Issuer Certification in Money Markets*

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Abstract

Using comprehensive issuance-level information for dollar-denominated short-term debt, we show that investments by money market mutual funds (MMFs) significantly reduce issuers' funding frictions. Issuers without MMF funding pay approximately 10 basis points more for placing their short-term debt, even when comparing issuers with small MMF investments to issuers without MMF investments. Funding costs increased for issuers who lost their MMF investors because of an exogenous regulatory shock to the MMF industry in 2016. Issuers who lose their MMF investors reduce their outstanding short-term debt by more than 50% and issue debt with shorter durations, suggesting that MMF investments reduce an issuers' funding fragility.

Keywords: Short-term debt; commercial paper; money market mutual funds

JEL: G23; G14

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Introduction

Prime money market mutual funds (MMFs) are important investors in uncollateralized short-term debt markets and finance themselves with cash-like share classes offered to their investors. This liquidity transformation makes MMFs susceptible to runs and potentially increases the fragility of money markets, making prudent MMF regulation a first-order policy concern. While a large literature (reviewed below) studies the effects of regulation on MMFs themselves, a critical unanswered question is whether regulating MMFs' risk-taking leads to elevated risks in other parts of money markets. Do short-term debt issuers face more funding frictions if they cannot raise funding from MMFs?

Answering this question is challenging because commercial papers (CPs) and most other uncollateralized short-term debt instruments (e.g., certificates of deposits) trade in over-the-counter markets; While MMFs' monthly portfolio holdings provide some insights into short-term funding conditions, information on issuers not held by MMFs is limited. To overcome this challenge, we exploit new transaction-level data that allow us to compare short-term debt issuance for entities held by MMFs to entities not held by MMFs.

We examine funding frictions in money markets along three dimensions. First, we focus on the cost for issuing short-term debt. Issuers not held by MMFs pay, on average, 10 basis points more for their short-term debt and this difference remains significant after adding a battery of controls and when comparing issuers with small MMF investments to similar issuers without MMF investments. In addition, costs increase for issuers who lost their MMF investors due to new MMF regulation passed in 2016, which led many MMF families to close their prime funds. Second, outstanding short-term debt volumes double when an issuer starts appearing on MMFs' monthly reports and halve when an issuer stops appearing. Finally, the duration of the short-term debt is lower for issuers without MMF investors, making those issuers more prone to funding dry-ups as illustrated during the March 2020 market turmoil.

The policy debate about banning MMFs from investing in short-term debt issuers without a "prime" credit rating (i.e., within the highest short-term rating categories) suggests that MMF investments can reduce funding frictions. While some argued that banning MMFs from holding non-prime issuers "should result in minimal market disruption because money market funds currently hold small amounts of such securities" (SEC, 2010, p. 13) a main concern was that "prohibiting the acquisition of second tier securities would have unintended consequences for the capital markets [because] it might discourage investors other than money market funds from investing in second tier securities" (SEC, 2010, p.15). Based on this debate, we derive and test three hypotheses linking funding frictions and MMF investments: (i) Issuing short-term debt is cheaper if part of the issuers' short-term debt is currently held by one or more MMFs; (ii) Outstanding short-term debt volumes drop (increase) when MMFs drop (add) an issuer to their holdings; (iii) issuers without MMF investors issue debt with shorter duration and are more prone to funding dry-ups.

Starting with the first hypothesis, we motivate our analysis by comparing the volume-weighted average issuance costs, measured as the spread between short-term debt yields and duration-matched overnight index swap (OIS) rates for issuers held by, at least, one MMF to issuers not held by any MMFs. As shown in Figure 1, issuers not held by MMFs pay a premium compared to issuers held by MMFs. This premium is more pronounced during periods of market turmoil, such as March 2020, when the World Health Organization (WHO) declared the COVID-19 virus to be a global pandemic. In addition, comparing the volume-weighted time-to-maturity of these issuances in the second panel of Figure 1 shows that the higher issuance costs are accompanied by shorter maturities.

To explore the link between issuance costs and MMF holdings further, we proceed in

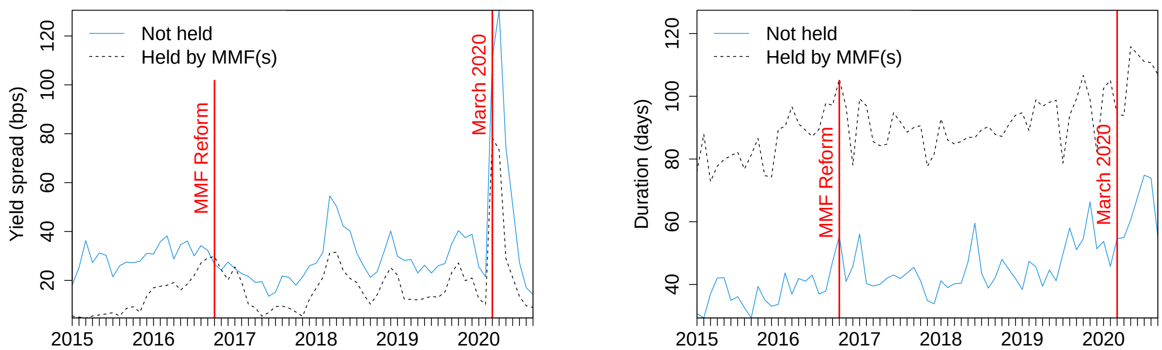

Figure 1: **CP yield spreads for different subsamples.** This figure shows either the average monthly yield spreads in excess of the OIS rate (left-hand side) or the average monthly duration (right-hand side) for two subsamples of the CP issuers in our data. The solid blue lines show the values for issuers that MMFs reported as part of their portfolio in month $t-1$ and the dashed black lines show the values for issuers that were not part of any MMF portfolio in month $t-1$.

four steps. First, because factors like credit ratings, firm size, and leverage could affect both short-term debt issuance costs and MMFs' choice to hold an issuer, we use panel regressions in which we examine the link between issuance costs in month t and an indicator variable that equals one if an issuer was not held by a MMF in month $t-1$. Even after controlling for maturity structure, issuer size, leverage, rating, country of incorporation, industry, and time-fixed effects, issuers not held by MMFs pay a 6.78 basis points higher yield spread than issuers not held by MMFs ($t = 7.01$). This difference remains significant even after separating issuers always or never held by MMFs, and controlling for the issuers credit quality (as proxied by market-implied default probabilities) or issuer-fixed effects.

Second, an alternative interpretation of our results so far is that debt issuers benefit from MMF investments simply because they form a stable investor base; Unlike other investors, who might place their money outside short-term debt markets when yield spreads are low, MMFs must invest in short-term debt. To explore this alternative view, we compare issuer-months with small MMF investments (around 1% of their short-term debt held by MMFs) to similar issuers without MMF investments, using propensity score matching. Consistent with our previous results, not having a MMF investor increases the issuance costs by approximately nine basis points, suggesting that our results are not driven by MMFs forming a more stable investor base.

Third, we exploit an exogenous drop in MMF ownership around the implementation of the 2016 MMF reform to confirm that the difference between issuers with and without MMFs is not driven by unobservable changes in issuer characteristics. The reform put stricter regulations on prime MMFs—it forced funds to report floating net asset values (NAVs) and allowed gates or lockups if a fund's liquid asset holdings drop below a pre-specified threshold—and resulted in large outflows from prime MMFs. These outflows led many MMF families to convert their prime funds into government MMFs, which cannot invest in short-term debt issued by companies or financial institutions. The decision to close a prime fund introduces exogenous variation because fund families converted prime funds based on their investor liquidity preferences and not because of the riskiness of their MMF portfolios (otherwise they could have simply rebalanced them). We first show that issuers who sold a larger share of their CPs to MMFs that ceased to exist after the reform have a higher propensity of losing their MMF investors after the reform. Next, we use this instrument and show that the yield spreads of issuers with a higher exposure to funds that ceased to exist increased significantly.

Finally, we expect MMF investments to be more valuable in situations with more asymmetric information, such as for issuers without a prime credit rating and during times of market turmoil. Consistent with this view, the average additional yield spread for prime issuers not held by any MMFs is 1.95 basis points and quadruples to 7.66 basis points for non-prime issuers. To further explore the role of asymmetric information, we examine the role of MMF investments in March 2020, when financial markets tumbled and the WHO declared the COVID-19 virus to be a global pandemic. During this month, funding frictions were significantly more pronounced for issuers without MMF investors and even more so if the issuer had a non-prime rating. A similar pattern emerges when focusing on months in which market uncertainty, as proxied by VIX, was elevated.

Turning to our second hypothesis, we focus on percentage changes in outstanding short-term debt volumes and use an event-study method to examine how these volumes fluctuate around months when an issuer is included into or excluded from MMF portfolios. Strikingly, on average, outstanding short-term debt *double* in months when issuers are included in MMF holdings and *halve* in months when they are excluded. Controlling for changes in other variables, such as market-implied default probabilities, and previous levels of outstanding short-term debt leave this result virtually unchanged.

Finally, we test our third hypothesis by first examining the duration of newly issued short-term debt. Repeating our regression analysis, now replacing issuance costs with issuance durations, we find that issuers without MMF investors place short-term debt with, on average, 15 days shorter maturities. As before, this difference remains significant even after controlling for market-implied default probabilities or issuer-fixed effects. To examine if these shorter issuance durations transmit to more funding fragility, we focus on the two weeks between March 9 and March 20 of 2020, when money markets experienced runs by investors. During this period, the average daily change in outstanding short-term debt was 3 percentage points lower for issuers not held by MMFs. Hence, despite MMFs experiencing funding difficulties during this period, issuers without MMF investors faced larger drops in their short-term debt volumes than issuers with MMF investors.

Our findings contribute to the large literature examining the fragility of short-term debt markets, as previously studied by Duygan-Bump, Parkinson, Rosengren, Suarez, and Willen (2013), Pérignon, Thesmar, and Vuillemey (2018), Covitz, Liang, and Suarez (2009), Kahl, Shivdasani, and Wang (2015), Downing and Oliner (2007), Aldasoro, Balke, Barth, and Eren (2019), Aldasoro, Ehlers, McGuire, and von Peter (2020). Our central contribution to this literature is that MMFs reduce this fragility by providing *issuer certification* for other investors.

Prime MMFs engage in liquidity transformation by offering cash-like securities to their investors and investing in illiquid, potentially risky short-term debt. This liquidity transformation exposes them to potential runs by their investors (e.g., Kacperczyk and Schnabl, 2013, Chernenko and Sunderam, 2014, Ivashina, Scharfstein, and Stein, 2015, Strahan and Tanyeri, 2015, Schmidt, Timmermann, and Wermers, 2016, Gallagher, Schmidt, Timmermann, and Wermers, 2020). To improve the stability of the MMF industry, the 2016 MMF reform tightened the regulation of prime MMFs (Baghai, Giannetti, and Jäger, 2020, Cipriani and La Spada, 2021, and Järvenpää and Paavola, 2021, among others). Anderson, Du, and Schlusche (2021) show that one (unintended) consequence of this reform was the reduction in arbitrage capital of global banks. Our study highlights another consequence of the reform: Issuers who lost their MMF investors after the reform lose the associated certification benefits, facing more fragile short-term financing and pay higher issuance costs.

1 Background and Hypotheses

Companies and financial institutions often manage their liquidity needs by issuing uncollateralized short-term debt such as commercial papers (CPs).[1] In contrast to raising funding through bank loans, short-term debt issuers rely on money market investors to purchase their short-term debt. While CPs are normally a cheap source of short-term financing, the reliance on money market investors combined with the short maturities of these instruments expose issuers to significant funding risk, especially during market turmoils. One such market turmoil occurred in March 2020 when the Federal Reserve Board (2020) noted that CPs "directly finance a wide range of economic activity" and announced the CP Funding Facility to stabilize the CP market.

One key investor in CP markets are prime MMFs, which act as intermediaries by offering cash-like shares to their investors and placing the proceeds in private short-term debt or government securities. Investors usually consider these funds as "money-like" investments because MMF share classes typically have a stable value. Hence, even a small drop in the portfolio value of a MMF can lead to run-like behavior among investors.[2] Because such runs can threaten the existence of a MMF and even damage the reputation of the entire fund family, prime MMFs have a strong incentive to carefully monitor the credit quality of the issuers in their portfolios.

Given prime MMFs' importance in the economy as both issuers of cash-like share classes and liquidity providers for short-term debt issuers, prudent MMF regulation is a first-order

[1]CPs are uncollaterized short-term debt instruments that typically have a maturity below 270 days. A similar form of short-term debt are certificates of deposits (CDs), which are issued by U.S. bank branches. Because there is no major difference between CPs and CDs, we include both instruments in our analysis but simply refer to them as CPs or "short-term debt."

[2]The most famous example is the Reserve Primary Fund. The fund held some CPs issued by Lehman Brothers and "broke the buck" on September 16, 2008 when its net asset value (NAV) fell to $0.97 cents per share. This event event triggered a run on MMFs (Kacperczyk and Schnabl, 2013).

policy concern. Since the global financial crisis (GFC), when prime MMFs invested in financial institutions faced large outflows and eventually received government support, MMFs are under increasingly strict regulatory scrutiny. The 2010 MMF reform introduced monthly portfolio disclosure requirements and stricter restrictions on MMF portfolio holdings. MMFs can invest a maximum of 3% of their portfolios in "non-eligible" securities that do not have a short-term debt rating in the highest categories (also called prime rating) and a maximum of 5% of their portfolios in any issuer. This 5% fraction is reduced to 0.5% if the issuer does not have a prime rating (see SEC, 2010).[3]

Another MMF reform that was announced in July 2014 and implemented in October 2016 (henceforth, the 2016 MMF reform) forced prime MMFs to impose liquidity fees and temporarily suspend redemptions if their liquid asset holdings fall below a certain threshold. In addition, the 2016 MMF reform reduced the money-likeness of prime MMFs, which now report floating net asset values instead of fixed values that were common before the reform. As explained in SEC (2014), these "amendments are designed to address money market funds' susceptibility to heavy redemptions in times of stress, improve their ability to manage and mitigate potential contagion from such redemptions, and increase the transparency of their risks" and the SEC "recognize[s] that these reforms may make certain money market funds less attractive to some investors."

In line with this SEC expectation, the 2016 MMF reform led to large prime MMF outflows (e.g., Baghai et al., 2020 or Cipriani and La Spada, 2021). To illustrate the effect of these outflows on CP markets, Figure 2 shows the fraction of CPs held by MMFs over time

[3]The ratings must come from Nationally Recognized Statistical Ratings Organizations (NRSROs). In addition to the three largest agencies—Standard and Poor's, Moody's, and Fitch—currently six smaller agencies are recognized. Whether an issuer is classified as "prime" depends on the granularity of the rating scale. For instance, for Standard and Poor's and Fitch, issuers within the two highest categories are classified as prime while Moody's applies a less granular scale with only the highest ratings corresponding to prime.

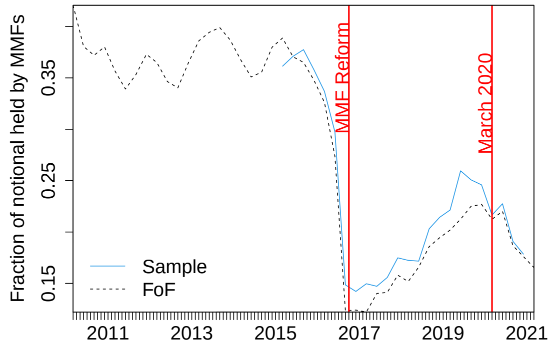

Figure 2: **Share of issuers held by MMFs.** This figure compares the fraction of CPs held by MMFs in our sample (blue line) to the same fraction obtained from the financial accounts of the U.S. (black line).

(either using aggregate numbers from the financial accounts of the U.S. or data from our sample, which we explain in Section 2). As we can see from the figure, before 2016, MMFs held between 35% − 40% of all outstanding CPs. This share dropped to approximately 15% in before the reform was implemented in October 2016 and gradually recovered to approximately 20% afterwards.

1.1 Hypotheses Development

While *collateralized* short-term debt such as repurchase agreements or asset-backed CPs are typically considered as information insensitive in normal times (e.g., Holmstrom, 2015), *un-collateralized* short-term debt always exposes investors to the default risk of the borrower. While short-term credit ratings provide some information on the credit quality of an issuer, they react slowly to adverse market shocks and are substantially broader than the rating categories for long-term ratings.[4] In addition, because non-banks are the main investors in this type of short-term debt, investors cannot rely on issuer certification by banks. As explained above, prime MMFs have strong incentives to monitor the credit quality of their borrowers. MMFs conduct their own screenings of CP issuers and consider "factors pertaining to credit quality in addition to any rating assigned to a security" (SEC, 2010). This MMFs screening generates additional information about the borrower, similar to bank monitoring in syndicated loans or interbank lending (King, 2008, Dinger and Von Hagen, 2009). Similar to initial public offering (IPO), where banks provide issuer certification to investors (Booth and Smith (1986), Carter and Manaster (1990), Michaely and Shaw (1994)), we hypothesize that debt issuers benefit from MMF investments because they provide additional assurance to investors.

Our central hypothesis is that the certification benefits of MMF investments lower the issuers' frictions in accessing short-term debt markets. We measure these frictions by focusing on either issuance costs, changes in outstanding volumes, or duration of the issued short-term debt. While issuers might choose the outstanding debt volumes and maturity structure, they have less influence on the issuance costs. Hence, issuance costs are our preferred measure of funding frictions and our first hypothesis is that MMF investments lower issuance costs.

Hypothesis 1 (Issuance costs and MMF holdings)**.** *Issuing short-term debt is cheaper if part of the issuers' short-term debt is currently held by one or more MMFs.*

While establishing a correlation between issuance costs and MMF is straight-forward, it is not obvious that the lower issuance costs are indeed a consequence of the MMF holdings. We therefore exploit the effect of the 2016 MMF reform, which led many MMF families

[4]For instance, the highest short-term rating by Moody's is P-1 and comparable to long-term ratings between Aaa and A3.

to either close their prime funds or convert them to government funds (e.g., Baghai et al., 2020). This decision was driven by MMF investors' demand and was arguably exogenous to the credit quality of the prime funds portfolios—if credit quality was the main concern, prime funds could have simply rebalanced their portfolios instead of closing them. Hence, as an additional test of Hypothesis 1, we test if short-term debt issuers whose MMF investors closed after the 2016 reform face elevated funding costs after the reform. Such elevated funding costs could be viewed as an unintended consequence of the 2016 MMF reform.

Even after establishing the link between MMF investments and issuance costs, an alternative interpretation could be that the lower issuance costs for issuers held by MMFs simply reflect the fact that MMFs are a more stable investor base. In contrast to other investors, who might invest in longer-term instruments, MMFs must place a certain fraction of their money into CPs every month. Hence, if issuers held by MMFs sell a significant portion of their short-term debt to MMFs, their lower issuance costs could simply reflect the fact that MMFs are less yield sensitive than other investors. To distinguish Hypothesis 1 from this alternative interpretation, we also compare CP issuers that sell only a small portion of their short-term debt to MMFs to comparable issuers without MMF investors.

Because certification is more important during times of market distress and for issuers with lower credit quality, we also explore the role of MMF investments across issuers and over time. In the cross-section, we use the credit rating of the issuer as proxy for uncertainty. Because MMFs face tighter constraints for investing in lower-rated issuers, we expect MMF certification to have a stronger impact on issuers with lower credit ratings. This view resonates with the concern that prohibiting MMFs from acquiring non-prime debt instruments "might discourage investors other than money market funds from investing in second tier securities" (SEC, 2010). In the time series, we measure high uncertainty either as crisis period (March 2020) or months in which market uncertainty (proxied by the implied volatility of the S&P 500, VIX) is elevated.

Motivated by Pérignon et al. (2018), who study funding dry-ups in money markets, we next examine the link between outstanding short-term debt volumes and MMF investments. If MMF investments provide issuer certification, we would expect increases in short-term debt volumes when MMFs add an issuer to their holdings and decreases when issuers are not held by MMFs anymore.

Hypothesis 2 (MMF holdings and short-term debt volumes)**.** *Outstanding short-term debt volumes drop when MMFs remove an issuer from their holdings and increase when MMFs add an issuer to their holdings.*

Finally, funding frictions also make manifest in shorter debt durations. Covitz et al. (2009) and Pérignon et al. (2018) show that issuers who face large drops in their outstanding short-term debt volumes first reduce the issuance duration of their debt. We therefore hypothesize that issuers without MMF investors rely on short-term debt with shorter maturities.

Hypothesis 3 (MMF holdings and debt maturity)**.** *Issuers without MMF investors rely on short-term debt with shorter durations.*

This reliance on debt with shorter maturities makes issuers without MMF investors more susceptible to funding dry-ups during times of market distress.

2 The Data

To conduct our analysis, we combine security-level information on money market instruments with MMF holdings data. We obtain month-end MMF portfolio holdings at the

CUSIP level from Crane Data, which collects this information from the SEC N-MFP filings that became mandatory after the 2010 MMF reform. Our short-term debt data are for U.S. dollar-denominated CPs (or CDs) and obtained from the Derivatives Trade and Clearing Corporation (DTCC). Because DTCC acts as clearinghouse for the settlement of most CP transactions (e.g., Anderson et al., 2021), this database contains comprehensive transaction-level information for all dollar-denominated CPs. Reporting in the database starts in December 2014, which we use as start date for our analysis. While merging the DTCC and Crane data is straight-forward using CUSIP identifiers, we hand-match the CP data to balance sheet information from either SNL or Compustat, depending on whether the issuer is a financial or non-financial institution. This matching gives us a total of 466 issuers of which 374 are non-financial institutions.

The main variable of interest for our analysis is an indicator variable that equals one if an issuer is not held by a MMF in a given month. Figure 3 illustrates how this variable varies over time. The blue line shows that approximately half of the issuers in our sample were not held by MMFs in the early part of our sample and that this share increased to approximately 0.65 around the implementation of the 2016 MMF reform. In addition, the black-dashed line illustrates the fraction of CP issuers that are *currently* not held by MMFs. To compute this fraction, we exclude issuer-months if, up to this month, the issuer has either always or never been held by a MMF.[5] As we can see from the figure, the increase in the fraction of issuers not held by MMFs around the 2016 MMF reform is even more pronounced than in the unconditional fraction.

To explore MMF holdings further, we next divide issuer-months into four categories: (i)

[5]Using such an expanding window to identify issuers that were always or never held by MMFs has the advantage that we avoid any look-ahead bias but the drawback that the variables are noisy in the early part of the sample.

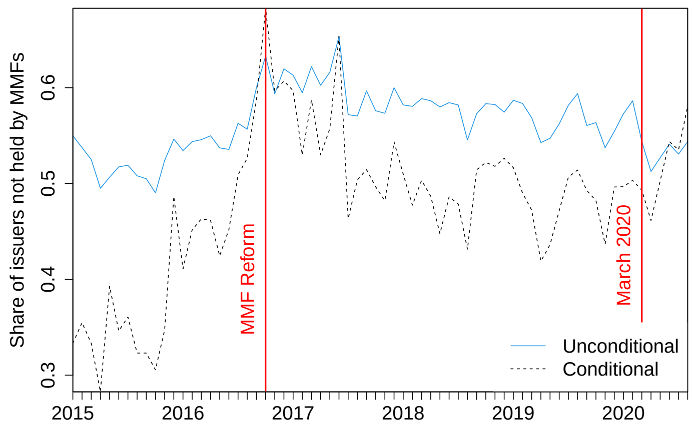

Figure 3: **Share of issuers held by MMFs.** The solid-blue line in this figure shows the fraction of issuers in our sample that are not held by MMFs. The black-dashed line shows the fraction conditional on the issuer having at least once both been held and not been held by a MMF, that is, we exclude all observations for issuers that were either always or never held by MMFs.

Always, which means that up to month t, the issuer always appeared on MMF balance sheet; (ii) *Currently*, which means that the issuer currently appears on a MMFs' balance sheet but that there was at least one month before in which it did not; (iii) *Currently not*, which means that the issuer is currently not held but that there was at least one month in which it was held; and (iv) *Never*, which means that, up until month t, the issuer has never appeared on a MMF report. Panel A of Table 1 shows the probabilities of transitioning from one category to another, where each row corresponds to the variable at time t and each column to the variable at time $t + 1$.

Starting with the first row, an issuer that is currently classified as always being held by MMFs has a 96.4% probability to remain in this category and a 3.1% probability to drop to not being held. Similarly, the last row shows that an issuer that is currently classified as never being held by MMFs has a 98.3% probability of remaining in this category. Hence, even though we use an expanding window to define *Always* and *Never*, the table suggests the vast majority of issuers classified as always or never held by MMFs remains in that category. Turning to issuers that are currently held by MMFs, Panel B shows that they have a 21.3% probability of not being held in the following month. Similarly, issuers that are currently not held have a 19.5% probability of being held in the following month. The higher probability of transition from being held to not being held is in line with Figure 3 which suggests that the MMF reform triggered the loss of MMF investors for some issuers.

We next hand-collect short-term credit ratings from the Bloomberg system. Even though, MMFs could choose among 9 NRSROs, MMF disclosures suggest four predominant agencies: Standard & Poor's, Moody's, Fitch, and Dominion Bonds. For each issuer, we obtain these four short-term ratings and aggregate them into one variable. The difficulty in aggregating the ratings is that different agencies use different scales and we therefore first unify the ratings by converting them into one of four categories: (i) prime rating, which makes the security eligible to MMFs (A-1+ or A-1 in the Standard & Poor's methodology); (ii) the highest non-prime rating category (A-2 in the Standard & Poor's methodology); (iii) below the highest non-prime category; and (iv) unrated. We then define six rating categories: (i) prime rating by all available agencies; (ii) prime rating by at least two available agencies; (iii) prime rating by at least one agency and at least one missing rating; (iv) no prime rating by any agency but highest non-prime rating by all available agencies; (v) below the highest non-prime rating; (vi) missing rating. We use these categories when controlling for rating fixed effects in our analysis throughout the paper.[6]

[6] An alternative approach would have been to simply use the ratings from Standard & Poor's (which is more common in the literature). However, we show in Table A2 in the appendix that using our numerical ratings is a more conservative approach because using S&P rating categories instead leads to *stronger* results.

Throughout our analysis (with the exception of Section 4), we only include issuer-months in which we observe any CP issuance. To get an overview of our data, we group issuer-months into three different rating categories: A-1, which corresponds to the two highest categories; A-2, which corresponds to categories four and five; and B, which corresponds to categories five and six. The first rows in Panel B show the number of issuer-month observations in each rating category and the percentage of issuer-months not held by MMFs. Approximately half of the issuer-month observations are concentrated in the A-2 rating category and more than one quarter have a prime rating. Only 24.9% of the issuer-month with a prime rating are not held by MMFs while the number increases to 76.0% and 87.7% for issuers with an A-2 rating and a rating below A-2, respectively.

To approximate short-term financing costs, we proceed as follows. First, we follow Covitz et al. (2009) and compute the implicit yields from the observed CP prices, assuming a 360-day year. Second, we observe the time to maturity of each CP issuance in our sample and interpolate the overnight index swap (OIS) curve to find a duration-matched proxy for the risk-free. Third, we compute the yield spread between the implied CP yields and the maturity-matched OIS rate to obtain a proxy for the credit spread or financing cost. Finally, because we are interested in the financing costs of a given issuer in a given month, we aggregate outstanding CP volumes at the issuer level, compute the volume-weighted yield spread of all CP issuances by the same issuer in a given issuer month, and compute volume-weighted CP issuance durations.[7]

[7] One challenge for our analysis is that we need the outstanding CP volumes, which are not directly observable from the database. The problem is that a CP transaction after the issuance date could still be part of the original issuance because the common procedure for CP issuance is that a dealer first purchases the entire issue and then sells the CPs in the secondary market afterwards. Following our conversations with market participants, we therefore estimate the CP volume as the sum of all transaction volumes between issuance and half the time to maturity. That way, we mitigate the risk of counting CP buybacks into the initial volume. To illustrate that we capture a substantial part of the CP market and that our outstanding estimates are of the right order of magnitude, Figure A1 in the appendix compares our financial and non-

For each rating category, we then compare the average yield spreads and issuance durations in month t for issuers held or not held by MMFs in month $t-1$. Panel B of Table 1 shows that, for issuers with a prime rating, the average yield spreads are 10.7 basis points for issuers with MMF investors and 9.4 basis points for issuers without MMF investors. In addition, the issuance duration in this rating category is 67.4 for issuers that are held by MMFs and drops to 33.2 for issuers not held by MMFs. For issuers in the A-2 rating category, the average yield spread (issuance duration) for issuers held by MMFs is 25.1 basis points (62.8 days) which increases (decreases) to 28.3 basis points (22.7 days) for issuers not held by MMFs. The difference in financing costs is even more pronounced in the lowest rating category, where issuers held by MMFs pay 25.8 basis points for their short-term debt while issuers not held by MMFs pay 43.9 basis points.

Finally, we provide cross-sectional issuer summary statistics in Panel C of Table 1, first computing time series averages for each issuer in our sample. The cross-sectional average yield spread and issuance duration in our sample are 26.8 basis points and 38.0 days to maturity, respectively. The average logarithm of outstanding CPs is 12.1 and we also report the logarithm of firm assets and the percentage of total firm debt relative to firm assets in the table. These figures are obtained from annual reports as provided by either Compustat (for non-financials) or SNL (for financials).

3 Issuance Costs and MMF Holdings

We now test Hypothesis 1, exploring the link between short-term debt issuance costs and MMF ownership. As explained in Section 2, we aggregate all short-term debt variables, such as yield spreads and issuance durations, at the issuer-month level. To ensure that all investors

fiancial CP volumes to the estimates from the Federal Reserve Bank of New York (New York FED).

Table 1: **Descriptive statistics.** This table provides descriptive statistics for our matched dataset. Panel A shows a transition matrix in which each row shows one of four possible scenarios: Always, where issuer i has always been held by a MMF up to month t; Currently, where issuer i is currently held by a MMF in month t (but there was at least one month when the issuer was not held by a MMF); Currently not, where issuer i is currently not held by MMF in month t (but there was at least one month when the issuer was held by a MMF); and Never, where issuer i has never been held by a MMF up to month t. The columns numbers in each column show the probability that the issuer moves to or stays in the indicated category in month $t+1$. Panel B shows descriptive statistics for issuer-months grouped by different rating categories. $\mathbb{1}_{\text{NoMMF}}$ is an indicator variable that equals one if the issuer is not held by any MMF. In Panel C, we compute time-series averages for each issuer and then provide cross-sectional summary statistics. For a detailed description of these variables see Table A1

Panel A: Transition matrix

	MMF holding in $t+1$			
	Always	Currently	Currently Not	Never
Always	0.976	0.004	0.021	0.000
Currently	0.000	0.818	0.182	0.000
Currently Not	0.000	0.180	0.820	0.000
Never	0.000	0.016	0.001	0.983

Panel B: Observations across S&P rating categories

	A-1	A-2	B
#Issuer-months	6,800	9,716	3,026
% NoMMF	24.9	76.0	87.7
YS ($\mathbb{1}_{\text{NoMMF}} = 0$)	10.7	25.1	25.8
YS ($\mathbb{1}_{\text{NoMMF}} = 1$)	9.4	28.3	43.9
TTM ($\mathbb{1}_{\text{NoMMF}} = 0$)	67.4	62.8	73.2
TTM ($\mathbb{1}_{\text{NoMMF}} = 1$)	33.2	22.7	25.4

Panel C: Cross-sectional summary statistics

	Mean	SD	25%	50%	75%	N
Yield spread	26.8	19.0	15.2	25.4	33.6	468
TTM	38.0	41.6	11.9	24.5	45.7	468
$\log(Outst)$	12.1	2.4	11.0	12.4	13.7	468
$\log(Assets)$	11.8	3.6	9.4	10.5	12.0	468
Debt(%)	32.0	15.0	23.1	30.9	38.9	468

can observe MMF holdings from their monthly reports, we focus on the link between yield spreads in month t and MMF holdings in month $t-1$.[8] We run panel regressions of the following form:

$$YS_{i,t} = \beta^{\text{NoMMF}} \mathbb{1}_{\text{NoMMF}(i,t-1)} + \gamma_1 Controls_{i,t-1} + \varepsilon_{i,t}. \tag{1}$$

Our main focus is on the indicator variable $\mathbb{1}_{\text{NoMMF}(i,t-1)}$, which equals one if issuer i was not held by any MMFs in month $t-1$. We include the following basic controls in our analysis: The fraction of outstanding CPs held by MMFs ($Frac^{MMF}_{i,t-1}$); the volume-weighted duration of newly-issued CPs ($TTM_{i,t-1}$); the total volume of outstanding CPs ($\log(Outst)_{i,t-1}$), an indicator variable that equals one if the issuer had regularly issued CPs in the previous three months ($\mathbb{1}_{Regular(i,t-1)}$); the issuers' debt as fraction of total assets ($Debt(\%)_{i,t-1}$, sampled at the end of the previous reporting year); the total firm size ($\log(Assets)_{i,t-1}$, also sampled at the end of the previous reporting year); time fixed effects interacted with seven different maturity buckets to absorb any unobservable changes in the yield curve (as in Rime, Schrimpf, and Syrstad, 2021); rating fixed effects (based on our construction from Section 2); the issuer's country of incorporation fixed effects; and the issuer's industry fixed effects (measured by the first two digits of the SIC code).

Column (1) of Table 2 shows the results of this baseline regression. Issuers without MMF investors pay 6.78 basis points ($t = 7.01$) higher yield spreads for their CP issuance compared to issuers with MMF investors. Throughout our regression analysis, we cluster the standard errors at both the time and issuer level to obtain conservative estimates.[9] Interestingly, the fraction of outstanding short-term debt held by MMFs is insignificant in explaining

[8] As we explain in more detail in Section 4, this is a conservative approach because dealers or intermediaries could observe MMF investments without relying on monthly MMF reports and we show in Table A3 in the appendix that our results *strengthen* if we focus on contemporaneous MMF holdings.

[9] By clustering the standard errors at the firm level, we ensure that we account for possible autocorrelation in the error term. Clustering the standard errors at the year-month level allows us to correct for possible cross-sectional correlation in residuals. To highlight that this approach leads to conservative t-statistcs, we follow the suggestion of Angrist and Pischke (2008) and compute standard errors with different clustering. The t-statistic without clustering, with clustering only at the time level, or with clustering only at the issuer level would have been 17.8, 15.8, or 6.8, respectively.

yield spreads. Moreover, apart from $TTM_{i,t-1}$, none of the other controls are statistically significant.

One critical concern with this analysis is that an unobservable change in the issuers' credit quality could both increase the yield spreads and lead MMFs to cut their ownership in the issuer. To address this concern, we collect 1-year stock market-implied default probabilities, estimated by the Credit Research Initiative, and add them as a control. Because we do not observe this variable for all issuers in our sample, the number of observations drops by approximately 20%. As expected, Column (2) shows a strong and statistically significant link between yield spreads and default probabilities. However, controlling for the default probability of the issuer leaves the statistical and economic significance of $\mathbb{1}_{NoMMF}$ virtually unchanged.

We next test if our results remain intact when we focus on issuers that are *currently* not being held by a MMF. To that end, we add two indicator variables that equal one if, until time $t-1$, issuer i was never ($\mathbb{1}_{\text{Never}(i,t-1)}$) or always ($\mathbb{1}_{\text{Always}(i,t-1)}$) held by MMFs. As shown in Column (3), adding these controls lead to a drop in the statistical and economic significance of $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ to 3.97 ($t = 4.67$). Hence, issuers *currently* not held by MMFs pay larger yield spreads than issuers *currently* held by MMFs. In addition, Column (3) shows that issuers never held by MMFs pay significantly higher yield spreads while issuers always held by MMFs tend to pay lower yield spreads.

As a fourth test, we repeat our analysis controlling for issuer fixed effects, which has the advantage of absorbing any unobservable issuer characteristics not captured by our controls. However, the disadvantage of controlling for issuer fixed effects is that they absorb a large part of the cross-sectional variation, which $\mathbb{1}_{\text{Never}(i,t-1)}$ and $\mathbb{1}_{\text{Always}(i,t-1)}$ would have captured in the absence of issuer fixed effects, and only leaves variation due to changes in MMF

Table 2: **Short-term funding costs and MMF holdings.** This table shows the results of regressing the volume-weighted average yield spreads of newly issued CPs for issuer i in month t on an indicator variable $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ that equals one if issuer i was not held by a MMF in month $t-1$. $Frac^{MMF}_{i,t-1}$ captures the fraction of CPs sold to MMFs. $TTM_{i,t-1}$ is the volume-weighted average time to maturity of CPs issued by issuer i in month $t-1$. $\log(Outst)_{i,t-1}$ is the logarithm of the notional of issuer i's outstanding CPs at the end of month $t-1$. $\mathbb{1}_{Regular(i,t-1)}$ is an indicator variable that equals one if issuer i had three consecutive months with positive issuance volumes up until month $t-1$. $Debt(\%)_{i,t-1}$ and $\log(Assets)_{i,t-1}$ are the total debt as fraction of firm assets and the logarithm of total firm assets, respectively, both measured at the end of the reporting year. $\mathbb{P}(Default)_{i,t}$ is the 12-month default probability of the issuer, as estimated by the Credit Research Initiative. $\mathbb{1}_{\text{Never}(i,t-1)}$ and $\mathbb{1}_{\text{Always}(i,t-1)}$ are indicator variables that equal one if, up to month $t-1$, issuer i was never held by any MMF or always held by at least one MMF, repsectively. Columns (1) to (4) show the results for the entire sample of CP issuers. Column (5) shows the results for the subsample of issuers with an average prime credit rating. Column (6) shows the results for the subsample of issuers with an average credit rating below prime. Column (7) shows the results for the subsample of issuers that either have a missing rating or an average credit rating below A-2. TTM^{Cat} is a categorical variable that takes one of seven values depending on the contemporaneous $TTM_{i,t}$. The categories are ≤ 3 days, $(3,10]$, $(10,20]$, $(20,40]$, $(40,80]$, $(80,160]$, and > 160 days. Rating FE are fixed effects capturing the issuers short-term credit rating. Country FE are a set of indicator variables capturing the issuers country of incorporation. Industry FE are fixed effects based on the first two digitis of an issuer's SIC code. The numbers in parantheses are t-statistics, based on heteroskedasticity robust standard errors, clustered at time and issuer level. ***, **, and * indicate significance at a 1%, 5%, and 10% level, respectively.

	Full Sample				A-1	A-2	B
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{\text{NoMMF}(i,t-1)}$	6.78***	6.50***	3.97***	1.39**	1.90*	5.38***	15.69***
	(7.01)	(5.92)	(4.67)	(2.57)	(1.73)	(3.89)	(4.57)
$Frac^{MMF}_{i,t-1}$	0.22	−3.68	0.70	−2.15	−0.84	−4.08	1.96
	(0.09)	(−1.37)	(0.30)	(−1.21)	(−0.49)	(−1.11)	(0.30)
$TTM_{i,t-1}$	0.00	0.01	0.01	0.01***	0.02***	0.02	0.01
	(0.61)	(1.61)	(0.80)	(3.34)	(4.09)	(1.10)	(0.42)
$\log(Outst)_{i,t-1}$	0.01	0.08	0.00	0.10**	−0.12*	−0.02	0.17
	(0.17)	(1.06)	(0.06)	(2.15)	(−1.81)	(−0.30)	(1.01)
$\mathbb{1}_{Regular(i,t-1)}$	−0.29	−0.19	0.36	0.11	−0.54	−0.05	2.87*
	(−0.52)	(−0.28)	(0.64)	(0.33)	(−0.76)	(−0.09)	(1.81)
$Debt(\%)_{i,t-1}$	−0.04	0.03	−0.03	0.20***	0.00	0.05	0.18
	(−0.88)	(0.63)	(−0.67)	(2.67)	(0.03)	(0.88)	(1.40)
$\log(Assets)_{i,t-1}$	−0.85**	−1.50***	−0.57	1.18	−0.62	−1.57**	2.13
	(−2.09)	(−2.86)	(−1.41)	(0.69)	(−1.36)	(−2.52)	(1.07)
$\mathbb{P}(Default)_{i,t}$		9.44***					
		(4.43)					
$\mathbb{1}_{\text{Never}(i,t-1)}$			6.02***				
			(5.61)				
$\mathbb{1}_{\text{Always}(i,t-1)}$			−2.04				
			(−1.46)				
TTM$^{Cat}\times$ Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	No	No	No
Country FE	Yes	Yes	Yes	No	Yes	Yes	No
Industry FE	Yes	Yes	Yes	No	Yes	Yes	No
Issuer FE	No	No	No	Yes	No	No	No
Adj. R^2	0.66	0.68	0.67	0.81	0.67	0.69	0.52
Num. obs.	19,542	15,173	19,542	19,542	6,800	9,716	3,026

holdings within the same issuer. Despite this reduction in cross-sectional variation, Column (4) shows that $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ remains statistically significant at a 5% level with a coefficient of 1.39 ($t = 2.57$).

Finally, we analyze the effect of $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ in three different subsamples, split by rating category. Focusing first on issuers in the A-1 category (with prime ratings from all available agencies), Column (5) shows that not being held by a MMF leads to a small and marginally significant increase of 1.90 basis points. This effect increases to 5.38 basis points ($t = 3.89$) for issuers with an A-2 rating, which make up the largest part of our sample. For issuers without a short-term credit rating or a credit rating below A-2, the effect of not being held by a MMF is most pronounced, suggesting that issuers not held by a MMF pay 15.69 basis points ($t = 4.57$) more for their CP issuance compared to issuers that are held by MMFs. These results suggest that MMF holdings have a stronger effect for issuers in lower rating categories and we further explore the role of MMF holdings for issuers of different riskiness and during different time periods in Section 3.3.

3.1 The 2016 MMF Reform

Our results so far suggest that the link between MMF ownership and financing costs is robust to a battery of control variables. To argue that it is indeed the variation in MMF ownership, as opposed to unobservable shocks that affect both issuers' yield spreads and the MMFs' decisions to hold the issuer, we exploit the exogenous variations in $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ due to the 2016 MMF reform. As shown in Figures 2 and 3, MMF investments in the CP market dropped sharply around the implementation of the reform, substantially increasing the fraction of issuers not held by MMFs. We argue that these drops are exogenous to the quality of the issuers held by MMFs. If the quality of the MMFs' portfolios was the only concern, funds could have simply rebalanced their portfolios. Instead, because the 2016 MMF reform reduced investors' demand for prime MMFs, fund families decided to either

Table 3: **The effect of 2016 MMF reform on CP ownership and yield spreads (cross-sectional regression).** This table reports first-differenced regressions of MMF ownership of CP issuers and CP yield spreads on the exposure of CP issuers to the 2016 MMF reform. Our sample includes the period from January 2015 to September 2017. The dependent variable in Columns (1) to (3) is the change in an issuer's average propensity to be held by prime MMF from the control period (January 2015 to December 2015) to the treatment period (October 2016 to September 2017); In Columns (4) to (6), the dependent variable is the change in an issuer's average yield spread from treatment to control period. $Treat_i$ is the ratio of the value of CPs held by prime MMFs that decided to close or convert to government MMFs as a result of the 2016 reform to overall value of CPs held by prime MMF during the control period. In Columns (2) and (5), we also include the natural logarithm of outstanding short-term debt and the average number of MMFs holding a given issuer (both measured during the control period). In Columns (3) and (6), we also include issuer's 12-month probability of default measured over the control period. The numbers in parantheses are t-statistics, based on heteroskedasticity robust standard errors. ***, **, and * indicate significance at a 1%, 5%, and 10% level, respectively.

	$\Delta\mathbb{1}_{\text{NoMMF}}$			ΔYS		
	(1)	(2)	(3)	(4)	(5)	(6)
$Treat_i$	0.419***	0.408***	0.485***	9.196**	8.031**	9.805*
	(3.69)	(3.49)	(3.04)	(2.28)	(2.03)	(1.68)
Controls:						
log($Outst$) and Number(Funds)		Yes	Yes		Yes	Yes
$\mathbb{P}(Default)$			Yes			Yes
Observations	322	322	246	322	322	246
R^2	0.078	0.11	0.094	0.023	0.099	0.100

convert their prime MMFs into government funds or to liquidate them.

To exploit this exogenous shock to investors' demand for prime MMFs, we define the variable $Treat_i$ as follows:

$$Treat_i = \begin{cases} \frac{\text{Ownership of liquidated MMFs}_i}{\text{Total MMF Ownership}_i} \text{ if Total MMF Ownership}_i > 0 \\ \\ 0 \text{ if Total MMF Ownership}_i = 0, \end{cases}$$

where *Ownership of liquidated* $MMFs_i$ is the notional amount of short-term debt held by MMFs that ceased to exist as a results of the MMF reform and *Total MMF Ownership*$_i$

is the total notional amount held by MMFs of issuer i. We average this variable over the January 2015 to December 2015 period, which we use as the pre-reform period.[10] Similar to Chernenko and Sunderam (2014), we examine the effect of $Treat_i$ in a single cross-section of issuers, computing the change in yield spreads for each issuer from before to after the reform, thereby eliminating any issuer fixed effects. This approach also allows us to remove a potential estimation bias stemming from positive serial correlation in issuers' yield spreads (Bertrand, Duflo, and Mullainathan, 2004). To eliminate any cyclical patterns in CP issuance over the calendar or reporting year, we use 12-month averages from January 2015 to December 2015 to compute the pre-reform level and from October 2016 to September 2017 to compute the post-reform level. We discard the phasing period from January 2016 to September 2016, when the MMF reform was announced but not yet fully implemented by all mutual fund families.

To highlight that $Treat_i$ is a valid instrument for changes in $\mathbb{1}_{\text{NoMMF}}$, Column (1) of Table 3 shows that a one standard deviation increase in $Treat_i$ increases the propensity of not being held by a MMF by 8.3 percentage points. Columns (2) and (3) show that controlling for the lagged outstanding, the average number of MMFs holding a given issuer, and issuer's 12-month probability of default (all measured as averages over the control period), leaves the link between $Treat_i$ and changes in $\mathbb{1}_{\text{NoMMF}}$ largely unchanged.[11] Adding *Number(Funds)* ensures that $Treat_i$ does not simply capture the fact that issuers that are currently held by few MMFs are less likely to be held by any MMF in the following month.

Turning to the second stage, Column (4) shows that a higher $Treat_i$ has a significant

[10] Even though the MMF reform came into effect in October 2016, we end our pre-reform period in December 2015 because several MMF families started closing their prime funds in anticipation of the MMF reform about nine months prior to October 2016.

[11] $Treat_i$ has a mean (median) of 0.08 (0) ranging from a 25% quantile of 0 to a 75% of 0.07 with a standard deviation of 0.2.

effect on yield spreads. To interpret the economic magnitude of this effect, we note that a one standard deviation increase in $Treat_i$ corresponds to 0.20 and increases the yield spread by 1.84 bps ($0.20 \cdot 9.196 = 1.84$). Compared to the pre-sample average yield spread of 18.90 bps, this is an increase of 10 percentage points. Moreover, Columns (5) and (6) show that the link remains intact when adding our baseline controls.

We illustrate the impact of the MMF reform on $\mathbb{1}_{\text{NoMMF}}$ and yield spreads in Figure 4. In this illustration, we follow Yagan (2019) depicting the effect of $Treat_i$ in each month. Every month t, we focus on either $\mathbb{1}_{\text{NoMMF}(i,t)}$ or $YS_{i,t}$ and subtract the pre-reform average of the variable (averaged over the January 2015 to December 2016 period). For both variables, we then run cross-sectional regressions on $Treat_i$ and plot the resulting regression coefficients together with 95% confidence intervals in Figure 4, where we smooth the coefficients over 3-month windows to avoid our results being clouded by high-frequency fluctuations.

As we can see from Figure 4, both $\mathbb{1}_{\text{NoMMF}}$ and yield spreads fluctuate around zero during the pre-reform period and start increasing from January 2016 on. After the implementation of the reform in October 2016, both variables are positive and statistically significant. Hence, the figure confirms our results from Table 3, suggesting that the MMF reform increased both the propensity of not being held by MMFs and yield spreads.

3.2 Propensity Matching

While Table 2 suggests that the fraction of short term debt held by MMFs is not a significant driver of funding costs, it is still plausible that the link between yield spreads and MMF ownership is driven by MMFs usually holding a substantial portion of the CP issuance, suggesting issuers held by MMFs simply benefit from a more stable investor base compared to issuers not held by MMFs. To distinguish this view from our interpretation that MMF

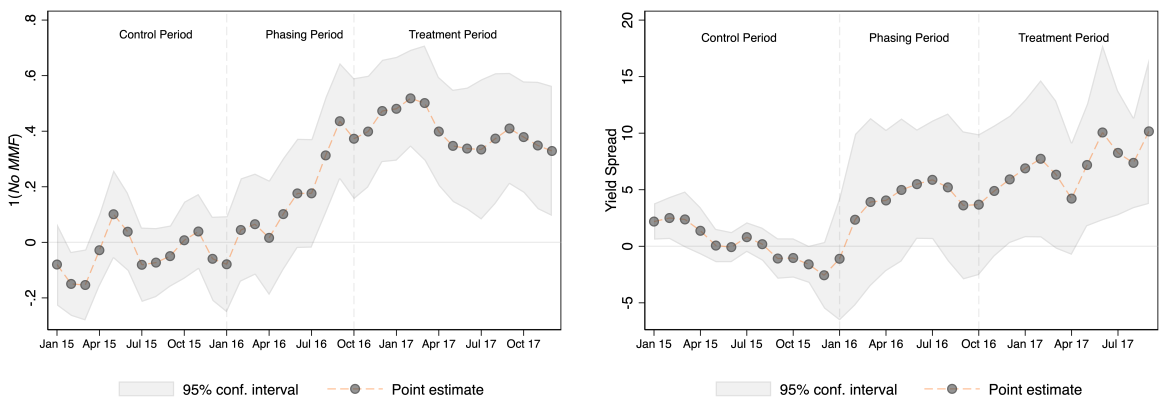

Figure 4: **The effect of 2016 MMMF reform on CP yields and MMF holdings.** This figure plots the regression coefficient δ_1 from cross-sectional regressions (ran every month) of the following form:

$$\mathrm{d}Y_{i,t} = \delta_0 + \delta_1 Treat_i + D_r + \eta_{i,t}.$$

$Y_{i,t}$ is either issuer the yield spread (right-hand side) or $\mathbb{1}(No\ MMF)$ (left-hand side) for issuer i at time t; $\mathrm{d}Y_{i,t}$ captures the difference between the indicated variable at time t and the average of the variable over the January 2015 to December 2015 period; $Treat_i$ is the ratio of the value of CPs held by prime MMF that ceased to exist (or converted to government MMFs) after the MMF reform to overall value of CPs held by prime MMF during the control period (form January 2015 to December 2015); D_r denotes ratings fixed effects. We use moving average with three-month window to smooth over monthly variability in yield spreads. The dark grey dots depict δ_1 coefficients estimates. The light-gray shaded area represents 95% confidence intervals adjusted for heteroskedasticity.

holdings provide assurance to other investors, we now compare issuers for which MMFs hold a very small fraction of their CPs to issuers without any MMF investors. This test helps us rule out the alternative explanation that CP issuers with MMFs benefit from the more stable investor base because the treatment group comprises issuers who sell only a small share of their CPs to MMFs.

We conduct three tests, defining small MMF holdings as issuer-months where less than 0.5%, 1%, or 1.5% of the outstanding CP volumes are held by MMFs. Focusing on these issuer-months, we match each observation to a comparable one, where the issuer is not held by any MMFs. To obtain comparable issuer-months without MMF holdings, we use

Table 4: **CP yield spreads and MMF ownership.**
This table shows OLS regression estimates of the yield spreads of newly issued CPs on an indicator variable $\mathbb{1}_{\text{NoMMF}}$ that equals one if the issuer was not held by a MMF in a previous month. The unit of observation is issuer-month. We limit our sample to issuer-months were less than 0.5% (Column (1)), 1% (Column (2)), or 1.5% (Column (3)) of the CPs were held by MMFs and propensity-score-match with issuers whose CPs were not held by any MMF in a previous month. We match the issuers based on one-month lagged time to maturity, outstanding, total debt as a fraction of firm assets, natural logarithm of total firm assets, lagged credit rating, and Industry dummy variable. TTM is weighted average time to maturity of all CPs of issuer i at time t. $\log(Outst)$ is a natural logarithm of the outstanding CPs. $Debt(\%)$ is the total debt as fraction of firm assets, and $\log(Assets)$ is the logarithm of total firm assets. The numbers in parantheses are heteroskedasticity robust standard errors, clustered at time and issuer level.

	$< 0.5\%$	$< 1\%$	$< 1.5\%$
	(1)	(2)	(3)
$\mathbb{1}_{\text{NoMMF}}$	5.997**	5.954***	5.686***
	(2.09)	(3.28)	(4.01)
TTM	0.118***	0.143***	0.153***
	(2.96)	(3.49)	(4.94)
$\log(Outst)$	2.340	0.272	0.016
	(1.60)	(0.26)	(0.02)
$Debt(\%)$	0.086	-0.032	-0.000
	(0.76)	(-0.25)	(-0.00)
$\log(Assets)$	-1.620	-0.689	-0.024
	(-1.21)	(-0.73)	(-0.03)
Observations	572	1092	1546
R^2	0.76	0.69	0.71
Controls:			
Rating FE	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes

propensity-score matching without replacement and find the closest issuer-month without CP holdings along the following five dimensions: $\log(Outst)$, $Debt(\%)$, $\log(Assets)$, industry, and rating category. We provide additional illustrations of the matching procedure results in the appendix (Figure A4) and focus on the effect of $\mathbb{1}_{\text{NoMMF}}$ for our matched sample in the body of the paper.

As shown in Table 4, the difference between issuers with small MMF ownership and issuers without MMF ownership is statistically significant at a 1% level in all three categories and varies between 5.997 bps for issuers with 0.5% MMF holdings to 5.686 bps for issuers with 1.5% holdings. Hence, Table 4 suggests that small fluctuations in the fraction of short-term debt held by MMFs have a large effect on issuance costs if these fluctuations lead to the issuer losing its MMF investor(s).

3.3 Information Sensitivity and MMF Holdings

To conclude our tests of Hypothesis 1, we further examine the role of $\mathbb{1}_{\text{NoMMF}}$ for yield spreads across issuers and in different time periods. Our hypothesis is that appearing on MMF reports is more valuable for riskier issuers and during times with heightened uncertainty. We therefore expect that the sensitivity of $YS_{i,t}$ to $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ increases for these instances. We use regression specification (1), include the same controls as in Column (1) of Table 2, and examine how $\mathbb{1}_{\text{NoMMF}}$ varies across issuers and time.

Starting with the riskiness of the issuers, we first test if $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ is a stronger predictor of yield spreads for issuers with a non-prime short-term rating. While Columns (5) to (7) of Table 2 already suggest that β^{NoMMF} increases for riskier issuers, Column (1) of Table 5 confirms that yield spreads are significantly more sensitive to $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ if the issuer does have a non-prime rating by at least one of the rating agencies. Specifically, β^{NoMMF} increases from 3.35 for issuers with a prime rating to 7.72 $(4.37 + 3.35)$ for issuers without a prime rating.

Table 5: **Conditional analysis.** This table shows the results of regressing the volume-weighted average yield spreads of newly issued CPs for issuer i in month t on an indicator variable $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ that equals one if issuer i was not held by a MMF in month $t-1$. We interact $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ with an indicator variable that equals one if the issuer has a non-prime rating from at least one of the four rating agencies ($\mathbb{1}_{NonPrime}$). We use two different proxies to examine the role of hightened information sensitivity by investors. $\mathbb{1}_{Mar\ 2020}$ is an indicator variable that equals one in March 2020 and zero otherwise. $\mathbb{1}_{VIX \geq q(80)}$ equals one in months when the average monthly VIX is above its 80% quantile and zero otherwise. Additional controls include $Frac^{MMF}_{i,t-1}$, $TTM_{i,t-1}$, $\log(Outst)_{i,t-1}$, $\mathbb{1}_{Regular(i,t-1)}$, $Debt(\%)_{i,t-1}$, and $\log(Assets)_{i,t-1}$. For a detailed description of these variables see the caption of Table 2. The numbers in parantheses are t-statistics based on heteroskedasticity robust standard errors, clustered at time and issuer level. ***, **, and * indicate significance at a 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)
$\mathbb{1}_{\text{NoMMF}(i,t-1)}$	3.35***	3.26***	2.91***
	(3.29)	(2.79)	(2.90)
$\mathbb{1}_{\text{NoMMF}(i,t-1)} \times \mathbb{1}_{NonPrime}$	4.37***	4.20***	4.49***
	(3.19)	(2.87)	(3.33)
$\mathbb{1}_{\text{NoMMF}(i,t-1)} \times \mathbb{1}_{Mar2020}$		10.42***	
		(23.68)	
$\mathbb{1}_{\text{NoMMF}(i,t-1)} \times \mathbb{1}_{NonPrime} \times \mathbb{1}_{Mar2020}$		17.53***	
		(27.97)	
$\mathbb{1}_{\text{NoMMF}(i,t-1)} \times \mathbb{1}_{VIX \geq q(80)}$			2.83*
			(1.93)
$\mathbb{1}_{\text{NoMMF}(i,t-1)} \times \mathbb{1}_{NonPrime} \times \mathbb{1}_{VIX \geq q(80)}$			−0.56
			(−0.24)
$\text{TTM}^{Cat} \times$ Time FE	Yes	Yes	Yes
Add. controls	Yes	Yes	Yes
Time FE	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes
Country FE	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes
Adj. R^2	0.63	0.63	0.63
Num. obs.	19,542	19,542	19,542

We next explore how β^{NoMMF} changes during periods of financial distress. To this end, we conduct two tests with different indicator variables. First, we focus on the month with most uncertainty in our sample period and define $\mathbb{1}_{Mar2020}$ as an indicator that equals one in March 2020 and zero in all other months. We then interact $\mathbb{1}_{\text{NoMMF}}$ with both $\mathbb{1}_{NonPrime}$ and $\mathbb{1}_{Mar2020}$ and examine the differences. Column (2) shows that, for issuers with a prime rating, the sensitivity to MMF holdings increases from 3.26 in normal times to 13.78 ($3.26 + 10.42$) in March 2020. For issuers without a prime rating, this difference is even more pronounced as the sensitivity increases from 7.46 $(4.20 + 3.26)$ to 35.41 $(7.46 + 10.42 + 17.53)$. Hence, the market turmoil of March 2020 affected issuers without MMF holdings more than issuers without MMF holdings and this difference became even more pronounced for issuers without a prime rating.

Second, we expand our definition of crisis periods and focus on months in which the month-average VIX is above the 80% quantile (measured over all month-average VIX observations during our sample period). In line with our previous results, Column (3) shows that issuers not held by MMFs face larger increases in their financing costs compared to issuers held by MMFs. For issuers with a prime rating the coefficient increases from 2.91 during normal periods to 4.74 $(2.91 + 2.83)$ during periods with high market uncertainty. In this specification, the effect of MMF holdings for non-prime issuers is not significantly different and increases from 7.40 $(4.49 + 2.91)$ to 9.67 $(7.40 + 2.83 - 0.56)$.

Taken together, Table 5 shows that effect of not being held by a MMF is significantly more pronounced during times with higher market uncertainty and for issuers of lower credit quality.

4 Short-Term Debt Volumes and MMF Holdings

We now test Hypothesis 2 by examining percentage changes in outstanding short-term debt volumes around months in which an issuer is either included or excluded in some MMF portfolios. We first compute the percentage change in outstanding short-term debt volumes (winsorized at the 2.5% and 97.5% percentiles) and define two indicator variables $\mathbb{1}_{Include}$ and $\mathbb{1}_{Exclude}$ that equal one in months when an issuer is included in or excluded from MMF portfolios. To avoid short-lived fluctuations in the holding status, we set these indicator variables to zero if the inclusion (exclusion) is preceded by an exclusion (inclusion) in the following month. We then run panel regressions of the following form:

$$\Delta(\%)Outst_{i,t} = \beta^{Incl}1_{Include(i,t)} + \beta^{Excl}1_{Include(i,t)} + Controls_{i,t} + \varepsilon_{i,t}, \tag{2}$$

where $Controls_{t,i}$ include time-fixed effects in our basic specification.

As shown in Column (1) of Table 6, outstanding short-term debt volumes increase by 121/17% in months when MMFs start holding the issuers and drop by -56.43% in months when MMFs stop holding the issuers. Columns (2) and (3) show that this strong pattern remains virtually unchanged when controlling for previous changes in outstanding short-term debt, the logarithm of the outstanding debt in the previous month, and issuer-fixed effects. Because changes in MMF holdings might coincide with a significant change in the credit quality of the issuer or with a drop in credit ratings, Column (4) shows the results including $\Delta PD_{i,t}^{12m}$ and $\Delta Rating_{i,t}$ as controls. While adding these additional controls leads to a small drop in the number of observations, the statistical and economic significance of MMF inclusions and exclusions remains virtually unchanged.

Figure 5 visualizes the effects of inclusions or exclusions from two months before the event to two months after the event. The grey bars in the figure indicate 95% confidence intervals. The figure shows that fluctuations in outstanding volumes are modest in the months before or after the inclusion or exclusion events. However, corroborating the results from Table 6, in months when an issuer is included into one or more MMF portfolios, the outstanding volumes increase by more than 100%. Similarly, in months when an issuer drops out of MMF portfolios the outstanding CP volumes drop by 50%. Phrased differently, short-term debt volumes double in months when an issuer is include in MMF portfolios and halve in months

Table 6: **Percentage changes in outstanding CP volumes.** This table shows the results of regressing percentage changes in outstanding short-term debt volumes on two indicator variables. $\mathbb{1}_{Included(i,t)}$ equals one if an issuer did not appear on any MMF reports in month $t-1$ but was added in month t. $\mathbb{1}_{Excluded(i,t)}$ equals one if an issuer did appear on at least one MMF report in month $t-1$ but did not appear on any in month t. $\Delta(\%)Outst_{i,t-1}$ and $\log(Outst)_{i,t-1}$ capture previous changes and levels of outstanding CPs in the previous month. $\Delta PD^{12m}_{i,t}$ captures changes in the 12-months default probability. $\Delta Rating_{i,t}$ captures changes in our numerical rating proxy. The numbers in parantheses are t-statistics based on heteroskedasticity robust standard errors, clustered at time and issuer level. ***, **, and * indicate significance at a 1%, 5%, and 10% level, respectively. .

	(1)	(2)	(3)	(4)
$\mathbb{1}_{Included(i,t)}$	121.17***	115.38***	108.03***	116.66***
	(9.03)	(9.21)	(9.62)	(8.71)
$\mathbb{1}_{Excluded(i,t)}$	−56.43***	−47.43***	−50.96***	−50.62***
	(−14.65)	(−13.37)	(−9.46)	(−8.61)
$\Delta(\%)Outst_{i,t-1}$		−0.21***	−0.26***	−0.27***
		(−14.60)	(−17.19)	(−16.46)
$\log(Outst)_{i,t-1}$		−6.67***	−7.92***	−7.92***
		(−18.18)	(−15.99)	(−15.37)
$\Delta PD^{12m}_{i,t}$				−6.16**
				(−2.30)
$\Delta Rating_{i,t}$				−5.65
				(−0.60)
Time FEs	Yes	Yes	Yes	Yes
Issuer FEs	–	–	Yes	Yes
Adj. R^2	0.06	0.12	0.15	0.16
Num. obs.	23,183	22,705	22,705	17,558

when the issuer is excluded.

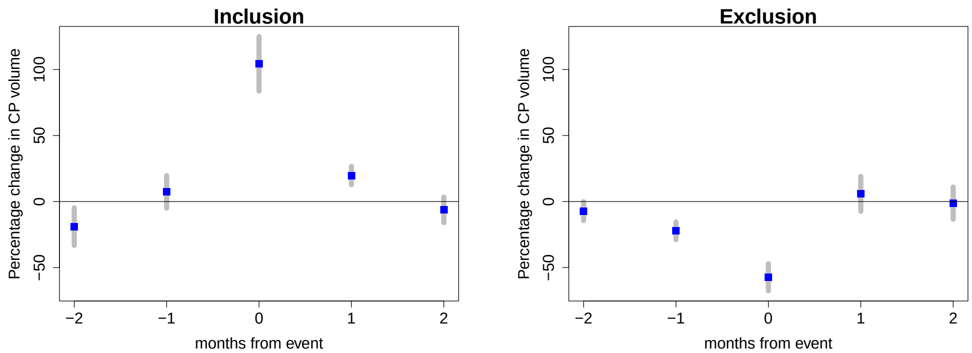

Figure 5: **Percentage changes in CP volumes around MMF inclusions or exclusions.** This figure visualizes the results of regressing percentage changes in outstanding CP volumes on a set of indicator variables that equal one in the event month or either 1 or 2 months before or after the event. The blue dots show coefficient estimates on $\mathbb{1}_{Include}$ (left-hand panel) and $\mathbb{1}_{Exclude}$ (right-hand panel) that equal one in months when an issuer is included or excluded from MMF portfolios. The regressions include time and issuer fixed effects as well as controls for lagged changes in outstanding short-term debt volumes and the lagged level of the outstanding volume. The grey or black bars show heteroskedasticity-robust standard errors at a 95% confidence level, which are clustered at the firm and time level.

Table 6 and Figure 5 suggest that volumes already adapt to MMF holdings in the month when $\mathbb{1}_{\text{NoMMF}}$ changes. This is plausible because some major investors, such as the CP dealers, can directly observe the change in $\mathbb{1}_{\text{NoMMF}}$ and intensify their CP intermediation. Hence, our approach of using lagged values of $\mathbb{1}_{\text{NoMMF}}$ is conservative and we show in Table A3 in the appendix that our results become indeed more significant when focusing on contemporaneous values of $\mathbb{1}_{\text{NoMMF}}$.

5 Issuance Durations and MMF Holdings

We now test Hypothesis 3. To that end, we first repeat our regression analysis from Section 3 for weighted-average issuance durations and conclude with an analysis of outstanding short-term debt volumes around the money market turmoil of March 2020.

5.1 Issuance Duration

Tighter frictions in accessing short-term debt markets could also be reflected in issuances with a shorter duration. Consistent with this view, Figure 1 and Table 1 suggest that issuers not held by MMFs tend to issue CPs with shorter durations. We now test this result more formally by modifying regression specification (1), where we replace $YS_{i,t}$ on the left-hand side with $TTM_{i,t}$ and drop the $TTM_{i,t-1}$ and TTM^{Cat} as controls.

The first column of Table 7 shows that issuers without MMF holdings indeed issue CPs with shorter duration. Similar to the analysis of yield spreads in Section 3, Columns (2) and (3) show that this negative link remains intact when controlling for the 12-month market-implied default probability or $\mathbb{1}_{\text{Never}(i,t-1)}$ and $\mathbb{1}_{\text{Always}(i,t-1)}$. In addition, Column (4) shows that, even after adding issuer-fixed effects as controls, issuers without MMF investors issue CPs with shorter durations. In contrast to the analysis of yield spreads, $Frac^{MMF}_{i,t-1}$ is statistically significant in this analysis, suggesting that the quantity of CPs held by MMFs also impacts the duration of issued CPs. Turning to the analysis for the three different rating categories, Columns (5) to (7) show a qualitatively similar picture to the analysis from Section 3. The effect of $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ is stronger for issuers without a prime credit rating.

Given the shorter duration for issuers without MMF holdings, it is plausible that issuers without MMF holdings are more exposed to funding dry-ups. We test this hypothesis in the next section.

5.2 Short-term Debt Volumes During March 2020

To conclude our analysis of funding fragility, we examine fluctuations in outstanding CP volumes around the market turmoil of March 2020. In particular, we focus on the period between March 9 to March 20 during which money markets went through severe distress. As

Table 7: **Issuance duration and MMF holdings.** This table shows the results of regressing the volume-weighted duration of newly issued CPs for issuer i in month t on an indicator variable $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ that equals one if issuer i was not held by a MMF in month $t-1$. $Frac_{i,t-1}^{MMF}$ captures the fraction of CPs sold to MMFs. $\log(Outst)_{i,t-1}$ is the logarithm of the notional of issuer i's outstanding CPs at the end of month $t-1$. $\mathbb{1}_{Regular(i,t-1)}$ is an indicator variable that equals one if issuer i had three consecutive months with positive issuance volumes up until month $t-1$. $Debt(\%)_{i,t-1}$ and $\log(Assets)_{i,t-1}$ are the total debt as fraction of firm assets and the logarithm of total firm assets, respectively, both measured at the end of the reporting year. $\mathbb{P}(Default)_{i,t}$ is the 12-month default probability of the issuer, as estimated by the Credit Research Initiative. $\mathbb{1}_{\text{Never}(i,t-1)}$ and $\mathbb{1}_{\text{Always}(i,t-1)}$ are indicator variables that equal one if, up to month $t-1$, issuer i was never held by any MMF or always held by at least one MMF, repsectively. Columns (1) to (4) show the results for the entire sample of CP issuers. Column (5) shows the results for the subsample of issuers with an average prime credit rating. Column (6) shows the results for the subsample of issuers with an average credit rating below prime. Column (7) shows the results for the subsample of issuers that either have a missing rating or an average credit rating below A-2. Rating FE are fixed effects capturing the issuers short-term credit rating. Country FE are a set of indicator variables capturing the issuers country of incorporation. Industry FE are fixed effects based on the first two digitis of an issuer's SIC code. The numbers in parantheses are t-statistics, based on heteroskedasticity robust standard errors, clustered at time and issuer level. ***, **, and * indicate significance at a 1%, 5%, and 10% level, respectively.

	Full Sample				A-1	A-2	B
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{\text{NoMMF}(i,t-1)}$	−16.03***	−15.82***	−12.41***	−5.31***	−5.31	−17.52***	−12.09**
	(−5.90)	(−4.89)	(−5.16)	(−3.60)	(−1.53)	(−4.93)	(−2.61)
$Frac_{i,t-1}^{MMF}$	−37.24***	−43.96***	−39.94***	−16.58***	−9.45	−68.64***	−50.86**
	(−3.69)	(−3.53)	(−3.94)	(−2.84)	(−0.77)	(−3.72)	(−2.30)
$\log(Outst)_{i,t-1}$	2.14***	2.22***	2.06***	0.90***	3.15***	1.80***	1.07***
	(10.48)	(9.72)	(10.83)	(9.01)	(6.25)	(8.09)	(7.90)
$\mathbb{1}_{Regular(i,t-1)}$	−1.99	−2.39	−2.85*	1.83	−3.25	−3.02	1.79
	(−1.20)	(−1.23)	(−1.73)	(1.40)	(−0.88)	(−1.49)	(1.39)
$Debt(\%)_{i,t-1}$	0.12	0.20	0.15	0.41***	0.05	0.35**	0.19**
	(1.02)	(1.34)	(1.28)	(2.99)	(0.32)	(2.26)	(2.16)
$\log(Assets)_{i,t-1}$	6.62***	7.42***	6.18***	1.63	4.45**	6.46***	4.23**
	(4.94)	(4.50)	(4.89)	(0.43)	(2.01)	(3.88)	(2.42)
$\mathbb{P}(Default)_{i,t}$		−1.27					
		(−0.80)					
$\mathbb{1}_{\text{Never}(i,t-1)}$			−1.58				
			(−0.77)				
$\mathbb{1}_{\text{Always}(i,t-1)}$			17.10**				
			(2.19)				
Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	No	No	No
Country FE	Yes	Yes	Yes	No	Yes	Yes	No
Industry FE	Yes	Yes	Yes	No	Yes	Yes	No
Issuer FE	No	No	No	Yes	No	No	No
Adj. R^2	0.44	0.43	0.45	0.70	0.35	0.48	0.71
Num. obs.	19,542	15,173	19,542	19,542	6,175	10,341	3,071

shown by Li, Li, Macchiavelli, and Zhou (2021), during these two weeks, investors withdrew about 30% of the assets under management from prime MMFs. To examine this period, we proceed similar to Li et al. (2021) and examine daily fluctuations between February and March 20. While their focus is on MMF flows, we focus on daily percentage changes in outstanding CP volumes. In contrast to MMF flows, there are no "redemptions" from CPs; instead, issuers in financial distress are unable to roll over existing short-term debt. Hence, we expect any drops in outstanding short-term debt to be less pronounced than the investor withdrawals from prime MMFs in the same period.

The goal of our analysis is to examine if, during the crisis period, CP issuers without MMF investors faced a larger reduction in their CP volumes compared to CP issuers with MMF investors. Because we focus on a period in which MMFs went through a funding crisis themselves, not being held by a MMF might be less of a disadvantage during this period, compared to a period without MMF distress.

To examine how $\mathbb{1}_{\mathrm{NoMMF}(i,k)}$ affects the fluctuations in outstanding CP volumes, we run regressions of the following form:

$$\begin{aligned}\Delta(\%)Outst_{i,t} = \beta_1 Crisis_t + \beta_2 \mathbb{1}_{\mathrm{NoMMF}(i,k)} + \beta_3 \mathbb{1}_{\mathrm{NoMMF}(i,k)} \times Crisis_t \\ + Controls_{i,t-1} + \varepsilon_{i,t}, \qquad (3)\end{aligned}$$

where $\Delta(\%)Outst_{i,t}$ is the daily percentage change in outstanding short-term debt for issuer i, winsorized at the 2.5% and 97.5% levels. As in Li et al. (2021), $Crisis_t$ is an indicator variable that equals one during the two weeks between March 9 and March 20. $\mathbb{1}_{\mathrm{NoMMF}(i,k)}$ is observed at the end of the previous calendar month k. Controls include our basic controls $\mathbb{1}_{Regular(i,k)}$, $Frac^{MMF}_{i,k}$, $\log(Assets)$, $Debt(\%)$, as well as rating, industry, and country fixed effects.

Starting with this baseline specification, Column (1) of Table 8 shows that issuers not held by MMFs experienced a 3.09% larger drop in their outstanding CP volumes compared to issuers held by MMFs. Following Li et al. (2021), we gradually add a set of control variables. Column (2) shows the results after controlling for lagged changes in outstanding CP volumes and Column (3) shows the results after also adding time fixed effects as control. Adding these controls leaves our results virtually unchanged.

We next control for potential pre-trends by adding two indicator variables Precrisis(-3) and Precrisis(-2) that equal one in the third to last and second to last week before the crisis. As shown in Column (4), adding these controls leaves our results largely unchanged. Finally, the pattern remains intact after adding time fixed effects in Column (5).

6 Conclusion

We document a new fact about money markets: Prime MMFs' investments in corporate or financial short-term debt provide issuer certification for other investors. Phrased differently, debt issuers with MMF investors face lower funding frictions when issuing short-term debt. We examine these funding frictions across three dimensions. Focusing first on the cost for issuing short-term debt, we show that issuers not held by MMFs pay, on average, 10 basis points more for their short-term debt and this difference remains significant after adding a battery of controls or when comparing issuers with small MMF investments to similar issuers without MMF investments. In addition, costs increase for issuers who lost their MMF investors due to new MMF regulation passed in 2016, which led many MMF families to close their prime funds. Second, outstanding short-term debt volumes double when an issuer starts appearing on MMFs' monthly reports and halve when an issuer stops appearing. Finally, the

Table 8: **MMF holdings and crisis drops in CP volumes.** This table shows regressions of daily percentage changes in outstanding CPs for a given issuer (winsorized at 2.5% and 97.5%). The sample period spans from February 6, 2020 to March 20, 2020, with *Crisis* equal to one from March 9 to March 20. Precrisis(-3) equals one in the third to last week before the crisis period and Precrisis(-2) equals one in the second to last week before the crisis. $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ is an indicator variable that equals one if a given issuer was not held by a MMF in the previous month. Controls include an indicator variable for regular issuance, the fraction of CPs held by MMFs, firm size and debt, as well as rating and industry fixed effects. The numbers in parantheses are t-statistics based on heteroskedasticity robust two-way clustered standard errors at the issuer and day level.

	(1)	(2)	(3)	(4)	(5)
$Crisis \times \mathbb{1}_{\text{NoMMF}(i,t-1)}$	-3.12^{***}	-3.42^{***}	-3.43^{***}	-2.95^{**}	-2.94^{**}
	(-2.69)	(-2.78)	(-2.79)	(-2.19)	(-2.20)
$\mathbb{1}_{\text{NoMMF}(i,t-1)}$	0.09	0.19	0.19	-0.27	-0.30
	(0.11)	(0.23)	(0.24)	(-0.29)	(-0.33)
$Crisis$	0.04	0.09		0.24	
	(0.07)	(0.13)		(0.36)	
$\Delta(\%)Outst_{t-1}$		-0.10^{***}	-0.11^{***}	-0.10^{***}	-0.11^{***}
		(-4.64)	(-4.52)	(-4.55)	(-4.67)
Precrisis(-3)				-0.01	
				(-0.02)	
Precrisis(-2)				0.69	
				(0.78)	
Precrisis(-3) $\times \mathbb{1}_{\text{NoMMF}(i,t-1)}$				0.88	0.91
				(0.72)	(0.75)
Precrisis(-2) $\times \mathbb{1}_{\text{NoMMF}(i,t-1)}$				1.21	1.23
				(0.86)	(0.89)
Controls	Yes	Yes	Yes	Yes	Yes
Day FE			Yes		Yes
Adj. R^2	0.00	0.01	0.02	0.01	0.02
Num. obs.	8,983	8,983	8,983	8,983	8,983

duration of the short-term debt is lower for issuers without MMF investors, making those issuers more prone to funding dry-ups as illustrated during the March 2020 market turmoil.

Our results contribute to our understanding of financial regulation. While reducing the risk taking of MMFs can improve the resilience of these funds during times of financial distress, this risk is either absorbed by different investors or transferred to debt issuers. Our results show that reducing the risk taking of MMFs increased the funding frictions of short-term debt issuers who lost their MMF investors in the process.

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Table A1: **Variable definitions.** This table defines the variables used in the empirical analysis. The logic behind indexing the variables is as follows: i indicates an issuer, j indicates one CP issue by a given issuer, t indicates a date, k indicates a time period, such as a quarter or year.

Variable	Definition	Source(s)
$Outst_{i,t}$	Outstanding CP debt for issuer i at date t	DTCC & own calc.
$\mathbb{1}(No\ MMF)_{i,t}$	Indicator variable that equals one if issuer i is not held by any MMFs at date t	DTCC & own calc.
$\mathbb{1}(Never\ MMF)_{i,t}$	Indicator variable that equals one if issuer i is never held by any MMFs before or at date t	DTCC & own calc.
$\mathbb{1}(Always\ MMF)_{i,t}$	Indicator variable that equals one if issuer i is always held by any MMFs before or at date t	DTCC & own calc.
$\mathbb{1}_{VIX \geq q(80)}$	Indicator variable that equals one in months when the average monthly VIX is above its 80th percentile and zero otherwise	CBOE & own calc.
$\mathbb{1}_{NonPrime}$	Indicator variable that equals one if the issuer has a non-prime rating from at least one of the four rating agencies	Bloomberg & own calc.
$\mathbb{1}_{Mar\ 2020}$	Indicator variable that equals one in March 2020 and zero otherwise	own calc.
$\mathbb{1}_{Include}$	Indicator variable that equals one in months when an issuer is included in a MMF portfolio	Crane & own calc.
$\mathbb{1}_{Exclude}$	Indicator variable that equals one in months when an issuer is excluded from all MMF portfolios	Crane & own calc.
$Frac\ MMF_{i,t}$	Sum of CP notional for issuer i at time t that is held by MMFs divided by the total notional	DTCC & own calc.
$TTM_{i,t}$	Weighted average time to maturity of all CPs of issuer i at time t	DTCC & own calc.
$\log(Outst)_{i,t}$	log notional of outstanding CPs for issuer issuer i at time t that is held by MMFs divided by the total notional t	DTCC & own calc.
$\mathbb{1}_{Regular_{i,t}}$	Indicator variable that equals one if the issuer has been issuing CPs over the last three months and zero otherwise	DTCC & own calc.
$Financial$	Indicator variable that equals one if the issuer is a financial instituion	DTCC & own calc.
$Debt(\%)_{i,t}$	Debt to asset ratio for i IN YEAR t	DTCC & own calc.
$\log(Assets)_{i,t}$	Total firm size for issuer i IN YEAR t	DTCC & own calc.
$Treat_i$	The ratio of the notional amount of short-term debt held by MMFs that ceased to exist as a result of the MMF reform and the total notional amount held by MMFs of issuer i. If the total amount held by MMFs is zero, $Treat_i$ takes a value of zero as well	Crane & DTCC & own calc.

$Number(Funds)$	The average number of MMFs holding a given issuer during the control period – i.e., from January 2015 to December 2016	Crane & DTCC & own calc.
$\mathbb{P}(Default)_{i,t}$	The 12-month default probability of the issuer	Credit Research Initiative.

A Additional Results and Descriptive Statistics

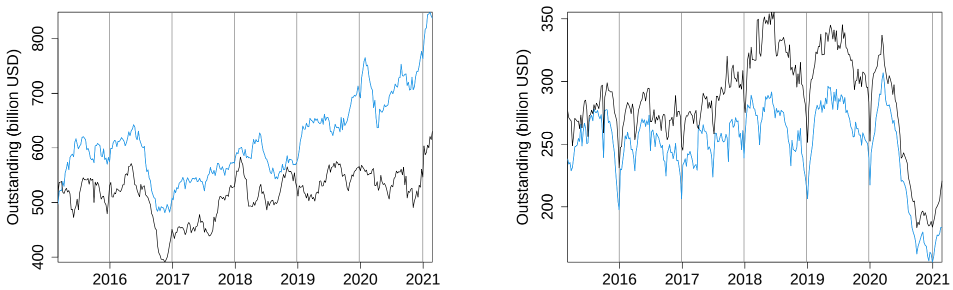


Figure A1: **Comparison of outstanding volumes.** This figure compares the aggregate outstanding volumes for financial and non-financial CPs based on our matched DTCC database to the aggregate numbers reported by the New York FED.

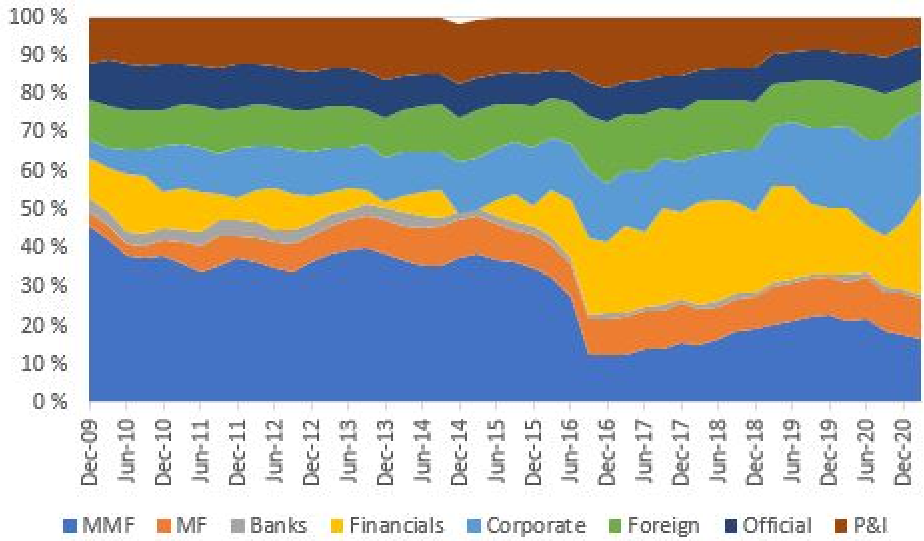
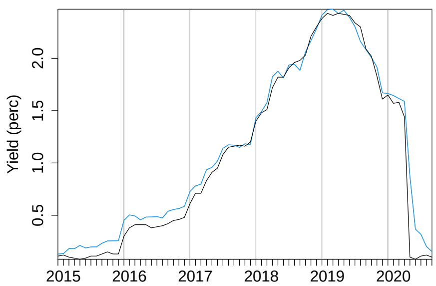
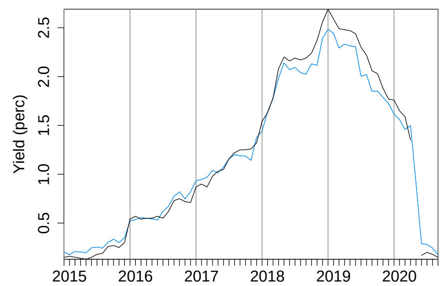


Figure A2: **CP holdings by different investor classes.** This figure shows the fraction of CPs held by different investor classes, which we group into seven categories: MMFs; MFs; Banks, which include Credit Unions and Broker Dealers; Financials, which are defined as "other financial business"; corporate, foreign (i.e, "rest of the world", official (state and government), and pensions and life insurance. Quarterly data from the financial accounts of the US.



(a) 1-month yields



(b) 3-month yields

Figure A3: **Sample Yields compared to AA Financial CP yields.** This figure compares the monthly average CP yield for financial CPs (issuers with AA rating) obtained from the Federal Reserve Bank of St. Louis with the average yields for our matched DTCC sample. Panel (a) shows the DTCC yields for issues with 20-40 days to maturity (including all issuers) and the FED estimate for 1-month CPs. Panel (b) shows the DTCC yields for issues with 80-100 days to maturity (including all issuers) and the FED estimate for 3-month CPs.

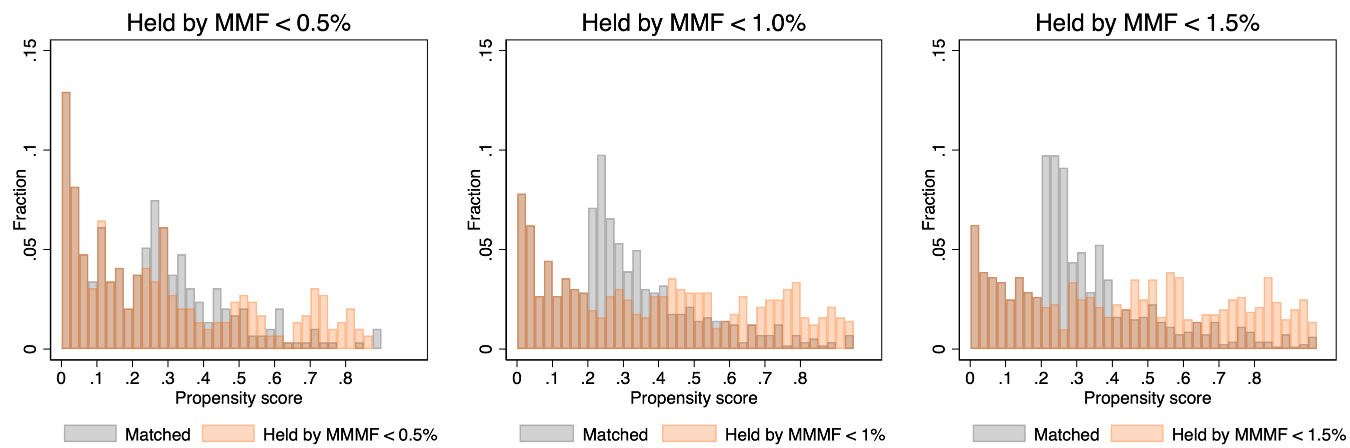


Figure A4: **Propensity score distribution plot.** These propensity-score histograms display the distribution of estimated propensity scores for treated (held by MMFs) and control (not held by any MMFs) issuers in bin sizes of 0.025 in order to visualise the common support assumption that underlies our matching procedure. The light-grey shaded bars represent the estimated propensity score distribution for our matched issuers – i.e., issuers without MMFs' ownership. The orange bars display the propensity score distribution for issuers with a small share of MMF ownership. In the left figure, we limit our sample to issuer-months with less than 0.5% of the CPs were held by MMFs in the previous month. In the middle figure, we include issuer-months with less than 1% of the CPs were held by MMFs. In the right figure, our sample comprises issuer-months with less than 1.5% of CPs held by MMFs.

Table A2: **Short-term funding costs and MMF holdings (S&P ratings only).** This table shows the results of regressing the volume-weighted average yield spreads of newly issued CPs for issuer i in month t on an indicator variable $\mathbb{1}_{\text{NoMMF}(i,t-1)}$ that equals one if issuer i was not held by a MMF in month $t-1$. The difference between this table and the results in Table 2 is that we now use the short-term ratings provided by Standard & Poor's. For a detailed description of the control variables see the caption of Table 2. The numbers in parantheses are heteroskedasticity robust standard errors, clustered at time and issuer level. ***, **, and * indicate significance at a 1%, 5%, and 10% level, respectively.

	Full Sample				A-1	A-2	B
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{\text{NoMMF}(i,t-1)}$	7.78***	7.48***	4.89***	1.72***	4.75***	5.63***	16.85***
	(8.14)	(7.28)	(5.68)	(3.25)	(4.15)	(5.35)	(5.30)
$Frac^{MMF}_{i,t-1}$	−0.85	−1.27	−0.08	−1.77	0.34	−6.62**	−7.88
	(−0.40)	(−0.50)	(−0.04)	(−1.01)	(0.20)	(−2.02)	(−0.99)
$TTM_{i,t-1}$	0.01	0.01	0.01	0.02***	0.01***	0.00	−0.02
	(1.35)	(1.47)	(1.50)	(3.39)	(3.22)	(0.16)	(−0.63)
$\log(Outst)_{i,t-1}$	0.10	0.12*	0.09	0.11**	0.10	0.02	0.19
	(1.64)	(1.86)	(1.51)	(2.23)	(1.12)	(0.33)	(0.89)
$\mathbb{1}_{Regular(i,t-1)}$	−0.14	0.12	0.51	0.02	−0.71	−0.09	0.28
	(−0.24)	(0.18)	(0.87)	(0.05)	(−1.11)	(−0.14)	(0.19)
$Debt(\%)_{i,t-1}$	0.06	0.11**	0.06*	0.19**	0.05	0.08	−0.22
	(1.52)	(2.34)	(1.67)	(2.47)	(1.47)	(1.48)	(−1.37)
$\log(Assets)_{i,t-1}$	−0.81**	−1.38***	−0.43	1.61	−0.73*	0.47	1.69
	(−2.23)	(−2.91)	(−1.28)	(0.88)	(−1.88)	(0.96)	(0.81)
$\mathbb{P}(Default)_{i,t}$		6.45***					
		(3.90)					
$\mathbb{1}_{\text{Never}(i,t-1)}$			6.14***				
			(5.50)				
$\mathbb{1}_{\text{Always}(i,t-1)}$			−1.90				
			(−1.46)				
$\text{TTM}^{Cat} \times$ Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	No	No	No
Country FE	Yes	Yes	Yes	No	Yes	Yes	No
Industry FE	Yes	Yes	Yes	No	Yes	Yes	No
Issuer FE	No	No	No	Yes	No	No	No
Adj. R^2	0.68	0.70	0.69	0.80	0.65	0.70	0.52
Num. obs.	18,088	14,424	18,088	18,088	6,655	9,756	3,131

Table A3: **Short-term funding costs and MMF holdings (without lags).** This table shows the results of regressing the volume-weighted average yield spreads of newly issued CPs for issuer i in month t on an indicator variable $\mathbb{1}_{\text{NoMMF}(i,t)}$ that equals one if issuer i was not held by a MMF in month t. $Frac_{i,t}^{MMF}$ captures the fraction of CPs sold to MMFs. $TTM_{i,t}$ is the volume-weighted average time to maturity of CPs issued by issuer i in month t. $\log(Outst)_{i,t}$ is the logarithm of the notional of issuer i's outstanding CPs at the end of month t. $\mathbb{1}_{Regular(i,t)}$ is an indicator variable that equals one if issuer i had three consecutive months with positive issuance volumes up until month t. $Debt(\%)_{i,t}$ and $\log(Assets)_{i,t}$ are the total debt as fraction of firm assets and the logarithm of total firm assets, respectively, both measured at the end of the reporting year. $\mathbb{P}(Default)_{i,t}$ is the 12-month default probability of the issuer, as estimated by the NUS Credit Risk Institute. $\mathbb{1}_{\text{Never}(i,t)}$ and $\mathbb{1}_{\text{Always}(i,t)}$ are indicator variables that equal one if, up to month t, issuer i was never held by any MMF or always held by at least one MMF, repsectively. Columns (1) to (4) show the results for the entire sample of CP issuers. Column (5) shows the results for the subsample of issuers with an average prime credit rating. Column (6) shows the results for the subsample of issuers with an average credit rating below prime. Column (7) shows the results for the subsample of issuers that either have a missing rating or an average credit rating below A-2. TTM^{Cat} is a categorical variable that takes one of seven values depending on $TTM_{i,t}$. The categories are ≤ 3 days, $(3, 10]$, $(10, 20]$, $(20, 40]$, $(40, 80]$, $(80, 160]$, and > 160 days. Rating FE are fixed effects capturing the issuers short-term credit rating. Country FE are fixed effects capturing the issuers country of incorporation. Industry FE are fixed effects based on the first two digitis of an issuer's SIC code. The numbers in parantheses are t-statistics, based on heteroskedasticity robust standard errors, clustered at time and issuer level. ***, **, and * indicate significance at a 1%, 5%, and 10% level, respectively.

	Full Sample				A-1	A-2	B
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$\mathbb{1}_{\text{NoMMF}(i,t)}$	7.20***	6.90***	4.47***	1.77***	2.70**	5.07***	16.15***
	(7.39)	(6.29)	(4.87)	(3.52)	(2.28)	(3.73)	(4.97)
$Frac_{i,t}^{MMF}$	2.34	−2.19	2.77	−0.38	1.89	−5.35	6.67
	(1.00)	(−0.87)	(1.25)	(−0.24)	(1.33)	(−1.51)	(1.06)
$TTM_{i,t}$	0.10***	0.10***	0.11***	0.12***	0.12***	0.12***	0.20***
	(6.61)	(6.68)	(6.69)	(7.88)	(9.01)	(4.18)	(3.73)
$\log(Outst)_{i,t}$	0.07	0.14	0.07	0.14*	−0.14	0.04	0.39**
	(0.74)	(1.49)	(0.73)	(1.71)	(−1.58)	(0.40)	(2.05)
$\mathbb{1}_{Regular(i,t)}$	−0.88	−0.93	−0.27	−0.63	−1.03	−0.36	1.20
	(−1.15)	(−1.08)	(−0.35)	(−1.10)	(−1.42)	(−0.54)	(0.78)
$Debt(\%)_{i,t}$	−0.04	0.02	−0.03	0.17**	0.00	0.04	0.19
	(−1.03)	(0.37)	(−0.78)	(2.41)	(0.01)	(0.74)	(1.53)
$\log(Assets)_{i,t}$	−0.96**	−1.51***	−0.68*	1.40	−0.51	−1.60***	1.70
	(−2.43)	(−2.96)	(−1.75)	(0.79)	(−1.14)	(−2.67)	(0.87)
$\mathbb{P}(Default)_{i,t}$		5.49***					
		(3.34)					
$\mathbb{1}_{\text{Never}(i,t)}$			6.02***				
			(5.77)				
$\mathbb{1}_{\text{Always}(i,t)}$			−1.67				
			(−1.19)				
$TTM^{Cat}\times$ Time FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Rating FE	Yes	Yes	Yes	Yes	No	No	No
Country FE	Yes	Yes	Yes	No	Yes	Yes	No
Industry FE	Yes	Yes	Yes	No	Yes	Yes	No
Issuer FE	No	No	No	Yes	No	No	No
Adj. R^2	0.66	0.68	0.67	0.81	0.69	0.69	0.53
Num. obs.	21,350	16,574	21,350	21,350	7,364	10,651	3,335