J. Finan. Intermediation 53 (2023) 101016

Contents lists available at ScienceDirect

Journal of Financial Intermediation

journal homepage: www.elsevier.com/locate/jfi

Cost of monitoring and risk taking in the money market funds industry☆

Stefano Lugo

Utrecht School of Economics (U.S.E.), Utrecht University, Kriekenpitplein 21-22, 3584 EC Utrecht, The Netherlands

ARTICLE INFO

JEL classification:
G11
G23
G24
G28

Keywords:
Money market mutual funds
Information acquisition
Rating-based regulation
Commercial paper
Clientele effects

ABSTRACT

Increasing the cost associated with gathering information can hamper the monitoring activity of the market even when information remains public. Using the 2015 US money market funds (MMFs) reform as a quasi-natural experiment, I find a positive effect of removing information requirements over credit ratings on the allocation by MMFs toward securities rated as second tier. The effect is driven by monitored MMFs catering to retail investors and by monitored MMFs that do not voluntarily report credit ratings after the reform. The verfied increase in the relative demand by MMFs for second tier securities is associated with a decrease in the spread paid at issuance by second tier commercial paper.

1. Introduction

Limited attention theories (e.g., Sims, 2003; Hirshleifer and Teoh, 2003; Caplin and Dean, 2015) suggest that a decrease in information immediacy is equivalent to an increase in the cost of accessing and using information even when the relevant information remains public. If a piece of information becomes less immediate, markets are expected to pay less attention to it. Funds previously constrained by monitoring can exploit the resulting increase in asymmetric information to undertake more risk.

This study investigates the relation between information immediacy and the risk taking of Money Market Mutual Funds (MMFs) by using the 2015 amendment of rule 2a-7 under the Investment Company Act of 1940 (SEC, 2015) as a quasi-natural experiment. The reform removes the requirement for a MMF to disclose the credit ratings assigned by Credit Rating Agencies (CRAs) to the individual securities held by the fund. Credit ratings themselves remain public information. However, investors can no longer directly and systematically observe these credit ratings in the Securities and Exchange Commission (SEC) filings submitted by MMFs. This information channel appears to play a relevant role in explaining the positive effect of the reform on the share of MMFs' portfolios allocated to securities rated second tier (or below) by CRAs.

The verified shift in allocation produces significant clientele effects on the price of credit risk for short-term securities. All else being equal, the increase in the relative demand by MMFs for riskier securities observed around the reform is associated with a significant decrease in the credit spreads paid at issuance by below-first tier commercial paper.

MMFs are open-end mutual funds required to invest primarily in short-term, safe fixed income securities. Rule 2a-7, as in place between 2010[1] and the reform, mandates that funds keep the weighted-average maturity (WAM) of their assets below 60 days and the share of second tier securities below 3%. As discussed in more details in Section 2, before the reform securities are classified as "first tier", "second tier", and "not eligible" based on the (short-term) credit ratings assigned by nationally recognized statistical rating organizations (NRSROs). The open-end structure of MMFs makes them particularly exposed to runs, as observed after the default of Lehman Brothers in 2008 (Kacperczyk and Schnabl, 2013). Competition among money market funds however is fierce, and even small differences in the yield offered to investors can determine significant shifts in the cross-sectional allocation of capital in the industry (e.g., La Spada, 2018). MMFs can thus have incentives to undertake more risk.

The 3% threshold appears however to be seldom binding before the reform. At the end of October 2015 (when the reform is introduced)

☆ For helpful discussions and suggestions I thank Joao Santos (the Editor), one anonymous referee, Gabriele La Spada, Daniel Hiltgen, Bo Becker, Jennie Bai, Thomas Mählmann, Hannes Wagner, Dion Bongaerts (discussant), Joel Shapiro, Ramin Baghai, Nicos Artavanis, Marcin Kacperczyk, and seminar participants at the 2019 Corporate Finance Day, the 2021 FMA European conference, VU Amsterdam, and SKEMA Business School. An earlier version of this paper circulated under the title "The perils of removing rating-based regulation". I am extremely grateful to Jonathan de Bruin for his help with parsing SEC filings.

E-mail address: S.Lugo@uu.nl.

[1] A first post-crisis reform of rule 2a-7 was introduced in 2010, reducing the maximum allowed weighted-average maturity and share of second tier securities.

https://doi.org/10.1016/j.jfi.2022.101016
Received 19 January 2022; Received in revised form 15 November 2022; Accepted 15 November 2022
Available online 17 November 2022

prime MMFs allocate on average only 0.18% of their portfolios to second tier securities. This can explain the decision by the Securities and Exchange Commission (SEC) to make the reform of rule 2a-7 one of the very first applications of the requirement by the Dodd–Frank act to "remove any reference to or requirement of reliance on credit ratings" for regulatory purposes (Dodd–Frank act, 2010, Sec. 939A). The 2015 revision of rule 2a-7 (henceforth "the reform") removes any rating-based criteria for assets eligibility. Crucially, the reform also forbids MMFs to continue reporting an official categorization of their holdings as first or second tier securities. The removal of these information requirements is the focus of this study. Despite removing the 3% ceiling, the new rule explicitly demands that the funds "retain a similar degree of credit quality standards as under [pre-reform] rule 2a-7".

Due to the low returns offered by MMFs and the potential for free riding, investors on average do not have strong incentives to invest resources in monitoring the investment behavior of these funds (Gallagher et al., 2020). The information provision associated with rating-based rules can obviate this issue. Reported credit ratings provide investors with a standardized and immediately observable metric of credit risk exposure. Removing such information, as mandated by the reform of rule 2a-7, can thus hamper the role of market monitoring in mitigating the exposure to credit risk of MMFs. Funds previously constrained by the monitoring activity of investors are expected to increase their allocation to second tier (or worse) securities as a result.

To investigate empirically the effects of the reform on the investment behavior of MMFs and its consequences, I construct two datasets covering the period between January 2013 and August 2018. The first one is a panel dataset including 17,251 (5974) fund-month observations for non-government (prime only) money market funds observable both before and after the reform. The second dataset is a cross-sectional sample of 111,533 nonfinancial commercial paper issued by corporations over the same period; the latter sample includes both securities purchased and not purchased by MMFs.

I begin by assessing whether prime MMFs on average change their portfolio allocation around the reform. Fund-level analyses show a significant increase in the average share of MMFs portfolios allocated to second tier (or worse) securities. This shift does not appear to be temporary; thus, it cannot be driven only by funds selling first tier legacy assets to meet the surge in the demand for redemptions observed around the reform (Cipriani and La Spada, 2021).

The shift could be driven in principle by funds performing independent risk assessments after the reform–rather than mechanically relying on ratings–and/or by funds anticipating rating upgrades. Results obtained from security-level analyses go against this explanation. There is no evidence that the observed increase in the portfolio allocation to second tier securities is driven by purchases of *underrated* second tier securities (identified using different proxies).

Does the removal of rating-based rules and the associated information contribute to this shift? To answer this question, I start by estimating Difference-in-Differences (DiD) baseline models to compute the treatment effect of the reform on funds more likely to be affected via the information channel; other prime MMFs constitute the control group. To identify funds subjected to an above-median level of investors' information acquisition before the reform (monitored funds), akin to Gallagher et al. (2020) I use SEC data on daily accesses to the MFP filings on EDGAR.

As expected, monitored funds increase their allocation to second tier securities more than other MMFs. The estimated treatment effect of the reform on monitored funds is around 0.5 percentage points (p.p.)—more than twice the average pre-reform allocation to second tier securities by prime MMFs (0.21 p.p.). There is no evidence of a diverging trend in the allocation of monitored and non-monitored funds before the reform. The estimated models include controls for the possible direct treatment effect of removing the 3% threshold on funds more likely to have been constrained by this ceiling.

The removal of rating-based rules is not the only change in rule 2a-7 introduced by the reform. A first version of the reform already approved in 2014 introduces two other major changes. The first change is that non-government funds are allowed to use redemption fees and redemption gates to discourage–or stop entirely–the redemption of their shares. As a result, several non-government MMFs exit the industry; the remaining funds face severe outflows and need to offer better returns to the investors (Cipriani and La Spada, 2021). The second change forces non-government funds catering to institutional investors to price their shares using a floating Net Asset Value (NAV) approach. Baghai et al. (2022) argue that this change increases the incentives for institutional funds to undertake more risk. If these mechanisms affect monitored funds more than they affect other prime funds, they could in principle drive the results from the baseline DiD models.

A number of robustness checks are used to control for the confounding effects of these concurrent changes in regulation. The first check exploits a specific feature of the 2015 amendment. After the reform MMFs cannot classify the assets held as first tier or second tier securities; however, they can still voluntarily report the actual ratings assigned by each CRA to individual securities. This voluntary disclosure of information should be irrelevant if the reform did not affect MMFs (also) via the information channel. This is not the case. Monitored funds that keep systematically reporting credit ratings in their filings increase their allocation to second tier securities significantly less than other monitored funds. As expected, the post-reform voluntary disclosure of credit ratings is immaterial only for non-monitored funds.

I then investigate the effect of the reform on the exposure of monitored MMFs to interest rate (maturity) risk. Both credit risk exposure and interest rate risk exposure allow to achieve higher non-risk adjusted returns. MMFs on average do not appear to substitute between their allocation to second tier securities and the weighted-average maturity of the assets held (WAM). The information channel predicts a positive treatment effect only on the allocation to second tier securities; other simple proxies of risk exposure such as WAM remain directly observable by the investors after the reform. Results are once again consistent with the information channel: If anything, the reform has a negative treatment effect on the interest rate risk exposure of monitored funds compared to other prime funds.

To address the potential confounding effect of introducing a floating NAV for institutional funds, I re-estimate the baseline models separately for funds who decide to cater to retail investors after the reform and funds who decide to cater to institutional investors. If the adoption of a floating NAV is the only reason for the verified treatment effect on monitored funds, the latter should be mostly driven by monitored institutional funds. The information channel predicts exactly the opposite: an increase in the cost of information acquisition arguably affects retail (unsophisticated) investors more than institutional investors. Gallagher et al. (2020) make a similar prediction in the context of the Eurozone crisis. Consistent with the information channel, the treatment effect on monitored funds is entirely driven by funds catering to retail investors after the reform. There is no evidence that institutional monitored funds increase their allocation to second tier securities more than other institutional funds.

To control for funds exiting the industry around the event of interest, akin to Di Maggio and Kacperczyk (2017) I estimate the baseline DiD models on a balanced panel including only funds observed every month in the sampling period. To control for the increase in outflows, I follow Cipriani and La Spada (2021) and re-estimate the baseline DiD model on a sample including only funds whose total assets do not change by more than 5% around the reform. I also re-estimate the baseline DiD models: (a) using a two-period panel dataset (Bertrand et al., 2004); (b) including in the sample all non-government MMFs; (c) excluding unrated securities or securities enhanced by a third party (e.g., with a guarantee) from a fund's portfolio; (d) including controls for a potential treatment effect on (pre-reform) large funds; and (e) controlling for changes around the reform in the conditional correlation

between a fund's observable characteristics and its allocation. All these additional robustness checks confirm the presence of a significant treatment effect of the reform on monitored funds.

A final piece of empirical evidence further support the theorized information channel. Before October 2015 the (lagged) allocation to second tier securities of a fund has a negative within effect on the growth of the fund; this pre-reform effect is driven as expected by monitored funds. After the reform is completed, investors on average do not seem to penalize a fund for increasing its allocation to second tier securities anymore.

It is important to clarify that the aforementioned results should not be interpreted as evidence of a decrease in the general monitoring activity of the investors after the reform; they are however highly consistent with the prediction that monitoring investors (are assumed by MMFs to) specifically pay less attention to the amount of second tier securities held by a fund once the latter becomes less immediate to observe.

The verified shift in MMFs' demand for second tier securities can produce relevant clientele effects on the price of short-term securities, given the size of the MMFs industry and its prominent role in the money market (Kacperczyk and Schnabl, 2010). Pricing models estimated on a panel dataset of second tier issuers of commercial paper reveal that the reform-led increase in the relative demand by MMFs for second tier securities is associated to a significant reduction in the average credit premia paid by second tier commercial paper. This result holds when controlling for several key pricing factors at the security, issuer, and macro level, including proxies for the relative supply of first and second tier CP.

Related literature. This article mainly contributes to three different strands of literature. First, it contributes to the rapidly expanding literature on money market mutual funds (Kacperczyk and Schnabl, 2013; Chernenko and Sunderam, 2014; Chodorow-Reich, 2014; Di Maggio and Kacperczyk, 2017; Parlatore, 2016; La Spada, 2018; Schmidt et al., 2016; Lugo, 2021; Li, 2021). Musto (1999) finds that MMFs hold less government issues when retail investors are less likely to observe their portfolio allocation. In the context of the Eurozone crisis, Gallagher et al. (2020) show that investors in MMFs exhibit limited attention and focus only on the most immediate piece of information deemed relevant. The evidence presented in this study suggests that even a small increase in the costs associated with gathering what is otherwise publicly available information (i.e., credit ratings) can significantly hamper the attention paid to that specific piece of information.

Both Cipriani and La Spada (2021) and Baghai et al. (2022) assess the effects of the reform of rule 2a-7 as firstly approved in 2014. This study shows a previously undocumented increase in the allocation to second tier securities by MMFs around the reform and investigates the role of the 2015 amendments to rule 2a-7 in explaining this shift. It is important to emphasize that the results presented in this article do not conflict with the evidence presented in Cipriani and La Spada (2021) and Baghai et al. (2022). The information channel constitutes a novel but complementary channel via which the general reform of rule 2a-7 affects the behavior of MMFs.

Second, this study contributes to the literature investigating the impact of rating-based regulation (Bongaerts et al., 2012; Kisgen and Strahan, 2010; Ellul et al., 2011; Opp et al., 2013; Becker and Ivashina, 2015; Cornaggia et al., 2018) by looking at the consequences of *removing* such rules. Becker et al. (2022) investigate the effect of a reform that ipse facto removes rating-based capital requirements against non-agency mortgage backed securities (MBS) for insurance companies. The authors find that insurance companies invest in more risky MBS after the reform. The evidence presented in this study complements their results by highlighting the informational value of standardized metrics of credit risk exposure. Removing rating-based rules doesn't only eliminate binding thresholds; it can also hamper the monitoring role of the market. The conclusions drawn in this study on the reliance of (retail) investors on standardized information such as credit ratings also echo those by Chen et al. (2021) and deHaan et al. (2021) for investments in bond mutual funds and individual corporate bonds, respectively.

Third, the verified relation between a demand shift from MMFs and the pricing of credit risk for commercial paper contributes to the literature (Guibaud et al., 2013; Greenwood and Vayanos, 2014; Greenwood and Vissing-Jorgensen, 2018, among others) addressing clientele effects in the fixed income market. This literature so far has predominantly focused on the impact on term spreads of a change in the (excess) demand from preferred habitat investors. To date, clientele effects on credit spreads have not received the same level of attention. I contribute to this literature by showing that the shift in the portfolio allocation of MMFs that occurs around the reform is associated with a significant decrease in the spread paid at issuance by second tier commercial paper. More generally, this paper contributes to the literature addressing the impact of the Dodd–Frank act, including Dimitrov et al. (2015) and Cohn et al. (2016).

The rest of this article proceeds as follows. Section 2 describes in more details the change in the regulation for US money market funds introduced between 2015 and 2016. Section 3 illustrates the two main datasets used. Section 4 presents the general evidence on the shift in the portfolio allocation of MMFs occurring around the reform. The core analyses addressing the role of the 2015 reform in explaining this shift are presented in Section 5. The evidence on the reform-induced clientele effects on the price of commercial paper is presented in Section 6. Section 7 concludes with some final remarks.

2. The 2015 US money market funds reform

US money market funds are regulated under rule 2a-7 of the Investment Company Act of 1940. On October 14th, 2014 a major reform of rule 2a-7 becomes effective (SEC, 2014). The 2014 reform introduces two main changes: (a) institutional non-government funds have to price and redeem their shares at market values, and; (b) under some circumstances, non-government money market funds are allowed to cope with potential runs by imposing a fee on share redemptions or by stopping redemptions altogether.

The 2014 reform does not modify the regulatory use of credit ratings. Under the rule as initially confirmed, a money market fund cannot hold securities rated below second tier and can only invest up to 3% of its portfolio in second tier securities. The classification of securities into first tier, second tier, and below second tier is done based on the short-term ratings assigned by the NRSROs. To be classified as first tier, a security must receive the highest short-term rating by one agency (in case only one CRA evaluates the security) or by at least two CRAs (in case of multiple ratings). Securities receiving at least the second highest rating by one (single rating) or at least two (multiple ratings) CRAs and that do not qualify as first tier are classified as second tier. Rated securities not meeting either criteria are classified as below second tier. All funds have to report the classification of each security in their portfolio based on this rule.

On September 25th, 2015 the SEC publishes a new final amendment to rule 2a-7 that entirely removes any reference to credit ratings (SEC, 2015). The 2015 reform, which becomes effective on October 26th, 2015, is the focal point of interest of this study. The reform removes *ipse facto* the 3% ceiling for second tier securities and the 0% ceiling for securities below second tier. It also explicitly forbids to categorize each security held as first tier, second tier, or below second tier. Despite removing the 3% ceiling, the new rule explicitly demands that the funds "retain a similar degree of credit quality standards as under [pre-reform] rule 2a-7". The amended text indicates some general factors, such as the issuer's financial condition, sources of liquidity, and ability to react to market-wide events, that funds should consider when independently assessing the eligibility of each security. Money market funds have to comply with the introduced reforms to rule 2a-7 by October 14th, 2016.

Rule 2a-7 also regulates the information that each fund has to provide with monthly frequency to the SEC by filing an N-MFP form. The content of N-MFP forms has changed with each revision of rule 2a-7 occurred since the financial crisis. I collectively refer to the filings of all different versions of the N-MFP form as the MFP filings. Version N-MFP2 is introduced by the 2015 reform. The main change from the previous version is that funds cannot and should not report anymore the credit risk classification of each security as first tier or second tier based on credit ratings. However, funds can still voluntarily report the actual credit ratings assigned by individual CRAs. The reform mandates that by October 14th, 2016 (the compliance date) all funds submit the version N-MFP2 of the form.

3. Data

This section presents the data used in this study. Additional details are provided in the Online Appendix.

3.1. Money market funds dataset

3.1.1. Panel dataset

The starting point to assemble a panel dataset of portfolio holdings by MMFs are the MFP filings, retrieved from EDGAR. All filings (including amendments of previous filings) submitted by MMFs between quarter 1 of 2013 and quarter 3 of 2018 are considered; the dataset thus covers the period between January 2013 and August 2018. The filings contain information at the fund-series (henceforth the fund) level as well as detailed information for each security held by the fund by the end of each reporting month. To take amendments into account, for each fund-reporting month only the most recent filing is considered.

After these initial adjustments, the dataset includes 36,995 fund-month observations for 698 distinct funds and 3,734,834 fund-month-security observations. Fund-month observations categorized as Government/Agency, Treasury, or Government tax-exempt funds (Government funds) are excluded. I also remove funds not observed at least once both before the implementation (October 2015) and after the compliance date (October 2016) of the reform. The resulting sample includes 17,251 fund-month observations for 311 distinct non-government funds. As it is customary in the literature (e.g., Cipriani and La Spada, 2021), only fund-month observations categorized as Prime funds are considered for the main analyses. Unreported analyses based on all non-government MMFs produce results that are largely coherent with those presented in Sections 4 and 5.

The final sample includes 5974 observations for 96 prime funds. A sub-set of 74 funds is observed every month during the sampling period (5032 fund-month observations). This sub-sample is referred to as the balanced MMFs dataset. Panel A of Table 1 presents some general descriptive statistics for the main variables included in the MMFs dataset. The definitions of all the variables are summarized in the caption of the table.

3.1.2. Allocation to second-tier securities

After October 2016 MMFs cannot report the official, rating-based categorization of each security anymore. In order to fill this gap, ratings assigned by each of the four main NRSROs–Moody's, S&P, Fitch, and DBRS–are retrieved from Refinitiv Eikon. Uncategorized observations at the fund-month-security level are then classified using the same official, rating-based rule in place before the reform. A first tier security is a security rated (using Moody's scale as a reference) P-1 or equivalent; a second tier is a security rated P-2 or equivalent; a rated security that is neither first tier nor second tier is labeled as below second tier. In presence of multiple ratings, at least two CRAs have to assign a P-1 (P-2 or better) rating for the security to classify as first tier (second tier). Unrated securities are treated as first tier.[2]

[2] As shown in Section 5.5, excluding unrated securities altogether does not materially affect the main results.

Information at the fund-month-security level is then aggregated at the fund-month level to compute the value-weighted share held in securities classified as second tier or below. The share is computed considering the total value of the fund's position in each security excluding the value of any sponsor support. The resulting share of second tier (or below) securities in the portfolio of fund f in month t, $ShareST_{f,t}$, is the main outcome variable of interest in this study. $ShareST$ is expressed in percentage points. To deal with potential outliers, $ShareST$ is winsorized at the 99.9th percentile.

As shown in Panel A of Table 1, the sample average of $ShareST$ is 0.37 percentage points (p.p.); it increases from 0.21 p.p. before the introduction of the reform to 0.67 p.p. after the implementation of the reform is completed. Panel B of Table 1 presents descriptive statistics on the portfolio allocation of prime MMFs between and within asset classes. For each asset class j, $Share^j$ is the share allocated to j, and $ShareST^j$ is the share of second tier (or below) securities within j (undefined when $Share^j = 0$). Nonfinancial commercial paper exhibits the highest average share of second tier securities (around 5.6%).

3.1.3. Monitored funds

To identify funds more likely to be affected by the reform via the information channel, following Gallagher et al. (2020) I start by building a proxy for the intensity of information acquisition by investors using the daily data provided by the SEC on individual accesses to files in the EDGAR database. After some initial filters, I use these SEC log data to compute the number of distinct (anonymized) users accessing the MFP filings of each fund in each month. The number of distinct users is then scaled by total number of users accessing any MFP filing during the same month and by the size of the fund (proxied by assets under management) in the same month .

The indicator $Monitored$ is then set equal to one for funds whose pre-reform average value for this scaled information acquisition proxy is above the sample median; it is set equal to zero for the remaining funds. For more details, see the Online Appendix. $Monitored$ is equal to one for 49 prime funds; monitored funds constitute the treated group in the main difference-in-differences analyses testing for the information channel.

The implicit source of cross-sectional heterogeneity assumed to explain why investors acquire information on certain funds is the (perceived) propensity of a fund to undertake more risk if left unmonitored. Since screening funds is costly, investors are likely to use simple heuristics to decide which funds to monitor.[3] These heuristics are thus unlikely to be based on hard-to-observe information. They are also unlikely to perfectly identify which funds would significantly change their behavior around the reform for reasons unrelated to the role of monitoring itself. Even though $Monitored$ is thus admittedly a crude proxy for which funds are more likely to be affected via the information channel, it is also unlikely to be systematically correlated with unobservable factors that may confound the results.

3.1.4. Other variables

Two time-varying indicators are used to identify the introduction of the reform. $During$ is equal to 1 since October 2015–when the reform becomes effective–and before the compliance date of October 2016. It is set equal to zero otherwise. $After$ is an indicator set equal to one from October 2016 on, and set equal to zero otherwise. Around 33% of the observations in the sample are in the post-reform period, and 19% are in the period during the implementation of the reform.

[3] For example, investors may focus on funds that have invested at least once in second tier securities. As of September 2015 the difference in the average $ShareST$ between monitored and non-monitored funds is small (0.09%) and not statistically significant. However, 55% of the monitored funds have held a second tier security at least once before then; the proportion is only 32% for the remaining prime funds.

Table 1
Money market funds dataset, descriptive statistics.

Panel A: General descriptive statistics

Variable	N	Mean	SD	Min	Median	Max
$ShareST$	5974	0.37	1.48	0.00	0.00	19.56
$Monitored$	5974	0.53	0.50	0.00	1.00	1.00
LNV	5974	21.34	3.27	0.00	22.02	25.69
WAM	5974	28.46	16.80	0.00	30.00	61.00
LNC	5974	0.78	0.80	0.00	0.69	2.64
$Bounded$	5974	0.10	0.30	0.00	0.00	1.00
y_{1m}	5974	0.39	0.55	0.00	0.11	1.95
$y_{3m} - y_{1m}$	5974	0.06	0.06	−0.02	0.04	0.22
$Premium_{CP}$	5974	0.12	0.07	−0.01	0.10	0.29
$Premium_{Loan}$	5974	0.02	0.06	−0.11	0.01	0.19
VIX	5974	14.80	3.45	9.51	13.95	28.43
$Yield$	5974	0.59	0.59	0.00	0.28	4.90

Panel B: Allocation by asset class

Variable:	$Share^j$			$ShareST^j$		
Asset class (j)	N	Mean	SD	N	Mean	SD
Asset-backed CP ($ABCP$)	5974	8.10	9.05	3832	0.15	3.65
Certificate of deposit (CD)	5974	20.72	15.89	4780	0.19	1.63
Financial CP (fCP)	5974	12.06	9.84	4527	0.37	3.17
Gov. Agency Debt (Ag)	5974	3.37	7.52	2490	0.00	0.00
Non financial CP (CP)	5974	6.72	12.74	3847	5.60	20.00
Other Municipal sec. (Mun)	5974	0.31	1.25	954	4.22	18.72
Repo ($Repo$)	5974	13.63	14.46	4456	0.51	3.86
Treasury debt (Tr)	5974	3.03	6.12	2534	0.00	0.00
Var. rate demand note (DN)	5974	4.06	8.44	3206	0.84	6.32
Other ($Other$)	5974	27.44	34.51	5498	0.20	1.54

This table presents general descriptive statistics for the key variables included in the MMFs dataset (Panel A) and statistics on the funds' portfolio allocation by asset class (Panel B). $ShareST$ is the share of the portfolio allocated to securities categorized as second tier or below. The variable is winsorized at the 99.99th percentile. $Monitored$ is a time-invariant indicator equal to one for funds whose MFP filings are accessed on EDGAR before the reform by an above-median scaled number of distinct users; it is set equal to zero otherwise. The number of users is scaled by the size of the fund and by the total number of distinct users in the same month. LNV is the natural logarithm of one plus the total gross value of all assets under management (in US dollars). WAM is the weighted-average maturity of a fund's portfolio, expressed in days. LNC is the natural logarithm of the number of share classes for the fund. $Bounded$ is a time-invariant indicator equal to one for funds with at least one observation before October 2015 where $ShareST > 2.8$ and equal to zero otherwise. y_{1m} and $y_{3m} - y_{1m}$ are respectively the 1-month yield on US Treasury securities and the difference between the 3-month and the 1-month yields (source: Fed). $Premium_{CP}$ is the difference between the yield paid by 90-day AA nonfinancial CP and the 3-month US Treasury yield. $Premium_{Loan}$ is the difference between the rate on US 3-month interbank loans and the yield paid by 90-day AA financial CP. VIX is the VIX index. $Yield$ is the 7-day gross yield. $Share^j$ is the share of a portfolio allocated to each asset class j; $ShareST_b^j$ is the share of second tier (or below) securities within asset class j; it is undefined for each fund-month observation where no investment in j is observed. All share variables are in percentage points.

To control for the potential direct effect of removing the 3% ceiling, I consider an indicator ($Bounded$) set equal to one for every fund exhibiting before October 2015 at least one observation where $ShareST > 2.8$. The indicator is set equal to zero otherwise.[4] $Bounded$ is equal to one for 9 funds, 5 of which are monitored.

Three variables are used to control for time-varying characteristics of the funds. LNV is the natural logarithm of one plus the total gross value of all assets held by the fund, in US dollars. The average portfolio size among all fund-month observations is around USD 12.6 billions. As shown in Fig. 1-A the average size of the funds decreases abruptly during the implementation period. As explained by Cipriani and La Spada (2021), this trend is a direct consequence of the measures introduced by the 2014 version of the reform. It is however interesting to notice (Fig. 1-B) that the average amount of second tier (or worse) securities remains quite stable during the same period; it actually starts to rapidly increase after October 2016, from c.a. 16 USD millions to c.a. 58 millions per fund.

WAM is the weighted-average maturity of all the fund's assets, expressed in days. LNC is the natural logarithm of the number of share classes of the fund; each MMF can have multiple types of shares backed by the same portfolio but differing in terms of e.g. fee structure or minimum investment (Cipriani and La Spada, 2021).

For models that do not include time indicators, I consider five macro control variables. The market yield on US Treasury securities at 1-month constant maturity (y_{1m}) and the difference between the 3-month and 1-month yields ($y_{3m} - y_{1m}$) control, respectively, for the level and slope of the yield curve at short maturities. To control for short-term credit and liquidity premia, I consider the spread paid by 90-day AA nonfinancial CP over the 3-month Treasury yield ($Premium_{CP}$) and the spread between the 3-month US interbank loan rate (source: OECD) and the yield on 90-day AA financial CP ($Premium_{Loan}$). The VIX index (VIX) is used to control for the general level of volatility in financial markets. Yields data are from the Federal Reserve; the VIX index is retrieved from Eikon.

3.2. Commercial paper dataset

Security-level analyses are performed on a dataset of commercial paper (CP). The starting point in creating the dataset is a list retrieved from Eikon of US dollar-denominated commercial paper issued in North America by nonfinancial corporations between January 1st, 2013 and August 31st, 2018. The list initially includes 169,347 securities for which at least the CUSIP, the issuance and maturity dates, and the yield to maturity at issuance (YTM) are available.[5]

Information at the fund-month-security level from the MFP filings is used to identify CP held by at least one MMF by the end of the month in which they are issued, as well as the total amount held by the end of the issuance month by all MMFs as a whole. Securities in the CP dataset and securities in the MFP filings are matched by both CUSIP and maturity date. Securities not held by MMFs by the end of the issuance

[4] Using alternative reasonable definitions for $Bounded$ does not materially affect the main results.

[5] Security-level data on the amount issued are not available.

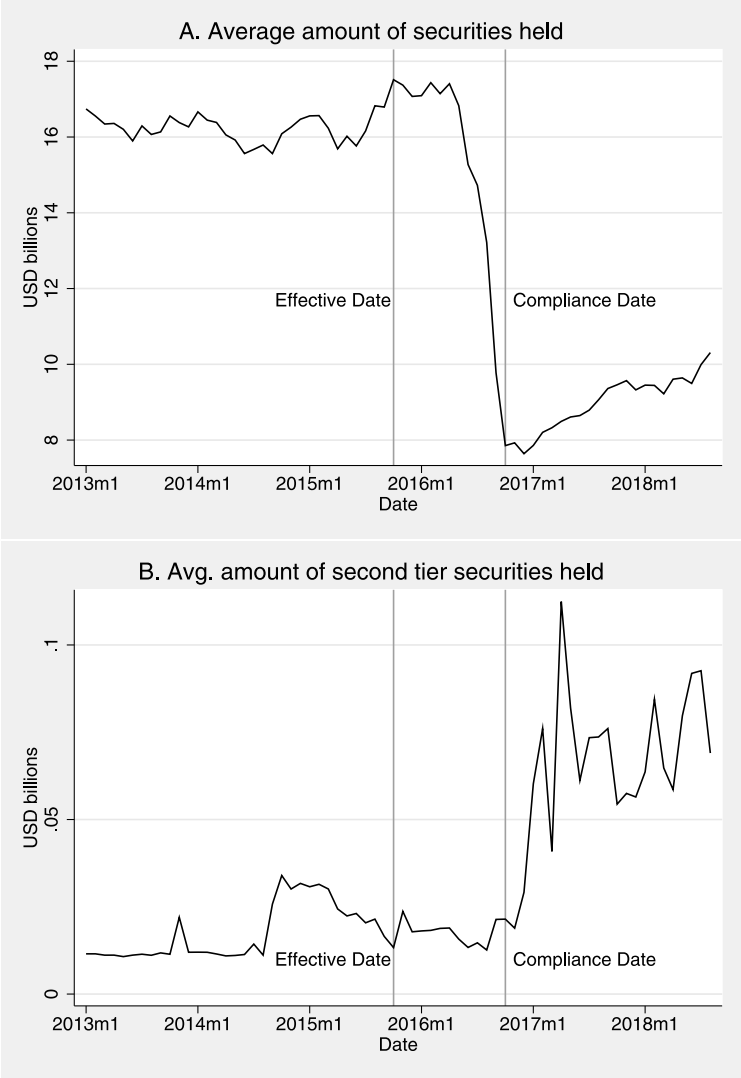

Fig. 1. Assets under management by prime money market funds.
This figure presents the average amount of securities (A) and the average amount of second tier or worse securities (B) held over time by funds in the MMFs balanced dataset. Data are in USD billions. The two vertical lines correspond to October 2015 (the reform of rule 2a-7 becomes effective) and to October 2016 (all non-government MMFs have to comply with the new rule).

month and maturing during the same month in which they are issued are excluded, as it would not be possible to observe whether MMFs effectively purchased them.

This resulting number of usable observations in the dataset is 111,533. This set of observations is referred to henceforth as the commercial paper dataset. Panel A of Table 2 presents some descriptive statistics for the main variables included in the dataset. Unless otherwise specified, all rates, yields, and shares are expressed in percentage points. Definitions of the variables are also summarized in the caption of Table 2.

LNP is the natural logarithm of one plus the total value (in US dollars) of all positions held by all MMFs in that security by the end of the calendar month during which it is issued. The average amount purchased for each security in the dataset (i.e., including securities not purchased) is around USD 6.5 millions. Around 14% of all securities in the dataset have been purchased by at least one fund. The mean of the natural logarithm of one plus the time to maturity at issuance in calendar days ($LNTM$) is 3.54, roughly corresponding to a time to maturity of 34 days.

Short-term ratings at issuance assigned by Moody's, S&P, Fitch, and DBRS are retrieved from Eikon. Ratings are then used to categorize securities following the same procedure described in Section 3.1. ST is an indicator set equal to 1 for securities categorized as second tier or below and set equal to 0 otherwise. Around 58% of the CP in the dataset are categorized as second tier or below. According to official aggregated statistics from the Federal Reserve, during the sample period considered the daily share of second tier CP over all nonfinancial commercial paper outstanding varies between 33% and 95%.[6] The indicator UR^{CRA} is defined for second tier securities only and it is discussed in Section 4.2

3.3. Issuer-level dataset

The pricing models presented in Section 6 are estimated on an issuer-month panel dataset. This panel dataset is constructed considering for each variable in the CP dataset its average value at the issuer-month level. There are 6552 observation in the resulting sample, corresponding to 248 distinct (based on the item TRFiOrgID from Eikon) second tier issuers.

The key outcome of interest is the average spread ($\overline{spread}$) paid at issuance over the reference rate for first tier nonfinancial CP (source:

[6] Data available at https://www.federalreserve.gov/releases/cp/. These data reflect also nonfinancial CP issued by entities other than corporations.

Table 2
CP and issuer-level datasets, descriptive statistics.

Variable	N	Mean	SD	Min	Median	Max
Panel A: Commercial paper cross-sectional dataset						
ST	111533	0.58	0.49	0.00	1.00	1.00
$LNTM$	111533	3.54	0.72	0.69	3.50	6.07
LNP	111533	2.29	5.77	0.00	0.00	21.53
UR^{CRA}	57115	0.15	0.35	0.00	0.00	1.00
Panel B: Second tier issuer-month panel dataset						
$\overline{spread}$	6552	0.35	0.13	0.34	0.02	1.20
$heldST$	6552	0.88	0.87	−0.32	0.76	2.71
$\overline{lntm}$	6552	2.99	0.69	0.69	3.08	5.37
$\overline{vix}$	6552	14.60	3.40	9.40	13.91	34.94
$\overline{level}$	6552	0.47	0.59	0.00	0.20	1.97
$\overline{slope}$	6552	0.05	0.06	−0.21	0.04	0.28
$issuedST$	6552	4.24	0.10	4.03	4.21	4.46
$holding$	6552	24.92	0.45	24.11	25.15	25.49
PD	4507	0.04	0.35	0.00	0.00	8.97

This table presents descriptive statistics for the variables included in the commercial paper dataset (Panel A) and for the issuer-month panel dataset based on second tier CP data (Panel B). ST is an indicator equal to 1 if the security is classified as second tier or below at issuance and zero otherwise. $LNTM$ is the natural logarithm of one plus the time to maturity at issuance (expressed in days). For each security, LNP is the natural logarithm of one plus the total amount held by all MMFs (in US dollars) by the end of the calendar month in which the security is issued. $Spread$ is the difference at issuance between the yield to maturity of the security (source: Thomson Eikon) and the rate for first tier, nonfinancial commercial paper in the same maturity bucket (source: Fed). UR^{CRA} is equal to one when a second tier security is rated as first tier by one credit rating agency (CRA); it is set equal to zero for all the other second tier securities. $\overline{spread}$ is the average for all second tier CP issued by a given firm in a given month of the difference between the yield to maturity paid at issuance by the CP (source: Thomson Eikon) and the reference rate for first tier, nonfinancial CP in the same maturity bucket (source: Fed). $\overline{lntm}$ is the issuer-month average of $LNTM$. PD is the estimated 1-year probability of default for the issuer of the security (source: CRI dataset). $heldST$ is the natural logarithm of the share of second-tier (or below) commercial paper over all nonfinancial commercial papers held by all MMFs measured by the end of the previous month. $issuedST$ is the natural logarithm of the share of second tier over first tier and second tier nonfinancial CP (source: Fed). $holding$ is the natural logarithm of the amount (expressed in US dollars) of nonfinancial CP held by all MMFs. $\overline{level}$, $\overline{slope}$, and $\overline{vix}$ are the issuer-month level averages of, respectively, y_{1m}, $y_{3m} - y_{1m}$, and VIX as observed on the day a CP is issued. Unless otherwise stated, variables are expressed in percentage points. Unless otherwise stated, variables are measured in the last calendar month before the security is issued.

Federal Reserve) of similar maturity. The spread for each individual ST security is computed assigning the CP to one of six possible maturity buckets and matching it with the corresponding official rate. To deal with outliers, the yield to maturity at issuance is winsorized at the 0.1th and 99.9th percentiles before subtracting the reference rate.

The variables $\overline{level}$, $\overline{slope}$, and $\overline{vix}$ are also defined as the average values at the issuer-month level of, respectively, y_{1m}, $y_{3m} - y_{1m}$, and VIX as observed on the day each security is issued. The probability of default (PD) of each issuer is measured using estimates over a 1-year horizon from the CRI database maintained by the National University of Singapore and measured by the end of the previous month. The CRI database contains monthly estimates of PD for 5216 US companies. PD is available for around 69% of the observations in the issuer panel dataset.[7]

The variable $heldST$ represents a proxy for the relative demand of MMFs for second tier CP. It is defined as the logarithm of the share of second tier CP over all nonfinancial CP held by all MMFs. $heldST$ is measured based on the holdings at the end of month $t-1$ as retrieved from the MFP filings. The variable $issuedST$ is defined as the natural logarithm of the share of second tier nonfinancial commercial paper over all first and second tier commercial paper issued over the previous calendar month (source: Federal Reserve). The variable $holding$ is the natural logarithm of the total amount (expressed in US dollars) of nonfinancial CP held by all MMFs based on their MFP filings by the end of the previous month. Descriptive statistics for the issuer panel dataset are presented in Panel B of Table 2.

4. General shift in portfolio allocation around the reform

This section presents the general evidence on the change in the portfolio allocation of MMFs occurring around the reform.

4.1. Money market funds holdings of second tier securities

Table 3 presents coefficient estimates for fixed effects (FE) models of the share of second tier (or below) securities over the total value of the assets held by a MMF. Models (1) to (3) are estimated on the whole MMF dataset. Models (4) and (5) are estimated on the balanced MMF sample. Finally, Model (6) is estimated as a robustness check on a two-period panel dataset (Bertrand et al., 2004); observations in the balanced sample where $During = 1$ are removed and the remaining observations are collapsed into two macro periods ($After = 0$ and $After = 1$) by taking the average value of each variable for each fund and macro period.

All else equal, since the reform funds appear to significantly increase the share of their portfolios allocated to second tier (or worse) securities compared to pre-reform levels. The estimated increase is between 0.4 and 0.7 percentage points, depending on the model; it is always statistically significant at least at the 1% confidence level. To better appreciate the change in portfolio allocation over time, Fig. 2 presents the average $ShareST$ over time for prime funds in the balanced dataset.

Before the reform, the average $ShareST$ fluctuates around 0.2 percentage points, with no clear upward or downward trend. A steep increase starts right after the reform is fully implemented. Importantly, this increase does not appear to be temporary; by August 2018 prime funds still allocate on average around 0.8% of their portfolios to second tier (or worse) securities, well above pre-reform levels. If the verified increase in $ShareST$ could be fully explained by funds prioritizing the sale of first tier securities to cope with the general outflow shown in Fig. 1, then $ShareST$ should reverse to pre-reform levels once large outflows stop and/or virtually all legacy assets mature. Given the very short maturity of the assets held by MMFs and the outflows dynamics described in Cipriani and La Spada (2021), this reversal to pre-reform levels should thus be observable within a couple of months from the completion of the reform. This is not the case.

The Online Appendix presents additional results on the general shift in the portfolio allocation. The increase in $ShareST$ is driven by an increase in the allocation to second tier securities within certain asset

[7] More details on the CRI database can be found at https://rmicri.org/en/.

Table 3
Money market funds holdings of second tier securities.

	Whole			Balanced		$T = 2$
	(1)	(2)	(3)	(4)	(5)	(6)
$After$	0.510***	0.448***	0.444***	0.481***	0.452***	0.685**
	(0.165)	(0.047)	(0.146)	(0.054)	(0.158)	(0.326)
$During$	0.105	0.063**	0.085	0.005	0.053	
	(0.084)	(0.026)	(0.065)	(0.017)	(0.067)	
LNV		−0.001	−0.002	0.075***	0.068**	0.150
		(0.026)	(0.027)	(0.023)	(0.027)	(0.097)
WAM		−0.005**	−0.005**	0.000	−0.000	0.010
		(0.002)	(0.002)	(0.001)	(0.001)	(0.017)
LNC		−0.163***	−0.160***	−0.163***	−0.144***	−0.118
		(0.046)	(0.043)	(0.045)	(0.040)	(0.208)
y_{1m}			0.027		0.087	
			(0.086)		(0.087)	
$y_{3m} - y_{1m}$			−0.173		−0.282	
			(0.451)		(0.459)	
$Premium_{CP}$			−0.123		−0.461	
			(0.420)		(0.457)	
$Premium_{Loan}$			−0.303		−0.254	
			(0.516)		(0.514)	
VIX			−0.003		0.002	
			(0.004)		(0.005)	
Funds FE	Yes	Yes	Yes	Yes	Yes	Yes
N observations	5974	5974	5974	5032	5032	148
N funds	96	96	96	74	74	74
Adj. R^2	0.0398	0.0409	0.0405	0.0460	0.0472	0.1036
Within R^2	0.0401	0.0417	0.0421	0.0470	0.0491	0.1280

This table presents coefficient estimates for a set of models of the share of second tier (or below) securities in the portfolio of prime money market funds. The dependent variable is the portfolio share allocated to second tier (or below) securities ($ShareST$). All models include funds fixed effects. $During$ is an indicator equal to one from October 2015 (when the reform is introduced) and before October 2016 (when all funds have to comply) and zero otherwise. $After$ is an indicator set equal to one from October 2016 onward; it is set equal to zero otherwise. All the other variables are as defined in Table 1. Models (1) to (3) are estimated on the whole sample of prime money market funds. Models (4) and (5) are estimated on a balanced panel dataset including only prime funds observed in every year-month period. Model (6) is estimated on a 2-period (i.e., $After = 0$ and $After = 1$) panel including the same funds of the balanced dataset; observations where $During = 1$ are discarded and all variables are set equal to their sample average for a given fund in each of the two macro periods. Standard errors robust to heteroskedasticity and clustered by year-month are reported in round brackets. *, **, and *** denote statistical significance at the 10%, 5%, and the 1% confidence levels, respectively.

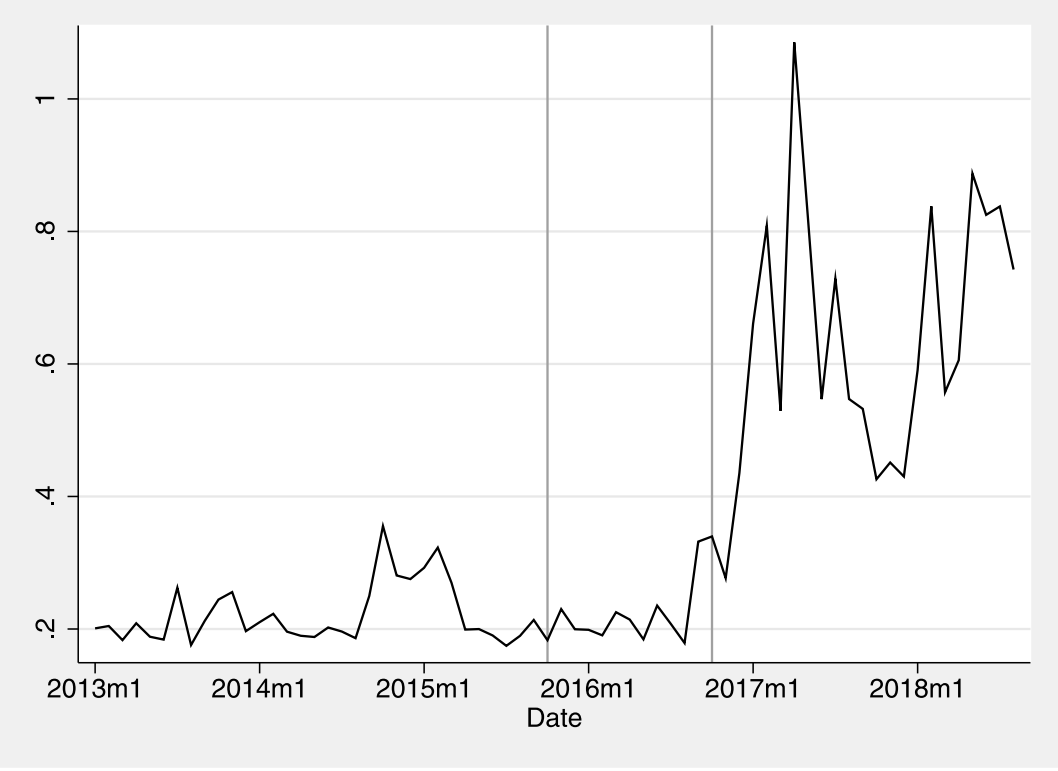

Fig. 2. Allocation to second tier securities by prime money market funds.
This figure presents the average share (in percentage points) invested in securities classified as second tier or below over time for prime funds in the balanced panel dataset. The two vertical lines correspond to October 2015 (the reform of rule 2a-7 becomes effective) and to October 2016 (all non-government MMFs have to comply with the new rule).

Table 4
Investments in underrated second tier securities.

	LNP				$Purchased$
	(1)	(2)	(3)	(4)	(5)
$UR^{CRA} \times After$	−1.461**	−1.140*	−1.235*	−1.144*	−0.073*
	(0.603)	(0.678)	(0.652)	(0.674)	(0.039)
$UR^{CRA} \times During$	−0.194	0.002	0.068	−0.085	−0.002
	(0.456)	(0.485)	(0.394)	(0.476)	(0.030)
$ST \times After$	3.248***	3.210***	3.623***		
	(0.355)	(0.354)	(0.361)		
$ST \times During$	1.548***	1.447***	1.716***		
	(0.328)	(0.325)	(0.323)		
UR^{CRA}	1.253**	0.889	0.676	0.882	0.057
	(0.579)	(0.719)	(0.449)	(0.713)	(0.042)
ST	−5.673***	−5.408***	−4.551***		
	(0.390)	(0.348)	(0.577)		
$LNTM$	−0.363***	−0.473***	−0.603***	−0.475***	−0.029***
	(0.122)	(0.138)	(0.146)	(0.139)	(0.008)
Time indicators	Yes	Yes	Yes	Yes	Yes
Sector indicators	No	Yes	No	Yes	Yes
Issuer indicators	No	No	Yes	No	No
ST × Time indicators	No	No	No	Yes	Yes
No. observations	104314	104314	104314	104314	104314
No. issuers	416	416	416	416	416
Adj. R^2	0.1521	0.1720	0.2694	0.1738	0.1719

This table presents coefficients estimates for models of the investment in nonfinancial commercial paper by money market funds. For Models (1) to (4), the dependent variable is the natural logarithm of one plus the total amount held by all MMFs (in US dollars) by the end of the calendar month in which the security is issued (LNP). For Model (5), the dependent variable is an indicator equal to one if at least one MMF holds the security by the end of the calendar month of issuance ($Purchased$). Models are estimated on the cross-sectional dataset of non financial commercial paper, excluding for ease of interpretation securities classified as below second tier. UR^{CRA} is an indicator set equal to one when $ST = 1$ and there is one rating agency who rates the security as first tier; it is set equal to zero otherwise. By definition, $UR^{CRA} = ST \times UR^{CRA}$. ST × Time Indicators includes the products between ST and each time indicator. All other variables are as defined in Table 2. Standard errors robust to heteroskedasticity and clustered by issuers are reported in round brackets. *, **, and *** denote statistical significance at the 10%, 5%, and the 1% confidence levels, respectively.

classes–most notably nonfinancial commercial paper–rather than by a shift between asset classes. Security-level analyses based on the CP dataset confirm a relatively higher propensity of prime MMFs to buy newly issued second tier (or worse) securities after the reform.

4.2. Independent risk assessment or risk seeking?

The 2015 reform of rule 2a-7 requires MMFs to perform independent credit risk assessments instead of mechanically relying on credit ratings. The verified general shift in the allocation by MMFs to second tier securities may in principle be systematically driven by purchases of second tier CP less risky than its rating-based categorization would imply. The shift could also be driven by MMFs anticipating second tier securities being upgraded to first tier securities due to improving economic conditions.

To assess whether this is the case, I use a Diff-in-Diff-in-Diff (DiDiD) approach and estimate on the security-level CP sample a set of linear models as presented in Eq. (1)

$$LNP_i = \beta_0 + \beta_1 UR_i^{CRA} \times After_t + \beta_2 ST_i \times After_t + \gamma X + \varepsilon_i \quad (1)$$

where UR_i^{CRA} is an indicator set equal to one for "underrated" second tier securities, i.e., securities rated as second tier that could have been classified as first tier; the indicator is set equal to zero otherwise. To identify underrated securities I exploit discording evaluations among different CRAs. In presence of multiple ratings, a security requires a first tier rating by at least two different CRAs to be categorized as first tier. This implies that a security can be categorized as second tier even when one CRA rates it as first tier. As shown by Fracassi et al. (2016), disagreements among CRAs can reflect a systematic upward or downward bias in the ratings assigned by certain analysts to certain securities/issuers. For this reason, a second tier security rated as first tier by at least one CRA can be considered as more likely to be underrated.

UR_i^{CRA} is thus equal to one for second tier securities that are rated as first tier by one CRA.[8] By construction, $UR_i^{CRA} = ST_i \times UR_i^{CRA}$; β_1 thus represents the differential treatment effect on underrated second tier securities vis-à-vis "regular" second tier securities. X is a set of control variables always including UR_i^{CRA}, ST_i, $ST_i \times During_t$, and $UR^{CRA}{}_i \times During_t$.

If the verified change in portfolio allocation is fully driven by funds becoming less reliant on ratings in their risk assessments or anticipating an upgrade for second tier securities, there should be a positive differential treatment effect (only) for second tier securities that are less risky than their rating-based categorization would imply, i.e., $\beta_1 > 0$ but $\beta_2 \leq 0$.

Estimated coefficients for models as described by Eq. (1) are presented in Table 4. For ease of interpretation securities rated below second tier are excluded. For Models (1) to (4) the dependent variable is LNP; Model (5) is a linear probability model for the likelihood that a security is purchased by at least one fund.

The evidence does not seem to support an explanation for the increased demand for second tier securities based on funds performing independent risk assessments or anticipating rating upgrades. The differential treatment effect for underrated second tier securities is negative and statistically significant at customary confidence levels. Using first tier securities as the control group, the estimated post-reform abnormal increase in MMFs investments in regular second tier securities is 3.2–3.6 percentage points; it is only 1.8–2.4 percentage points for underrated second tier securities. The Online Appendix reports additional robustness checks for these analyses, including an assessment of whether MMFs reach for yield (Becker and Ivashina, 2015) less after the reform; results are consistent with those presented in Table 4.

[8] As shown in Table 2, around 15% of second tier securities in the CP dataset are classified as underrated.

Table 5
Treatment effect on monitored funds.

	Whole		Balanced		$T = 2$
	(1)	(2)	(3)	(4)	(5)
$After \times Monitored$	0.602**	0.608**	0.480**	0.540**	0.647**
	(0.293)	(0.277)	(0.225)	(0.232)	(0.253)
$During \times Monitored$	0.114	0.106	−0.005	0.017	
	(0.157)	(0.145)	(0.053)	(0.061)	
$After \times Bounded$	1.247	1.257	1.145	1.114	1.223
	(0.978)	(0.984)	(1.044)	(1.060)	(1.042)
$During \times Bounded$	−0.339	−0.338	−0.368**	−0.366**	
	(0.215)	(0.217)	(0.160)	(0.174)	
LNV		−0.004		0.064	0.120
		(0.046)		(0.067)	(0.100)
WAM		−0.002		0.002	0.020
		(0.005)		(0.004)	(0.018)
LNC		−0.245*		−0.260*	−0.307
		(0.141)		(0.142)	(0.241)
Funds FE	Yes	Yes	Yes	Yes	Yes
Time indicators	Yes	Yes	Yes	Yes	Yes
N observations	5974	5974	5032	5032	148
N funds	96	96	74	74	74
Adj. R^2	0.0834	0.0846	0.1062	0.1098	0.2471
Within R^2	0.0943	0.0959	0.1188	0.1229	0.2778

This table presents coefficient estimates for a set of models of the share of second tier (or below) securities in the portfolio of prime money market funds. The dependent variable is the portfolio share allocated to second tier (or below) securities ($ShareST$). All models include funds fixed effects. Time indicators are at the year-month level. All variables are as defined in Tables 1 and 3. Models (1) and (2) are estimated on the whole sample of prime money market funds. Models (3) and (4) are estimated on a balanced panel dataset including only prime funds observed in every year-month period. Model (5) is estimated on a 2-period (i.e., $After = 0$ and $After = 1$) panel including the same funds of the balanced dataset; observations where $During = 1$ are discarded and all variables are set equal to their sample average for a given fund in each of the two macro periods. Standard errors robust to heteroskedasticity and clustered by funds are reported in round brackets. *, **, and *** denote statistical significance at the 10%, 5%, and the 1% confidence levels, respectively.

5. Monitoring and shift in portfolio allocation

The results presented so far demonstrate a general increase in the demand by MMFs for second tier securities around the introduction of the reform. The analyses presented in this section test the specific role played by the removal of rating-based rules and the associated information in explaining this shift. Section 5.1 presents the results for the baseline models estimating the treatment effect of the reform on monitored funds. Several robustness checks for these main results are presented in the rest of the section.

5.1. Baseline DiD models

To estimate the treatment effect of the reform on funds subjected to an above-median level of information acquisition before the reform, I estimate a set of baseline DiD models as presented in Eq. (2)

$$ShareST_{f,t} = \alpha_f + \beta_1 After_t \times Monit_f + \beta_2 Dur_t \times Monit_f + \sum_s \gamma_{1,s} I_t^{(s)} + \sum_c \gamma_{2,c} X_{f,t}^{(c)} + \epsilon_{f,t} \quad (2)$$

where $I_t^{(s)}$ is an indicator equal to one if month t is in period s; and $X_{f,t}^{(c)}$ is a control variable varying at the fund- and month-level. To account for the effect of the reform on funds possibly bounded by the 3% threshold, control variables include $After \times Bounded$ and $During \times Bounded$.

The theorized information channel predicts a positive treatment effect of the reform on the allocation to second tier securities by monitored funds vis-à-vis other prime funds (i.e., $\beta_1 > 0$). The channel postulates that monitored funds are more likely to have been constrained in their pre-reform risk taking by the monitoring activity of the investors. Their pre-reform allocation is thus more likely to reflect a constrained choice. The pre-reform allocation of a completely unmonitored fund would instead reflect its desired allocation absent any monitoring constraint. To the extent that the reform weakens this monitoring constraint, monitored funds are thus expected to increase their allocation to second tier securities more than funds already unconstrained.

Estimated coefficients for these DiD models are presented in Table 5. Model (3) and (4) are specified as Models (1) and (2), respectively, but estimated on a balanced panel dataset including only funds observed every month from January 2013 to August 2018. Model (5) is estimated as a robustness check on a two-period panel sample that collapses all the time series information into a pre-reform period and a post-reform period (Bertrand et al., 2004). All reported models include funds and time fixed effects.

As predicted, the estimated coefficient for $After \times Monitored$ is always positive and statistically significant at customary confidence levels. All else equal, since the reform funds more likely to have been constrained by the monitoring activity of investors increase the share allocated to second tier securities by around 0.6 percentage points (p.p.) more than otherwise similar funds. This treatment effect is economically relevant when compared to the average allocation to second tier securities observed before the reform (around 0.2 p.p.).

Consistent with the trends illustrated in Figs. 1 and 2, the treatment effect fully materializes only once the reform is completed; the estimated coefficient for $During \times Monitored$ is (generally) positive but not statistically different from zero at customary confidence levels. The estimated coefficient for $After \times Bounded$ is positive and large, albeit not statistically significant at customary confidence levels. Some funds may have been effectively constrained in their risk taking by the 3% threshold in place before the reform.

As a non-parametric test for the common trend assumption, Fig. 3 presents the evolution over time of the average share allocated to second tier securities by funds with $Monitored = 1$ and funds with $Monitored = 0$. To better contrast these two groups over time, bounded funds and funds not included in the balanced dataset are excluded.

Neither group of funds exhibits an upward or downward trend in their allocation to second tier securities before the reform. The two trends start to diverge remarkably only by the time the implementation of the reform is completed.

5.2. Voluntary information disclosure

The information channel predicts a positive treatment effect on monitored funds because the reform increases the *cost* associated with

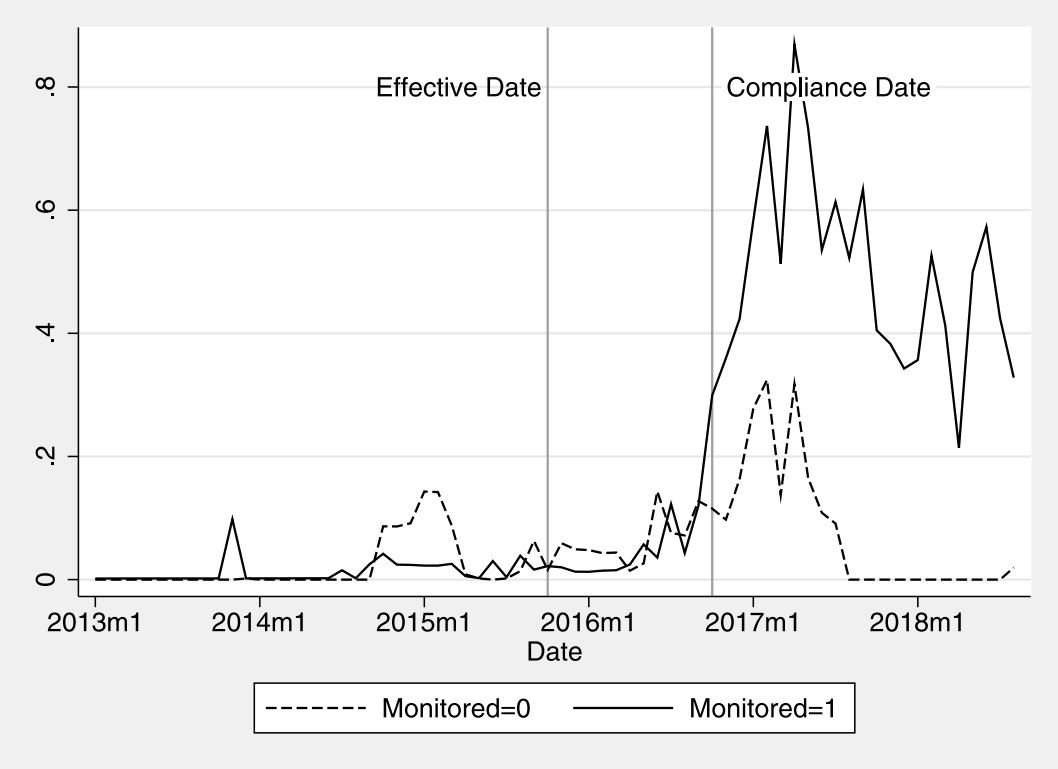

Fig. 3. Allocation to second tier securities by monitored vs. non-monitored funds.
This figure presents the average share (in percentage points) invested in securities classified as second tier or below over time for monitored (continuous line) and non-monitored (dashed line) non-bounded prime funds in the balanced panel dataset. The two vertical lines correspond to October 2015 (the reform of rule 2a-7 becomes effective) and to October 2016 (all MMFs have to comply with the new rule).

monitoring a fund's portfolio allocation. The reform of rule 2a-7 may affect also the *value* for investors of adequately monitoring MMFs.

The 2014 reform gives non-government MMFs the possibility to discourage or stop altogether investors from running the fund by introducing redemptions fees and redemption gates. This change may increase or decrease the incentives for the investors to adequately monitor a fund. On the one hand, there is a strong first-move advantage when running an open-end fund (e.g., Chen et al., 2010). This could contribute to the incentives for individual investors to effectively monitor the portfolio allocation of a fund. The possibility to block or strongly discourage a run may thus hamper these monitoring incentives.

On the other hand, investors who fear a potential suspension of convertibility may actually have stronger incentives to effectively monitor a fund after the reform (Cipriani and La Spada, 2020). To the extent that the first argument dominates, the potential incentive channel linked to the introduction of redemption fees and gates may be a valid alternative explanation for the verified positive treatment effect on monitored funds.

To disentangle this potential incentive channel from the information channel, I exploit the fact that after the reform MMFs can still decide to report the credit ratings assigned by CRAs to individual securities. If the treatment effect of the reform on monitored funds operates (also) via the information channel, this voluntary information disclosure should not be irrelevant. In particular, the treatment effect on monitored funds should be weaker for those monitored funds that keep systematically reporting credit ratings in their MFP filings.

I test this conjecture by estimating DiDiD models including a triple interaction term between $Disclosure$, $Monitored$, and $After$. $Disclosure$ is an indicator identifying funds still voluntarily reporting credit ratings for at least 95% of the rated securities in their portfolios on average. Based on this definition, 33 funds continue to systematically provide credit ratings information to the investors after the reform.[9]

The estimated coefficient for the aforementioned triple interaction is expected to be negative. To the extent that the reform operates (also) via the information channel, the treatment effect should be weaker (or even null) when investors can still easily observe the fund's allocation in terms of credit ratings. Estimated coefficients for these DiDiD models are reported in Table 6.

Consistent with the information channel, disclosing monitored funds increase their allocation to second tier securities significantly less than other monitored funds. The estimated coefficient for $After \times Monitored \times Disclosure$ is negative and statistically significant at the 10% confidence level.

The positive treatment effect of the reform on monitored funds is fully driven by non-disclosing funds; the latter increase their allocation to second tier securities by around 1 p.p. more than non-disclosing, non-monitored funds. This estimated treatment effect is almost twice as large as the treatment effect estimated with the baseline models. The total estimated treatment effect on disclosing monitored funds (i.e., the sum of the estimated coefficients for $After \times Monitored \times Disclosure$ and $After \times Monitored$) is very small and not statistically different from zero at customary confidence levels.

The decision by a fund to keep reporting credit ratings after the reform is of course unlikely to be exogenous. $Disclosure$ appears however to have a negative effect only on monitored funds. The estimated coefficient for $After \times Disclosure$ is positive, albeit not statistically significant at customary confidence levels. If unobserved factors unrelated

[9] The 95% threshold has been chosen balancing the need for a strict definition of systematic disclosure and the need to identify a minimum number of disclosing funds. Alternative thresholds produce consistent results.

Table 6
Rating disclosure and change in allocation.

	Whole		Balanced		$T = 2$
	(1)	(2)	(3)	(4)	(5)
$After \times Monitored \times Disclosure$	−1.126*	−1.117*	−0.866*	−0.866*	−0.874*
	(0.572)	(0.567)	(0.509)	(0.500)	(0.478)
$After \times Monitored$	1.140**	1.143**	0.904**	0.959***	1.050***
	(0.476)	(0.454)	(0.351)	(0.352)	(0.366)
$After \times Disclosure$	0.088	0.076	0.140	0.152	0.229
	(0.204)	(0.207)	(0.212)	(0.210)	(0.222)
During interactions	Yes	Yes	Yes	Yes	No
Bounded interactions	Yes	Yes	Yes	Yes	Yes
Other controls	No	Yes	No	Yes	Yes
Funds FE	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes
N observations	5974	5974	5032	5032	148
N funds	96	96	74	74	74
Adj. R^2	0.1045	0.1057	0.1244	0.1278	0.2746
Within R^2	0.1158	0.1173	0.1375	0.1413	0.3141

This table presents coefficient estimates for a set of models of the share of second tier (or below) securities in the portfolio of money market funds. The dependent variable is the portfolio share allocated to second tier (or below) securities ($ShareST$). All models include funds and month-year fixed effects. $Disclosure$ identifies those funds that keep systematically reporting credit ratings after the reform. $Disclosure$ is set equal to one for funds reporting ratings on average for 95% of more of the securities held after the reform; the indicator is set equal to zero otherwise. During interactions include the three cross products of $During$ with $Disclosure$, with $Monitoring$, and with both. Bounded interactions include the two cross products of $Bounded$ with $After$ and with $During$. Other controls include LNV, WAM, and LNC. All other variables are as defined in Tables 1 and 5. Models (1) and (2) are estimated on the whole sample of prime money market funds. Models (3) and (4) are estimated on a balanced panel dataset including only prime funds observed in every year-month period. Model (5) is estimated on a 2-period (i.e., $After = 0$ and $After = 1$) panel including the same funds of the balanced dataset; observations where $During = 1$ are discarded and all variables are set equal to their sample average for a given fund in each of the two macro periods. Standard errors robust to heteroskedasticity and clustered by funds are reported in round brackets. *, **, and *** denote statistical significance at the 10%, 5%, and the 1% confidence levels, respectively.

to the information channel could explain a negative relation between disclosure and risk taking, one would expect this relation to hold also for non-monitored funds.

A more likely source of endogeneity is that both the observed allocation and the decision to report ratings depend on a fund's unobservable propensity to undertake more risk. Similarly, the observed allocation to second tier securities could be thought of as causing the decision to not disclose credit ratings. If these forms of endogeneity drive the results presented in Table 6, the latter indicate that monitored funds who are inclined to undertake more risk decide to avoid reporting credit ratings once the reform allows them to take this decision. This interpretation of the results is fully consistent with the theorized information channel.

5.3. Credit risk exposure versus interest rate risk exposure

The introduction of redemption fees and gates also renders the shares of non-government MMFs less money-like. Cipriani and La Spada (2021) show that the difference between the yield offered by prime MMFs versus government MMFs increases after the reform; prime MMFs need to compensate their investors for the reduction in the money-likeness of their shares. MMFs may decide to meet this goal also by increasing their holdings of second tier securities. If this mechanism affects monitored funds more than it affects the other prime MMFs, it could explain the results from the baseline models presented in Table 5.

To partially address this concern, I investigate whether monitored funds appear to also increase their exposure to interest rate risk more than other prime funds. Both credit risk exposure and interest risk exposure allow in principle to achieve higher (non risk-adjusted) returns. However, the reform can affect via the information channel only the share allocated to second tier securities; the weighted-average maturity of the assets held by the fund remains directly observable by the investors after the reform. Table 7 reports estimated coefficients for models of the level of interest risk exposure as proxied by the weighted-average maturity of the assets held by the fund.

There is no evidence of a positive treatment effect on the exposure to interest rate risk for monitored funds vis-à-vis other non-government funds; the estimated coefficient for $After \times Monitored$ is always negative. To account for a possible substitution effect between credit risk exposure and interest rate risk exposure, $ShareST$ is included among the fund-level control variables. The estimated coefficient is generally positive; funds on average do not seem to substitute between interest rate risk exposure and credit risk exposure. This further supports an information-based interpretation of the difference between the shift in credit risk exposure and the shift in interest rate risk exposure for monitored funds.

It is important to stress that these results should not be interpreted as evidence against a material impact of removing redemption fees and gates on the behavior of MMFs. The evidence presented in Tables 6 and 7 simply indicates that the removal of rating-based rules and the associated information is likely to play an important role in explaining why MMFs specifically increase their allocation to second tier securities.

5.4. Retail versus institutional funds

The 2014 reform forces funds who intend to serve institutional investors to price their shares using the actual net asset value (NAV) per share. Baghai et al. (2022) argue that this change can drive an increase in the risk-taking by institutional MMFs because it increases the sensitivity of money inflows to performances. If the introduction of a floating NAV is the only explanation for the verified increase in risk taking by monitored MMFs, the results presented in Table 5 should then be entirely driven by institutional monitored funds.

The effect of the reform via the information channel is instead predicted to be stronger for retail monitored funds: An increase in the cost of monitoring arguably affects (unsophisticated) retail investors more than institutional investors. To control for this specific change in rule 2a-7, I thus re-estimate the baseline models separately for prime funds who opt for a retail status (33 funds) and for funds who opt for an institutional status (63 funds) after the reform. The results are presented in Rows (1) and (2) of Table 8.

The results are fully consistent with the information channel. The treatment effect on monitored funds is positive and statistically significant at the 5% confidence level when the model is estimated on the

Table 7
Change in interest rate risk exposure.

	Whole		Balanced		$T = 2$
	(1)	(2)	(3)	(4)	(5)
$After \times Monitored$	−3.395	−2.500	−3.366	−2.424	−3.048
	(2.090)	(2.066)	(2.274)	(2.386)	(2.436)
$During \times Monitored$	−5.456***	−5.444***	−5.763***	−5.715***	
	(1.713)	(1.690)	(1.907)	(1.907)	
$After \times Bounded$	−3.575	−4.241	−3.428	−4.806	−5.985*
	(2.808)	(2.825)	(3.060)	(3.160)	(3.318)
$During \times Bounded$	−3.131**	−3.347**	−2.737	−2.919	
	(1.511)	(1.571)	(1.751)	(1.768)	
LNV		1.111***		1.553*	1.073
		(0.259)		(0.813)	(1.189)
LNC		−4.064*		−2.717	−2.086
		(2.270)		(3.014)	(4.206)
$ShareST$		−0.086		0.170	1.436
		(0.216)		(0.260)	(0.943)
Funds FE	Yes	Yes	Yes	Yes	Yes
Time indicators	Yes	Yes	Yes	Yes	Yes
N observations	5974	5974	5032	5032	148
N funds	96	96	74	74	74
Adj. R^2	0.4626	0.4814	0.4601	0.4694	0.6406
Within R^2	0.4690	0.4878	0.4677	0.4772	0.6552

This table presents coefficient estimates for a set of models of the weighted average maturity of securities in the portfolio of prime money market funds. The dependent variable is the weighted average maturity of a fund's portfolio, expressed in days (WAM). All models include funds and month-year fixed effects. All other variables are as defined in Table 1. Models (1) and (2) are estimated on the whole sample of non-government money market funds. Models (3) and (4) are estimated on a balanced panel dataset including only funds observed in every year-month period. Model (5) is estimated on a 2-period (i.e., $After = 0$ and $After = 1$) panel including the same funds of the balanced dataset; observations where $During = 1$ are discarded and all variables are set equal to their sample average for a given fund in each of the two macro periods. Standard errors robust to heteroskedasticity and clustered by funds are reported in round brackets. *, **, and *** denote statistical significance at the 10%, 5%, and the 1% confidence levels, respectively.

Table 8
Treatment effect on monitored funds, additional evidence.

$After \times Monitored$:	Coeff.	SE	N obs	Within R^2
(1) Retail only	1.348**	(0.526)	2213	0.2128
(2) Institutional only	0.019	(0.234)	3761	0.0581
(3) Stable	2.005***	(0.508)	612	0.6178
(4) All non-government	0.480**	(0.200)	17251	0.1158
(5) No unrated	0.779**	(0.364)	5974	0.1094
(6) No DEG	0.947**	(0.367)	5919	0.1276
(7) Size control	0.632**	(0.312)	5974	0.0966
(8) Full interactions	0.802**	(0.388)	5974	0.1217

This table presents the estimated treatment effect of the reform on monitored funds (i.e., the estimated coefficient for $After \times Monitored$) for a set of models for the allocation to second tier (or below) securities ($ShareST$) including the same explanatory variables of Model (2) of Table 5. Each row corresponds to a different model. Models (1) and (2) are estimated on a sample including respectively only funds that opt for a retail fund classification after the reform or only funds that opt for an institutional fund classification. Model (3) is estimated on a sample including only prime funds whose total gross assets do not change by more than 5% between September 2015 (just before the reform is introduced) and November 2016 (right after the implementation of the reform is completed). Model (4) includes also non-prime, non-government funds. Model (5) is estimated using as the dependent variable a proxy for the share of second tier (or worse) securities computed excluding all unrated securities. For Model (6) the dependent variable is defined as the share of second tier (or worse) securities computed excluding all holdings with a Demand feature, Enhancement, or Guarantee (DEG); only observations where non-DEG holdings constitute at least 20% (by value) of the portfolio are included in the sample. Model (7) includes interaction terms of $During$ and $After$ with an indicator set equal to one for funds that before the reform are in the top 25% of prime funds by average amount of gross assets. Model (8) includes the six interaction terms of $During$ and $After$ with LNV, WAM, and LNC. All variables are as defined in Tables 1 and 5. Standard errors robust to heteroskedasticity and clustered by funds are reported in round brackets. *, **, and *** denote statistical significance at the 10%, 5%, and the 1% confidence levels, respectively.

sample including only funds that opt to serve retail investors after the reform. The estimated coefficient for $After \times Monitored$ is instead small and not statistically different from zero at customary confidence levels for the other funds.

5.5. Other alternative explanations and robustness checks

Cipriani and La Spada (2021) document that several non-government funds exit the industry in response to the 2014 reform. If funds exiting the industry are systematically less likely to invest in second tier securities, the baseline results could in principle be affected by a survivorship bias. The evidence obtained by estimating the models on the balanced MMFs dataset, shown in Tables 5 and 6, seems to rule out this possibility: estimated coefficients and their standard errors are very similar to those obtained estimating the models on the whole sample.

The 2014 reform also leads to a significant decrease in the AUM of funds that do not exit the industry. In principle these outflows could be systematically driven by the most risk-averse investors especially for monitored funds. If the average level of risk tolerance of investors in monitored funds increases compared to the risk tolerance of investors in other funds, this could explain the larger increase in the allocation to second tier securities by monitored funds. To partially control for this possibility, akin to Cipriani and La Spada (2021) I restrict the sample to those funds whose total assets do not change by more than 5% from September 2015 to November 2016. As shown in Row (3) of Table 8, the estimated treatment effect for monitored funds is statistically significant at the 1% confidence level in this case.

Rows (4) to (8) of Table 8 present additional robustness checks for the main results presented in Table 5. The model in Row (4) is

estimated re-including in the sample all non-prime non-government MMFs excluded from the general analyses.[10] Row (5) presents a model estimated using an alternative proxy for the share of second tier (or worse) securities computed excluding unrated securities.

In the model presented in Row (6) the dependent variable is computed excluding any security with a Demand feature, Enhancement, or Guarantee (DEG). Even before the reform, the classification of DEG holdings implies a certain degree of discretion for the funds, as the credit quality of the provider of such features can be taken into account. This does not entail that DEG holdings are more likely to be classified as first tier: before the reform 1.76% of DEG fund-month-security observations are classified by the funds as second tier, against 0.56% for pre-reform observations where none of these features is present. Nonetheless the post-reform, rating-based classification of DEG holdings could in principle differ systematically from the (unobservable) classification that funds themselves would have done of those holdings.

As a further check on the possible confounding role of the (pre-reform) size of a fund, the model presented in Row (7) includes as additional control variables the interaction term of $After$ (and $During$) with an indicator set equal to one for funds in the top 25% by pre-reform average amount of assets under management and set equal to zero otherwise. Finally, the model presented in Row (8) includes six additional control variables obtained interacting the three fund-level control variables (LNV, LNC, and WAM) with the two indicators for the introduction of the reform ($After$ and $During$). Results from these additional robustness checks are fully consistent with those obtained with the baseline models. The estimated treatment effect of the reform on monitored funds is always positive and statistically significant at least at the 5% confidence level.

5.6. Risk taking and assets under management

If investors do pay attention to credit ratings before the reform but less so once ratings become less immediate to observe, and if the verified change in the portfolio allocation of MMFs is a rational reaction to this change in information immediacy, there should be a significant shift in the relation between the share allocated to second tier securities by a fund and its net inflows.

To test if this is the case, I estimate models of the percentage monthly growth of the gross assets held by a fund. The key explanatory variables of interest are the 1-month lag of $ShareST$ and its interaction with $After$. Before the reform, (monitored) funds should experience a decrease in size when increasing their allocation to second tier securities if investors do pay attention to ratings. The estimated coefficient for $ShareST$ should thus be negative.

The estimated coefficient for $ShareST \times After$ is instead expected to be positive: after the reform an increase over time in the allocation to second tier (or worse) securities should be associated on average with a smaller decrease (or a larger increase) in the size of the fund. Estimated coefficients are reported in Table 9.

Models (1) and (2) include the 1-month lag of the dependent variable. Models (3) to (6) include funds FE. A fund's growth is of course affected by its returns; to control for the latter, all models include the 1-month lag of the annualized 7-day yield as a control variable. For Models (1) to (4), the estimated coefficient for $ShareST$ is negative and statistically significant at the 5% confidence level. Before the reform, a fund increasing its allocation to securities classified as second tier would experience on average a decrease in net inflows. This result is driven as expected by monitored funds (Model (5)); for non-monitored funds (Model (6)), the pre-reform conditional correlation between (past) allocation and size is smaller and not statistically significant. This piece of evidence is highly consistent with the idea that monitoring investors do pay attention to credit ratings before the reform.

After the reform, the negative conditional correlation between the share allocated to second tier securities and the size of a fund is no longer in place. The estimated coefficient for $After \times ShareST$ is positive and statistically significant at the 5% confidence level when considering all funds in the balanced sample as well as monitored funds only. More importantly, the sum of the estimated coefficient for $After \times ShareST$ and the estimated coefficient for $ShareST$ is never significantly different from zero at customary confidence level. After the reform, a fund increasing its allocation to second tier securities no longer appears to get penalized by the investors. This result is once again highly consistent with the theorized information channel.

6. Implications for credit risk premia

Analyses presented in previous sections show that the reform is associated with an increase in the relative demand for second tier securities by MMFs. Does this shift produce clientele effects on the market price of credit risk? To answer this question I estimate pricing models as the one presented in Eq. (3)

$$\Delta\overline{spread}_{i,t} = \alpha + \beta_1 \Delta heldST_{t-1} + \sum \gamma_j \Delta X^j_{i,t} + \sum \gamma_q \Delta Z^q_{t-1} + \varepsilon_{i,t} \quad (3)$$

where Δ is the first difference operator. The models are estimated on the issuer panel sample described in Section 3.3. The dependent variable $\overline{spread}$ is the average value of the spread paid by CP issued by second tier issuer i in a given month t over the official reference rate for first nonfinancial CP of similar maturity.[11] Most control variables at the issuer-month level (X^j) are similarly defined as averages of values observed at issuance. The key explanatory variable of interest, $\Delta heldST$, proxies for the change over time in the aggregate relative demand of MMFs for second tier CP. To reduce endogeneity, $\Delta heldST$ is lagged by one month, i.e., it represents the change during $t-1$ in (the logarithm of) the share of second tier securities over all nonfinancial CP held by MMFs. The same lag is applied to other control variables varying only over time (Z_j). Estimated coefficients for these pricing models are reported in Table 10. Statistical significance is assessed using Newey and West (1987) standard errors robust to autocorrelation with lags up to 18 months.

Model (1) is the most parsimonious, controlling only for the maturity at issuance of commercial paper and for market yields and volatility as on the day of issuance. Model (2) includes $\Delta issuedST$ to control for changes in the relative supply of second tier securities and $\Delta holding$ to control for changes in the size of the MMFs industry. Model (3) controls for changes in credit risk at the issuer-month level, as proxied by changes in PD and its square (PD^2); Covitz and Downing (2007) find credit quality to be the most important determinant of the spreads paid by commercial paper. Model (3) also includes $After$ to allow for a potential structural shift in average credit premia occurring at the same time the reform takes place. Model (4) controls for the 1-month lag of the dependent variable. Finally, Models (5) and (6) are specified, respectively, as Models (1) and (3) but include also issuer FE.

Regardless of the model considered, results point toward a significant negative conditional correlation between the change in relative demand by MMFs for second tier nonfinancial CP and the change in the spread paid at issuance by second tier issuers. All else being equal, a 1% increase in $heldST$ is associated with a reduction in credit spreads paid at issuance of 0.01–0.02 basis points (bps). The average share of

[10] As a further check, the analyses presented in Sections 5.2, 5.3, and 5.4 have also been repeated considering all non-government MMFs. Results are largely aligned with those presented in the paper.

[11] Results obtained log-transforming $\overline{spread}$ (unreported) are fully consistent with those presented in Table 10. Consistent results are also found when estimating the pricing model in levels on the cross-sectional dataset of CP observed at issuance.

Table 9
Money market funds holdings and size.

	Whole				$Mon = 1$	$Mon = 0$
	(1)	(2)	(3)	(4)	(5)	(6)
$After \times ShareST_{t-1}$	0.025**	0.027*	0.053***	0.040**	0.049**	0.029
	(0.010)	(0.016)	(0.016)	(0.017)	(0.021)	(0.027)
$During \times ShareST_{t-1}$	0.020	0.021	0.058***	0.045**	0.047**	0.095***
	(0.014)	(0.018)	(0.019)	(0.019)	(0.023)	(0.032)
$ShareST_{t-1}$	−0.030***	−0.031**	−0.050***	−0.038**	−0.048**	−0.020
	(0.010)	(0.015)	(0.015)	(0.016)	(0.018)	(0.028)
$Yield_{t-1}$	0.075***	0.131	−0.074**	−0.755	0.005	−0.149**
	(0.022)	(0.299)	(0.036)	(0.566)	(0.049)	(0.071)
Lag	0.011***	0.010***				
	(0.002)	(0.003)				
WAM_{t-1}	−0.003***	−0.003***	−0.002	−0.002	−0.001	−0.005**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
LNC_{t-1}	−0.042***	−0.043***	0.014	0.008	0.076	−0.090*
	(0.015)	(0.014)	(0.045)	(0.047)	(0.077)	(0.047)
Funds FE	No	No	Yes	Yes	Yes	Yes
Time indicators	Yes	Yes	Yes	Yes	Yes	Yes
Other interactions	No	Yes	No	Yes	No	No
N observations	5950	5950	5962	5962	3136	2826
N funds	96	96	96	96	49	47
Adj. R^2	0.0609	0.0606	0.0610	0.0611	0.0172	0.1282
Within R^2			0.0725	0.0729	0.0400	0.1508

This table presents coefficient estimates for a set of models of the growth of money market funds. The dependent variable is *Growth*, defined as the percent change in the assets held by the fund from the previous period, expressed in percentage points. $Yield$ is the 7-day gross yield paid by the fund (item A.19 of the MFP2 filings), expressed in decimal points. Lag is the one-month lag of *Growth*. Other interactions include the interactions of $Yield$ and (if included in the model) of Lag with $After$ and *During*. Models (1) to (4) are estimated on the whole sample of prime MMFs. Models (5) and (6) are estimated, respectively, on the sub-sample of monitored funds and on the sub-sample of non-monitored funds. Time indicators are at the year-month level. All other variables are as defined in Table 1; fund-level variables are as measured with a 1-month lag. Standard errors robust to heteroskedasticity and clustered by funds are reported in round brackets. *, **, and *** denote statistical significance at the 10%, 5%, and the 1% confidence levels, respectively.

Table 10
Money market funds holdings and credit premia.

	(1)	(2)	(3)	(4)	(5)	(6)
$\Delta held ST_{t-1}$	−0.011***	−0.019***	−0.020***	−0.016***	−0.010***	−0.017***
	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
$\Delta\overline{lntm}$	0.038***	0.038***	0.035***	0.033***	0.039***	0.035***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$\Delta\overline{vix}$	−0.001***	−0.001**	−0.001**	−0.001**	−0.001***	−0.001**
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\Delta\overline{level}$	0.127***	0.119***	0.125***	0.131***	0.140***	0.212***
	(0.014)	(0.014)	(0.016)	(0.016)	(0.015)	(0.023)
$\Delta\overline{slope}$	−0.040*	−0.053**	−0.041	−0.019	−0.032	0.017
	(0.021)	(0.021)	(0.026)	(0.025)	(0.022)	(0.028)
$\Delta issued ST_{t-1}$		0.140***	0.183***	0.186***		0.178***
		(0.013)	(0.016)	(0.015)		(0.016)
$\Delta holding_{t-1}$		0.003	0.023***	0.017*		0.018**
		(0.007)	(0.009)	(0.009)		(0.009)
ΔPD_{t-1}			0.050**	0.053**		0.045**
			(0.021)	(0.021)		(0.022)
ΔPD^2_{t-1}			−0.004*	−0.004**		−0.004
			(0.002)	(0.002)		(0.002)
Lag				−0.169***		
				(0.013)		
Constant	−0.000	−0.000	−0.000	−0.000		
	(0.001)	(0.001)	(0.001)	(0.001)		
Issuer FE	No	No	No	No	Yes	Yes
N observations	6552	6552	4501	4501	6543	4496
N issuers	248	248	170	170	239	165
Adj. R^2	0.0775	0.0946	0.1016	0.1359	0.0444	0.0740

This table presents the coefficients for a pricing model as the one presented in Eq. (3) estimated on an issuer-month panel dataset obtained collapsing the cross section of second tier commercial paper at the issuer-month level. Δ is the first difference operator. The dependent variable, $\Delta\overline{spread}$, is the monthly change in the average spread paid by second tier CP issued by a given firm over the reference rate on the day of issuance for first CP of similar maturity. The key explanatory variable of interest, $\Delta held ST$, is the monthly change over $t-1$ in the natural logarithm of the share of second tier CP over all the CP held by MMFs. Lag is the 1-month lag of $\Delta\overline{spread}$. $After$ is an indicator set equal to one from October 2016 onward; it is set equal to zero otherwise. All the other variables included in the model are first differences of the variables presented in Table 2. Newey and West (1987) standard errors robust to autocorrelation up to 18 lags are presented in round brackets; the bandwidth is selected following Newey and West (1994). *, **, and *** denote statistical significance at the 10%, 5%, and the 1% confidence levels, respectively.

second tier securities over all nonfinancial CP held by MMFs more than doubled from before to after the reform, from 2.1% to 6.9%.

Everything else equal, the model thus predicts a reduction in credit spreads associated to the change in allocation by MMFs seen around

the reform of roughly 2–5 basis points. This amount is economically relevant: it represents around 10% of the sample average of $\overline{spread}$. The sign of the estimated coefficients for the control variables is largely as expected, e.g., credit spreads increase with credit risk, with time to maturity, and with the relative supply of second tier securities.

7. Conclusions

The 2015 reform of rule 2a-7 removes any reference to ratings assigned by credit rating agencies (CRAs) in determining whether a certain security is an eligible asset for US money market funds (MMFs). Funds are no longer requested nor allowed to report to investors a standardized (i.e., rating-based) classification in terms of credit risk of the securities held in their portfolios. Removing this clear-cut and easily observable measure of credit risk exposure increases the cost of monitoring for investors. This information channel contributes to explain the average increase in the share of MMFs' portfolios allocated to securities rated as second tier that is observed around the reform. These results suggest that policy makers should be wary of the risks of removing standardized rules and the associated information; absent a credible alternative, using ratings assigned by CRAs may be the lesser of two evils.

The verified shift in the portfolio allocation of MMFs has important consequences not only for the general level of exposure to credit risk of MMFs. The change in the relative demand for second tier securities by MMFs appears also to produce economically and statistically significant clientele effects on the price of credit risk for short-term securities.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

Appendix A. Supplementary data

Supplementary material related to this article can be found online at https://doi.org/10.1016/j.jfi.2022.101016.

References

Baghai, R., Giannetti, M., Jäger, I., 2022. Liability structure and risk-taking: Evidence from the money market fund industry. J. Financ. Quant. Anal. 57 (5), 1771–1804.

Becker, B., Ivashina, V., 2015. Reaching for yield in the bond market. J. Finance 70 (5), 1863–1902.

Becker, B., Opp, M.M., Saidi, F., 2022. Regulatory forbearance in the US insurance industry: The effects of eliminating capital requirements. Rev. Financ. Stud. 35 (12), 5438–5482.

Bertrand, M., Duflo, E., Mullainathan, S., 2004. How much should we trust differences-in-differences estimates? Q. J. Econ. 119 (1), 249–275.

Bongaerts, D., Cremers, K.J.M., Goetzmann, W.N., 2012. Tiebreaker: Certification and multiple credit ratings. J. Finance 67 (1), 113–152.

Caplin, A., Dean, M., 2015. Revealed preference, rational inattention, and costly information acquisition. Amer. Econ. Rev. 105 (7), 2183–2203.

Chen, H., Cohen, L., Gurun, U., 2021. Don't take their word for it: The misclassification of bond mutual funds. J. Finance 76 (4), 1699–1730.

Chen, Q., Goldstein, I., Jiang, W., 2010. Payoff complementarities and financial fragility: Evidence from mutual fund outflows. J. Financ. Econ. 97 (2), 239–262.

Chernenko, S., Sunderam, A., 2014. Frictions in shadow banking: Evidence from the lending behavior of money market mutual funds. Rev. Financ. Stud. 27 (6), 1717–1750.

Chodorow-Reich, G., 2014. Effects of unconventional monetary policy on financial institutions. Brook. Pap. Econ. Act. 155–204.

Cipriani, M., La Spada, G., 2020. Sophisticated and Unsophisticated Runs. FRB of New York Staff Report, No. 956.

Cipriani, M., La Spada, G., 2021. Investors' appetite for money-like assets: The MMF industry after the 2014 regulatory reform. J. Financ. Econ. 140 (1), 250–269.

Cohn, J., Gillan, S., Hartzell, J., 2016. On enhancing shareholder control: A (Dodd-) Frank assessment of proxy access. J. Finance 71 (4), 1623–1668.

Cornaggia, J., Cornaggia, K., Israelsen, R., 2018. Credit ratings and the cost of municipal financing. Rev. Financ. Stud. 31 (6), 2038–2079.

Covitz, D., Downing, C., 2007. Liquidity or credit risk? The determinants of very short-term corporate yield spreads. J. Finance 62 (5), 2303–2328.

deHaan, E., Li, J., Watts, E.M., 2021. Retail Bond Investors and Credit Ratings. Working Paper.

Di Maggio, M., Kacperczyk, M., 2017. The unintended consequences of the zero lower bound policy. J. Financ. Econ. 123 (1), 59–80.

Dimitrov, V., Palia, D., Tang, L., 2015. Impact of the Dodd-Frank act on credit ratings. J. Financ. Econ. 115 (3), 505–520.

Dodd-Frank Wall Street reform and consumer protection act, 2010. One hundred and eleventh congress of the United States.

Ellul, A., Jotikasthira, C., Lundblad, C.T., 2011. Regulatory pressure and fire sales in the corporate bond market. J. Financ. Econ. 101 (3), 596–620.

Fracassi, C., Petry, S., Tate, G., 2016. Does rating analyst subjectivity affect corporate debt pricing? J. Financ. Econ. 120 (3), 514–538.

Gallagher, E.A., Schmidt, L.D., Timmermann, A., Wermers, R., 2020. Investor information acquisition and money market fund risk rebalancing during the 2011–2012 eurozone crisis. Rev. Financ. Stud. 33 (4), 1445–1483.

Greenwood, R., Vayanos, D., 2014. Bond supply and excess bond returns. Rev. Financ. Stud. 27 (3), 663–713.

Greenwood, R.M., Vissing-Jorgensen, A., 2018. The Impact of Pensions and Insurance on Global Yield Curves. Harvard Business School WP 18-109.

Guibaud, S., Nosbusch, Y., Vayanos, D., 2013. Bond market clienteles, the yield curve, and the optimal maturity structure of government debt. Rev. Financ. Stud. 26 (8), 1914–1961.

Hirshleifer, D., Teoh, S.H., 2003. Limited attention, information disclosure, and financial reporting. J. Account. Econ. 36 (1–3), 337–386.

Kacperczyk, M., Schnabl, P., 2010. When safe proved risky: Commercial paper during the financial crisis of 2007–2009. J. Econ. Perspect. 24 (1), 29–50.

Kacperczyk, M., Schnabl, P., 2013. How safe are money market funds? Q. J. Econ. 128 (3), 1073–1122.

Kisgen, D.J., Strahan, P.E., 2010. Do regulations based on credit ratings affect a firm's cost of capital? Rev. Financ. Stud. 23 (12), 4324–4347.

La Spada, G., 2018. Competition, reach for yield, and money market funds. J. Financ. Econ. 129 (1), 87–110.

Li, Y., 2021. Reciprocal lending relationships in shadow banking. J. Financ. Econ. 141 (2), 600–619.

Lugo, S., 2021. Short-term debt catering. J. Corp. Finance 66, 101817.

Musto, D.K., 1999. Investment decisions depend on portfolio disclosures. J. Finance 54 (3), 935–952.

Newey, W.K., West, K., 1994. Automatic lag selection in covariance matrix estimation. Rev. Econom. Stud. 61 (4), 631–653.

Newey, W.K., West, D., 1987. A simple, positive semi-definite and autocorrelation consistent covariance matrix. Econometrica 55 (3), 703–708.

Opp, C.C., Opp, M.M., Harris, M., 2013. Rating agencies in the face of regulation. J. Financ. Econ. 108 (1), 46–61.

Parlatore, C., 2016. Fragility in money market funds: Sponsor support and regulation. J. Financ. Econ. 121 (3), 595–623.

Schmidt, L., Timmermann, A., Wermers, R., 2016. Runs on money market mutual funds. Amer. Econ. Rev. 106 (9), 2625–2657.

Securities and Exchange Commission, 2014. Money market fund reform; amendments to form PF. Final Rule Plublished on July 23rd, 2014.

Securities and Exchange Commission, 2015. Removal of certain references to credit ratings and amendment to the issuer diversification requirement in the money market fund rule. Final Rule Published on September 25th, 2015.

Sims, C.A., 2003. Implications of rational inattention. J. Monetary Econ. 50 (3), 665–690.