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Liability Structure and Risk Taking: Evidence from the Money Market Fund Industry

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Abstract

How does the structure of financial intermediaries' liabilities affect their asset holdings? We investigate the consequences of the 2014 money market fund (MMF) reform, which imposed redemption gates and liquidity fees on prime MMFs and forced prime funds marketed to institutional investors to switch from constant to floating net asset value. These changes made prime MMFs' liabilities less money-like. As a consequence, the affected MMFs experienced an increase in flow–performance sensitivity and started taking more risks. In addition, the total funding provided by MMFs to the corporate sector, and especially to safer issuers, has decreased.

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I. Introduction

Money market funds (MMFs) intermediate short-term credit flows and perform a crucial function in the shadow-banking system. To improve their stability and decrease the probability of runs, the U.S. Securities and Exchange Commission (SEC) announced new rules for the U.S. money market industry in July 2014, which became effective in Oct. 2016. The main consequences of the reform were that all prime MMFs can impose liquidity fees and redemption gates (i.e., suspend redemptions temporarily) in times of market stress and have to do so if their liquidity falls below a certain threshold. In addition, the reform forced prime MMFs to switch from a constant net asset value (NAV) to a floating NAV if the funds are marketed to institutional investors.

As a consequence of the reform, the liabilities of all prime MMFs and, to an even larger extent, those of institutional prime MMFs, which lost the certainty of nominal value, became less money-like. We study the effect of the reform on the liabilities of prime MMFs and investigate how changes in the liability structure affect intermediaries' investment strategies and asset holdings.

In general, investors are unlikely to consider an asset safe if they may not be able to redeem it in bad times, which may occur as a result of the imposition of redemption gates. However, we expect the reform to have had a large impact, especially on the liabilities of institutional prime MMFs, which had to adopt a floating NAV. The absolute certainty of nominal value is often considered as the defining characteristic of safe assets, and some institutions may not be able to hold marked-to-market securities as cash for regulatory reasons (Gennaioli, Shleifer, and Vishny (2012), Krishnamurthy and Vissing-Jørgensen (2015)).[1] Furthermore, with a floating NAV, institutional investors have to track and report the daily fluctuations in the value of their portfolios. In this respect, to the extent that investors have to acquire information on the value of their claims, the liabilities of MMFs became less money-like because of the reform (Gorton and Pennacchi (1990)). Finally, the adoption of a floating NAV increases the time required to strike a market-based price and therefore decreases the ability of funds to guarantee immediate redemptions to investors, thus decreasing the liquidity services expected from money-like securities (Nagel (2016)).

We posit that all these factors made investors treat prime MMFs' liabilities as more information sensitive and less money-like. As a consequence, investors may have started to collect more information and request a higher yield to hold MMFs' shares, spurring prime MMFs' risk taking. Consistent with these conjectures, we show that after the reform, investors in prime MMFs have significantly increased their information-acquisition efforts, as measured by the frequency of downloads of fund-specific regulatory filings from the SEC's Electronic Data Gathering, Analysis, and Retrieval (EDGAR) website. Furthermore, flows into prime MMFs became more sensitive to performance. All changes are more pronounced for institutional prime MMFs, whose liabilities were more affected by the reform because of the adoption of a floating NAV. The effects we document support our

[1]Corporations are often able to invest their cash only in securities that can guarantee the nominal value, such as stable NAV funds (see Treasury Strategies (2013)).

conjecture that the liabilities of prime MMFs became less money-like as a consequence of the reform.

The change in the nature of prime MMFs' liabilities, by increasing the sensitivity of flows to performance, is expected to increase competition between fund managers to produce high returns (Sirri and Tufano (1998)). Theoretically, stronger competition should result in stronger incentives to invest in higher-yielding, riskier, and less liquid securities (Chevalier and Ellison (1997)). Consistent with these arguments, we find that prime MMFs have higher portfolio gross spreads after the reform. Interestingly, we do not observe such changes for bond funds specialized in investing in short-term securities, which are similar to prime MMFs but were unaffected by the reform.[2]

Consistent with the larger increase in flow–performance sensitivity observed in institutional prime MMFs, we find that portfolio spreads have increased more for institutional prime funds in comparison to retail prime MMFs. This evidence supports our interpretation that the reform, and not shocks to spreads or to the supply of different types of securities, drive the increase in risk taking. In addition to higher portfolio spreads, we observe that institutional prime MMFs have also decreased the proportion of their holdings invested in safe securities and have increased investment in riskier assets to a larger extent than their retail counterparts. Furthermore, by focusing on a balanced panel, we show that the effects are largely driven by surviving funds that changed their behavior after the reform rather than by the exit of safer funds.

Using security-level data and issuers' outstanding liabilities with different funds, we confirm that our conclusions on the changes in investment strategies are not driven by changes in the demand for funding by different types of issuers. We observe that the total funding provided by U.S. MMFs to the corporate sector has decreased after the reform. However, consistent with prime MMFs' higher propensity to take risk, the value of the outstanding liabilities toward U.S. MMFs has decreased to a lower extent for riskier issuers (those with a higher risk of default, as well as emerging-market issuers). MMFs marketed to institutional investors appear to be driving these changes. Put differently, after the reform, safer borrowers receive less short-term funding by institutional prime MMFs than riskier borrowers.

The reform also imposed the segregation of retail and institutional share classes in different funds. We perform a number of robustness tests to evaluate the possibility that our results are driven by this aspect of the reform rather than by a change in the nature of liabilities, which we highlight. As a consequence of the imposed segregation of share classes, retail and institutional investors can no longer comingle in the same funds. This results in higher sophistication and performance-chasing behavior of investors in funds that only offer institutional share classes after the reform but had some retail investors before. In principle, this mechanical change in the funds' clienteles could explain the relative increase in information acquisition, flow–performance sensitivity, and risk taking in institutional prime MMFs, even if investors do not perceive the nature of MMFs' liabilities to have substantially changed. Such an explanation, however, cannot account for the similar, albeit attenuated, effects

[2]We also show that our conclusions are invariant if we compare prime funds to government funds, which were also unaffected by the reform, as a control group.

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experienced by retail funds, in which investor sophistication and propensity to chase high yields are unlikely to have increased much.[3] Furthermore, we observe similar increases in information acquisition and changes in flow–performance sensitivity in prime funds that, already prior to the reform, were exclusively marketed to either institutions or retail investors and whose clienteles did not change because of the segregation of institutions and retail investors imposed by the reform.

Last but not least, we uncover similar effects in tax-exempt funds, which were subject to exactly the same reform as prime MMFs.[4] These findings are more difficult to rationalize with an explanation merely based on the segregation of institutional and retail funds than an explanation based on the liquidity of the funds' liabilities. Tax-exempt funds invest in securities that are considered rather safe and consequently have low yields. Therefore, they are unlikely to be particularly attractive to yield-chasing and sophisticated investors, and the segregation of institutional and retail funds should have affected tax-exempt funds to a much lesser extent.

Overall, our evidence supports the conjecture that the reform has changed the nature of prime MMFs' liabilities. Specifically, some investors appear to have changed their behavior and started to track the performance of prime MMFs more regularly. Other investors who prefer liquid claims with a certain nominal value and no risk of gates and liquidity fees may have stopped investing in prime MMFs.[5] The change in liabilities has contributed to an increase in risk taking in this sector of the money market industry and has reduced the availability of short-term funding, especially for safer borrowers. The consequences of the reform are particularly pronounced for institutional funds, which had to switch from constant to floating NAV. Institutional investors that hold prime MMFs' liabilities appear to more closely track performance after the reform. As a consequence, institutional prime MMFs now have stronger incentives to take risk.

Our article contributes to the literature on the relationship between the nature of intermediaries' assets and liabilities, which has been studied both theoretically and empirically by influential articles in banking but has been widely neglected in the case of other financial intermediaries (Kashyap, Rajan, and Stein (2002), Gatev and Strahan (2006), and Hanson, Shleifer, Stein, and Vishny (2015)). Furthermore, to our knowledge, we are the first to exploit an exogenous shock to the structure of intermediaries' liabilities to identify the effect on asset holdings and, in particular, incentives to take risk.

As we argued earlier, the 2014 MMF reform provides an apt experiment to explore these issues. In theory, prime MMFs could have attempted to circumvent

[3]Retail funds are defined as funds that have no institutional share classes.

[4]We mainly focus on prime funds in the article, which are of central importance to the financial system because they provide much of the external short-term financing to corporations and financial institutions. Tax-exempt funds invest mainly in the debt of municipal issuers and manage much less assets than prime funds.

[5]The results appear not to be merely due to a possible change in prime funds' clienteles following the change in the nature of their liabilities. We observe that the reform also led to a relative increase in flow–performance sensitivity and the risk taking of prime institutional funds if we focus on funds with moderate asset volatility during the period in which the reform was implemented. These funds are unlikely to have experienced significant changes in clienteles following the reform, suggesting instead that the behavior of their investors has changed.

the effects of the regulation by trying to increase the liquidity and safety of the investments. However, consistent with Holmström and Tirole (2011), our findings suggest that financial intermediaries have limited ability to create money-like securities absent government regulation.

Our article is also related to a small but growing strand of literature exploring the shadow-banking system and, in particular, MMFs. A large part of the literature describes the behavior of MMFs during the global financial crisis. Kacperczyk and Schnabl (2013) show that MMFs sponsored by financial intermediaries with more MMF business took on more risk during the 2007–2008 period. Schmidt, Timmermann, and Wermers (2016) document that institutional investors withdrew from MMFs to a larger extent than retail investors in 2008, presumably because they have better monitoring capabilities. Di Maggio and Kacperczyk (2017) report that the zero-lower-bound policy of the Federal Reserve led MMFs to exit the industry and increased the risk taking of the remaining funds. La Spada (2018) argues that these effects arose from increased competitive pressure in a low-interest-rate environment.

Another strand of this literature shows that the arrival of negative public information increases the information sensitivity of the liabilities issued by MMFs. Gallagher, Schmidt, Timmerman, and Wermers (2020) show that sophisticated institutional investors were most responsive to the cross-sectional heterogeneity in funds' exposures to eurozone securities. Chernenko and Sunderam (2014) report that the withdrawals from U.S. MMFs that were exposed to European banks affected by the euro crisis led to reduced availability of short-term funding to U.S. borrowers. In contrast to previous work, we consider a period without spikes in risks and show that changes in the nature of liabilities may drive significant changes in investor behavior and funds' strategies.

More closely related to our article, recent work by Cipriani and La Spada (2021) shows that the prime MMF segment shrank following the announcement of the 2014 reform and that the government segment increased commensurably. They also document that many outflows from prime and municipal MMFs into government funds occurred within the same fund family. Finally, they show that the net returns of prime MMFs increased compared with government MMFs because prime funds decreased their fees. In contrast to their work, we explore the effects of the 2014 reform on information acquisition, flow–performance sensitivity, and the risk taking of prime as well as tax-exempt MMFs. To achieve this, we focus on gross returns, abstracting from the effects of changes in fees, and consider alternative benchmarks to control for changes in the yields of the underlying securities. Crucially, we also explore the consequences of MMFs' behavior for the provision of short-term funding to the corporate sector.

II. Institutional Background

MMFs are open-ended funds that issue shares to investors, including institutions and retail investors, and specialize in investing in money market instruments of different types. As of year-end 2019, the total assets of U.S. MMFs, including government MMFs, were \$3.6 trillion (Investment Company Institute (2020)).

Whereas government MMFs invest primarily in treasuries and short-term securities issued by government agencies, prime MMFs purchase short-term money market instruments issued by corporations and financial institutions, such as commercial paper, asset-backed securities, and bank obligations. Tax-exempt MMFs invest primarily in tax-exempt securities, including short-term obligations of U.S. states, territories, or municipalities. These types of securities are safer and have lower yields than similar corporate securities (Schwert (2017)). Tax-exempt funds historically account for only a small share of total U.S. MMF assets (as of year-end 2019, tax-exempt MMFs had $138 billion in assets). Henceforth, our focus will be on prime MMFs, but we consider tax-exempt funds to validate the interpretation of our findings.

Shares in MMFs have historically been regarded by investors as profitable substitutes for deposits and other money-like securities, such as Treasury bills. Although MMFs do not benefit from explicit deposit guarantees, investors could typically expect to redeem their investment at par value and obtain a safe stream of dividends. This expectation was reinforced by the fact that MMFs promised their investors a constant NAV of $1 for a $1 investment. Despite this, MMFs may "break the buck," a rare situation in which the marked-to-market value of the fund's net assets falls to 99.5 cents or less per dollar. In such a case, MMFs may experience a run. An important recent example is the Reserve Primary Fund, which, because of its large holdings of Lehman's commercial paper, experienced a large drop in the market value of the short-term securities it held and suffered a run in Sept. 2008.

In 2008, the government ultimately guaranteed the value of any investment in MMFs to stave off runs on their assets. The money market industry has subsequently been at the center of sweeping regulatory efforts aiming to improve financial stability (Hanson, Scharfstein, and Sunderam (2015)). These amendments to Rule 2a-7 were announced on July 23, 2014, and took effect on Oct. 14, 2016. Government MMFs were exempt from these regulatory changes.

Following the reform, all nongovernment MMFs are entitled to impose liquidity fees and redemption gates (i.e., suspend redemptions temporarily) in times of market stress and have to do so when their weekly liquidity drops below 30%. In addition, nongovernment MMFs that are marketed to institutional investors can no longer guarantee the nominal value of investor claims but have to trade at a price equal to their actual NAV. By not rewarding investors that are faster to withdraw, the floating NAV should reduce the probability of runs.

On the one hand, the change from constant to floating NAV can be viewed as a mere accounting change because the funds' actual NAV was always subject to fluctuations, which were observable to all investors even prior to the reform (albeit on a monthly basis). On the other hand, the adoption of floating NAV may have contributed to changing the nature of the securities that prime MMFs can offer to institutional investors. The liabilities issued by prime MMFs lost the certainty of nominal value, which is typical of money-like securities. An important practical consequence of this change is that investors must track and report the daily fluctuations in the value of their portfolios. Assiduous monitoring of the portfolio could contribute to an increase in flow–performance sensitivity. The marking to market of prime MMF claims may also lead to the payment of capital gains taxes by institutional investors. Last but not least, the adoption of a floating NAV increases the amount of time required to strike a market-based price and therefore decreases the ability of prime MMFs to guarantee immediate redemptions to institutional investors. In sum, the changes introduced by the 2014 reform make it more costly to invest in institutional prime MMFs.

Besides changing the nature of nongovernment funds' liabilities, the reform brought about other regulatory changes. Most notably, the reform mandated the segregation of institutional and retail investors in nongovernment funds. This led to a change in the clienteles of nongovernment MMFs that originally had both institutional and retail share classes and that, following the reform, could only offer one type. We explore to what extent the separation of retail and institutional investors may drive our findings on the effects of the reform.

The 2014 reform also required more diversification by MMFs and mandated additional disclosures.[6] Finally, the SEC removed references to nationally recognized statistical rating organization (NRSRO) credit ratings in Rule 2a-7 to comply with the Dodd–Frank Act. Prior to the rule change, eligible securities were determined based on NRSRO ratings. Under the amended rule, an "eligible security" is a security that the MMF's board determines to present "minimal credit risk."[7] We regard these aspects of the reform as less consequential because they cannot jointly explain the changes in fund behavior we uncover.[8]

The announcement of the 2014 reform initiated a period of major adjustment in the MMF industry. Starting roughly 12 months before the implementation of the new regulation on Oct. 14, 2016, the assets of prime MMFs shrank dramatically compared with the period before the announcement of the regulation. According to Graph A of Figure 1, the total net assets (TNA) of prime institutional MMFs permanently dropped by more than 70%, whereas the drop in assets was 50% and partially reversed for retail funds. A broadly similar pattern can be observed for tax-exempt MMFs, albeit at a much lower level of assets (Graph B). The assets of these funds shrank by approximately 50% after the announcement of the reform. As in the case of prime funds, the assets of institutional funds contracted more (by approximately 90%) than those of retail funds (which shrank by approximately 30%). The assets of government MMFs grew commensurably during this period as a large number of prime and tax-exempt MMFs converted into government funds.

The process of adjustment ended with the reform implementation, when the TNA of MMFs stabilized and started to increase moderately. As Cipriani and La Spada (2021) discuss, MMFs' families reorganized their structure in anticipation of changes in demand. In addition, preparing for the reform implementation, investors are likely to

[6]These additional disclosures concern i) daily disclosures on the funds' websites of liquid assets, net shareholder flows, NAV per share, imposition of fees and gates, and use of affiliate sponsor support; ii) new material event (e.g., imposition or removal of fees or gates; current sponsor or affiliate support) disclosure on a new Form N-CR; and iii) disclosure of any historical sponsor or affiliate support during the past 10 years.

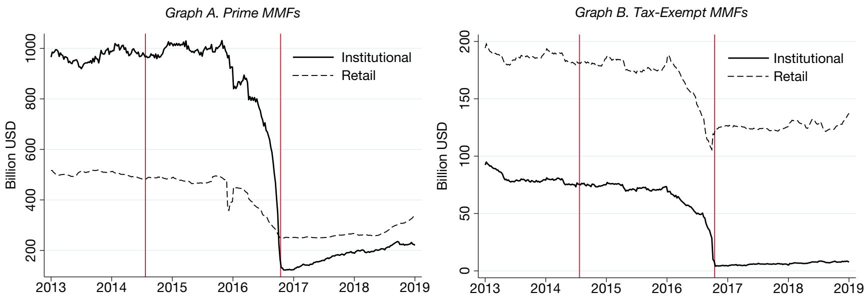
[7]These amended rules do not completely remove references to ratings: Item C-10 of the amended Form N-MFP (i.e., the form that MMFs use to report monthly information on their portfolio holdings to the SEC) requires the disclosure of "each rating assigned by any NRSRO that the fund's board of directors (or its delegate) considered in determining that the security presents minimal credit risks (together with the name of the assigning NRSRO)." The regulations concerning the ratings were initially proposed in Mar. 2011, then again in July 2014. They became effective on Oct. 26, 2015, with a compliance date of Oct. 14, 2016.

[8]In particular, contrary to what we document, higher portfolio diversification should decrease yields and investors' incentives to monitor.

FIGURE 1

Prime and Tax-Exempt MMF Assets

Figure 1 shows the weekly aggregate outstanding total net assets (TNA) of prime money market funds (MMFs) (Graph A) and tax-exempt MMFs (Graph B) ($billions). Institutional (retail) assets represent the aggregate assets of all institutional (retail) share classes of MMFs. The first vertical line represents July 2014, when the amendments to Rule 2a-7 were adopted; the second line represents Oct. 2016, when the new rules came into effect.



have started to consider alternative liquid assets and compare different MMFs. This led to a gradual adjustment in the months leading up to the reform implementation.

In what follows, we exploit the 2014 changes in regulation to evaluate i) how the regulation has affected the nature of MMFs' liabilities, ii) how the portfolio composition and risk taking of these financial intermediaries have changed, and iii) what the implications are for the U.S. MMFs' supply of short-term financing to firms.

III. Data

This section describes the main data sources that we employ in our analyses. We obtain data on MMFs from iMoneyNet. This database provides share-class-level data on the net assets and various characteristics of the underlying portfolios, including the percentage of holdings invested in different asset classes; the percentage of assets maturing in 7 days; sponsor, yields, expenses, and inception date; share classes marketed to institutional or retail investors; and other fund characteristics. From iMoneyNet, we also download the security-level holdings that funds report on Form N-MFP.

Before the reform, prime and tax-exempt funds could have different share classes, with different fee structures, for retail investors and institutional investors. We perform all tests at the portfolio level. Throughout the article, we designate the funds that have at least one institutional share class as institutional MMFs. We provide evidence that this definition is innocuous. Only 20% of the funds target both institutional and retail investors, and as we confirm later, our results are invariant if we focus on funds that have either only institutional share classes or only retail share classes during the whole sample period. The number of distinct prime MMFs in the most comprehensive sample is 195, of which 112 are institutional. The sample period is Jan. 2013 to Dec. 2018.[9]

[9]We start our sample in 2013 to exclude the previous MMF reform (2010) and the euro crisis (2011–2012).

We obtain estimates of 1-month corporate default probabilities at a monthly frequency for issuers of money market securities from the National University of Singapore (NUS) Risk Management Institute (RMI) Credit Research Initiative.[10] We manually match issuers of money market securities held by the MMFs to the NUS-RMI data. Finally, information on commercial paper issued by U.S. companies is from Standard & Poor's (S&P's) Capital IQ database.

Table 1 provides variable definitions. Panel A of Table 2 describes the weekly fund-level data that we use to explore how funds' flow–performance sensitivity and propensity to take risk are affected by the reform. We separately report information for institutional and retail prime funds, institutional and retail tax-exempt funds, and institutional and retail government funds.

Panel B of Table 2 reports summary statistics for the data sets that we use to explore MMFs' funding provision to firms. In the first data set (used for the tests in Table 6), we aggregate the nominal value of the securities of a given issuer that each fund holds in a given month. Thus, the unit of observation is at the issuer-fund-month level. The nominal value of the securities of a given issuer held by a fund is set to 0 if the fund held the issuer's securities in the past but not any longer. The data set includes 506 unique issuers. For the tests in Table 8, which explore the implications of cross-sectional differences in default risk across issuers of money market instruments, we sum the securities issued by each firm in a given month; we also report summary statistics for this data set with observations at the issuer-month level in Panel B. Finally, we compute the total nominal values of the securities of issuers in a given country that are held by a given fund during a particular month to have a different measure of the fund's propensity to take risk. This allows us to consider the funds' holdings of securities of issuers in countries that on average have higher default risk than U.S. issuers, such as emerging-market issuers. Summary statistics for this data set are also reported in Panel B of Table 2.

Panel C of Table 2 reports the data set used to study commercial paper issuance by U.S. firms. We obtain the amount of commercial paper outstanding by U.S. issuers as reported in 10-K filings from Capital IQ's Capital Structure Summary files. The data set used for the tests is constructed by manually matching issuers from Capital IQ to iMoneyNet and the NUS-RMI default probabilities database. It has a yearly frequency and includes 108 unique issuers.

IV. Changes in Liability Structure

This section provides evidence that the 2014 reform has changed the nature of prime MMFs' liabilities and that prime MMFs marketed to institutional investors are more affected. We also show that these conclusions extend to tax-exempt funds. The conclusions of this section inform the choice of the empirical methodology from Section V, in which we study how changes in the nature of liabilities affect asset holdings.

[10]These default probabilities are derived from a forward-intensity credit-risk model based on Duan, Sun, and Wang (2012). The default probabilities from the NUS-RMI Credit Research Initiative are reported at a monthly frequency and are only available for listed firms.

TABLE 1
Variable Definitions

Table 1 presents the definitions of the main variables (in alphabetic order) used in this article. Unless specified, the data are from iMoneyNet.

AGE	Number of years since the inception date of the oldest share class of a fund; winsorized at 0.5% and 99.5% levels.
EMERGING	Takes the value of 1 for the portion of funding of a given fund to issuers in an emerging market country according to the MSCI definition (in the sample, these are Brazil, Chile, China, India, Kuwait, North and South Korea, and the United Arab Emirates). It is 0 in the case of funding to issuers from other countries.
EXPENSES	Annual expense ratio, percent per annum; asset weighted across share classes; winsorized at 0.5% and 99.5% levels.
FOREIGN	Takes the value of 1 for the portion of funding of a given fund to issuers in any non-U.S. country (0 for the U.S.).
FRANK	A fund's percentile rank in week t among the institutional or retail prime funds based on the weekly gross yield for week $t-1$; higher rank implies better performance.
FUND_FLOW	Return-adjusted change in net assets; computed as $(\text{TNA}_t-(1+R_t)\text{TNA}_{t-1}))/\text{TNA}_{t-1}$, where R denotes the weekly gross yield, and TNA denotes the total net assets; winsorized at 0.5% and 99.5% levels.
FUND_FLOW_VOLATILITY	Standard deviation of FUND_FLOW over the previous 12 weeks; winsorized at 0.5% and 99.5% levels.
HOLDING_RISK	Fraction of the fund portfolio invested in bank obligations (domestic and foreign), net of investments in Treasury/agency debt and repos; winsorized at 0.5% and 99.5% levels.
INST_DEPENDENCE	Issuers are defined as dependent on institutional MMFs if the proportion of funding they obtain from institutional MMFs is above the sample median; in such cases, the indicator variable INST_DEPENDENCE takes the value of 1, and 0 otherwise. An issuer's proportion of funding from institutional MMFs is measured as the average of the monthly funding from institutional MMFs divided by total monthly MMF funding observed in 2013, the year prior to the reform announcement, through N-MFP filings.
INSTITUTIONAL	Takes the value of 1 if the fund is marketed to institutional investors, and 0 otherwise; a fund is classified as institutional if it offers at least one institutional share class.
LIQUID_SHARE	Fraction of the fund portfolio maturing in 7 days; winsorized at 0.5% and 99.5% levels.
ln(ABCP+1)	Natural logarithm of (1 plus) the total value of asset-backed commercial paper ($millions) issued by a given firm, held by U.S. prime MMFs; winsorized at 0.5% and 99.5% levels.
ln(COMMERCIAL_PAPER+1)	The natural logarithm of (1 plus) the amount of commercial paper ($millions) that an issuer has outstanding in a given fiscal year, according to its 10-K filings (variable "Total outstanding balance of commercial paper" in Capital IQ's Capital Structure Summary files); winsorized at 0.5% and 99.5% levels.
ln(FAMILY_SIZE)	Natural logarithm of the sum of fund family's assets ($millions); winsorized at 0.5% and 99.5% levels.
ln(FUND_SIZE)	Natural logarithm of the fund portfolio's outstanding assets ($millions); winsorized at 0.5% and 99.5% levels.
ln(VALUE+1)	Natural logarithm of (1 plus) the total value of securities ($millions) issued by a given firm that are held by U.S. prime MMFs; winsorized at 0.5% and 99.5% levels.
ln(VALUE_ NONCOLLATERALIZED+1)	Natural logarithm of (1 plus) the total value of securities ($millions) issued by a given firm that are held by U.S. prime MMFs, excluding asset-backed commercial paper and repos; winsorized at 0.5% and 99.5% levels.
ln(VALUE_INSTITUTIONAL+1)	Natural logarithm of (1 plus) the total value of securities ($millions) issued by a given firm that are held by U.S. institutional prime MMFs; winsorized at 0.5% and 99.5% levels.
ln(VALUE_RETAIL+1)	Natural logarithm of (1 plus) the total value of securities ($millions) issued by a given firm that are held by U.S. retail prime MMFs; winsorized at 0.5% and 99.5% levels.
PD	One-month probability of default, for a given issuer and month, obtained from the Credit Research Initiative at the RMI of the NUS; in percent.
POST	Takes the value of 1 after July 23, 2014 (the date of the announcement of the amendments to Rule 2a-7), and 0 otherwise.
POST_2014	Takes the value of 1 after July 23, 2014, but before Oct. 14, 2016 (the date the 2014 rules became effective), and 0 otherwise.
POST_2016	Takes the value of 1 after Oct. 14, 2016 (the date on which the 2014 rules became effective), and 0 otherwise.
PRIME	Dummy variable taking the value of 1 if a fund is a prime MMF; it takes a value of 0 if a fund is a government MMF.
SAFE_HOLDINGS	Fraction of the fund portfolio invested in Treasury/agency debt and repos; winsorized at 0.5% and 99.5% levels.
SPREAD	Gross yield minus the 1-month constant-maturity T-bill rate (DGS1MO), obtained from the Federal Reserve Bank of St. Louis Economic Data (FRED); the gross yield is computed as the sum of the net yield and the expense ratio, then asset-weighted across a fund's share classes; in percent per annum; winsorized at 0.5% and 99.5% levels.

TABLE 2

Summary Statistics

Table 2 reports summary statistics for the various samples used in the empirical analysis. The sample period is Jan. 2013–Dec. 2018. Variables are defined in Table 1.

Variable name	No. of Obs.	Mean	Std. Dev.	Minimum	Maximum
Panel A. Summary Statistics for the Flow–Performance Sensitivity (Table 3) and Risk-Taking Tests (Tables 4 and 5) by Fund Type, Fund Portfolio-Level Weekly Observations					
Panel A1. Prime, Institutional					
FUND_FLOW	21,104	−0.002	0.054	−0.250	0.217
FRANK	21,104	0.500	0.293	0.000	1.000
SPREAD	21,111	0.198	0.094	−0.110	0.550
SAFE_HOLDINGS	21,235	0.227	0.179	0.000	1.000
HOLDING_RISK	21,235	−0.035	0.254	−1.000	0.370
LIQUID_SHARE	21,023	0.452	0.153	0.120	1.000
ln(FAMILY_SIZE)	20,752	10.523	2.093	4.452	13.104
ln(FUND_SIZE)	21,125	7.929	1.936	2.303	11.704
EXPENSES	21,125	0.173	0.074	0.000	0.791
AGE	21,125	21.499	9.155	0.477	43.551
FUND_FLOW_VOLATILITY	20,886	0.048	0.047	0.000	0.326
Panel A2. Prime, Retail					
FUND_FLOW	16,708	−0.001	0.029	−0.250	0.217
FRANK	16,704	0.500	0.294	0.000	1.000
SPREAD	16,712	0.197	0.111	−0.110	0.550
SAFE_HOLDINGS	16,834	0.236	0.200	0.000	1.000
HOLDING_RISK	16,834	−0.072	0.258	−1.000	0.370
LIQUID_SHARE	16,608	0.415	0.141	0.120	1.000
ln(FAMILY_SIZE)	16,292	9.826	2.439	4.452	13.104
ln(FUND_SIZE)	16,749	6.983	1.796	2.303	11.704
EXPENSES	16,749	0.282	0.183	0.000	0.936
AGE	16,749	25.985	9.650	0.477	43.551
FUND_FLOW_VOLATILITY	16,532	0.020	0.034	0.001	0.326
Panel A3. Tax-Exempt, Institutional					
FUND_FLOW	16,548	−0.004	0.048	−0.234	0.186
FRANK	16,548	0.500	0.294	0.000	1.000
SPREAD	16,551	0.069	0.126	−0.800	0.589
ln(FAMILY_SIZE)	16,456	11.381	1.388	6.704	13.010
ln(FUND_SIZE)	16,456	6.151	1.428	2.715	9.899
EXPENSES	16,456	0.133	0.088	0.000	0.734
AGE	16,456	22.241	7.853	2.022	37.893
FUND_FLOW_VOLATILITY	16,420	0.043	0.040	0.002	0.279
Panel A4. Tax-Exempt, Retail					
FUND_FLOW	23,117	−0.002	0.033	−0.234	0.186
FRANK	23,117	0.500	0.292	0.000	1.000
SPREAD	23,118	0.025	0.219	−0.800	0.589
ln(FAMILY_SIZE)	23,036	11.328	1.550	6.704	13.137
ln(FUND_SIZE)	23,036	6.220	1.575	2.715	9.899
EXPENSES	23,036	0.253	0.221	0.000	0.870
AGE	23,036	25.866	6.228	5.132	37.893
FUND_FLOW_VOLATILITY	23,012	0.026	0.034	0.002	0.279
Panel A5. Government, Institutional					
FUND_FLOW	31,201	0.002	0.056	−0.227	0.259
SPREAD	31,330	0.053	0.072	−0.220	0.500
ln(FAMILY_SIZE)	31,221	10.619	1.946	4.332	13.104
ln(FUND_SIZE)	31,221	8.047	1.842	2.303	11.714
EXPENSES	31,221	0.171	0.139	0.000	0.970
AGE	31,166	21.536	8.959	0.548	43.370
FUND_FLOW_VOLATILITY	30,995	0.053	0.054	0.001	0.420
Panel A6. Government, Retail					
FUND_FLOW	14,820	0.000	0.039	−0.227	0.259
SPREAD	14,874	0.047	0.079	−0.220	0.500
ln(FAMILY_SIZE)	14,833	9.933	2.693	4.332	13.104
ln(FUND_SIZE)	14,833	6.887	1.882	2.303	11.714
EXPENSES	14,833	0.305	0.247	0.000	0.970
AGE	14,833	26.780	9.097	0.548	43.370
FUND_FLOW_VOLATILITY	14,768	0.030	0.053	0.001	0.420

(continued on next page)

TABLE 2 (continued)

Summary Statistics

Panel B. Summary Statistics for the Fund-Issuer-Level Tests (Tables 6 and 8) and the Fund-Country-Level Tests, Monthly Frequency (Table 7)					
Panel B1. Fund-Issuer-Month Sample (Table 6)					
ln(VALUE+1)	1,012,680	1.076	1.963	0.000	7.759
ln(ABCP+1)	1,012,680	0.160	0.784	0.000	5.679
ln(VALUE_NONCOLLATERALIZED+1)	1,012,680	0.832	1.783	0.000	7.647
PD	1,012,680	0.010	0.028	0.000	2.387
INSTITUTIONAL	1,012,680	0.538	0.499	0.000	1.000
Panel B2. Fund-Country-Month Sample (Table 7)					
ln(VALUE+1)	259,780	1.672	2.618	0.000	9.106
INSTITUTIONAL	259,780	0.555	0.497	0.000	1.000
FOREIGN	251,400	0.967	0.180	0.000	1.000
EMERGING	251,400	0.267	0.442	0.000	1.000
Panel B3. Issuer-Month Sample (Table 8)					
ln(VALUE+1)	22,789	4.038	3.332	0.000	10.654
ln(ABCP+1)	22,789	0.664	2.028	0.000	8.613
ln(VALUE_NONCOLLATERALIZED+1)	22,789	3.440	3.296	0.000	10.488
ln(VALUE_RETAIL+1)	22,789	3.059	2.950	0.000	9.309
ln(VALUE_INSTITUTIONAL+1)	22,789	3.318	3.418	0.000	10.383
PD	22,789	0.014	0.113	0.000	3.476
Panel C. Summary Statistics for U.S. Issuers of Commercial Paper, Annual Frequency (Table 9)					
ln(COMMERCIAL_PAPER+1)	507	5.542	3.140	0.000	10.507
INST_DEPENDENCE	507	0.497	0.500	0.000	1.000
PD	452	0.000	0.002	0.000	0.038

A. Information Acquisition

First, we explore whether investors' efforts to collect information on nongovernment MMFs have changed following the reform. It is plausible that investors would want to collect more information if their investments in MMFs are no longer perceived to be completely safe because of the possibility of gates and fees and, in the case of institutional funds, because of the adoption of a floating NAV.

Following Gallagher et al. (2020), we measure the propensity to collect information using the number of viewings of MMFs' regulatory filings on the EDGAR website. We consider both summary prospectuses (497K filings) and disclosures of funds' security holdings (N-MFP filings). Summary prospectuses are updated at least once per year and are designed to provide investors with key fund information in a clear and concise (2- to 3-page) format; they contain information on, for example, funds' investment strategies, potential risks, and historical performance. During periods without heightened risks, such as the one we consider, investors may be most interested in the funds' strategies and their changes. For this reason, we view summary prospectuses as particularly important in our context. N-MFP filings provide monthly information on the funds' security holdings.

Figure 2 reports the TNA-weighted-average number of document views per fund by quarter. Graphs A1 and A2 show that both retail and institutional investors in prime MMFs started to collect more information following the reform. As is particularly evident in the case of the 497K filings, institutional investors in prime MMFs collect significantly more information after the reform compared with retail investors. Until mid-2014, the propensity to access these filings was relatively low for both institutional and retail prime MMFs. In the adjustment period, following

FIGURE 2

Information Acquisition by Institutional and Retail Investors of Prime MMFs

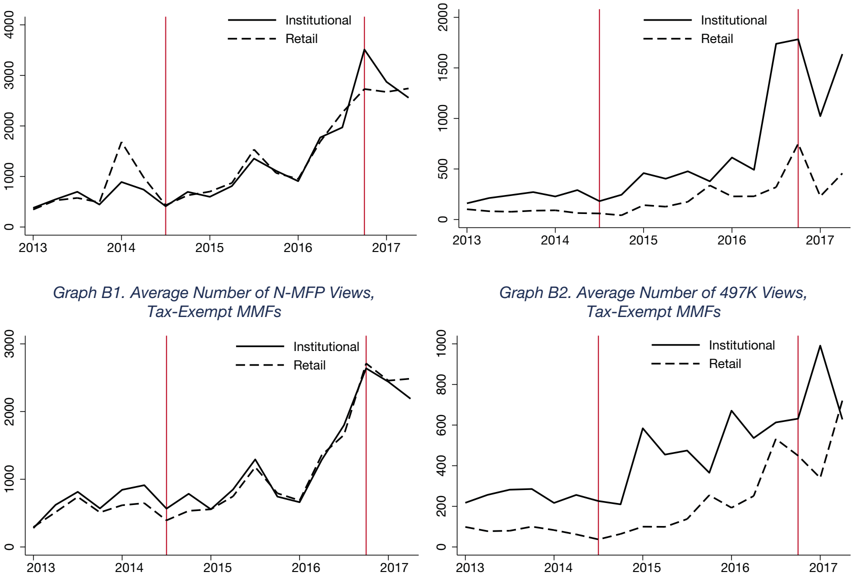
Figure 2 reports the average number of filing views by fund type and quarter in the U.S. Securities and Exchange Commission's (SEC) Electronic Data Gathering, Analysis, and Retrieval (EDGAR) website. In Graphs A1 and A2, we report views for institutional and retail prime money market funds (MMFs); we report views for institutional and retail tax-exempt MMFs in Graphs B1 and B2. We report the number of times investors view the following 2 filing types: N-MFP filings, which contain information on funds' security holdings, and fund-specific summary prospectus filings (form 497K). Because we use the EDGAR–CRSP linking file to obtain fund-specific EDGAR identifiers ("series IDs"), the sample consists of MMFs from the CRSP mutual fund database. We identify prime MMFs using the following Lipper Objective Codes: IMM and MM. For tax-exempt MMFs, we use the following Lipper Objective Codes: CAM, CTM, ITE, MAM, MIM, NJM, NYM, OHM, OTM, PAM, and TEM. The sample includes 176 prime funds and 106 tax-exempt funds. For the funds in the sample (identified by the EDGAR series ID), we collect all unique document IDs ("accession numbers") corresponding to the relevant filings from the EDGAR index pages (this step is necessary to map documents from the EDGAR website to a corresponding fund portfolio, i.e., series ID). From the daily EDGAR Server Log files, we consider only the successful (response code 200) nonindex page views, which are matched with the previously collected list of document IDs and corresponding fund series IDs. The EDGAR views are aggregated to the quarterly level for each fund. Finally, for each fund type and quarter, we plot the average number of filing views, where the average is weighed using a fund's total net assets (TNA). Our sample ends in June 2017 (EDGAR log files are, as of Feb. 2021, only available until that time). In the figure, the first vertical line indicates the passage of the reform in July 2014 (third quarter of 2014), whereas the second line indicates the implementation of the reform in Oct. 2016 (fourth quarter of 2016).

Graph A1. Average Number of N-MFP Views, Prime MMFs

Graph A2. Average Number of 497K Views, Prime MMFs

Graph B1. Average Number of N-MFP Views, Tax-Exempt MMFs

Graph B2. Average Number of 497K Views, Tax-Exempt MMFs



the announcement of the reform, the average number of viewings of the filings per fund-quarter increased dramatically. This is unsurprising because the industry was experiencing a profound reorganization. In many cases, investors in prime MMFs had to choose how to reallocate their portfolios between funds. It appears reasonable that investors would acquire information about other funds when choosing a new fund to invest in. However, although this can be expected to lead to a one-time spike in information acquisition during the period when most funds were closed or converted from prime to government, information collection on prime MMFs remains higher after the implementation of the reform, especially for institutional funds and 497K forms. This indicates that the propensity of investors in prime MMFs to collect information has increased permanently.

These findings are consistent with a change in the nature of prime MMFs' liabilities, which has led some investors to acquire more information and has

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attracted new investors who are more inclined to acquire information to prime MMFs. Can the observed increase in file viewings be explained by the requirement to separate retail and institutional funds? Some retail investors had entered institutional funds through brokerage accounts and had to switch to retail funds after the reform.[11] The loss of investors with a low propensity to acquire information cannot explain why the number of filing viewings per fund has increased. In addition, the mere separation of retail investors cannot necessarily explain why we also detect an increase in regulatory filings views for retail prime funds: The average sophistication and propensity to acquire information of these investors are unlikely to have varied much over time.

More importantly, in Graphs B1 and B2 of Figure 2, we consider investors' propensity to acquire information on tax-exempt funds. Because they invest in very safe and, consequently, low-yield securities, these funds presumably did not attract many sophisticated yield-chasing investors even in their institutional share classes. Hence, any increase in the investors' propensity to acquire information is unlikely to be a mechanical consequence of the segregation of institutional and retail investors. The increase in the average number of viewings for tax-exempt funds' prospectuses and N-MFP filings is therefore more likely to arise from the perceived change in the nature of their liabilities.

B. Flow–Performance Sensitivity

By increasing investors' incentives to track the funds' performance, the reform may have made the demand for MMFs' liabilities, measured by MMFs' flows, more sensitive to their performance.

To explore this, Figure 3 follows the approach of, among others, Chevalier and Ellison (1997), Chen, Goldstein, and Jiang (2010), and Franzoni and Giannetti (2019). It reports nonparametric estimates of the flow–performance sensitivity in retail and institutional prime funds, distinguishing between the period before the reform, the interim period between the announcement and the implementation of the reform, and the period following the implementation of the reform. We consider the funds' relative performance each period by employing their fractional rank (i.e., the fund's return percentile ranking relative to other funds during each week). A higher value of the fund's fractional rank implies relatively better performance. The figure plots the nonparametric function G(·) in the following semiparametric specification run at the fund level and weekly frequency:

$$\text{FUND\_FLOW}_{f,t} = \alpha + \beta \times G\left(\text{FRANK}_{f,t}\right) + X'_{f,t-1}\gamma + \varepsilon_{f,t}, \quad (1)$$

where f denotes a fund, and t denotes a week. FRANK denotes the fractional performance rank of the fund, with a higher rank indicating higher gross returns.[12]

[11] Gallagher et al. (2020) show that some retail investors had entered institutional prime funds through brokerage omnibus accounts and through 401k plans. After the reform, these investors (for which the end-investor had a Social Security number) had to be segregated into retail funds.

[12] We compute the funds' fractional rank (FRANK) using gross returns over the previous week, with separate performance ranks for institutional and retail funds. This is common practice in the literature (see, e.g., Kacperczyk and Schnabl (2013), Di Maggio and Kacperczyk (2017), and Schmidt et al. (2016)) because funds have institutional and retail share classes with different fees.

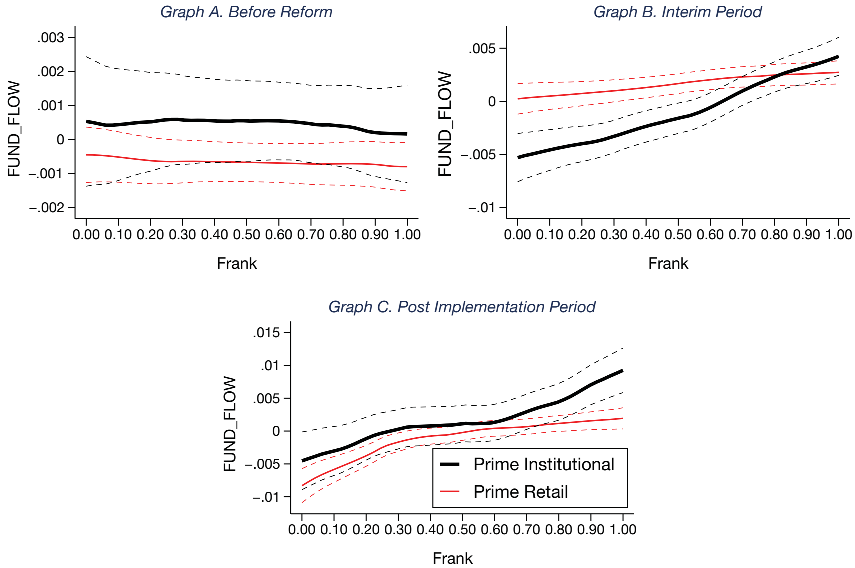
FIGURE 3

Flow–Performance Sensitivity

Figure 3 reports the sensitivity of flows to the performance of institutional and retail prime money market funds (MMFs). The figure plots the fitted values from a local polynomial smoother applied to fund flows, where the independent variable is the fund's fractional performance rank (FRANK) in a given week. The thick black line denotes institutional prime funds; the thin red (or gray) line is for retail prime funds. The figure plots the nonparametric function $G(\cdot)$ in the following semiparametric specification run at the fund level and at weekly frequency:

$$\text{FUND\_FLOW}_{f,t} = \alpha + \beta \times G(\text{FRANK}_{f,t}) + X_{f,t-1}{}'\gamma + \varepsilon_{f,t},$$

where f denotes the fund, and t denotes the week. X is a set of the following control variables (lagged by 1 week): ln(FUND_SIZE), ln(FAMILY_SIZE), EXPENSES, AGE, FUND_FLOW, FUND_FLOW_VOLATILITY, and fund and week fixed effects. The variables are defined in detail in Table 1. Standard errors are clustered by week. The estimation uses kernel-weighted local polynomial smoothing. We perform the analysis separately for prime institutional and prime retail MMFs. We report separate graphs for the pre-reform period (Jan. 1, 2013–July 23, 2014), the period between the passage and adoption of the reform (July 24, 2014–Oct. 13, 2016), and the postimplementation period (after Oct. 14, 2016). The dashed lines represent 95% confidence intervals. The smoother uses the Epanechnikov (1969) kernel with optimal bandwidth chosen with a rule-of-thumb estimator, as described by Fan and Gijbels (1996). The sample period is 2013–2018.



X is a set of the following control variables (lagged by 1 period): ln(FUND_SIZE), ln(FAMILY_SIZE), EXPENSES, AGE, FUND_FLOW, FUND_FLOW_VOLATILITY, and fund and week fixed effects. The estimation uses kernel-weighted local polynomial smoothing.

Figure 3 shows that before the announcement of the reform, the flow–performance sensitivity was rather low. This pattern changes after the announcement and implementation of the reform. Both retail and institutional prime funds experience an increase in flow–performance sensitivity, even though the change is more pronounced for institutional funds.

After the announcement of the changes affecting prime MMFs, investors had to rebalance their portfolios and started reevaluating their investment in MMFs. Arguably, this led them to pick the best-performing managers, thus increasing the flow–performance sensitivity. However, Figure 3 clearly shows that the increase is permanent and persists after the adjustment period, suggesting that investors in prime MMFs continue to collect more information on the funds' performance.

Are the changes we highlight after the reform at least partially driven by the change in the nature of the funds' liabilities? To shed light on this, in what follows, we consider the differential effects of the reform on the flow–performance sensitivity of retail and institutional prime funds. Because Figure 3 does not point to major differences between the period between the announcement and implementation of the reform and the postreform period, we do not distinguish between these 2 phases. Focusing on the differential effects observed in institutional and retail funds allows us to abstract from concurrent shocks affecting all prime funds. Furthermore, by considering different subsamples of funds, we can try to shed light on the mechanisms driving the changes.

We estimate the following regression model:

$$\text{FUND\_FLOW}_{f,t} = \alpha + \beta \times \text{POST}_t \times \text{INSTITUTIONAL}_{f,t-1} \times \text{FRANK}_{f,t} + X_{f,t-1}{}'\gamma + \varepsilon_{f,t}, \quad (2)$$

where f denotes the fund, and t denotes the week. FRANK denotes the fractional performance rank of the fund. The dummy variable POST is equal to 1 after July 2014, and 0 otherwise, and the dummy INSTITUTIONAL takes a value equal to 1 for institutional funds, and 0 otherwise. Finally, the matrix X includes the lower-order interaction terms as well as the following control variables (lagged by 1 period): ln(FUND_SIZE), ln(FAMILY_SIZE), EXPENSES, AGE, FUND_FLOW, and FUND_FLOW_VOLATILITY.

Because both institutional and retail funds are subject to the same shocks as a result of the reforms, we cluster standard errors at the time (week) level. We further absorb any correlation in funds' flows for the same fund or across funds over time by including fund and week fixed effects in all specifications.[13]

The coefficient on the triple-interaction term, β in equation (2), allows us to study cross-sectional differences between retail and institutional funds in the changes of the flow–performance relationship following the reform. Column 1 in Table 3 shows that the increase in the sensitivity of flows to performance is more pronounced for institutional prime MMFs. This is consistent with the observation that institutional prime MMFs have been more affected by the reform because of the imposition of a floating NAV. In terms of magnitudes, we find that the flow–performance sensitivity increases by almost 50% after the reform and that the increase in flow–performance sensitivity for institutional prime funds is more than twice as large as that for retail prime funds. The effects persist if we give a larger weight to funds with more TNA under management in the prereform year (column 2), indicating that our findings are not driven by a few small funds.

It is conceivable that only funds whose investors were already monitoring more before the reform and were therefore already more sensitive to performance survived. Alternatively, the flow–performance sensitivity may have increased even for the funds that remained active throughout the sample period. To shed light on this, in column 3 of Table 3, we reestimate the flow–performance relation in a

[13]The specifications of our empirical models follow Di Maggio and Kacperczyk (2017), who explore the effects of shocks to policy interest rates on MMFs. All results we present thereafter are robust when we use alternative specifications. Specifically, results are robust if we allow for correlation of the errors for the same fund over time and exclude time-varying controls (ln(FUND_SIZE) and FUND_FLOW) that are transformations of the lagged dependent variable.

TABLE 3

Flow–Performance Relationship

Table 3 reports coefficients from the following regressions:

$$\text{FUND\_FLOW}_{f,t} = \alpha + \beta \times \text{POST}_t \times \text{INSTITUTIONAL}_{f,t-1} \times \text{FRANK}_{f,t} + X_{f,t-1}{}'\gamma + \varepsilon_{f,t},$$

where f denotes the fund, and t denotes the week. FRANK is the fractional rank of the fund. The dummy variable POST is equal to 1 after July 23, 2014, and 0 otherwise; the dummy INSTITUTIONAL is equal to 1 for institutional funds, and 0 otherwise. The matrix X includes the lower-order interaction terms; the control variables (lagged by 1 period) ln(FUND_SIZE), ln(FAMILY_SIZE), EXPENSES, AGE, FUND_FLOW, and FUND_FLOW_VOLATILITY; and fund and week fixed effects (FE). All variables are defined in Table 1. The sample has a weekly frequency and covers the period Jan. 2013–Dec. 2018. In column 2, observations are weighed using the average weekly total net assets (TNA) for each fund in the pre-reform year (2013). In column 3, we exclude any money market funds (MMFs) that exited the sample before Dec. 2018. The sample in column 4 consists of funds that have, throughout the sample period, either no institutional share classes (i.e., are "pure" retail funds) or only institutional share classes (i.e., are "pure" institutional funds). In column 5, we consider a subsample of prime MMFs with low asset volatility during the period between the announcement and implementation of the reform. Specifically, we calculate a fund's asset volatility in the interim period using weekly data on TNA; we then select funds for which the interim-period asset volatility is in the lowest tercile. Finally, in column 6, we consider tax-exempt MMFs. Heteroscedasticity-robust standard errors, clustered by week, are reported below coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: FUND_FLOW					
Sample:	Whole Sample	TNA-Weighted	Balanced Panel	Pure Institutional/ Retail	Low Asset Volatility	Tax-Exempt MMFs
	1	2	3	4	5	6
POST × FRANK × INSTITUTIONAL	0.006**	0.008**	0.012**	0.011***	0.017***	0.008**
	(0.003)	(0.004)	(0.005)	(0.004)	(0.006)	(0.003)
FRANK	0.013***	0.030***	0.012***	0.015***	−0.003	0.006***
	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.002)
POST × FRANK	0.005***	0.003*	0.008***	0.002	0.002	−0.000
	(0.002)	(0.002)	(0.003)	(0.002)	(0.002)	(0.002)
INSTITUTIONAL	−0.003	0.008*	0.000		0.000	−0.006***
	(0.003)	(0.004)	(0.003)		(0.005)	(0.002)
POST × INSTITUTIONAL	−0.006***	−0.008***	−0.013***	−0.010***	−0.008**	−0.003
	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.002)
FRANK × INSTITUTIONAL	0.008**	−0.007	0.003	0.007	0.003	0.004
	(0.004)	(0.005)	(0.005)	(0.006)	(0.007)	(0.003)
ln(FAMILY_SIZE)	−0.006**	−0.014***	−0.005*	−0.001	−0.003	0.002
	(0.002)	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)
ln(FUND_SIZE)	−0.004***	−0.003*	−0.004***	−0.005***	−0.009***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.001)
EXPENSES	−0.009**	−0.011**	−0.017***	−0.012**	0.018**	−0.018***
	(0.005)	(0.006)	(0.004)	(0.006)	(0.009)	(0.004)
AGE	0.001	0.001***	0.001	0.001	−0.000	0.000
	(0.001)	(0.000)	(0.001)	(0.001)	(0.000)	(0.001)
FUND_FLOW	−0.045**	0.020	−0.027	−0.044**	−0.131***	−0.049***
	(0.019)	(0.034)	(0.026)	(0.020)	(0.025)	(0.016)
FUND_FLOW_VOLATILITY	−0.043***	−0.034	−0.012	−0.035**	−0.041**	−0.096***
	(0.015)	(0.031)	(0.020)	(0.017)	(0.020)	(0.015)
Fund and week FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	36,589	34,971	16,377	25,738	12,051	39,431
Adj. R^2	0.069	0.186	0.098	0.065	0.044	0.076

balanced panel, excluding any MMFs that exited during the sample period (2013–2018) and, in particular, following the reform. The positive and significant coefficient on the interaction term POST × FRANK × INSTITUTIONAL corroborates our earlier interpretation of the empirical evidence that the flow–performance sensitivity has increased for the surviving funds, in particular for institutional funds, and is not driven by selection effects alone.

The rest of Table 3 estimates equation (2) on different subsamples, with the aim of understanding the mechanisms through which the reform produced a relative increase in the flow–performance sensitivity in institutional prime MMFs. In particular, we explore whether this relative increase is driven by the fact that the reform segregated the less performance-chasing retail investors in separate funds. If this were the case, we should observe that our results are weaker when we restrict the sample to MMFs that, during the entire 2013–2018 sample period, have either only institutional share classes or only retail share classes. The reason is that the change in flow–performance sensitivity in these funds cannot reflect the loss of the less performance-chasing retail investors.

The estimates in column 4 of Table 3 show that "pure" institutional prime funds experience a relative increase in flow–performance sensitivity after the reform that is at least as large as in our baseline estimates (column 1). This finding supports our conjecture that the most salient economic effects of the reform are due to a change in the nature of prime MMFs' liabilities rather than due to changes in the funds' clienteles driven by the separation of institutional and retail share classes. Further, this specification shows that the switch from constant to floating NAV is driving the relative changes and that our broad conclusions do not depend on the definition of the institutional (retail) funds we use.

Other tests also support the conclusion that changes in funds' clienteles are not the primary drivers of the observed changes in flow–performance sensitivity. First, in column 5 of Table 3, we identify funds for which the reforms are unlikely to have triggered substantial changes in clientele by focusing on funds with more stable assets during the period between the announcement and implementation of the reform.[14] That is, we assume that investor turnover will be smallest within the subsample of funds with low asset volatility during the period between the announcement and the implementation of the reform. In column 5, our estimates appear to be qualitatively and quantitatively invariant in this subsample, suggesting that the relative change in flow–performance sensitivity we observe is not merely driven by a change in investor clienteles.

Such a conclusion is also supported in column 6 of Table 3, in which we consider tax-exempt funds. Consistent with our prior evidence, the estimates show that institutional tax-exempt funds experience an increase in flow–performance sensitivity relative to their retail counterparts. Given that they can invest only in very safe securities, these funds tend to attract more homogeneous and less performance-chasing investors. Consequently, in this subsample, the relative increase in flow–performance sensitivity is less likely to derive from a change in investor clienteles and more likely to derive from a change in investor behavior.

To the extent that our results are unlikely to be driven by a change in investor clienteles mandated by the segregation of institutional and retail investors, our findings support the hypothesis that the reform caused changes in the nature of the affected funds' liabilities. In particular, institutional prime (as well as tax-exempt) MMFs are likely to have been more affected because of the passage from stable to floating NAV.

Importantly, the increase in the sensitivity of flows to performance may have affected MMFs' incentives. Fund managers' incentives to provide high returns to investors depend on the structure of managerial compensation. Because the latter is ultimately determined by fees, which are charged as a percentage of assets, an

[14]To capture funds for which changes in investor composition are likely to be low, we proceed as follows: First, we calculate a fund's asset volatility in the interim period using weekly data on TNA. We then select funds for which the interim-period asset volatility is in the lowest tertile of the sample.

increase in the sensitivity of flows to performance strengthens competition between funds and efforts to produce high returns for investors (Chevalier and Ellison (1997), Sirri and Tufano (1998)). Given the limited set of securities in which MMFs are able to invest, high returns can only be achieved by taking more risk. Thus, the changes in the structure of liabilities we documented so far may have increased prime MMFs' incentives to take risk. In what follows, we design tests to investigate this conjecture.

V. Changes in Asset Composition

We explore whether the reform has changed the portfolio risk and asset holdings of the affected funds. We present 3 types of tests. First, we show how the reform has affected retail and institutional funds separately to shed light on absolute changes in risk taking. Second, to rule out that the changes in risk taking are driven by contemporaneous shocks, we explore the differential effects of the reform on institutional and retail funds' portfolios using difference-in-differences regressions. Finally, we exploit security-level data and compare different funds' security holdings of the same issuer at a given point in time to hold constant the issuer's demand for funding.

A. Funds' Portfolios

Figure 4 provides evidence on how the investment strategies of the average prime MMF changed following the announcement and implementation of the reform. To do so, we display time-series variation in institutional and retail funds' gross returns. As a benchmark, we also plot the gross returns of bond funds specializing in very short-term securities. These funds have an investment mandate and, consequently, an investment opportunity set similar to those of prime MMFs but were not affected by the reform.[15] We average the gross returns for all 3 fund types by month (weighing observations by the fund's TNA) and normalize the monthly averages to 1 at the beginning of the sample period (Jan. 2013). It is apparent that the gross returns of institutional and retail prime MMFs and short-term bond funds evolve very similarly before the reform announcement. After the announcement of the reform, the strategies of prime MMFs start to diverge. Compared with short-term bond returns, prime MMFs' returns increase and rise steeply after the reform is implemented and the assets under management of prime MMFs stabilize. Importantly, we do not observe similar changes for very short-maturity bond funds, whose gross yields do not change significantly. This suggests that the reform may have led to an increase in risk taking for prime MMFs. Consistent with our earlier findings, the effects are more pronounced for institutional prime MMFs.

To abstract from shocks affecting the returns of the short-term assets held by prime MMFs and the issuance of different securities, our main tests identify the effects of the reform by examining differences between institutional and retail prime MMFs. This enables us to control for any changes in the macro-environment and the investment opportunities available to all prime MMFs, which could have changed concurrently with the reform.

[15]We transform the monthly net returns reported in CRSP (MRET) for each fund into annualized gross returns in percent as follows: $R = 100 \times \left(\left(1 + \text{MRET}/\left(1 - \frac{\text{EXP\_RATIO}}{12}\right)\right)^{12} - 1 \right)$, where EXP_RATIO is the fund's expense ratio as of the most recently completed fiscal year.

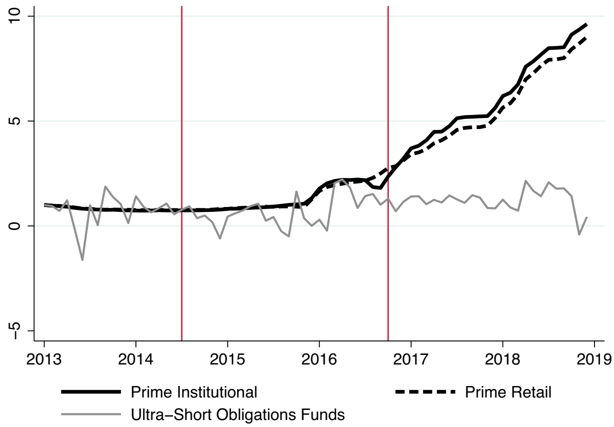
FIGURE 4

Returns of Prime MMFs and Short-Term Bond Funds

Figure 4 reports time-series variation in institutional and retail money market fund (MMF) returns. As a benchmark, we also plot the returns of bond funds specializing in very short-term securities (Lipper Objective Code USO). For MMFs, we use the annualized weekly gross yield in percent from iMoneyNet, calculated as net yield (variable 7-DSY) plus expense ratio (variable CHARGED EXPENSE RATIO). For the short-term bond funds, we use monthly net returns from CRSP (variable MRET). We transform the monthly net returns from CRSP for each fund into annualized gross returns in percent as follows:

$$R = 100 \times \left(\left(1 + \text{MRET} / \left(1 - \frac{\text{EXP\_RATIO}}{12} \right) \right)^{12} - 1 \right),$$

where EXP_RATIO is the fund's expense ratio as of the most recently completed fiscal year (from CRSP). We average the gross returns for all 3 fund types by month (weighing observations by the fund's total net assets (TNA)) and normalize the monthly averages to 1 at the beginning of the sample period (Jan. 2013). The first vertical line indicates the passage of the reform in July 2014, and the second vertical line indicates the implementation of the reform in Oct. 2016.



The regulatory changes, except for the adoption of the floating NAV for institutional prime MMFs, affected all prime MMFs. Our findings in Section IV suggest that the main drivers of the increase in information acquisition and flow–performance sensitivity are the change in the nature of MMFs' liabilities. Therefore, a difference-in-differences test with retail prime MMFs as the control group allows us to investigate the effect of the adoption of floating NAVs by institutional prime MMFs on risk taking. We also perform a number of robustness checks to mitigate concerns that changes in funds' clienteles, and the separation of institutional and retail classes in particular, may be driving our findings.

We estimate the following difference-in-differences regression model:

$$\text{(3)} \quad \text{FUND\_RISK}_{f,t} = \alpha + \beta \times \text{POST}_t \times \text{INSTITUTIONAL}_{f,t-1} + X_{f,t-1}{}'\delta + \varepsilon_{f,t}$$

where f denotes the fund and t the week. FUND_RISK is one of the following measures of fund risk taking: SPREAD, SAFE_HOLDINGS, HOLDING_RISK, and LIQUID_SHARE. The matrix X includes the following set of control variables: ln(FUND_SIZE), ln(FAMILY_SIZE), EXPENSES, AGE, FUND_FLOW, and FUND_FLOW_VOLATILITY. X also includes fund fixed effects and week fixed effects, which control for changes in the aggregate demand for funding by issuers and other macroeconomic shocks. All time-varying controls are lagged by 1 period.

As in our earlier tests, because both institutional and retail funds are subject to the same shocks due to the reforms, we cluster standard errors at the time level. Fund

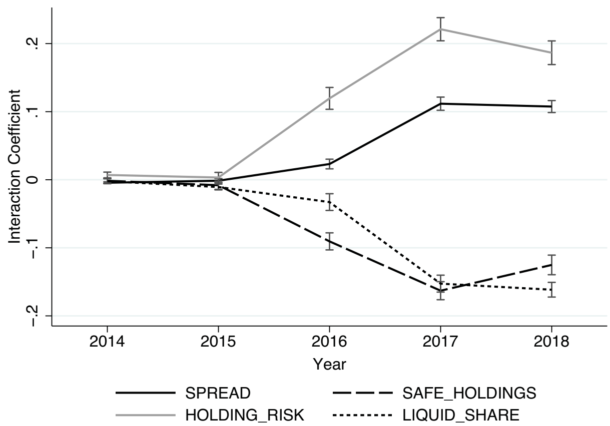
FIGURE 5

Prime MMF Risk Taking Before and After the Reform: Institutional Versus Retail Funds

Figure 5 depicts the difference between portfolio risk-taking measures of institutional and retail prime money market funds (MMFs) over the period 2013–2018. Specifically, we run the following regression model:

$$\text{FUND\_RISK}_{f,t} = \text{INSTITUTIONAL}_{f,t-1} \times Y_t{}'\beta + X_{f,t-1}{}'\delta + \varepsilon_{f,t},$$

where f denotes the fund, and t denotes the week. FUND_RISK denotes one of the following measures of fund risk: SPREAD, SAFE_HOLDINGS, HOLDING_RISK, and LIQUID_SHARE. The matrix X includes the following (lagged) control variables (as in Tables 4 and 5): INSTITUTIONAL, ln(FUND_SIZE), ln(FAMILY_SIZE), EXPENSES, AGE, FUND_FLOW, and FUND_FLOW_VOLATILITY. X also includes fund and week fixed effects. Y includes the set of year dummies from 2014 to 2018. The variables are defined in detail in Table 1. The figure plots the coefficients on the interaction terms between INSTITUTIONAL and the respective year dummies, as well as 95% confidence intervals based on standard errors that are clustered by week. The interaction between the 2013 year dummy and INSTITUTIONAL is omitted from the regression model and thus serves as a reference point.



and week fixed effects further absorb any within-fund correlation in risk taking and correlation in risk taking across funds over time.

Critical to our difference-in-differences methodology is the assumption of a common trend between retail and institutional prime funds in the pre-period. Indeed, as shown in Figure 5, differences in the portfolio spreads and other measures of risk taking between institutional and retail prime MMFs before the reform were economically small; these differences were also largely statistically insignificant. This suggests that these funds had similar strategies and propensities to take risk before the reform. Differences in risk taking emerge only after the reform announcement, when, according to all our proxies, institutional prime MMFs, which had to adopt a floating NAV, appear to start taking more risk.

Table 4 reports coefficients from the difference-in-differences regressions. Column 1 shows that the spread of the securities in MMFs' portfolios has increased after the reform to a larger extent for prime MMFs marketed to institutional investors. Column 2 shows that the differential increase is not merely driven by the period between the announcement and implementation of the reform, but it persists until after the reform is implemented. Furthermore, the differences are, if anything, larger after the implementation of the reform. In terms of magnitudes, after the implementation of the reform, institutional prime MMFs' spreads have increased by nearly 10 basis points compared to the period prior to the passage of the regulation and relative to the benchmark group of retail prime funds.

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TABLE 4

Heterogeneity in Risk Taking After the Change in Regulation

Table 4 reports coefficients from the following regressions:

$$\text{FUND\_RISK}_{f,t} = \alpha + \beta \times \text{POST}_t \times \text{INSTITUTIONAL}_{f,t-1} + X_{f,t-1}{}'\delta + \varepsilon_{f,t}.$$

In this equation, f denotes the fund, and t denotes the week. FUND_RISK denotes one of the following measures of fund risk: SPREAD, SAFE_HOLDINGS, HOLDING_RISK, and LIQUID_SHARE. The matrix X includes the same control variables as in Table 3. All variables are defined in Table 1. In column 3, we exclude observations from the year 2016. The sample has a weekly frequency and covers the period from Jan. 2013 until Dec. 2018. Heteroscedasticity-robust standard errors, clustered by week, are reported below coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable					
	SPREAD	SPREAD	SPREAD	SAFE_HOLDINGS	HOLDING_RISK	LIQUID_SHARE
	1	2	3	4	5	6
POST × INSTITUTIONAL	0.009***			−0.026***	0.030***	−0.020***
	(0.001)			(0.003)	(0.004)	(0.002)
POST_2014 × INSTITUTIONAL		0.004***	−0.001			
		(0.001)	(0.001)			
POST_2016 × INSTITUTIONAL		0.088***	0.086***			
		(0.005)	(0.004)			
INSTITUTIONAL	−0.002	−0.038***	−0.029***	0.003	−0.015**	0.009***
	(0.002)	(0.003)	(0.002)	(0.005)	(0.006)	(0.003)
ln(FAMILY_SIZE)	0.003	0.000	−0.003	−0.043***	0.054***	−0.028***
	(0.002)	(0.002)	(0.002)	(0.005)	(0.007)	(0.006)
ln(FUND_SIZE)	0.017***	0.022***	0.021***	−0.031***	0.049***	−0.026***
	(0.002)	(0.001)	(0.002)	(0.002)	(0.003)	(0.002)
EXPENSES	0.066***	0.144***	0.135***	0.051***	0.016	−0.090***
	(0.009)	(0.011)	(0.009)	(0.010)	(0.013)	(0.012)
AGE	−0.002***	−0.001***	−0.002***	0.006***	−0.015***	0.002***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
FUND_FLOW	0.049***	0.040***	0.006	−0.040**	0.064**	−0.087***
	(0.010)	(0.010)	(0.007)	(0.017)	(0.025)	(0.027)
FUND_FLOW_VOLATILITY	−0.138***	−0.145***	−0.127***	0.351***	−0.505***	0.337***
	(0.012)	(0.012)	(0.014)	(0.029)	(0.036)	(0.021)
Fund and week fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	36,589	36,589	31,709	36,593	36,593	36,168
Adj. R^2	0.845	0.854	0.888	0.750	0.768	0.705

This suggests that the increase in risk taking is not merely driven by the funds' desire to attract and maintain customers during the period in which the industry was transitioning to the new equilibrium. We also observe more risk taking after the implementation of the reform in column 3, in which we drop any observations from the year 2016. This specification confirms that the results are not merely driven by the period surrounding the implementation of the reform, when competition for flows should have been particularly fierce.

In columns 4–6, we employ alternative measures of portfolio risk, which directly reflect changes in portfolio composition: SAFE_HOLDINGS, HOLDING_RISK, and LIQUID_SHARE. We find that after the reform, prime MMFs marketed to institutional investors have actively tilted the composition of their portfolios toward riskier securities to a larger extent than those marketed to retail investors. To be specific, institutional prime MMFs have decreased the proportion of safe holdings, defined as the percentage of the fund portfolio invested in Treasury/agency debt and repos, to a larger extent than retail prime MMFs (column 4). At the same time, institutional prime MMFs appear to have increased their portfolios' holding risk—that is, the proportion of (riskier) bank obligations relative to (safer) repos and Treasury bills—more than retail prime MMFs (column 5). Institutional prime MMFs have also decreased the proportion of securities in their portfolios that matures within 7 days to a larger extent than retail MMFs (column 6). Overall, these findings suggest that institutional prime MMFs have become relatively riskier than their retail counterparts.

Table 5 considers a number of robustness tests that allow us to better interpret the drivers of the results in Table 4. Column 1 of Panel A shows that institutional

TABLE 5

Heterogeneity in Risk Taking After the Change in Regulation (Robustness)

Panel A of Table 5 reports coefficients from the following regression:

$$\text{SPREAD}_{f,t} = \alpha + \beta \times \text{POST}_t \times \text{INSTITUTIONAL}_{\ f,t-1} + X'_{f,t-1}\delta + \varepsilon_{f,t}.$$

In this equation, f denotes the fund, and t denotes the week. The matrix X includes the same control variables as in Table 4. All variables are defined in Table 1. In column 1, observations are weighed using the average weekly total net assets (TNA) for each fund in the pre-reform year (2013). In column 2, we exclude any money market funds (MMFs) that exit the sample before Dec. 2018. The sample in column 3 consists of funds that have, throughout the sample period, either no institutional share classes (i.e., are “pure” retail funds) or only institutional share classes (i.e., are “pure” institutional funds). In column 4, we consider a subsample of prime MMFs with low asset volatility during the period between the announcement and implementation of the reform. Specifically, we calculate a fund’s asset volatility in the interim period using weekly data on TNA. We then select funds for which the interim-period asset volatility is in the lowest tercile of the sample. Finally, in column 5, we consider tax-exempt MMFs that have, throughout the sample period, either no institutional share classes or only institutional share classes.

Panel B reports coefficients from the following regression:

$$\text{SPREAD}_{f,t} = \alpha + \beta \times \text{POST}_t \times \text{PRIME}_{f,t-1} + X_{f,t-1}{}'\delta + \varepsilon_{f,t},$$

where f denotes the fund, and t denotes the week. The sample includes both prime and government MMFs. PRIME equals 1 for observations for prime funds, and 0 for government funds. The matrix X includes the same control variables as in Table 4. All variables are defined in Table 1. Column 1 in Panel B includes only retail funds, whereas column 2 focuses on institutional funds. The sample in column 3 consists of funds that, throughout the sample period, have only institutional share classes (i.e., “pure” institutional funds). The sample in column 4 includes only institutional funds that, throughout the sample period, are either prime or government funds (but do not change from one to the other). The sample has a weekly frequency and covers the period from Jan. 2013 until Dec. 2018. Heteroscedasticity-robust standard errors, clustered by week, are reported below coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

Panel A. Risk Taking in Prime (Columns 1–4) and Tax-Exempt Funds (Column 5)

	Dependent Variable: SPREAD				
Sample:	TNA Weighted	Balanced Panel	Pure Institutional/ Retail	Low Asset Volatility	Tax-Exempt MMFs
	1	2	3	4	5
POST × INSTITUTIONAL	0.018***	0.004**	0.011***	0.007***	0.003**
	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
INSTITUTIONAL	−0.049***	−0.001		−0.015***	
	(0.006)	(0.002)		(0.005)	
ln(FAMILY_SIZE)	0.042***	0.004*	0.017***	−0.006***	0.015***
	(0.005)	(0.002)	(0.003)	(0.002)	(0.004)
ln(FUND_SIZE)	0.012***	0.006***	0.013***	−0.009***	−0.003***
	(0.003)	(0.001)	(0.002)	(0.002)	(0.001)
EXPENSES	0.028	0.055***	0.077***	0.286***	0.064***
	(0.022)	(0.008)	(0.010)	(0.015)	(0.008)
AGE	−0.001**	−0.002***	−0.002***	0.001***	0.003***
	(0.001)	(0.000)	(0.000)	(0.000)	(0.001)
FUND_FLOW	0.163***	0.083***	0.049***	0.003	0.012
	(0.028)	(0.019)	(0.012)	(0.009)	(0.011)
FUND_FLOW_VOLATILITY	−0.199***	−0.085***	−0.094***	0.009	−0.084***
	(0.044)	(0.018)	(0.011)	(0.011)	(0.018)
Fund and week fixed effects	Yes	Yes	Yes	Yes	Yes
No. of obs.	34,971	16,377	25,738	12,051	22,547
Adj. R^2	0.836	0.837	0.851	0.889	0.971

(continued on next page)

TABLE 5 (continued)

Heterogeneity in Risk Taking After the Change in Regulation (Robustness)

Panel B. Prime vs. Government MMFs

	Dependent Variable: SPREAD			
Sample:	Retail Only	Institutional Only	Pure Institutional	Institutional; Pure Prime/ Government
	1	2	3	4
POST × PRIME	0.048***	0.037***	0.045***	0.040***
	(0.003)	(0.002)	(0.003)	(0.003)
PRIME	0.091***	0.102***	0.117***	
	(0.002)	(0.002)	(0.002)	
ln(FAMILY_SIZE)	−0.001	0.021***	0.016***	0.016***
	(0.001)	(0.002)	(0.002)	(0.002)
ln(FUND_SIZE)	−0.008***	−0.012***	−0.008***	−0.012***
	(0.001)	(0.001)	(0.001)	(0.001)
EXPENSES	0.078***	−0.020***	−0.050***	−0.065***
	(0.010)	(0.006)	(0.010)	(0.007)
AGE	0.004***	−0.002***	−0.003***	−0.004***
	(0.001)	(0.000)	(0.000)	(0.000)
FUND_FLOW	0.050***	0.027***	0.031***	0.027***
	(0.009)	(0.005)	(0.006)	(0.005)
FUND_FLOW_VOLATILITY	−0.058***	−0.052***	−0.049***	−0.050***
	(0.012)	(0.006)	(0.007)	(0.007)
Fund and week fixed effects	Yes	Yes	Yes	Yes
No. of obs.	31,020	51,603	28,059	43,511
Adj. R^2	0.882	0.882	0.874	0.892

prime MMFs appear to take more risk than retail prime MMFs also when we weigh observations by the fund's TNA.[16] This indicates that the results are not driven by a few smaller funds taking relatively more risk and suggests that the reform may have systemic risk consequences.

Column 2 of Panel A in Table 5 shows that the results are not driven by the exit of safer MMFs: the estimates indicate an increase in risk taking following the implementation of the reform when we restrict the sample to funds that are active during the whole sample period.

Also, the findings are not merely driven by the funds whose clienteles changed to a larger extent because of the reform. First, in column 3 of Panel A in Table 5, we limit the sample to funds that have, throughout the whole sample period, either no institutional share classes or only institutional share classes. Considering this sample of "pure" institutional and "pure" retail funds leaves our estimates unaffected. This indicates that the relative increase in risk taking of institutional prime MMFs is not driven by the separation of retail and institutional share classes and the mechanical change in funds' clienteles that this implied. This result also shows that the definition of what constitutes an institutional fund does not affect our estimates.

Second, in column 4 of Panel A in Table 5, we also find a relative increase in risk taking for institutional prime MMFs when we consider funds that have low asset volatility during the period between the reform announcement and implementation, suggesting modest changes in investor clienteles. This implies that the

[16]As in the flow–performance sensitivity tests reported in Table 3, we weigh observations by the average weekly TNA in the pre-reform year 2013.

institutional prime MMFs do not change their strategy merely to please new clienteles that are more inclined to chase high yields. Presumably, the change in the nature of liabilities and the adoption of floating NAV also affected the expectations of existing clients.

In column 5 of Panel A in Table 5, we find a relative increase in risk taking also for institutional tax-exempt funds compared to their retail counterparts. These funds, given their investment opportunity set of municipal debt, invest in relatively low-risk securities and attract fewer performance-chasing investors. Therefore, they are less likely to have experienced a significant change in clienteles because of the reform.

Finally, to mitigate concerns that our results depend on the control sample of retail MMFs, in Panel B of Table 5, we consider how prime MMFs' risk taking changes in comparison to government MMFs following the reform. Column 1 in Panel B compares the gross spread of retail prime funds and retail government funds. The coefficient of interest, the interaction between PRIME and POST, is positive and statistically significant, suggesting that retail prime funds increase risk taking following the reform, compared with retail government funds. Column 2 in Panel B focuses on institutional funds. The estimates imply an increase in risk taking in institutional prime funds after the reform, relative to the comparison group of institutional government funds. Column 3 further corroborates this finding in a sample of funds that, throughout the sample period, only have institutional share classes ("pure" institutional funds). Finally, because a number of prime funds converted into government funds during the sample period, in column 4, we consider a sample of prime institutional and government institutional funds that did not change fund type. That is, the funds in this sample were, throughout the sample period, either prime or government funds.[17] Consistent with our prior estimates, we observe an increase in prime institutional fund risk taking after the 2014 reform. Overall, the results in Panel B of Table 5 are consistent with our previous findings, indicating that our conclusions do not depend on the control sample we use and that we are not just capturing a general increase in investors' risk appetite following the 2014 reform.

Taken together, these results suggest that prime MMFs changed their investment strategies because investors started to view their liabilities differently. It appears that a change in financial intermediaries' liabilities imposed by regulators affects those intermediaries' asset composition. In particular, higher information and performance sensitivity of the intermediaries' claims appears to lead to more risk taking.

B. Issuer-Level Evidence on the Supply of Short-Term Funding by Prime MMFs

To study the relative increase in risk taking by institutional prime MMFs after the 2014 reform in more detail, we consider the propensity of different funds to hold securities of issuers with different default risk. In particular, we compute the value

[17]Note that in contrast to the sample in column 3, the institutional funds used in the regression of column 4 may have had some retail share classes, in addition to institutional ones, prior to the reform; that is, the funds in the sample of column 4 are not "pure institutional" funds.

of the securities of issuer i held by fund f in month t by adding up the nominal value of the different securities issued by i, held by fund f in month t, as reported in the funds' N-MFP forms. We then estimate the following regression:

$$\text{(4)} \qquad \ln(\text{VALUE}+1)_{f,i,t} = \alpha \times \text{POST}_t \times \text{PD}_{i,t} \times \text{INSTITUTIONAL}_{f,t} + \Xi_{f,i,t} + \varepsilon_{f,i,t},$$

where i denotes the issuer, f the fund, and t the month. ln(VALUE+1) is the natural logarithm of (1 plus) the total value of securities issued by a given firm that are held by a given prime MMF.[18] PD is the 1-month default probability of the issuer. The matrix Ξ includes the lower-order interaction terms, as well as fund fixed effects and interactions of issuer and month fixed effects. The observations are at the fund-issuer-month level. Observations for a given borrower enter the sample, eventually with a zero (i.e., ln(1)), if the issuer reports a positive amount of outstanding securities with a fund any time during the sample period.[19] Put differently, we consider all issuers that are financed by an MMF at any point in our sample and generate a balanced panel within each fund-issuer combination, assigning ln(VALUE+1) = ln(1) when an issuer has no securities outstanding to a given fund at a given point in time. As in our other tests, we cluster standard errors at the time level, to take into account that shocks triggered by the reform may lead to correlation in portfolio holdings across funds at a given point in time.

Crucially, including interactions of issuer and time effects allows us to compare funding provided by different funds to the same issuer at a given point in time and to identify supply as Chernenko and Sunderam (2014) do in a similar context (see Khwaja and Mian (2008) for the first application of this methodology in banking). Specifically, evidence that certain funds provide systematically different amounts of funding to borrowers with different risk can be interpreted as a different propensity to supply funding to those issuers because the interactions of issuer and time fixed effects absorb differences in demand.

Column 1 of Table 6 shows that the funding provided by institutional prime MMFs to a given borrower has decreased relative to the funding provided by the less affected retail prime MMFs after the reform implementation. Column 2 shows that the differences between institutional and retail funds are less pronounced for riskier borrowers, as indicated by a positive and significant coefficient on the triple-interaction term POST × INSTITUTIONAL × PD. Consistent with our earlier findings on institutional prime MMFs' higher propensity to take risk after the reform, the positive coefficient on the interaction term indicates a higher willingness of institutional prime MMFs to provide funding to relatively riskier borrowers. The effect is not only statistically but also economically significant: a 1-standard-deviation increase in the probability of default is associated with a 2 percent increase in the liabilities outstanding toward institutional funds after the implementation of the reform.[20]

[18] In particular, before taking the logarithm, we add one to the value of the securities that fund f holds in issuer i at time t to take into account periods in which borrowers have no outstanding securities with a given fund.

[19] To determine prior issuance by borrowers and active security holdings of funds, we consider information starting in 2011. The actual sample for the regressions starts in 2013, as in all of our tests.

[20] The economic effect is obtained as follows: $0.028 \times 0.735 = 2.06\%$.

TABLE 6

Availability of Funding from U.S. Money Market Funds and Issuer Default Risk

Table 6 reports coefficients from the following regression:

$$\ln(\text{VALUE}+1)_{f,i,t} = \alpha \times \text{POST}_t \times \text{PD}_{i,t} \times \text{INSTITUTIONAL}_{f,t} + \boldsymbol{\Xi}_{f,i,t} + \varepsilon_{f,i,t},$$

where *i* denotes the issuer, *f* denotes the fund, and *t* denotes the month; PD is the 1-month default probability of the issuer. The matrix $\boldsymbol{\Xi}$ includes the lower-order interaction terms, as well as fund fixed effects (FE) and interactions of issuer and month FE. Note that the coefficients on PD and POST × PD are subsumed by the issuer-month FE. The dependent variable is indicated in the column headings. The variables are defined in detail in Table 1. The observations are at the fund-issuer-month level. The sample covers the period from Jan. 2013 until Dec. 2018. Heteroscedasticity-robust standard errors, clustered by month, are reported below coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable					
	ln(VALUE+1)		ln(VALUE_NONCOLLATERALIZED+1)		ln(ABCP+1)	
	1	2	3	4	5	6
POST × INSTITUTIONAL	−0.147***	−0.153***	−0.096***	−0.100***	−0.016***	−0.015***
	(0.027)	(0.025)	(0.022)	(0.021)	(0.005)	(0.004)
INSTITUTIONAL	−0.212***	−0.216***	−0.128***	−0.136***	−0.046***	−0.047***
	(0.031)	(0.031)	(0.024)	(0.024)	(0.006)	(0.006)
POST × INSTITUTIONAL × PD		0.735*		0.711*		−0.122
		(0.380)		(0.405)		(0.112)
INSTITUTIONAL × PD		0.379		0.715**		0.092*
		(0.282)		(0.354)		(0.055)
Fund FE	Yes	Yes	Yes	Yes	Yes	Yes
Issuer-month FE	Yes	Yes	Yes	Yes	Yes	Yes
No. of obs.	1,012,680	1,012,680	1,012,680	1,012,680	1,012,680	1,012,680
Adj. R^2	0.372	0.372	0.371	0.371	0.294	0.294

Even borrowers with relatively high probability of default may issue safe securities if these are asset backed. In this case, the issuer's probability of default would overstate the riskiness of the securities. To evaluate whether such a bias may be affecting our results, in columns 3 and 4, we reestimate the specifications in columns 1 and 2 excluding any asset-backed securities (asset-backed commercial paper and repos) from the computation of issuer *i*'s securities value held by fund *f* in month *t*. We confirm the earlier result that institutional funds extend less funding to issuers after the reform compared to retail funds by focusing on non–asset-backed securities. Consistent with our conjecture that the issuer's probability of default is a good proxy for the riskiness of an issuer's outstanding securities, the coefficient on the triple-interaction term POST × INSTITUTIONAL × PD is positive and statistically significant. Taken together, the specifications estimated in columns 3 and 4 suggest that institutional prime funds reduce their investment after the reform more than retail prime funds. More importantly, consistent with the effects documented in Tables 4 and 5, institutional prime funds appear to have a greater appetite for non-collateralized debt from riskier borrowers.

In columns 5 and 6, we consider only asset-backed securities. Following the reform, institutional prime MMFs supply less funding also to issuers of asset-backed securities compared to retail funds (column 5). In column 6, the coefficient on the triple-interaction term POST × INSTITUTIONAL × PD is not statistically significant, consistent with the expectation that the probability of default of the issuer overestimates the risk of asset-backed securities.

Overall, Table 6 shows that institutional prime MMFs have decreased funding to safe borrowers to a larger extent, consistent with an increase in risk taking following the reform.

To further gauge institutional and retail prime MMFs' relative propensity to take risk, we also consider funds' propensity to hold securities issued in foreign (non-U.S.) countries and emerging markets, in particular. Due to higher political risk and weaker creditor protection, foreign-issued securities, especially those issued in emerging markets, are likely to be riskier and therefore to provide higher yields. If institutional prime MMFs have a higher propensity to take risk following the reform, we should thus observe that they are relatively more inclined, compared to their retail counterparts, to supply funding to foreign and, in particular, emerging-market issuers.

To test whether this is the case, we aggregate the value of the securities held by prime fund f in a given month by the country of the issuer.[21] The dummy variable FOREIGN is 1 in the case of any non-U.S. country, and 0 for the United States, and EMERGING is 1 for emerging-market countries according to the MSCI definition, and 0 otherwise. We then estimate a model similar to equation (4), except that each observation in the sample is at the fund-country-month level. Instead of the default probability, we consider an interaction term with a dummy variable that takes a value equal to 1 for securities issued in foreign markets and emerging markets, respectively. We saturate the regressions by including fund fixed effects, as well as interactions of country and time fixed effects, which hold constant the demand for funding by issuers in different countries. As in earlier tests, we cluster standard errors at the time level because institutional and retail funds appear to be subject to similar shocks.

We report the results of these regressions in Table 7. We observe a positive and statistically significant coefficient on the triple interaction terms POST $\times$ INSTITUTIONAL $\times$ FOREIGN (column 1) and POST $\times$ INSTITUTIONAL $\times$ EMERGING (column 2). This indicates a relative increase in the propensity of institutional prime MMFs to supply funding to foreign issuers (column 1) and issuers in emerging markets (column 2), in particular, which is consistent with a higher propensity of institutional prime funds to take risk after the 2014 reform.

Overall, these findings support our conclusion that institutional prime MMFs' propensity to purchase riskier securities increases relative to their retail counterparts because of the reform.

VI. Consequences of the Reform for Corporate Issuers

This section explores whether the reform has affected the amount of short-term funding available to issuers and, in particular, safer issuers. Although it is clear from Figure 1 that overall funding from institutional prime MMFs decreased, in principle, retail prime MMFs and other investors in short-term securities could have partially substituted institutional prime MMFs, limiting the effects on safe corporate issuers.

[21]We proceed in this way, instead of considering the securities of individual issuers, because in an international context, most issuers do not obtain funding from a given fund. Emerging-market countries in the sample are Brazil, Chile, China, India, Kuwait, North and South Korea, and the United Arab Emirates.

TABLE 7

The Geography of U.S. MMFs' Investments

Column 1 of Table 7 reports coefficients from the following regression:

$$\ln(\text{VALUE}+1)_{f,c,t} = \beta \times \text{POST}_t \times \text{INSTITUTIONAL}_{f,t} \times \text{FOREIGN}_{f,c,t} + \Xi_{f,c,t} + \varepsilon_{f,c,t},$$

where c denotes the country of issuance, f denotes the fund, and t denotes the month. The matrix Ξ includes lower-order interactions as well as fund fixed effects (FE) and interactions of country and month FE. The dependent variable is obtained by aggregating the value of the securities held by prime fund f by country of the issuer during a month; multinational issuers are excluded. The dummy variable FOREIGN takes the value of 1 for the portion of funding of fund f for issuers in any non-U.S. country, and 0 for the United States, whereas EMERGING is 1 for emerging market countries according to the MSCI definition, and 0 otherwise. The variables are defined in detail in Table 1. The sample has a monthly frequency, covers the period from 2013 until 2018, and includes investments in 31 countries by 208 prime money market funds (MMFs). Heteroscedasticity-robust standard errors, clustered by month, are reported below coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: ln(VALUE+1)	
	1	2
POST × INSTITUTIONAL	−0.363***	−0.109***
	(0.059)	(0.025)
INSTITUTIONAL	0.315***	0.131***
	(0.029)	(0.019)
INSTITUTIONAL × FOREIGN	−0.376***	
	(0.021)	
POST × INSTITUTIONAL × FOREIGN	0.343***	
	(0.053)	
INSTITUTIONAL × EMERGING		−0.674***
		(0.007)
POST × INSTITUTIONAL × EMERGING		0.291***
		(0.042)
Fund FE	Yes	Yes
Country-month FE	Yes	Yes
No. of obs.	251,400	251,400
Adj. R^2	0.703	0.705

Such a possibility would be consistent with evidence by Sundaresan and Xiao (2018), who show that following the 2014 reform, U.S. banks obtain more short-term liquidity from the Federal Home Loan Bank System, which in turn borrows more from government MMFs. On the other hand, Chernenko and Sunderam (2014) show that corporate borrowers experienced a reduction in funding when U.S. MMFs' assets contracted because of their exposure to European banks affected by the euro crisis. The fact that financial frictions arise following what Chernenko and Sunderam (2014) consider an episode of moderate stress to the MMF industry suggests that the 2014 reform may have had considerable consequences for U.S. corporations' access to short-term funding.

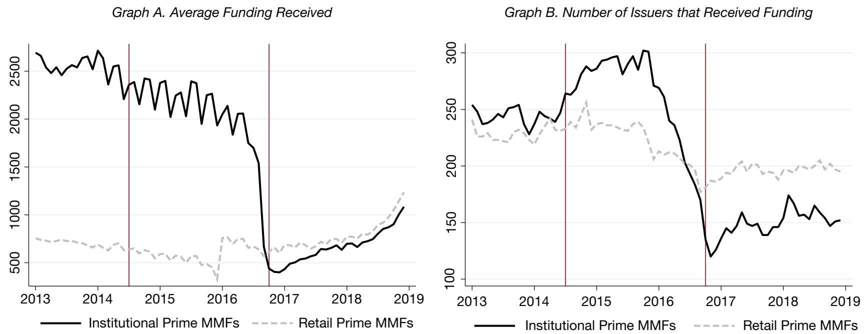
We start by exploring whether retail prime MMFs substituted their institutional counterparts in funding safer issuers, even if this is unlikely, because Figure 4 suggests that the risk of the portfolios of retail prime MMFs has also increased.

Graph A of Figure 6 shows that the amount of funding that the average issuer obtains from institutional and retail prime MMFs has decreased following the reform, even though it has steadily recovered following the reform's implementation. However, as shown by Graph B of Figure 6, the number of issuers obtaining funding from U.S. MMFs has decreased dramatically, especially for institutional prime MMFs, and has barely recovered after the reform's implementation. The evidence in Figure 6 suggests that U.S. prime MMFs can provide less short-term

FIGURE 6

Funding Provided by Prime MMFs

Graph A of Figure 6 depicts the amount of funding (winsorized at the 0.5% and 99.5% levels; $millions) that the average corporate issuer obtains from institutional and retail prime money market funds (MMFs) over the period 2013–2018. Graph B reports the monthly number of issuers whose securities are held by institutional and retail prime MMFs over the same period. The sample of issuers is from Table 8, which encompasses issuers that we can match to the National University of Singapore (NUS) Risk Management Institute (RMI) database of default probabilities. The amount of funding received per issuer is obtained from iMoneyNet.



funding in the aggregate and is consistent with the sharp decrease in their assets under management (Figure 1).

To evaluate which issuers are more affected by the reduced provision of funding, we estimate the following regression:

$$\ln(\text{VALUE}+1)_{i,t} = \alpha \times \text{PD}_{i,t} + \beta \times \text{POST}_t + \gamma \times \text{POST}_t \times \text{PD}_{i,t} + \Psi + \varepsilon_{i,t}, \qquad (5)$$

where i denotes the issuer, and t denotes the month. In different specifications, $\ln(\text{VALUE}+1)_{i,t}$ is the value of the outstanding securities of issuer i with all U.S. prime MMFs or with institutional and retail prime MMFs, respectively.[22] PD is the 1-month default probability of the issuer. Vector Ψ denotes issuer fixed effects. The observations are at the issuer-month level. As in previous tests, we cluster standard errors at the time level to take into account possible residual correlation across issuers at a given point in time.

Table 8 reports the estimates. In column 1, we find that the difference-in-differences coefficient POST × PD is positive, suggesting that the value of the outstanding short-term liabilities of U.S. issuers with higher credit risk decreases less than for other issuers following the reform. The effect is not only statistically but also economically significant. Before the reform, default-risk increases are associated with lower funding from MMFs. After the reform, this relationship is partially reversed. Specifically, the coefficient –0.924 in column 1 indicates that before the reform, a 1-standard-deviation increase in the probability of default (0.113 percentage points) was associated with 0.924 × 0.113 = 10.4% less funding. After the reform, a 1-standard-deviation increase in the probability of default is associated with only (0.924 – 0.864) × 0.113 = 0.7% less funding,

[22]Observations for an issuer are included in the regression sample with a 0 (ln(1)) if the issuer reported securities placed with at least 1 MMF in the past and will do so in the future.

TABLE 8
Issuer-Level Tests

Table 8 reports coefficients from the following type of regression:

$$\ln(\text{VALUE}+1)_{i,t} = \alpha \times \text{PD}_{i,t} + \beta \times \text{POST}_t + \gamma \times \text{POST}_t \times \text{PD}_{i,t} + \Psi + \varepsilon_{i,t},$$

where *i* denotes the issuer, and *t* denotes the month. $\ln(\text{VALUE}+1)_{i,t}$ is the value of outstanding securities of issuer *i* with all U.S. prime money market funds (MMFs) in month *t*. PD is the 1-month default probability of the issuer. Vector Ψ denotes issuer fixed effects (FE). The dependent variable is indicated in each column heading. The variables are defined in detail in Table 1. The observations are at the issuer-month level. The sample covers the period from 2013 until 2018. Heteroscedasticity-robust standard errors, clustered by month, are reported below coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable				
	ln (VALUE+1)	ln(VALUE_ INSTITUTIONAL+1)	ln(VALUE_ RETAIL+1)	ln(VALUE_ NONCOLLATERALIZED+1)	ln (ABCP+1)
	1	2	3	4	5
POST × PD	0.864**	1.189***	0.234	0.801**	0.031
	(0.327)	(0.352)	(0.152)	(0.322)	(0.019)
PD	−0.924**	−1.059***	−0.410**	−0.911**	−0.032
	(0.361)	(0.376)	(0.169)	(0.358)	(0.020)
POST	−0.495***	−0.822***	−0.165***	−0.452***	−0.104***
	(0.074)	(0.112)	(0.033)	(0.072)	(0.011)
Issuer FE	Yes	Yes	Yes	Yes	Yes
No. of obs.	22,789	22,789	22,789	22,789	22,789
Adj. R^2	0.789	0.781	0.797	0.781	0.917

suggesting that prime MMFs allocate relatively more funding to risky issuers after the reform.

In column 2 (3) of Table 8, the dependent variable is constructed considering only the value of outstanding securities of issuer *i* with all institutional (retail) prime MMFs. The effects appear to be driven by the funding provided by institutional funds (column 2); the coefficient on the interaction POST × PD is not statistically significant when we consider the funding provided by retail funds to issuers with different default probabilities (column 3).

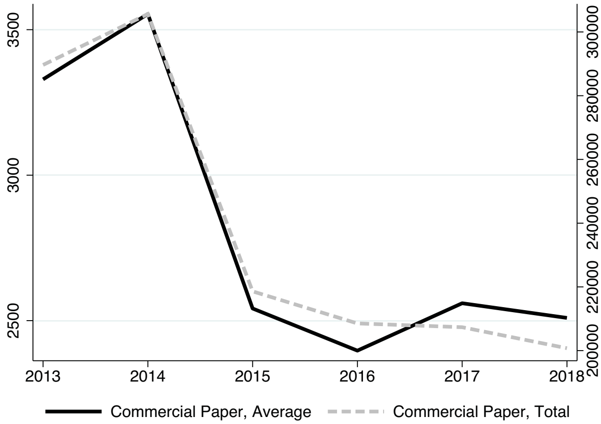
Finally, we consider that the default probability is a noisy signal of risk for asset-backed securities, which, being collateralized, are not expected to experience large losses when a company defaults. For this reason, in column 4, we exclude repos and asset-backed securities when we define the dependent variable and consider the value of noncollateralized securities held by MMFs. It emerges that following the reform, prime MMFs hold relatively more unsecured securities of riskier borrowers. Consistent with our conjecture, in column 5, we do not find an analogous effect when we consider the value of asset-backed securities, for which the borrower's default probability does not reflect the actual risk faced by the lender.

Taken together, the results in Tables 6–8 indicate that the reform led to a drop in the provision of short-term funding to issuers of money market securities by U.S. MMFs, in particular to issuers with lower default risk. Next, we consider firm-level data from Capital IQ to evaluate whether U.S. issuers indeed have access to less short-term funding or whether other intermediaries that we do not observe (in the iMoneyNet sample of MMFs) may have substituted U.S. MMFs. We first examine this question graphically. Figure 7 shows, using data from Capital IQ, that the average firm has significantly less commercial paper outstanding following the

FIGURE 7

Commercial Paper Outstanding

Figure 7 depicts the average amount of commercial paper outstanding (left axis) and the total amount of commercial paper outstanding (right axis) for U.S. issuers ($millions) per year. The sample underlying the figure is the same as that used for the regressions reported in Table 9. Information on commercial paper outstanding per issuer is from Capital IQ's Capital Structure Summary files (10-K filings). The sample period is 2013–2018.



2014 reform. The sharp drop occurs after 2014, that is, after the reform was announced and the money market industry started to shrink and experience a profound reorganization. Figure 7 also shows an analogous drop in the aggregate value of commercial paper outstanding.

This diminished ability to access short-term funding is apparent in Table 9, in which we estimate difference-in-differences regressions (conceptually similar to equation (5)) that employ, as a dependent variable, the value of commercial paper outstanding of U.S. corporate issuers. This sample is smaller than in previous specifications in Table 8 because U.S. issuers report commercial paper outstanding in their corporate filings on a voluntary basis, and we rely on annual data. However, it reflects funding to U.S. issuers from all sources, not only U.S. MMFs.

We define issuers as dependent on funding from institutional MMFs if the proportion of short-term funding they obtain from institutional prime MMFs during 2013 (the pre-reform year), which we observe from N-MFP filings, is above the sample median. In column 1 of Table 9, we document that issuers that have relied more on funding from institutional prime funds before the reform have less commercial paper outstanding. This suggests that because of frictions limiting the entry of new intermediaries in U.S. money markets, the reform has had a negative effect on the availability of short-term funding for U.S. issuers. Such an interpretation is confirmed in column 2, which shows that riskier issuers that relied to a larger extent on institutional prime MMFs before the reform have relatively more commercial paper outstanding, suggesting that they maintain better access to the money market after the 2014 reform, thanks to institutional prime funds' risk appetite.

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TABLE 9

Firm-Level Effects of the 2014 MMF Reform

In column 1 of Table 9, we estimate the following regression model:

$$\ln(\text{COMMERCIAL\_PAPER}+1)_{i,t} = \alpha \times \text{POST}_t + \beta \times \text{POST}_t \times \text{INST\_DEPENDENCE}_i + \Psi + \varepsilon_{i,t}.$$

Our sample consists of U.S. firms with nonmissing observations for commercial paper in the Capital IQ Capital Structure Summary (variable TOTOUTSTBALCOMMERCIALPAPER). We consider data from filings of the type "10-K" or "10-K/A" and the latest information about a given financial period (i.e., LATESTFORFINANCIALPERIODFLAG = 1). ln(COMMERCIAL_PAPER+1) is the natural logarithm of (1 plus) the amount of commercial paper ($millions) that an issuer has outstanding in a given fiscal year. The vector Ψ denotes issuer fixed effects (FE). We study cross-sectional effects by interacting the dummy POST with INST_DEPENDENCE, a dummy variable, which we construct as follows: We define issuers as dependent on institutional money market funds (MMFs) if the proportion of funding they obtain from institutional MMFs is above the sample median; in such cases, the indicator variable INST_DEPENDENCE takes the value of 1, and 0 otherwise. We calculate an issuer's proportion of funding from institutional MMFs as the average of the monthly funding from institutional MMFs divided by total MMF funding in the pre-reform year (2013), obtained from N-MFP filings. PD is the annual average of the monthly 1-month default probability of the issuer; the data are from the National University of Singapore (NUS) Risk Management Institute (RMI). The variables are defined in detail in Table 1. The observations are at the issuer-year level. The sample has an annual frequency and covers the period from 2013 until 2018. Heteroscedasticity-robust standard errors, clustered by year, are reported below coefficients. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

	Dependent Variable: ln(COMMERCIAL_PAPER+1)	
	1	2
POST	−0.410*	0.065
	(0.183)	(0.257)
POST × INST_DEPENDENCE	−0.582***	−0.954**
	(0.103)	(0.279)
POST × INST_DEPENDENCE × PD		675.750***
		(31.864)
PD		−62.078
		(59.548)
POST × PD		−582.957***
		(57.235)
INST_DEPENDENCE × PD		−7.512
		(99.923)
Issuer FE	Yes	Yes
No. of obs.	507	452
Adj. R^2	0.598	0.589

VII. Conclusion

We investigate how the structure of liabilities affects financial intermediaries' asset holdings. As a consequence of the changes introduced by the 2014 reform, U.S. prime MMFs have increased the riskiness of their portfolios and provide less funding, especially to safer corporate borrowers.

Our article shows that regulation plays a crucial role in the creation of liquid assets and provides evidence in support of theories highlighting that financial intermediaries' assets and liabilities are jointly determined: A change in the structure of the liabilities that funds can offer to investors necessarily leads to changes in funds' investment strategies.

We also show that a reform to limit runs on open-end funds may have unintended consequences: The portfolio risk of institutional prime MMFs, which were most affected by the 2014 reform, has increased, and safe borrowers have less access to short-term funding after the reform. Because of frictions in short-term funding markets, prime MMFs do not appear to have been substituted by other intermediaries. Higher provision of funding to risker borrowers may also lead to more volatility in money markets and may help explain recent episodes of volatility in short-term funding markets. We view this as a promising area for future research.

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