FlowVol_{ft}$ is the rolling standard deviation of a fund's net inflows over a six-month fixed window. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between the gross yield and the net yield of a fund. $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. Standard errors are clustered by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $Change_f$	**Coef**	**Marginal**	**Coef**	**Marginal**
	(1)	(2)	(3)	(4)
$NoOfFunds_{ft}$	-0.19***	-0.04***	0.02	0.00
	(0.04)	(0.01)	(0.06)	(0.01)
$Size_{ft}$	-0.17**	-0.04**	-0.58***	-0.13***
	(0.08)	(0.02)	(0.16)	(0.03)
ELM_{ft} (bp)	0.17**	0.04**	-0.16***	-0.03***
	(0.08)	(0.02)	(0.05)	(0.01)
$FlowVol_{ft}$ ($)	0.00	0.00	0.10*	0.02*
	(0.03)	(0.01)	(0.06)	(0.01)
$ExRatio_{ft}$ (bp)	-0.00	-0.00	-0.04	-0.01
	(0.02)	(0.00)	(0.03)	(0.01)
$WLiq_{ft}$ (%)	0.01	0.00	-0.01	-0.00
	(0.01)	(0.00)	(0.01)	(0.00)
Constant	3.89**		13.74***	
	(1.94)		(3.42)	
Pseudo R^2	0.267		0.394	
Observations	724	724	396	396

Table 4.7: Changes in Retail vs Institutional Prime MMFs (Averages)

This table presents averages of the variables before reforms ("BR" is the period from January 2014 to June 2014) and after reforms ("AR" is the period from October 2016 to March 2017). "Diff" is the difference between "AR" and "BR". $NetAssets_{ft}$ is equal to the total value of a fund's securities plus other assets less liabilities. ELM_{ft} is the expected loss of a fund which is a proxy for the credit risk of a fund (see appendix B1 for calculation). $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. WAL_{ft} is the Weighted Average Life, calculated as average days to maturity weighted by the investment weight of each security. $Spread_{ft}$ is calculated as the difference between the gross yield of the fund's assets and the 1-month Treasury bill rate. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between gross yield (a fund's portfolio yield) and net yield (the yield paid to a fund's investor). $NetYield_{ft}$ is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP form. This represents the difference between the gross yield of portfolio less management fee. $\overline{GovtNY}_t$ is the average net yield of government funds each month. Significance levels are indicated by *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

	Institutional			**Retail**			**Institutional – Retail**		
	BR	**AR**	**Diff**	**BR**	**AR**	**Diff**	**BR**	**AR**	**Diff**
Mean	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$NetAssets_{ft}$ ($ bn)	6.41***	6.17***	-0.23	9.82***	6.95***	-2.87	-3.42***	-0.78	2.64
$WLiq_{ft}$ (%)	36.71***	66.74***	30.03***	32.96***	51.19***	18.23***	3.75***	15.55***	11.80***
WAL_{ft} (days)	67.36***	34.98***	-32.37***	66.94***	50.94***	-16.00***	0.42	-15.96***	-16.38***
ELM_{ft} (bp)	5.54***	8.39***	2.85***	6.07***	8.43***	2.36***	-0.53**	-0.04	0.49
$Spread_{ft}$ (bp)	7.77***	23.58***	15.81***	10.02***	32.14***	22.12***	-2.25***	-8.56***	-6.31***
$NetYield_{ft}$	2.69***	32.10***	29.40***	1.62***	27.48***	25.86***	1.08***	4.62***	3.54***
$NetYield_{ft}$ - $\overline{GovtNY}_t$	1.68***	13.94***	12.26***	0.60***	9.19***	8.59***	1.08***	4.75***	3.67***
$ExRatio_{ft}$ (bp)	12.29***	24.03***	11.75***	15.14***	43.57***	28.43***	-2.85***	-19.54***	-16.68***

Table 4.8: Liquidity Management at MMFs After the 2016 Amendments

This table presents results for panel fixed effects regressions before reforms ("BR" is the period from January 2014 to June 2014) and after reforms ("AR" is the period from October 2016 to March 2017). The dependent variable $\Delta WLiq_{ft}$ the first difference of weekly liquidity, $WLiq_{ft}$. $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. ELM_{ft} is the expected loss of a fund and is a proxy for credit risk (see appendix B1 for calculation). ΔELM_{ft} is the predicted value of change in expected loss of a fund. We use fitted values of change in expected loss in order to avoid endogeneity issues that could arise due to simultaneity bias resulting from possible bidirectional causality of changes in weekly liquidity $\Delta WLiq_{ft}$ and changes in expected loss, ELM_{ft}. $NetInflows_{ft}$ is a difference between gross subscriptions and redemptions. We use fitted values of $\Delta NetInflows_{ft}$ to avoid endogeneity issues that could arise due to simultaneity bias resulting from possible bidirectional causality of changes in weekly liquidity, $\Delta WLiq_{ft}$ and changes in net inflows, $\Delta NetInflows_{ft}$. The standard errors are clustered by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $\Delta WLiq_{ft}$ (%)	**BR**	**AR**	**BR**	**AR**
	(1)	(2)	(3)	(4)
ΔELM_{ft} (bp)	**-1.54*** **	**0.72*** **	**1.06***	0.51
	(0.55)	(0.24)	(0.61)	(0.54)
ELM_{ft-1} (bp)	0.18	**0.59** **	0.48	0.03
	(0.25)	(0.27)	(0.38)	(0.25)
$\Delta NetInflows_{ft}$ (%)	**0.25** **	0.06	0.16	-0.06
	(0.11)	(0.09)	(0.27)	(0.20)
$NetInflows_{ft-1}$ (%)	0.06	0.07	0.09	0.03
	(0.10)	(0.07)	(0.27)	(0.17)
Constant	-0.53	-6.15***	-2.46	-1.56
	(1.32)	(1.87)	(2.12)	(2.00)
Fund FE	Y	Y	Y	Y
Adjusted R^2	0.03	0.03	0.01	0.01
Observations	693	284	398	206

Table 4.9: Shareholders' Response to the 2016 Amendments

This table presents results for panel fixed effects regressions before reforms ("BR" is the period from January 2014 to June 2014) and after reforms ("AR" is the period from October 2016 to March 2017). The dependent variable is $NetInflows_{ft}$, calculated as a difference between gross subscriptions and redemptions of a fund. ELM_{ft} is the expected loss of a fund and is a proxy for credit risk (see appendix B1 for calculation). ΔELM_{ft} is the predicted values of changes in loss of a fund. We use fitted values of change in expected loss in to avoid endogeneity which could lead to simultaneity bias resulting from possible bidirectional causality of $NetInflows_{ft}$ and changes in expected loss. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. $\Delta WLiq_{ft}$ is the predicted values of the changes in the weekly liquidity of a fund. We use fitted values of $\Delta WLiq_{ft}$ to avoid endogeneity issues that could arise from possible bidirectional causality of changes in weekly liquidity, $\Delta WLiq_{ft}$ and net inflows, $NetInflows_{ft}$. We additionally control but do not report the following variables: $NetYield_{ft}$ which is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP form. This represents the difference between the gross yield of portfolio less management fee. $ExRatio_{ft}$ which is the expense ratio of a fund calculated as the difference between gross yield (a fund's portfolio yield) and net yield (the yield paid to a fund's investor). $Size_{ft}$ calculated as the log of total net assets of a fund. The standard errors are clustered by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $NetInflows_{ft}$ (%)	**BR**	**AR**	**BR**	**AR**
	(1)	(2)	(3)	(4)
ΔELM_{ft} (bp)	-0.22	-1.17***	-0.47	-0.40
	(0.45)	(0.40)	(0.69)	(0.44)
ELM_{ft-1} (bp)	-0.40	-0.45*	-1.18**	-0.28
	(0.40)	(0.23)	(0.46)	(0.21)
$\Delta WLiq_{ft}$ (%)	0.10	-0.03	0.13	-0.00
	(0.10)	(0.15)	(0.21)	(0.15)
$WLiq_{ft-1}$ (%)	0.04	-0.16***	-0.08	-0.02
	(0.07)	(0.05)	(0.11)	(0.06)
Constant	-2.78	0.96	5.34	-11.98**
	(4.42)	(6.24)	(6.23)	(5.26)
Fund FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Adjusted R^2	0.0159	0.258	0.0228	0.0818
Observations	606	291	359	209

Appendix B

B1: Calculation of Expected Loss at Maturity (ELM_{ft})

We procure data from Risk Management Institute (RMI) who use the reduced form forward intensity model of Duan et al. (2012) to calculate default probabilities for over 66,000 publicly listed firms around the world. RMI's PDs have performed well for short-term maturity securities from developed countries. RMI's 2017 technical report, shows the accuracy ratios for US, Canada, and Japan to be 0.94, 0.95, and 0.91 at 1-month horizon and 0.87, 0.83, 0.83 at 1-year, respectively. We match monthly portfolio holdings of prime funds issuer-by-issuer and maturity-by-maturity. RMI generates daily forward-looking default probabilities (PDs) for issuers for maturities of 1, 3, 6, 12, and 24 months ahead. We match the remaining maturities of each security of an issuer with the issuer's default probability at that maturity. We make several assumptions to match the default probabilities and maximize issuer coverage. We linearly interpolate default probabilities for every day between the maturities obtained from RMI to match the PD with the remaining maturities outside of those provided by RMI. We also need probabilities for securities with remaining maturity of less than one month. We assume that the security with remaining maturity of one day has no risk and therefore has $\mathrm{PD_{it}}(\mathrm{ttm_j} = 1)$ = 0. This allows us to linearly interpolate between maturities from one day to 30 days. In addition, we assume that US Treasury, government agency and municipal issuers present minimal risk and therefore, have $\mathrm{PD_{it}}(\mathrm{ttm_j})$ = 0, for all values of $\mathrm{ttm_j}$. Then, we match annualized default probabilities with the parent firms of the issuers obtained from N-MFP form. Once we obtain all PDs, we use them to calculate the expected loss of a fund portfolio using the eq. B1. The funds for which less than 75 percent of their securities could be matched with the default probabilities are removed from the analysis. These represent only 5 percent of the funds. On average, 92 percent of the total net assets of the prime funds in our sample here matched default probabilities.

$$\mathrm{ELM_{ft}} = \sum_{i=1}^{I} \sum_{j=1}^{J} \mathrm{w_{ij}}(1 - \mathrm{rr_i})\widetilde{\mathrm{PD}}_{\mathrm{it}}(\mathrm{ttm_j}) \qquad \text{eq. (B1)}$$

f = Fund
t = Month
I = Number of issuers in a fund's portfolio
J = Number of securities in a fund's portfolio
w_{it} = Proportion of a fund's total assets invested in security "j" issued by issuer "i".
rr_i = Recovery Rate [Market convention is 0.40 for corporate issuers except Japanese banks for which it is 0.35]
$\mathrm{PD_{it}}(\mathrm{ttm_j})$ = Probability of default for issuer "i" in month "t" for security "j" with remaining time to maturity "ttm".
$\widetilde{\mathrm{PD}}_{\mathrm{it}}(\mathrm{ttm_j}) = 1 - [1 - \mathrm{PD_{it}}(\mathrm{ttm_j})]^{360/\mathrm{ttm_j}}$ = Annualized probability of default.

B2: Factors that Influenced Decision of Prime MMFs to Change Category (with Time FE)

This table shows results of probit models over the pre-transition period from May 2015 to October 2015. *We control for time fixed effects.* The dependent variable, $Change_f$ is a dummy variable which takes the value of 1 if a fund changes its category from prime fund to government fund or quits the fund management industry, and 0 if the fund stays a prime fund. "Coef" represents the coefficients of the probit model. "Marginal" are the marginal effects of the probit model. $NoOfFunds_{ft}$ represents the number of funds managed by the fund family of the fund. $Size_{ft}$ is the log of total net assets of a fund. ELM_{ft} is the expected loss of a fund portfolio and is a proxy for credit risk (see appendix B1 for calculation). $FlowVol_{ft}$ is the rolling standard deviation of a fund's net inflows over a six-month fixed window. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between the gross yield and the net yield of a fund. $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets include cash, US treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. Standard errors are clustered by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $Change_f$	**Coef**	**Marginal**	**Coef**	**Marginal**
	(1)	(2)	(3)	(4)
$NoOfFunds_{ft}$	-0.1876***	-0.0425***	0.0256	0.0056
	(0.0386)	(0.0074)	(0.0586)	(0.0128)
$Size_{ft}$	-0.1652**	-0.0374**	-0.5703***	-0.1257***
	(0.0801)	(0.0180)	(0.1578)	(0.0276)
ELM_{ft} (bp)	0.1662**	0.0376**	-0.1795***	-0.0396***
	(0.0801)	(0.0183)	(0.0625)	(0.0130)
$FlowVol_{ft}$ ($)	0.0052	0.0012	0.0696	0.0153
	(0.0232)	(0.0052)	(0.0495)	(0.0109)
$ExRatio_{ft}$ (bp)	-0.0041	-0.0009	-0.0403	-0.0089
	(0.0200)	(0.0045)	(0.0299)	(0.0065)
$WLiq_{ft}$ (%)	0.0110	0.0025	-0.0096	-0.0021
	(0.0085)	(0.0020)	(0.0103)	(0.0023)
Constant	3.8303*		13.6663***	
	(1.9703)		(3.4233)	
Time FE	Y	Y	Y	Y
Pseudo R^2	0.268		0.387	
Observations	724	724	396	396

B3: Factors that Influenced Decision of Prime MMFs to Change Category (Different Pre-Transition Period)

This table shows results of probit models *with time fixed effects over the pre-transition period from July 2014 to October 2015.* The dependent variable, $Change_f$ is a dummy variable which takes the value of 1 if a fund changes its category from prime fund to government fund or quits the fund management industry, and 0 if the fund stays a prime fund. "Coef" represents the coefficients of the probit model. "Marginal" are the marginal effects of the probit model. $NoOfFunds_{ft}$ represents the number of funds managed by the fund family of the fund. $Size_{ft}$ is the log of total net assets of a fund. ELM_{ft} is the expected loss of a fund portfolio and is a proxy for credit risk (see appendix B1 for calculation). $FlowVol_{ft}$ is the rolling standard deviation of a fund's net inflows over a six-month fixed window. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between the gross yield and the net yield of a fund. $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets include cash, US treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. Standard errors are clustered by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $Change_f$	**Coef** (1)	**Marginal** (2)	**Coef** (3)	**Marginal** (4)
$NoOfFunds_{ft}$	-0.1682***	-0.0383***	0.0019	0.0005
	(0.0349)	(0.0070)	(0.0506)	(0.0123)
$Size_{ft}$	-0.1516**	-0.0345**	-0.5344***	-0.1304***
	(0.0768)	(0.0171)	(0.1530)	(0.0284)
ELM_{ft} (bp)	0.1233**	0.0281**	-0.1415***	-0.0345***
	(0.0553)	(0.0130)	(0.0542)	(0.0134)
$FlowVol_{ft}$ ($)	-0.0073	-0.0017	0.0498	0.0122
	(0.0240)	(0.0055)	(0.0350)	(0.0088)
$ExRatio_{ft}$ (bp)	-0.0358	-0.0082	0.0359	0.0088
	(0.0236)	(0.0053)	(0.0365)	(0.0088)
$WLiq_{ft}$ (%)	0.0088	0.0020	0.0123	0.0030
	(0.0088)	(0.0021)	(0.0124)	(0.0030)
Constant	4.2333**		11.0548***	
	(1.9636)		(3.0274)	
Time FE	Y	Y	Y	Y
Pseudo R^2	0.267		0.335	
Observations	1,894	1,894	1,056	1,056

B4: Changes in Retail vs Institutional Prime MMFs (Medians)

This table presents medians of the variables before reforms ("BR" is the period from January 2014 to June 2014) and after reforms ("AR" is the period from October 2016 to March 2017). "Diff" is the difference between "AR" and "BR". $NetAssets_{ft}$ is equal to the total value of a fund's securities plus other assets less liabilities. ELM_{ft} is the expected loss of a fund which is a proxy for the credit risk of a fund (see appendix B1 for calculation). $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets include cash, US treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. WAL_{ft} is the Weighted Average Life, calculated as average days to maturity weighted by the investment weight of each security. $Spread_{ft}$ is calculated as the difference between the gross yield of the fund's assets and the 1-month Treasury bill rate. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between gross yield (a fund's portfolio yield) and net yield (the yield paid to a fund's investor). $NetYield_{ft}$ is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP form. This represents the difference between the gross yield of portfolio less management fee. $\overline{GovtNY}_t$ is the average net yield of government funds each month. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional			Retail			Institutional- Retail		
	BR	AR	Diff	BR	AR	Diff	BR	AR	Diff
Median	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$NetAssets_{ft}$ ($ bn)	1.18***	0.87***	-0.31	1.49***	0.92***	-0.58**	-0.32*	-0.05	0.26
$WLiq_{ft}$ (%)	33.89***	57.86***	23.97***	30.46***	44.98***	14.52***	3.43***	12.88***	9.45***
WAL_{ft}(days)	70.00***	31.00***	-39.00***	67.00***	54.00***	-13.00***	3.00	-23.00***	-26.00***
ELM_{ft} (bp)	5.23***	7.14***	1.91***	5.28***	6.49***	1.21**	-0.05	0.65	0.70
$Spread_{ft}$ (bp)	8.72***	29.94***	21.22***	10.72***	37.12***	26.40***	-2.00***	-7.17***	-5.17***
$NetYield_{ft}$	1.00***	58.00***	57.00***	1.00	37.00***	36.00***	0.00	21.00***	21.00***
$NetYield_{ft} - \overline{GovtNY}_t$	-0.03	28.02	28.05***	-0.03***	17.84***	17.87***	0.00	10.18***	10.18***
$ExRatio_{ft}$ (bp)	14.00***	28.20***	14.20***	15.88***	45.00***	29.12***	-1.88***	-16.80***	-14.92***

B5: Liquidity Management at MMFs After Reforms (Bootstrapped Errors)

This table presents results for panel fixed effects regression before reforms ("BR" is the period from January 2014 to June 2014) and after reforms ("AR" is the period from October 2016 to March 2017). The dependent variable $\Delta WLiq_{ft}$ is change i.e. first difference of weekly liquidity, $WLiq_{ft}$. $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. ELM_{ft} is the expected loss of a fund and is a proxy for credit risk (see appendix B1 for calculation). ΔELM_{ft} is the predicted values of change in expected loss of a fund. We use fitted values of changes in expected loss in order to avoid endogeneity issues that could arise due to simultaneity bias resulting from possible bidirectional causality of changes in weekly liquidity $\Delta WLiq_{ft}$ and changes in actual expected loss. $NetInflows_{ft}$ is a difference between gross subscriptions and redemptions. We use fitted values of changes in net inflows to avoid endogeneity issues that could arise due to simultaneity bias resulting from possible bidirectional causality of changes in weekly liquidity $\Delta WLiq_{ft}$ and changes in actual $NetInflows_{ft}$. *The standard errors are calculated by using bootstrapped method to correct for regression bias and are clustered by fund*. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $\Delta WLiq_{ft}$ (%)	**BR**	**AR**	**BR**	**AR**
	(1)	(2)	(3)	(4)
ΔELM_{ft} (bp)	-1.54**	0.72***	1.06	0.51
	(0.68)	(0.23)	(0.82)	(0.33)
ELM_{ft-1} (bp)	0.18	0.59**	0.48	0.03
	(0.44)	(0.29)	(0.75)	(0.23)
$\Delta NetInflows_{ft}$ (%)	0.25**	0.06	0.16	-0.06
	(0.12)	(0.13)	(0.29)	(0.11)
$NetInflows_{ft-1}$ (%)	0.06	0.07	0.09	0.03
	(0.10)	(0.09)	(0.29)	(0.08)
Constant	-0.53	-6.15***	-2.46	-1.56
	(2.49)	(2.14)	(4.23)	(1.39)
Fund FE	Y	Y	Y	Y
Adjusted R^2	0.03	0.03	0.01	0.01
Observations	693	284	398	206

B6: Liquidity Management at MMFs After 2016 Amendments (Different Lag specification for fitted values of contemporaneous variables - 7 lags)

This table presents results for panel fixed effects regressions before reforms ("BR" is the period from January 2014 to June 2014) and after reforms ("AR" is the period from October 2016to March 2017). The dependent variable $\Delta WLiq_{ft}$ the first difference of weekly liquidity, $WLiq_{ft}$. $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. ELM_{ft} is the expected loss of a fund and is a proxy for credit risk (see appendix B1 for calculation). ΔELM_{ft} is the predicted value of change in expected loss of a fund. We use fitted values of change in expected loss in order to avoid endogeneity issues that could arise due to simultaneity bias resulting from possible bidirectional causality of changes in weekly liquidity $\Delta WLiq_{ft}$ and changes in expected loss, ELM_{ft}. $NetInflows_{ft}$ is a difference between gross subscriptions and redemptions. We use fitted values of $\Delta NetInflows_{ft}$ to avoid endogeneity issues that could arise due to simultaneity bias resulting from possible bidirectional causality of changes in weekly liquidity, $\Delta WLiq_{ft}$ and changes in net inflows, $\Delta NetInflows_{ft}$. The standard errors are clustered by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $\Delta WLiq_{ft}$ (%)	**BR**	**AR**	**BR**	**AR**
	(1)	(2)	(3)	(4)
ΔELM_{ft} (bp)	-0.99**	0.60**	1.05*	0.81
	(0.48)	(0.29)	(0.63)	(0.58)
ELM_{ft-1} (bp)	0.32	0.64***	0.39	0.15
	(0.26)	(0.23)	(0.36)	(0.28)
$\Delta NetInflows_{ft}$ (%)	0.28**	0.14*	0.37	-0.02
	(0.12)	(0.08)	(0.25)	(0.17)
$NetInflows_{ft-1}$ (%)	0.09	0.11	0.31	0.06
	(0.12)	(0.08)	(0.29)	(0.17)
Constant	-1.18	-6.26***	-1.92	-2.27
	(1.38)	(1.67)	(2.01)	(2.19)
Fund FE	Y	Y	Y	Y
Adjusted R^2	0.03	0.04	0.02	0.03
Observations	693	284	398	206

B7: Shareholders' Response to 2016 Amendments (Bootstrapped Errors)

This table presents results for panel fixed effects regressions before reforms ("BR" is the period from January 2014 to June 2014) and after reforms ("AR" is the period from October 2016 to March 2017). The dependent variable is $NetInflows_{ft}$, calculated as a difference between gross subscriptions and redemptions of a fund. ELM_{ft} is the expected loss of a fund and is a proxy for credit risk (see appendix B1 for calculation). ΔELM_{ft} is the predicted values of changes in loss of a fund. We use fitted values of change in expected loss in to avoid endogeneity which could lead to simultaneity bias resulting from possible bidirectional causality of $NetInflows_{ft}$ and changes in expected loss. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. $\Delta WLiq_{ft}$ is the predicted values of the changes in the weekly liquidity of a fund. We use fitted values of $\Delta WLiq_{ft}$ to avoid endogeneity issues that could arise from possible bidirectional causality of changes in weekly liquidity, $\Delta WLiq_{ft}$ and net inflows, $NetInflows_{ft}$. We additionally control but do not report the following variables: $NetYield_{ft}$ which is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP form. This represents the difference between the gross yield of portfolio less management fee. $ExRatio_{ft}$ which is the expense ratio of a fund calculated as the difference between gross yield (a fund's portfolio yield) and net yield (the yield paid to a fund's investor). $Size_{ft}$ calculated as the log of total net assets of a fund. *The standard errors are calculated by using bootstrapped method to correct for regression bias and are clustered by fund*. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $NetInflows_{ft}$ (%)	**BR**	**AR**	**BR**	**AR**
	(1)	(2)	(3)	(4)
ΔELM_{ft} (bp)	-0.22	-1.17***	-0.47	-0.40
	(0.52)	(0.45)	(0.72)	(0.48)
ELM_{ft-1} (bp)	-0.40	-0.45	-1.18**	-0.28
	(0.62)	(0.32)	(0.59)	(0.27)
$\Delta WLiq_{ft}$ (%)	0.10	-0.03	0.13	-0.00
	(0.13)	(0.13)	(0.21)	(0.17)
$WLiq_{ft-1}$ (%)	0.04	-0.16**	-0.08	-0.02
	(0.08)	(0.08)	(0.12)	(0.08)
Constant	-2.78	0.96	5.34	-11.98
	(6.93)	(8.80)	(7.98)	(8.62)
Fund FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Adjusted R^2	0.03	0.10	0.04	0.01
Observations	606	291	359	209

B8: Shareholders' Response to 2016 Amendments (Dynamic Panel)

This table presents results for panel fixed effects regressions before reforms ("BR" is the period from January 2014 to June 2014) and after reforms ("AR" is the period from October 2016 to March 2017). The dependent variable is $NetInflows_{ft}$, calculated as a difference between gross subscriptions and redemptions of a fund. ELM_{ft} is the expected loss of a fund and is a proxy for credit risk (see appendix B1 for calculation). ΔELM_{ft} is the predicted values of changes in loss of a fund. We use fitted values of change in expected loss in to avoid endogeneity which could lead to simultaneity bias resulting from possible bidirectional causality of $NetInflows_{ft}$ and changes in expected loss. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. $\Delta WLiq_{ft}$ is the predicted values of the changes in the weekly liquidity of a fund. We use fitted values of $\Delta WLiq_{ft}$ to avoid endogeneity issues that could arise from possible bidirectional causality of changes in weekly liquidity, $\Delta WLiq_{ft}$ and net inflows, $NetInflows_{ft}$. We additionally control but do not report the following variables: $NetYield_{ft}$ which is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP form. This represents the difference between the gross yield of portfolio less management fee. $ExRatio_{ft}$ which is the expense ratio of a fund calculated as the difference between gross yield (a fund's portfolio yield) and net yield (the yield paid to a fund's investor). $Size_{ft}$ calculated as the log of total net assets of a fund. *$NetInflows_{ft-1}$ is also included to control for possible persistence of net inflows.* The standard errors are clustered by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $NetInflows_{ft}$ (%)	**BR**	**AR**	**BR**	**AR**
	(1)	(2)	(3)	(4)
ΔELM_{ft} (bp)	-0.37	-1.17***	-0.58	-0.39
	(0.47)	(0.40)	(0.62)	(0.44)
ELM_{ft-1} (bp)	-0.60	-0.45*	-1.30**	-0.27
	(0.41)	(0.23)	(0.49)	(0.21)
$\Delta WLiq_{ft}$ (%)	0.01	-0.04	-0.01	0.00
	(0.11)	(0.14)	(0.14)	(0.15)
$WLiq_{ft-1}$ (%)	0.05	-0.16***	-0.06	-0.00
	(0.07)	(0.05)	(0.08)	(0.06)
$NetInflows_{ft-1}$	0.14***	0.01	0.28***	0.03
	(0.05)	(0.05)	(0.04)	(0.04)
Constant	-1.67	0.97	3.58	-11.89**
	(4.59)	(6.29)	(5.19)	(5.22)
Fund FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Adjusted R^2	0.05	0.26	0.15	0.08
Observations	606	291	359	209

B9: Shareholders' Response to 2016 Amendments (Different Lag specification for fitted values of contemporaneous variables - 7 lags)

This table presents results for panel fixed effects regressions before reforms ("BR" is the period from January 2014 – June 2014) and after reforms ("AR" is the period from October 2016 – March 2017). The dependent variable is $NetInflows_{ft}$, calculated as a difference between gross subscriptions and redemptions of a fund. ELM_{ft} is the expected loss of a fund and is a proxy for credit risk (see appendix B1 for calculation). ΔELM_{ft} is the predicted values of changes in loss of a fund. We use fitted values of change in expected loss in to avoid endogeneity which could lead to simultaneity bias resulting from possible bidirectional causality of $NetInflows_{ft}$ and changes in expected loss. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. $\Delta WLiq_{ft}$ is the predicted values of the changes in the weekly liquidity of a fund. We use fitted values of $\Delta WLiq_{ft}$ to avoid endogeneity issues that could arise from possible bidirectional causality of changes in weekly liquidity, $\Delta WLiq_{ft}$ and net inflows, $NetInflows_{ft}$. We additionally control but do not report the following variables: $NetYield_{ft}$ which is the value-weighted average of the 7-day net yields of fund classes as reported on N-MFP form. This represents the difference between gross yield of portfolio less management fee. $ExRatio_{ft}$ which is the expense ratio of a fund calculated as the difference between gross yield (a fund's portfolio yield) and net yield (the yield paid to a fund's investor). $Size_{ft}$ calculated as the log of total net assets of a fund. The standard errors are clustered by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		Retail	
DepVar: $NetInflows_{ft}$ (%)	**BR**	**AR**	**BR**	**AR**
	(1)	(2)	(3)	(4)
ΔELM_{ft} (bp)	0.02	-0.68*	-0.91	-0.07
	(0.43)	(0.39)	(0.60)	(0.42)
ELM_{ft-1} (bp)	-0.33	-0.28	-1.25***	-0.14
	(0.42)	(0.27)	(0.46)	(0.21)
$\Delta WLiq_{ft}$ (%)	0.19*	-0.07	0.03	0.25
	(0.10)	(0.09)	(0.17)	(0.15)
$WLiq_{ft-1}$ (%)	0.09	-0.13***	-0.11	0.02
	(0.06)	(0.05)	(0.10)	(0.06)
Constant	-4.41	-4.19	6.92	-13.83**
	(4.18)	(5.75)	(5.62)	(5.83)
Fund FE	Y	Y	Y	Y
Controls	Y	Y	Y	Y
Adjusted R^2	0.02	0.27	0.02	0.09
Observations	583	278	346	201

Chapter 5 A New Performance Indicator for Money Market Funds

5.1 Introduction

Since October 2016, institutional MMFs, which serve a more volatile shareholder base than retail MMFs, have floated their net asset value (NAV) and operated separately from the more stable retail funds. This has stripped money-like features from institutional MMFs. This is a new characteristic that has not been studied extensively before. It is interesting to explore how floating NAV affects the risk-taking of funds and the response of shareholders to it. This chapter specifically focuses on exploring the drivers of NAV, the impact of floating NAV on risk-taking of funds and investors' response to floating NAV.

This paper fills a gap in the literature since it is, to the best of our knowledge, the first to explore how floating NAV for institutional prime funds influences the characteristics of the funds after their complete segregation from retail prime funds. Utilizing a unique dataset, we explore how shareholders of money market funds react to floating NAV. We also explore how portfolio characteristics influence the NAV of funds.

Our contributions to the literature are as follows. First, we contribute to the existing performance-flow literature of money market funds (Sirri and Tufano 1998; Koppenhaver and Sapp 2005; Chernenko and Sunderam 2014) which established a positive relationship between yield and net inflows. A key novelty of our paper is that we identify a new indicator of performance, the floating NAV, which is now used particularly by institutional investors. We show that MMFs with higher floating net asset value attract more inflows. In fact, they actively shift their investments to funds that offer higher potential for capital gains as compared to other MMFs. So, MMFs have an incentive to increase their net asset value.

Second, we add to the literature that deals with factors influencing returns of money market funds. Domian and Reichenstein (1998) argue that a fund's return is determined by the size of the expense ratio. Koppenhaver (1999) shows that along with expenses, portfolio characteristics also affect returns. We explore the factors that influence the newly introduced source of return, capital gains from floating NAV, which has not been studied before. We find that portfolio risk and the higher weighted average of a fund has a positive effect on NAV. But, a higher proportion of liquid assets leads to lower NAV. These results imply that to offer higher capital gains a fund must hold a riskier portfolio mix.

Third, our study contributes to the literature on the impact of the introduction of the floating NAV on money funds and investor behaviour. Some studies focus on the effect of floating NAV on runs. Gordon and Gandia (2014) and Witmer (2016) suggest that it does not eliminate run-like behaviour while Hanson et al. (2015) argue that it successfully removes strategic motives to run. Other studies investigate its influence on the risk-taking behaviour of funds. For instance, Hanson et al. 2015 argue that it does not remove ex-ante risk-taking incentives. Parlatore (2016) studies the consequences of the adoption of a floating NAV among other new regulations using a tournament model. The paper states that adopting floating NAV for the whole industry could boost the total supply of liquidity because investors would be attracted to MMFs as they can earn returns from floating NAV. But the risk should be kept low by restraining asset price volatility. La Spada (2018) also proposes a novel tournament model to study whether competition over relative performance generates reach for yield in a low risk-free rate environment. La Spada conducts empirical analysis over the January 2002 to August 2008 period to confirm the predictions of the model relating to risk-taking of MMFs. The paper argues that requiring institutional prime MMFs to adopt a floating NAV, could lead institutional prime MMFs to take on more risk in a low policy rate environment. Furthermore, for stable NAV funds, if the regulator externally imposes a cost on MMFs that break the stable NAV, the model predicts that this would reduce the risk taking of all MMFs. These studies are based on the period prior to the actual implementation of the new SEC rules and are lacking empirical analysis after the reforms. The only paper that performs empirical analysis after reforms is Li et al (2018), who document the impact of the NAV flotation introduced for institutional funds. They find that during the months around and just after the reform took effect, institutional funds engaged in less risk-taking than retail funds by decreasing interest rates, liquidity and credit risk. This resulted in lower yields and NAVs and less volatile NAVs. But this difference faded through 2017 when institutional funds increased their risk-taking to pre-reform levels. Li et al. (2018) focus on the evolution of risk-taking of MMFs during reforms. By contrast, we explore risk-taking incentives of MMFs after reforms. Using actual floating NAV data, we empirically show that the introduction of floating NAV has two competing effects on risk-taking of money market funds, one risk-increasing and the other risk-limiting. On the one hand, to attract investors, a fund must increase portfolio risk. This suggests that floating NAV has not altered incentives to chase risk. On the other hand, to keep investors, a fund must select the portfolio mix cautiously to limit NAV volatility because investors withdraw from funds whose NAV fluctuates excessively.

Fourth, we expand the existing literature about runs on constant NAV money market funds which find that runs are more intense for less liquid funds (Wermers 2011; Jank and Wedow 2015), funds with higher sponsor risk (Schmidt et al. 2016) and higher credit risk (Chari and Jagannathan 1988; Jacklin and Bhattacharya 1988; Chernenko and Sunderam 2014). In addition, these studies show that the funds that cater to institutional investors (Wermers 2011; Schmidt et al 2016; Chernenko and Sunderam 2014) undergo stronger run episodes. The 2016 Amendments mandate that institutional investors cannot invest in constant NAV funds anymore, so we explore the possibility of instability in such funds. We show that investors in constant NAV funds (i.e. retail investors) actively track the shadow NAV of their fund and tend not to remain in funds that have a more volatile shadow NAV. This is because of the risk of such a fund to breach the par value threshold and result in loss of principal. This implies that the constant NAV (retail) funds after complete segregation from institutional funds may still be subject to runs when in distress.

The rest of the paper proceeds as follows: Section 5.2 discusses the regulatory landscape of this study. Section 5.3 describes the data. Section 5.4 presents the empirical analysis and results. Section 5.5 concludes.

5.2 Regulatory Landscape

During the global financial crisis and sovereign debt crisis, prime money market funds proved vulnerable to financial shocks and are now considered to add fragility to the financial system. During these events, institutional prime funds were more likely to undergo heavy redemption pressure than retail prime funds. This is because institutional investors have larger investments at risk and better access to resources for monitoring fund performance (Schapiro 2012). Moreover, they understand that they can lower exit costs if they redeem before others should liquidity dry up (McCabe 2010). Consequently, rule 2a-7 was amended in 2014 (amendments became effective in October 2016) to attenuate *run* risk among institutional funds.

Before the reform, a fund could have both retail and institutional share classes. The new rules have fully segregated institutional funds from retail funds, which means that a single fund can offer shares to either retail[31] shareholders or institutional shareholders, but not both. Since their inception, MMFs have operated under a special provision in rule 2a-7 which allowed them to maintain a stable NAV of $1.00 by using the amortized cost method to value individual securities and the penny rounding method to value fund shares. This has changed for institutional funds, which are now required to trade at floating net asset value. This means that a fund must use market-based values of their securities to value their portfolio so that the daily share prices of the funds now fluctuate with the market. This change addresses the first-mover advantage that institutional investors usually gain at the expense of

[31] A retail money market fund, under 2016 Amendments, is defined as a fund that has policies and procedures which would limit beneficial investors of the fund to natural persons (SEC 2014).

retail investors, during a crisis. Sceptics remain unconvinced about the ability of floating NAV to have much effect on the risk of runs (Gordon and Gandia 2014; Witmer 2016). They claim that the incentive to withdraw early from a fund remains the same or might even lead to pre-emptive runs. The way events unfold in a distress period remains yet to be seen. Government and retail money market funds continue to use the amortized cost method and/or penny rounding method to maintain a stable NAV.

The new rules have consequences for shareholders of MMFs. Before the SEC reforms following the global financial crisis, all MMFs were higher yielding investments than bank deposits while retaining deposit-like features such as same-day redemption and preservation of capital. Now, shareholder redemptions in institutional prime funds trading at floating NAV may incur a gain or a loss in capital. This led to shareholders shifting their money from prime to government funds. However, many of these funds remained institutional funds. It is of great interest to observe the behaviour of the investors who choose to remain in institutional prime funds. We limit out analysis to prime money market funds because these are the funds that are affected more by the reforms and are considered to be a source of instability.

5.3 Data Description

We create a unique dataset comprising detailed portfolio holdings of US prime money market funds which are filed monthly with the Securities and Exchange Commission. These filings are publicly available from the SEC EDGAR database.

The amendments to rule 2a-7 that were introduced in May 2010 require MMFs to file a monthly report on the N-MFP form, which includes a detailed schedule of portfolio holdings of money market funds, starting from November 2010. From April 2016, the reporting of additional information is required under the new version of the form (N-MFP2). Our sample includes information from both versions of the form. Both forms provide information about fund-level variables like total net assets, type of fund, gross yield, net yield and monthly shareholders subscriptions and redemptions. In addition, for each security held, these report issuer name, amount of principal, type of instrument, yield, legal maturity date and the CUSIP number. The N-MFP2 form additionally reports daily and weekly liquidity, floating net asset value, target net asset value and type of shareholder base.

Our final dataset ranges from January 2013 to April 2018. Most of the analysis focuses on the after-reform period which starts from the compliance month, October 2016, and ends in April 2018, which is the latest date the data was avaiable at the time of analysis. In figures, we utilize the before-reform period which starts from January 2013 and ends July 2014, the month of the announcement of 2016 Amendments. The number of months is selected to get before- and after-reform periods of equal length. We conduct our analysis by analysing retail prime money market funds and institutional prime money market funds separately. The funds that report themselves as “retail exempt” funds are called retail prime money market funds and the remaining funds are institutional prime money market funds.

5.4 Empirical Results

The institutional funds have floated their NAV since October 2016. Retail funds still maintain a constant NAV. For institutional investors, the floating NAV has introduced previously non-existent risk of losing the principal. So, post reform, institutional investors must be more cautious of the NAV of the MMF portfolio like any other mutual fund investor. Many funds have converted into government money market funds, which have no such requirement. Others have decided to stay in the prime money market funds. Our analysis focuses on exploring the behaviour of investors that have remained in the prime fund industry. We explore institutional prime funds' performance-flow sensitivity based on a new measure of performance, the floating NAV. In addition, we identify factors that influence the magnitude and fluctuations in NAV.

5.4.1 Descriptive Statistics

Table 5.1 reports summary statistics for prime funds in the before-reform (BR) period, from January 2013 to July 2014, and after-reform (AR) period, from October 2016 to April 2018. Panel A presents statistics for institutional prime funds. In our sample, we have 149 institutional prime funds before reforms which drop to 77 funds after reforms. After reforms, the median institutional fund has approximately $1.39 billion in total net assets, but the distribution is positively skewed with a mean of $7.36 billion. Furthermore, the median fund's NAV moves upward by one basis point from their target NAV, which is a small movement considering that these funds are using floating NAV. Panel B reports statistics for retail prime funds. Our data includes 94 retail prime funds before reforms and 41 retail prime funds after reforms. The median retail prime fund manages about $0.89 billion of net assets with average net assets of $5.87. This indicates the presence of some very large funds. The median retail fund's NAV movement is very similar to that of institutional funds. We plot the distribution of NAV changes to explore its characteristics. Figure 5.1 shows the box and whiskers plot of the distribution of NAV changes for institutional prime money market funds in the before-reform and after-reform periods. Before-reforms the NAV remains within a narrow range, moving only one basis point in each direction. However, there are several outliers indicating that some funds took on more risk and let their NAV fall by up to 18 bps. After reforms, the distribution of NAV changes becomes wider with values ranging from –4 bps to +8 bps, which is to be expected because funds use floating NAV and can let their values move away from the target NAV without fear of having to break the buck and liquidate a fund. We see that the majority of times funds' NAV moves upward while there are some funds whose NAV moves downward. This drop in NAV happens only for 25 percent of the funds during the early months after switching to floating NAV. Interestingly, as more time goes by since the introduction of floating NAV, especially since January 2018, about 50 percent of the funds have negative movements in NAV which may indicate that funds are becoming less concerned about downward NAV adjustments.

Retail prime funds need to keep a constant NAV even after the 2016 Amendments. Like institutional prime funds they have a very narrow range of movement in (shadow) NAV (Figure 5.2) before reforms. But they are characterized by several instances of relatively large NAV variations, where in some cases it drops by –23 bps. Still they stay well above the –50 bps threshold of acceptable movement in NAV breaching which requires a fund to break the buck and possibly face liquidation. After reforms, retail funds, in line with institutional funds, also have wider NAV distribution where NAV moves between -4 bps to +8 bps. However, there is a reduction in outliers. This more liberal movement could be due to the complete segregation of retail prime funds from institutional funds. However, because of several changes in MMFs taking place simultaneously, there might be other factors contributing to the reduction in outliers. In any case, retail prime funds have a more stable shareholder base than before, which gives them an opportunity to take on more risk without adverse consequences.

Finally, we observe that before reforms institutional prime funds have higher volatility in NAV than retail prime funds.[32] However, after reforms, institutional prime funds restrain NAV fluctuations. This indicates that they are more cautious about the extent of the movements in the NAV as they must now float the NAV, and higher deviations could lead to investor withdrawals.

5.4.2 Drivers of NAV

We start our analysis by investigating the portfolio characteristics that influence the net asset value of a fund. This would inform the actions that an institutional fund

[32] To ensure that this is empirically verifiable, we calculate differences in averages of NAV volatility between retail and institutional prime fund, before and after reforms. On average, before reforms institutional prime funds have 0.15 basis points higher volatility than retail prime funds, whereas after reforms they have 0.21 basis points lower NAV volatility (NAV volatility is calculated as rolling standard deviation of a fund's NAV over a fixed window of the past six-months).

can take to rein in the floating NAV and keep it within an acceptable range for investors. We estimate the following monthly panel fixed effects regression,

$$NAVM_{ft} = \alpha_f + \beta_1 FlowVol_{ft-1} + \beta_2 Spread_{ft-1} + \beta_3 WAL_{ft-1} + \beta_4 Size_{ft-1} + \beta_5 FFSize_{ft-1} + \beta_6 NetYield_{ft-1} + \varepsilon_{ft} \qquad eq.\ (1)$$

where the dependent variable $NAVM_{ft}$ is the difference between actual NAV and the target NAV as a percentage of target NAV, which captures the potential of a fund to generate a capital gain/loss. α_f are fund fixed effects to control for unobserved fund characteristics. The extent of unpredictable investors' redemption patterns can influence a fund's NAV because to meet unexpected withdrawals a fund must sell its portfolio of securities, which affects its net asset value (Nanda et al. 2000; Chen et al. 2010). Unpredictable redemption behaviour is captured by $FlowVol_{ft,}$ which is flow volatility calculated as the 6-month rolling standard deviation of $NetInflows_{ft}$. $NetInflows_{ft}$ is the difference between monthly subscriptions and redemptions as a percentage of the lagged total net assets of a fund. $Spread_{ft}$ is a fund's portfolio gross yield net of the average government money market funds' gross yield, a proxy for portfolio risk. We include a measure of portfolio maturity, $WAL_{ft,}$ which is the weighted average life, calculated as average days to maturity weighted by the investment weight of each security. In some regressions, we include $WLiq_{ft}$ instead of WAL_{ft}. WAL_{ft} and $WLiq_{ft}$ are highly correlated so they are not used together to avoid multicollinearity issues. $WLiq_{ft}$ is weekly liquidity calculated as percentage of a fund's total assets invested in weekly liquid assets. Weekly liquid assets are cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. We control for the size of a fund and its family, that is a group of funds owned by the same manager. $Size_{ft}$ is the log of total net assets of a fund. $FFSize_{ft}$ is the log of total net assets of a fund family. We add net yield to assess its relationship with capital gains. $NetYield_{ft}$ is the yield earned by funds' shareholders, calculated as the value-weighted average of the 7-day net yields of fund share classes as reported on N-MFP form. All variables are lagged by one month. We cluster standard errors by fund.

Table 5.2 contains the regression results for eq. (1). In Column 1, the coefficient of $Spread_{ft}$ is positive and significant indicating that institutional prime funds with riskier portfolios have more potential for capital gains. Similarly, the funds with longer maturity securities have bigger $NAVM_{ft}$ and therefore higher capital gains. On the contrary, the funds with more liquid portfolio (Column 2) have lower $NAVM_{ft}$ because the funds with higher proportion of very short-term securities do not move up as compared to the ones with longer maturities. These results imply that the funds must invest in riskier securities to increase the floating NAV of their funds to boost their performance. The funds that belong to bigger fund families tend to have lower $NAVM_{ft}$. This could have two explanations. First, it could be that the funds that belong to bigger fund families have a more cautious attitude towards excessive risk-taking to avoid bad reputation in case the market value of a portfolio security goes down. Second, they could have invested in riskier securities whose market value has plunged.

Interestingly, the funds with higher $NetYield_{ft}$ have lower $NAVM_{ft}$ possibly because the funds are using the increases in floating NAV as an alternative form of compensation. So, if a fund is providing larger capital gains they seem to pay lower yields to the investors. This has consequences for expense ratios charged by funds. Usually the funds waive their management fee to offer higher yields, but if the investors subscribe to funds because of potential for capital gains they could charge higher expenses while still attracting inflows. However, this potential for funds to earn a higher fee is limited because the returns from net yield is much higher than that from capital gains. But the investors could opt for funds offering higher capital gains for deferred tax purposes.

In Column 3, retail prime funds with riskier portfolio have higher $NAVM_{ft,}$ however, this significance is not robust and disappears in Column 4 when we control for liquidity of a fund. They do not seek to increase their risk and portfolio maturity to increase their NAV because they trade at a stable share price and therefore cannot attract retail investors by differentiating themselves on capital gains. Like institutional funds, retail funds with more liquid portfolios have lower $NAVM_{ft}$.

Overall, we document that net asset value of a fund is influenced by portfolio characteristics such as portfolio risk, average portfolio maturity and fund liquidity. To increase NAV, in order to provide higher capital gains, a fund must increase its portfolio risk, hold less liquid longer maturity assets which could put a fund in distress in a time of crisis.

5.4.3 Risk from Floating NAV

The extent of fluctuation in floating NAV is of importance to investors because it is an indicator of the stability of a fund's performance. Greater NAV volatility means higher risk of incurring a capital loss. Therefore, it is valuable to investigate the factors that influence the NAV volatility.

We estimate the following panel fixed effects regression,

$$NAVVol_{ft} = \alpha_f + \beta_1 FlowVol_{ft-1} + \beta_2 Spread_{ft-1} + \beta_3 WAL_{ft-1} + \beta_4 Size_{ft-1} + \beta_5 FFSize_{ft-1} + \beta_6 NetYield_{ft-1} + \varepsilon_{ft} \qquad eq.\ (2)$$

where the dependent variable $NAVVol_{ft}$ is NAV volatility calculated as rolling standard deviation of NAV over a six-month fixed window. It is a proxy for the risk of loss from investing in a floating NAV. Our main explanatory variables are flow volatility, $FlowVol_{ft}$ and portfolio risk, $Spread_{ft}$, defined as before. The uncertainty in redemptions of shareholders can lead to more volatility in net asset value. Riskier portfolio can influence the volatility of portfolio value as evident from our previous findings. We control for weighted average life, WAL_{ft} fund size, $Size_{ft}$ fund family size, $FFSize_{ft}$ and net yield, $NetYield_{ft}$ of a fund which are defined as before. As in the previous specification, in some regressions, we include $WLiq_{ft}$ of a fund, while avoiding to use WAL_{ft} and $WLiq_{ft}$ together to avoid multicollinearity issues. We include fund fixed effects in all regressions and cluster standard errors at fund level.

Table 5.3 shows the estimation results for eq. (2). We find that both institutional and retail prime funds with higher flow volatility have more NAV volatility. This is because the funds with higher unpredictability in net inflows must sell their securities on short-notice, which affects the net asset value, and therefore leads to higher unpredictability in the NAV of a fund. Greater unpredictability in NAV denotes elevated risk of capital loss. This means that in the event of a crisis, when investors redeem ferociously it would deteriorate the value of NAV further, which would lead to more outflows, hence creating a feedback loop. Furthermore, institutional prime funds that carry more portfolio risk, $Spread_{ft}$ have greater variability in NAV because the market value of riskier securities fluctuates more, leading to greater risk of capital loss. To restrict the risk of capital losses institutional funds must rein in their risk-taking and seek to create a more stable shareholder base by taking appropriate measures. In the next sections we investigate factors that influence the behaviour of shareholders, to learn more about the steps a fund must take to retain shareholders.

5.4.4 Shareholders' Response to Floating NAV

For institutional investors, the floating NAV has introduced a previously non-existent opportunity for capital gains and a possible risk of incurring losses on redemptions. So, we next examine the response of shareholders to movement in NAV and the risk of losing principal associated with possible negative changes in NAV. We run the following panel fixed effects regression:

$$NetInflows_{ft} = \alpha_f + \beta_1 NAVM_{ft-1} + \beta_2 NAVVol_{ft-1} + \beta_3 NetYield_{ft-1} + \beta_4 Wliq_{ft-1} + \beta_5 ExRatio_{ft-1} + \beta_6 Size_{ft-1} + \beta_7 FFSize_{ft-1} + \beta_8 NetInflows_{ft-1} + \varepsilon_{ft} \qquad eq.\ (3)$$

where NetInflows_{ft} is calculated as a difference between monthly subscription and redemptions as a percentage of lagged total net assets of a fund. α_f represents fund fixed effects. Our main explanatory variables are movement in NAV, NAVM_{ft} and NAV volatility, NAVVol_{ft}. NAVM_{ft} captures the potential of a fund to produce a capital gain/loss. NAVVol_{ft} is a proxy for the risk of capital loss from investing in a floating NAV. We use it to test the response of investors to funds whose NAV changes a lot. We control for other factors that might impact the investment decision of investors such as net yield, $\text{NetYield}_{ft,}$ weekly liquidity, WLiq_{ft}, size of a fund, Size_{ft} and fund family size, FFSize_{ft}. We also include $\text{ExRatio}_{ft,}$ which is the expense ratio of a fund calculated as the difference between the gross yield and the net yield of a fund. We include the lagged dependent variable, $NetInflows_{ft}$ to control for persistence of net inflows (Domian and Reichenstein 1998; Christoffersen and Musto 2002). Standard errors are clustered by fund.

Table 5.4 presents the regression results for both retail and institutional prime funds. Column 1 shows the results for institutional prime funds. The coefficient of $NAVM_{ft}$ is positive and significant. $NAVM_{ft}$ is a measure of the potential of a fund to offer capital gains on an investment. An increase in NAV results in capital gains, while decrease in NAV could lead to loss in the value to principal invested. We find that money market funds with higher $NAVM_{ft}$ attract more inflows. This implies that the institutional investors i) seek to invest in funds that offer higher capital gains, ii) and use NAV to assess the performance of funds. These results add to the existing literature on performance-flow relationship by documenting a new performance measure that the investors seem to have adopted to differentiate money market funds. This relationship between flow and floating NAV has not been studied before. As expected, the funds with higher yield, $NetYield_{ft}$ have more net inflows, $NetInflows_{ft}$, which is a well-established relationship in previous studies (Christoffersen 2001; Christoffersen and Musto 2002; Kacperczyk and Schnabl 2013; Chernenko and Sunderam 2014). $NetYield_{ft}$ continues to be the primary indicator of performance[33] and explains higher degree of variation in net inflows as compared to movement in NAV, $NAVM_{ft}$ which makes sense because the returns earned from $NAVM_{ft}$ stay within a very narrow range.

[33] In unreported univariate regressions, we find that R-squared for $NetYield_{ft}$ is higher than that of $NAVM_{ft}$.

The floating NAV can lead to losses. So, we investigate how investors react to the volatility of NAV. A fund with higher volatility in NAV presents increased risk of capital losses. As expected, the coefficient of NAV volatility, $NAVVol_{ft}$ is negative and significant indicating that a fund with higher NAV volatility tends to have lower net inflows. The investors avoid the funds that might drive their capital to take a plunge. The investors are watchful of the risks associated with the floating NAV. This behaviour is consistent with the literature that recognizes that institutional shareholders have greater capital at risk, therefore they tend to monitor the risks and returns of a fund portfolio (Schapiro 2012). Overall, this shows that while the investors are searching for higher returns they are doing so with caution and weigh the risks associated with the prospective gains from the floating NAV.

Our control variables have expected signs and significance. We find that the lagged weekly liquidity, $WLiq_{ft}$ is negative and highly significant which is consistent with Jank and Wedow's (2015) findings that MMFs with more liquid assets tend to have lower inflows. This is possibly because the investors, once confident about the safety of the funds, tend to withdraw from funds with higher liquidity because that results in lower yields. Next, the coefficient of expense ratio, $ExRatio_{ft}$ is negative and significant. This shows that institutional investors are sensitive to the cost of investment in the money market funds. The institutional investors withdraw money from the funds that have higher expense ratios because this leads to lower yields. Further, we control for size of a fund, $Size_{ft}$ and its family, $FFSize_{ft}$. Both coefficients are insignificant showing that the investors do not regard size of a fund or its sponsor as a major factor in their investment decisions. We also include lagged dependent variable to account for persistence of $NetInflows_{ft}$. The coefficient is positive and significant showing persistence in fund net inflows.

In Column 2, we repeat the analysis for retail prime funds. The coefficients of $NAVM_{ft}$ and $NAVVol_{ft}$ are not significant indicating that the funds do not take the value of NAV into account when making investment decisions. This is understandable as the retail prime funds trade on a target NAV of $1.00, even if the shadow NAV (i.e. fair value of portfolio divided by number of shares, as reported on N-MFP form) is higher or lower than the target NAV. Unlike institutional funds, retail funds do not have significant inflows with higher $NAVM_{ft}$. This is expected because retail funds keep using stable NAV. Therefore, investors redeem the principal at stable NAV and have no possibility of capital gain. However, these investors are attracted to higher yielding funds as seen from a positive and significant coefficient of $NetYield_{ft}$. Because retail investors do not have a possibility of loss when they trade, NAV volatility, $NAVVol_{ft}$ does not have a significant impact these funds. Next, the control variable $WLiq_{ft}$ is negative and significant indicating that retail investors withdraw their money from the funds with higher proportion of liquid assets, which is plausible because this leads to lower yields. Interestingly, in contrast to institutional counterpart, the coefficient of $ExRatio_{ft}$ is positive and significant demonstrating that the retail investors tend to invest more in funds with higher expense ratios.

One explanation could be that the retail investors, having lower resources to track a fund's portfolio, put more confidence in the funds with higher expense ratios because such funds are deemed to be managed actively (Morningstar 2015). We also include lagged dependent variable to account for persistence of $NetInflows_{ft}$. As expected, the coefficient is positive and significant showing persistence in fund net inflows.

In short, institutional investors seek funds with higher capital gains but avoid funds with higher propensity for incurring capital losses. This behaviour is not observed in retail prime funds who do not have option to earn capital gains from their investments in money market funds.

5.4.5 MMF Shareholders Seek Capital Gains

We next investigate whether investors actively shift between prime funds based on capital gains incentives - an action consistent with chasing higher yields. In other words, if a fund changes its NAV so that its percentile rank becomes higher than others, would it attract more inflows? La Spada (2018) finds that rank-based performance is a key determinant of fund flows to MMFs. We expect this to hold true for capital gains as a measure of performance. If so, a fund has incentive to increase its NAV by engaging in higher risk-taking to increase its NAV to make the fund more competitive, which would eventually translate into wider systemic risk. We test this using the following monthly panel fixed effects regression:

$$NetInflows_{ft} = \alpha_f + \beta_1 \Delta NAVRank_{ft-1} + \beta_2 (\Delta NAVRank_{ft-1} \times NAVVol_{ft-1} + \beta_3 C_{ft-1} + \varepsilon_{ft} \qquad eq.\ (4)$$

where main explanatory variable is ΔNAVRank$_{ft}$, calculated as month-over-month change in the percentile rank of a fund's NAV$_{ft}$. This change in percentile ranking captures the shift in NAV, relative to all prime funds at the same time. As evidenced from the previous section, investors respond negatively to volatility in NAV. Therefore, we interact the changes in percentile rank with NAV volatility, (ΔNAVRank$_{ft-1}$ ×

$NAVVol_{ft-1}$) to control for the funds that increase their percentile rank in combination with higher volatility in NAV. As before, $NAVVol_{ft}$ is the net asset value volatility calculated as the rolling standard deviation of a fund's NAV over a fixed window of the past six months. In all regressions, we control for, but do not show, the variables represented by C_{ft} which includes $NAVM_{ft}$, $NAVVol_{ft}$, $NetYield_{ft}$, $Wliq_{ft}$, $ExRatio_{ft}$, $Size_{ft}$, $FFSize_{ft}$, and $NetInflows_{ft}$ calculated as before.

We also include interaction of changes in NAV with date fixed effects to ensure that the results are being driven by the changes in the rank of NAV and not by some unidentified time trend.

Table 5.5 presents the results. Column 1 shows that the institutional investors respond positively to lagged changes in the percentile rank of NAV of a fund. The institutional investors actively shift their investments to funds that offer higher potential for capital gains as compared to other MMFs. This is consistent with the well-known fact that the institutional investors are more likely to watch markets and react by moving large amounts of money in and out of funds (Bair 2013; Scharfstein 2012). This reinforces our previous findings that there is a significant flow/NAV sensitivity in institutional prime funds. This indicates that the institutional investors are using floating NAV funds as an investment vehicle instead of just a cash management tool. However, they do so cautiously and avoid the excess risk as seen from the negative and significant sign of lagged interaction term, $\Delta NAVRank_{ft-1} \times NAVVol_{ft-1}$.

Since the funds with higher NAV attract more inflows, they have an incentive to hold riskier securities to increase NAV which could eventually lead to increased fragility. To offer higher yields a fund can either take on more risk or alternatively charge less expense ratios. Whereas, to increase the NAV of a fund to offer higher capital gains a fund must rely almost entirely on increasing portfolio risk. In the event of a crisis, the funds that invest in riskier securities to increase NAV will experience a higher drop in NAV, which would potentially trigger runs. This motivation to take risk is however limited by the fact that the funds with higher capital gains in combination with higher volatility in capital gains (as proxied by NAV volatility) tend to lose investors. This means that funds have a reason to keep their NAV in a narrow range to boost investor confidence. Together, this means the funds must elevate risk to boost NAV-based performance but do so in a controlled fashion by ensuring reduced volatility in portfolio value to attract investors. This could induce stability in a fund portfolio.

Column 2 shows results for retail prime funds. All the main explanatory variables are insignificant indicating that the retail investors do not consider the rank-based NAV performance in their investment decisions. These funds have stable NAV and therefore the investors do not benefit from any increases in the NAV of the fund at the time of redemptions.

In summary, we establish that institutional investors, consistent with their yield-seeking behaviour, look to invest in funds with higher capital gains actively which could encourage funds to invest in risky assets which in crisis periods could lead to distress.

5.4.6 Drivers of Flow Volatility

Institutional funds are known to have higher flow volatility because these funds deal with sophisticated investors who are highly information sensitive and react to news by moving money faster and more frequently. After complete segregation of institutional funds from retail funds the buffer of stable money sourced from individual investors is completely removed. Therefore, it is of interest for institutional funds to know the factors that might prove useful to reduce the flow volatility of a fund. We run the following panel fixed effects model:

$$FlowVol_{ft} = \alpha_f + \beta_1 NAVM_{ft-1} + \beta_2 NAVVol_{ft-1} + \beta_3 NetYield_{ft-1} + \beta_4 Wliq_{ft-1} + \beta_5 ExRatio_{ft-1} + \beta_6 Size_{ft-1} + \beta_7 FFSize_{ft-1} + \varepsilon_{ft} \qquad eq. (5)$$

where the dependent variable flow volatility, $FlowVol_{ft}$ is the rolling standard deviation of net inflows, $NetInflows_{ft}$, calculated as fixed window of past 6-month observations. $NAVM_{ft}$, $NAVVol_{ft}$, $NetYield_{ft}$, $Wliq_{ft}$, $ExRatio_{ft}$, and $Size_{ft}$, are defined as before.

Column 1 in Table 5.6 shows that the institutional funds with higher NAV have lower flow volatility suggesting that the funds that offer higher capital gains have lower unpredictability in their inflows. In other words, investors stay invested in funds with more potential for return. Similarly, $NetYield_{ft}$ is positive and significant reinforcing the results that the funds with higher performance have a more stable shareholder base. Together, this shows that the funds can decrease the volatility in their flows by paying investors a higher yield and giving them loftier capital gains. Retail prime funds, on the other hand, can stabilize their inflows by offering higher yields (Column 2). Having a higher NAV does not significantly impact the flow volatility of retail funds because their share trade at stable NAV and therefore investors do not consider it in making investment decisions. But they do watch for volatility in NAV which leads to higher unpredictability in the inflows, because if the NAV goes below a certain threshold a fund can "break the buck" which would result in loss of principal. Interestingly, the coefficient of $WLiq_{ft}$ is positive and significant indicating that the funds with higher liquidity have higher flow volatility possibly because it leads to lower yields.

Overall, we see that institutional funds can bridle unpredictability in net inflows by incentivizing the investors to stay invested in them by differentiating on yield and capital gains.

5.5 Conclusion

This paper finds that the floating NAV may be used by institutional money market fund investors as a new performance indicator to inform their investment decisions. This carries additional information with respect to the funds' yield, the traditional performance measure. Consistent with their yield-seeking behaviour, we show that institutional investors seek to hold funds with higher capital gains. They actively shift their investments to funds that offer higher potential for capital gains as compared to other MMFs. However, they do so cautiously and avoid investing in funds with excessive NAV fluctuation. Still, this incentivizes funds to increase their floating NAV, to boost their performance and attract more net assets. To do so, funds must keep liquidity low and invest in longer maturity/riskier securities. But this higher risk could lead to a higher likelihood of distress during crisis periods. A relevant topic that is unexplored in this paper and remains of interest for future research is whether the introduction of floating NAV helps mitigate the risk of runs in institutional prime funds. We could not address this point because we investigate a period in which financial markets have been calm. Therefore, we could not directly investigate the response of institutional investors during market stress, when operating under floating NAV.

Figures

Figure 5.1: NAV Movement in Institutional Prime MMFs

The figure is box and whiskers plot for size of NAV Movement for US institutional prime funds. NAV Movement is calculated as the difference between actual NAV and target NAV as a percentage of the target NAV. The left-hand side panel is for before-reform (BR) period from January 2013 to July 2014. The right-hand side panel is for after-reform (AR) period from October 2016 to April 2018. Rectangles show the interquartile range (IQR), which represent the 25th to 75th percentile, and the horizontal line in the middle of the rectangle is median. The ends of the lines below and above the rectangle represent the minimum and maximum values from Q1 − 1.5 * IQR to Q1 and from Q3 to Q3 + 1.5 * IQR, respectively. The observations falling outside of this range, are outliers denoted with a dot.

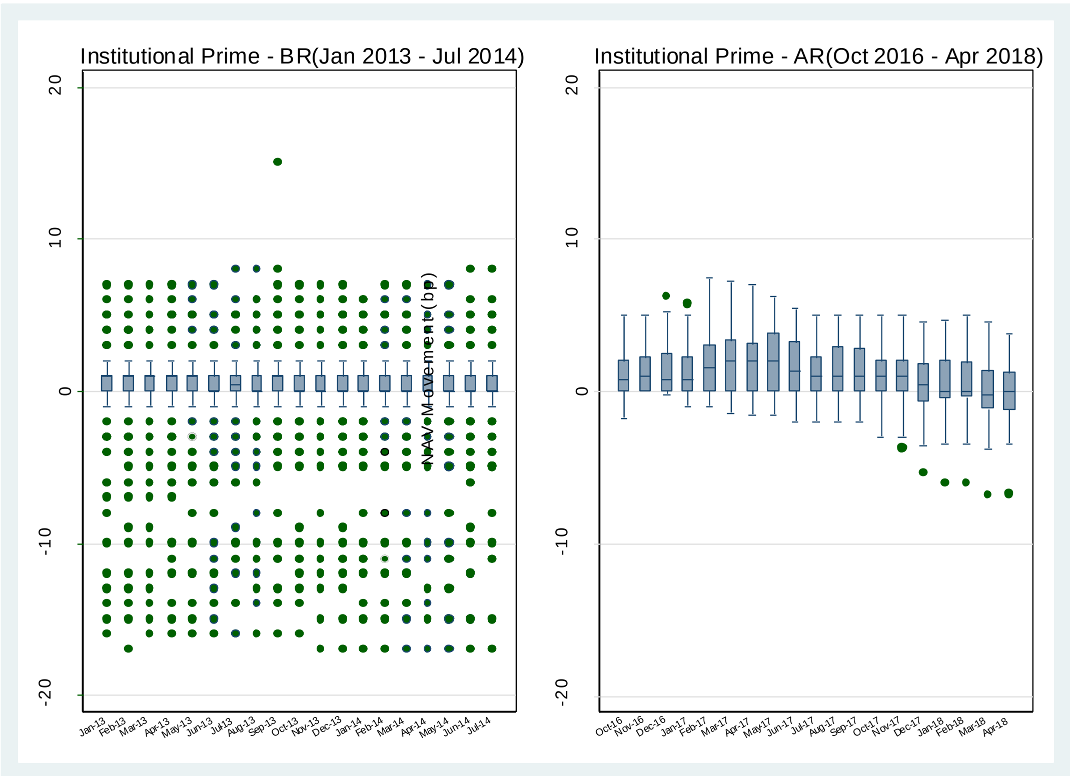
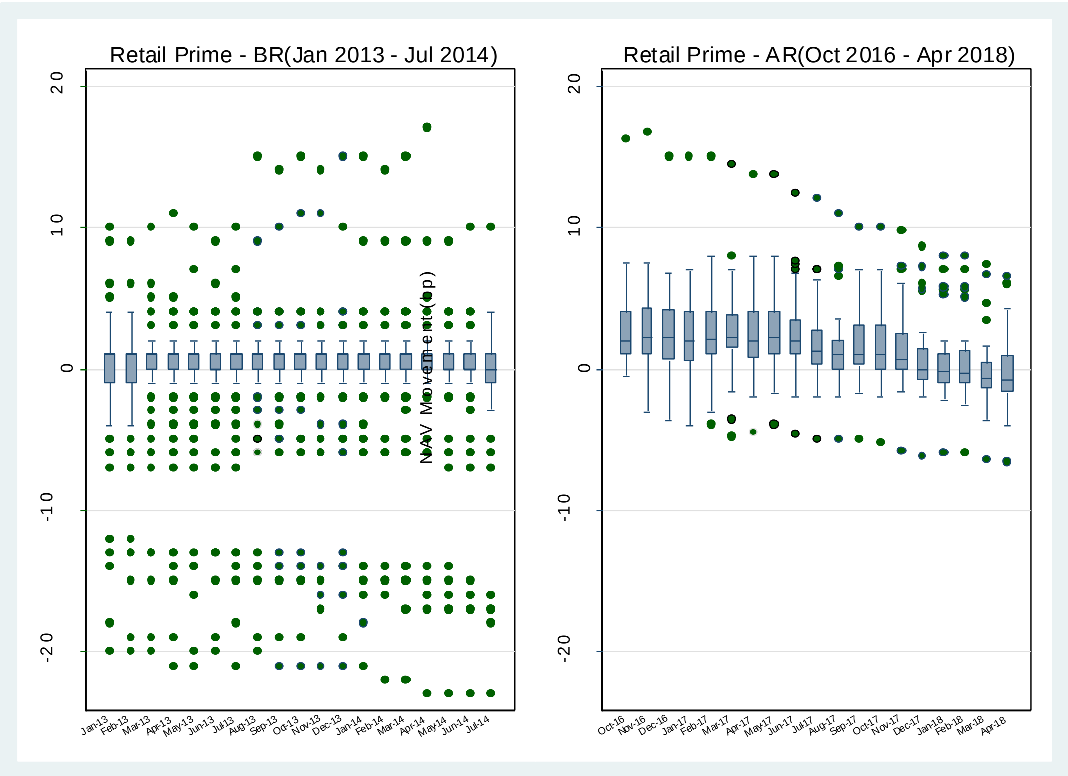


Figure 5.2: NAV Movement in Retail Prime MMFs

The figure is box and whiskers plot for size of NAV Movement for US retail prime funds. NAV Movement is calculated as the difference between actual NAV and target NAV as a percentage of the target NAV. The left-hand side panel is for before-reform (BR) period from January 2013 to July 2014. The right-hand side panel is for after-reform (AR) period from October 2016 to April 2018. Rectangles show the interquartile range (IQR), which represent the 25th to 75th percentile, and the horizontal line in the middle of the rectangle is median. The ends of the lines below and above the rectangle represent the minimum and maximum values from Q1 − 1.5 * IQR to Q1 and from Q3 to Q3 + 1.5 * IQR, respectively. The observations falling outside of this range, are outliers denoted with a dot.



Tables

Table 5.1: Descriptive Statistics

This table shows summary statistics for before-reform (BR) period from January 2013 to July 2014 and after-reform (AR) period from October 2016 to April 2018. Family TNA is the total net assets of a fund family. Fund TNA is the total net assets of a fund. $NAVM_{ft}$ is the difference between actual NAV and target NAV as a percentage of the target NAV. $NAVVol_{ft}$ is NAV volatility calculated as rolling standard deviation of NAV over a six-month fixed window. $NetInflows_{ft,}$ calculated as a difference between gross subscriptions and gross redemptions of a fund. $FlowVol_{ft}$ is rolling standard deviation of a fund's $NetInflows_{ft}$ over a six-month fixed window. WAL_{ft} is Weighted Average Life calculated as average days to maturity weighted by the investment weight of each security. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. $Spread_{ft}$ is a fund's portfolio gross yield net of the average government money market funds' gross yield. $NetYield_{ft}$ is the yield earned by funds' shareholders, calculated as the value-weighted average of the 7-day net yields of fund share classes as reported on N-MFP form. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between gross yield and net yield of a fund.

Panel A: Institutional Funds	***BR (Jan 2013 - Jul 2014)***				***AR (Oct 2016 - Apr 2018)***			
VARIABLES	**Mean**	**Median**	**SD**	**N**	**Mean**	**Median**	**SD**	**N**
Family TNA ($ bil)	24.83	2.010	49.69	2,666	59.52	46.06	63.27	1,138
Fund TNA ($ bil)	6.182	1.143	10.99	2,666	7.306	1.389	13.27	1,138
$NAVM_{ft}$ (bp)	-0.201	0.000	3.829	2,411	1.407	1.000	2.460	998
$NAVVol_{ft}$ (bp)	0.355	0.408	0.518	2,407	0.541	0.432	0.621	976
$NetInflows_{ft}$ (%)	-0.394	-0.662	9.188	2,651	1.339	0.000	13.96	1,131
$FlowVol_{ft}$ (%)	7.029	5.061	6.350	2,663	9.465	7.091	8.206	1,115
WAL_{ft} (days)	65.70	68.00	24.40	2,668	36.91	41.00	27.19	1,138
$WLiq_{ft}$ (%)	36.91	34.09	16.14	2,357	57.55	47.14	22.07	1,138
$Spread_{ft}$ (bp)	8.079	9.158	6.806	2,668	20.67	27.46	11.18	1,138
$NetYield_{ft}$ (bp)	3.054	1.000	4.988	2,668	89.86	97.04	42.88	1,134
$ExRatio_{ft}$ (bp)	13.48	15.00	8.077	2,668	19.66	19.15	14.82	1,134
Number of funds				149				77

Panel B: Retail Funds	***BR (Jan 2013 - Jul 2014)***				***AR (Oct 2016 - Apr 2018)***			
VARIABLES	**Mean**	**Median**	**SD**	**N**	**Mean**	**Median**	**SD**	**N**
Family TNA ($ bil)	31.88	1.844	56.07	1,683	64.77	20.81	72.22	723
Fund TNA ($ bil)	7.990	1.490	15.54	1,683	5.874	0.890	12.41	723
$NAVM_{ft}$ (bp)	-0.499	1.000	4.456	1,682	1.752	1.000	3.105	715
$NAVVol_{ft}$ (bp)	0.343	0.408	0.466	1,687	0.670	0.548	0.468	709
$NetInflows_{ft}$ (%)	-0.602	-0.325	5.937	1,680	0.379	-0.297	9.061	732
$FlowVol_{ft}$ (%)	3.953	2.766	4.341	1,687	6.170	3.825	6.260	728
WAL_{ft} (days)	65.63	67.00	22.87	1,687	51.26	55.00	25.00	736

$WLiq_{ft}$ (%)	34.47	31.46	15.72	1,358	46.85	43.24	12.31	735
$Spread_{ft}$ (bp)	10.36	11.45	5.833	1,687	23.87	27.46	8.228	736
$NetYield_{ft}$ (bp)	1.914	1.00	3.021	1,429	77.38	78.73	40.38	733
$ExRatio_{ft}$ (bp)	16.54	16.78	6.214	1,429	42.20	44.00	20.31	733
Number of funds				94				41

Table 5.2: Drivers of Floating NAV

This table shows results of monthly fund fixed effects regressions after the 2016 Amendments from October 2016 to April 2018. The dependent variable is movement in NAV, $NAVM_{ft}$ calculated as the difference between actual NAV and target NAV as a percentage of the target NAV. $FlowVol_{ft}$ is rolling standard deviation of a fund's net inflows over a six-month fixed window. $Spread_{ft}$ is a fund's portfolio gross yield net of the average government money market funds' gross yield. $NetYield_{ft}$ is the yield earned by funds' shareholders, calculated as the value-weighted average of the 7-day net yields of fund share classes as reported on N-MFP form. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. WAL_{ft} is Weighted Average Life calculated as average days to maturity weighted by the investment weight of each security. $Size_{ft}$ is the log of total net assets of a fund. $FFSize_{ft}$ is the log of total net assets of a fund family. Our data contains outliers, so we winsorize all variables at 1st and 99th percentile. We cluster standard errors by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $NAVM_{ft}$ (bp)	(1)	(2)	(3)	(4)
$FlowVol_{ft-1}$ (%)	-0.011	-0.008	-0.043	-0.039
	(0.013)	(0.014)	(0.028)	(0.027)
$Spread_{ft-1}$ (bp)	0.056***	0.045***	0.038**	0.024
	(0.015)	(0.014)	(0.018)	(0.021)
WAL_{ft-1} (days)	0.015**		0.012	
	(0.006)		(0.008)	
$WLiq_{ft-1}$ (%)		-0.026***		-0.028**
		(0.007)		(0.013)
$Size_{ft-1}$	-0.040	-0.033	-0.854	-0.854
	(0.252)	(0.262)	(0.515)	(0.512)
$FFSize_{ft-1}$	-0.974*	-1.011*	-0.166	-0.210
	(0.528)	(0.518)	(0.259)	(0.275)
$NetYield_{ft-1}$ (bp)	-0.015***	-0.017***	-0.032***	-0.034***
	(0.003)	(0.003)	(0.003)	(0.003)
Constant	24.354**	27.568**	24.637*	28.008**
	(11.221)	(10.799)	(13.150)	(12.973)
Fund FE	Y	Y	Y	Y
Adj R-squared	0.197	0.210	0.534	0.542
Observations	966	966	696	696

Table 5.3: Risk from Floating NAV

This table shows results of monthly fund fixed effects regressions after the 2016 Amendments from October 2016 to April 2018. The dependent variable is movement in NAV volatility, $NAVVol_{ft}$ is NAV volatility calculated as rolling standard deviation of NAV over a six-month fixed window. $FlowVol_{ft}$ is rolling standard deviation of a fund's net inflows over a six-month fixed window. $Spread_{ft}$ is a fund's portfolio gross yield net of the average government money market funds' gross yield. $NetYield_{ft}$ is the yield earned by funds' shareholders, calculated as the value-weighted average of the 7-day net yields of fund share classes as reported on N-MFP form. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. WAL_{ft} is Weighted Average Life calculated as average days to maturity weighted by the investment weight of each security. $Size_{ft}$ is the log of total net assets of a fund. $FFSize_{ft}$ is the log of total net assets of a fund family. Our data contains outliers, so we winsorize all variables at 1st and 99th percentile. We cluster standard errors by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional		**Retail**	
DepVar: $NAVVol_{ft}$ (bp)	(1)	(2)	(3)	(4)
$FlowVol_{ft-1}$ (%)	0.010**	0.011**	0.040***	0.040***
	(0.004)	(0.004)	(0.008)	(0.009)
$Spread_{ft-1}$ (bp)	0.006***	0.004**	0.001	0.001
	(0.002)	(0.002)	(0.005)	(0.004)
WAL_{ft-1} (days)	0.001		0.002	
	(0.001)		(0.003)	
$WLiq_{ft-1}$ (%)		-0.003		-0.003
		(0.002)		(0.009)
$Size_{ft-1}$	-0.078	-0.080	0.059	0.058
	(0.052)	(0.050)	(0.095)	(0.097)
$FFSize_{ft-1}$	0.065	0.060	-0.022	-0.028
	(0.075)	(0.074)	(0.164)	(0.160)
$NetYield_{ft-1}$ (bp)	0.000	-0.000	0.001	0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Constant	0.337	0.741	-0.508	-0.102
	(1.555)	(1.572)	(4.047)	(3.862)
Fund FE	Y	Y	Y	Y
Adj R-squared	0.0746	0.0802	0.186	0.184
Observations	967	967	697	697

Table 5.4: Shareholders' Response to Floating NAV

This table shows results of monthly fund fixed effects regressions after the 2016 Amendments from October 2016 to April 2018. The dependent variable is $NetInflows_{ft}$, calculated as a difference between gross subscriptions and gross redemptions of a fund. $NAVM_{ft}$ is the difference between actual NAV and target NAV as a percentage of the target NAV. $NAVVol_{ft}$ is NAV volatility calculated as rolling standard deviation of NAV over a six-month fixed window. $NetYield_{ft}$ is the yield earned by funds' shareholders, calculated as the value-weighted average of the 7-day net yields of fund share classes as reported on N-MFP form. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between gross yield and net yield of a fund. $Size_{ft}$ is the log of total net assets of a fund. $FFSize_{ft}$ is the log of total net assets of a fund family. Our data contains outliers, so we winsorize all variables at 1st and 99th percentile. We cluster standard errors by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional	**Retail**
DepVar: $NetInflows_{ft}$ (%)	(1)	(2)
$NAVM_{ft-1}$ (bp)	0.024***	-0.027
	(0.008)	(0.215)
$NAVVol_{ft-1}$ (bp)	-0.102***	0.686
	(0.029)	(1.191)
$NetYield_{ft-1}$ (bp)	0.058***	0.140***
	(0.017)	(0.024)
$WLiq_{ft-1}$ (%)	-0.134***	-0.128**
	(0.030)	(0.060)
$ExRatio_{ft-1}$ (bp)	-0.083**	0.152***
	(0.040)	(0.027)
$Size_{ft-1}$	-0.910	-1.442**
	(0.562)	(0.712)
$FFSize_{ft-1}$	-0.163	0.715
	(0.434)	(0.445)
$NetInflows_{ft-1}$ (%)	0.202***	0.145*
	(0.051)	(0.076)
Constant	28.184***	6.684
	(8.407)	(9.563)
Fund FE	Y	Y
Adj R-squared	0.2084	0.1786
Observations	960	694

Table 5.5: Shareholders of MMFs Seek Capital Gains

This table shows results of monthly fund fixed effects regressions after the 2016 Amendments from October 2016 to April 2018. The dependent variable is $NetInflows_{ft}$, calculated as a difference between gross subscriptions and gross redemptions of a fund. $\Delta NAVRank_{ft}$, calculated as month-over-month change in the percentile rank of a fund's NAV_{ft}. $NAVVol_{ft}$ is NAV volatility calculated as rolling standard deviation of NAV over a six-month fixed window. The controls included in the regressions but not shown for brevity are as follows: $NetYield_{ft}$ is the yield earned by funds' shareholders, calculated as the value-weighted average of the 7-day net yields of fund share classes as reported on N-MFP form. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between gross yield and net yield of a fund. $Size_{ft}$ is the log of total net assets of a fund. $FFSize_{ft}$ is the log of total net assets of a fund family. Our data contains outliers, so we winsorize all variables at 1st and 99th percentile. We cluster standard errors by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional	**Retail**
DepVar: $NetInflows_{ft}$ (%)	(1)	(2)
$\Delta NAVRank_{ft-1}$ (bp)	0.374***	-0.538
	(0.111)	(0.335)
$\Delta NAVRank_{ft-1} \times NAVVol_{ft-1}$	-0.040***	0.142
	(0.012)	(0.094)
Constant	32.726	-12.520
	(22.159)	(24.241)
Fund FE	Y	Y
Controls	Y	Y
Adj R-squared	0.213	0.156
Observations	1,023	693

Table 5.6: Drivers of Flow Volatility

This table shows results of monthly fund fixed effects regressions after the 2016 Amendments from October 2016 to April 2018. The dependent variable flow volatility, $FlowVol_{ft}$ is rolling standard deviation of a fund's net inflows over a six-month fixed window. $NAVM_{ft}$ is the difference between actual NAV and target NAV as a percentage of the target NAV. $NAVVol_{ft}$ is NAV volatility calculated as rolling standard deviation of NAV over a six-month fixed window. $NetYield_{ft}$ is the yield earned by funds' shareholders, calculated as the value-weighted average of the 7-day net yields of fund share classes as reported on N-MFP form. $WLiq_{ft}$ is the weekly liquidity calculated as total weekly liquid assets of a fund as a percentage of its total assets. Weekly liquid assets include cash, US Treasury securities, government agency securities with remaining maturities of 60 days or less, and securities that convert into cash within five business days. $ExRatio_{ft}$ is the expense ratio of a fund calculated as the difference between gross yield and net yield of a fund. $Size_{ft}$ is the log of total net assets of a fund. $FFSize_{ft}$ is the log of total net assets of a fund family. Our data contains outliers, so we winsorize all variables at 1st and 99th percentile. We cluster standard errors by fund. Significance levels are indicated by *** p<0.01, ** p<0.05, * p<0.1.

	Institutional	**Retail**
DepVar: $FlowVol_{ft}$	(1)	(2)
$NAVM_{ft-1}$ (bp)	-0.03***	-0.67
	(0.01)	(0.43)
$NAVVol_{ft-1}$ (bp)	-0.04	3.31***
	(0.03)	(0.64)
$NetYield_{ft-1}$ (bp)	-0.05***	-0.06***
	(0.01)	(0.01)
$WLiq_{ft-1}$ (%)	0.04	0.14***
	(0.04)	(0.04)
$ExRatio_{ft-1}$ (bp)	0.01	-0.05
	(0.05)	(0.06)
$Size_{ft-1}$	-0.84	-1.82*
	(0.82)	(0.99)
$FFSize_{ft-1}$	1.18	0.51
	(4.16)	(1.07)
Constant	2.21	31.16
	(90.79)	(33.22)
Fund FE	Y	Y
Adj R-squared	0.14	0.40
Observations	966	696

Chapter 6 Conclusions and Future Research

6.1 Conclusions

This thesis investigates the changes in the MMF industry after the introduction of 2010 and 2016 Amendments to rule 2a-7 which governs US money market funds. Specifically, we look at the following: (1) minimum liquidity requirements; (2) "know your investor" requirement; (3) liquidity fee and redemption gate; (4) and floating net asset value.

We find that the liquidity requirements have compelled funds to hold a safer asset mix and endure high redemption pressure. This was evident during the sovereign debt crisis, when the funds withstood the redemption pressure easily and had unused liquidity after servicing redemptions. This liquidity hoarding has put downward pressure on portfolio returns thwarting the ability of funds to survive and differentiate on yield especially during a zero-interest rate environment. Moreover, in response to "know your investor" requirement, the funds have become acquainted with the redemption behaviour of their investors and adjust liquidity if expecting higher outflows. We find that investors do not respond to liquidity but to the credit risk of funds during distress, indicating that they are more concerned about preserving their capital.

The assessment of MMF industry after the 2016 Amendments shows that, to avoid liquidity fee, redemption gates and floating NAV, prime MMFs have migrated to government funds which do not have such requirements, indicating that investors prefer the money-like features of MMFs. We find that the riskier institutional prime

MMFs had the higher probability of migrating to government funds, probably to avoid dealing with the stricter regulations for institutional funds. Post-reform, the remaining institutional prime MMFs behave prudently by changing their portfolio composition dramatically and have become very active in managing their liquidity in response to the changing risk profile of their portfolios i.e. any increases in credit risk are accompanied with increases in liquidity to ensure the comfortable servicing of investor redemptions. Because of losing attractive money-like features institutional prime funds forego more fee to provide positive returns and maintain their competitiveness. Whereas, retail prime MMFs behave very differently from institutional prime MMFs. Unlike institutional prime funds, the riskier prime MMFs were less likely to convert to government MMFs and have become more relaxed in management of liquidity, possibly because of the removal of market discipline previously imposed by the presence of institutional investors in the shareholder mix of retail prime MMFs.

We examine the reaction of institutional prime MMFs to the introduction of floating NAV since October 2016. We find that shareholders use floating NAV as a new performance indicator and utilize it to make investment decisions. We show that shareholders seek to invest in funds that offer higher capital gains. In fact, they actively transfer their money to funds who grow their percentile rank of capital gains. But they remain watchful of the volatility of floating NAV and shun the funds with unstable NAV. We document that funds with higher average portfolio maturity, higher credit risk and lower weekly liquidity grow their floating NAV more. Together, our results suggest that institutional funds have an incentive to differentiate themselves on capital gains to build asset size. To do so, they must hold a riskier portfolio mix which could leave a fund prone to distress.

In summary, the thesis shows that the various rules introduced by SEC reforms have countervailing effects. Some requirements like minimum liquidity levels, weighted average life ceiling and the “know your investor” rule seem to induce stability in MMFs albeit having some limitations. Other requirements such as liquidity fee, redemption gates and floating NAV requirement have mixed results.

6.2 Main Contributions

Our main contributions to the existing literature are as follows. To the best of our knowledge, this is the only study to investigate the changes in the MMF industry after the 2010 reforms using before and after reforms data. We observe that, after reforms, the MMFs have a safer asset mix and they seem to be more resilient as compared to the pre-reform period.

Second, we extend the analysis of Jank and Wedow (2015), who look at liquidity and inflows for German funds in a crisis. With our sample of US prime MMFs we evaluate the role of daily and weekly liquidity in mitigating outflows if the portfolio is perceived to carry considerable credit risk. In the context of the sovereign debt crisis, we use the level of Eurozone bank holdings as a credit risk proxy. When the sovereign debt crisis worsened in 2011, credit default spreads of Eurozone banks increase sharply. This caused concerns about the solvency of Eurozone banks which led to massive withdrawals from exposed funds. We find that higher daily and weekly liquidity do not compensate for higher credit risk in a crisis. In this sense, investors appear to have over-riding concerns about the preservation of capital even when the funds are better able to meet redemptions.

Third, we show that after the 2016 Amendments retail and institutional prime MMFs have become very different in their liquidity positions, maturity structure, competitiveness and risk management behaviour.

Fourth, we investigate the factors that influenced funds to convert from prime to government funds in response to the 2016 reforms. We find that institutional prime MMFs that held more credit risk were more likely to convert to government funds to preserve their money-like features, while risky retail prime MMFs do not tend to switch.

Fifth, we show that institutional prime MMFs have become more active in risk and liquidity management after the introduction of redemptions gates, liquidity fee and floating NAV. They maintain higher liquidity and tend to increase their liquidity actively as they increase the credit risk of their portfolio. On the other hand, retail prime MMFs have become more relaxed in their liquidity management.

Finally, we investigate how floating NAV has influenced the liquidity and risk management of institutional prime MMFs, what are the factors that influence NAVs, how floating NAV has influenced the risk-taking incentives of MMFs and the response of investors to this new requirement. We find that investors are attracted to higher NAV funds, but they run from funds with higher NAV fluctuations. So, a fund must increase risk to boost capital gains in order to attract investors, whereas to retain investors, it must ensure less volatility in NAV.

6.3 Implications

The changes in MMFs that have been discussed have implications for shareholders, regulators and money market funds. For instance, we show that funds have higher liquidity and have become more resilient to stress. Moreover, we show that institutional funds after segregation from retail funds have become more active in their liquidity management and tend to hoard liquidity as they increase their risk. This means that investors can be more confident about their investments in MMFs because these funds hold a higher safety cushion and are equipped to service redemptions. However, investors must still remain cautious about the risk-taking incentives of MMFs because these might have increased after the introduction of floating NAV for institutional funds. Retails investors should also keep up with the evolution of risk in fund portfolio because these funds seem to have become more relaxed in their liquidity and risk management after the discipline imposed by the presence of institutional investors has been removed.

Our results show that having higher daily and weekly liquidity does not necessarily compensate for higher credit risk of a fund's portfolio during a crisis. In fact, investors seem to have over-riding concerns about the preservation of capital even when the funds are equipped to meet redemptions. So, in order to reduce the likelihood of heavy redemptions during a crisis, MMFs must ensure their portfolio risk is kept low, in addition to having higher liquidity levels.

This paper sheds light on changes in the MMFs industry and contributes to the recent debate on their new regulation. Some requirements like minimum liquidity levels, weighted average life ceiling and the "know your investor" rule seem to induce stability in MMFs albeit having some limitations. Other requirements such as liquidity fee, redemption gates and floating NAV requirement have mixed results. For instance, the new SEC regulation, which took effect in October 2016, by requiring institutional prime MMFs to adopt a floating NAV may have provided institutional prime MMFs with more incentives to chase yield and invest in riskier securities. The resulting increase in NAV would attract investors, especially in a low interest rate environment. At the same time, the transparency of inherent risk of MMFs communicated through floating NAV seems to have a risk reducing impact.

6.4 Limitations and Future Research

We recognise that this thesis has limitations. The analysis of this thesis is based on a research design that does not make it possible to clearly determine a causal effect between regulatory changes directly related to MMFs and observed changes in MMF behaviour due to multiple confounding effects. For instance, other reforms aimed at banks and financial markets such as Basel III and the Dodd-Frank Act may have indirectly caused some of the changes documented in the thesis. That said, we do believe that the reforms we have studies, which were aimed specifically at MMFs, have influenced the industry more profoundly than other factors. Furthermore, despite the above limitations, the analysis we have provided offers important insights into the MMF industry that represent a meaningful contribution to our understanding of the new MMF landscape.

There are various ways to further develop the findings presented in this dissertation. We briefly mention some potentially interesting directions that could expand the study and provide additional contributions to the literature.

In chapter 3, we examine how liquidity floor introduced by 2010 Amendments have influenced prime MMFs risk and the reaction of shareholder to this requirement. Future research could investigate more in detail the limitations of higher liquidity in financial markets. As money market funds are required to hold more liquid assets, banks and corporations will face higher borrowing costs.[34] This, combined with new SEC reforms that have made prime MMFs less attractive to investors due to, for example, the introduction of discretionary redemption suspensions, may have serious consequences for the availability of affordable short-term credit to the private sector. The wider implications of these radical changes in the credit markets remain to be explored.

In chapters 4 and 5, we explore the way 2016 Amendments (especially liquidity fee, redemption gates and floating NAV) have altered the MMF industry. A relevant topic that is unexplored in this thesis and remains of interest for future research is whether the introduction of floating NAV helps mitigate the risk of runs in institutional prime funds. We could not address this point because we investigate a period in which financial markets have been calm. Therefore, we could not directly investigate the response of institutional investors during market stress, when operating under floating NAV. A related extension would be to see whether liquidity fee and redemption gates lead to pre-emptive runs.

[34] See "US money market fund reform: an explainer. New rules are already impacting the $2.7tn industry", Financial Times, October 14, 2016.

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