The Impact of the Shadow Banking Sector on Public Finance

Chuck Boyer and Kelly Posenau*

Current Draft: November 2021

ABSTRACT

Prior to 2016, money market mutual funds held about $250 billion in municipal government debt. These funds were an important source of short-term and low cost financing for state and local governments as well as other municipal entities in the United States. In response to the financial crisis of 2008, the SEC implemented a series of reforms in 2016 designed to make these funds more stable. We study the effects of the reforms on the U.S. municipal debt market. We use the negative shock to demand to explore the effects of frictions and asset-specific demand in this market. We show that tax-exempt fund holdings of municipal debt dropped precipitously around implementation of the reform. Issuers more exposed to the reform experienced a decrease in lending from funds, an increase in borrowing costs from funds, and an overall increase in borrowing costs for all new municipal debt issues. Our results suggest the reform may have increased borrowing costs for municipal entities that were more reliant on money markets for funding, and the effects were larger for smaller issuers. Our results demonstrate the importance of financial intermediaries, potential information frictions, and asset specific demand for municipal markets.

*University of Chicago Booth School of Business. cboyer@chicagobooth.edu, kposenau@chicagobooth.edu. We thank Doug Diamond, Wenxin Du, Matt Fabian, Jessica Jeffers, Anil Kashyap, Ralph Koijen, Rich Ryffel, Amir Sufi, and seminar participants at the University of Chicago for their comments and feedback. We thank Peter Crane from Crane Data for providing money market fund data. We thank the Fama-Miller Center for providing access to Atlas Muni data. This research was funded in part by the John and Serena Liew Fellowship Fund at the Fama-Miller Center for Research in Finance, University of Chicago Booth School of Business.

1 Introduction

Despite the fact that municipal debt markets tend to be highly segmented and dominated by retail investors, prominent clienteles can potentially move prices or transmit stress from other sectors of the financial system. In particular, the variable rate and short-term municipal debt market has historically been held by tax-exempt money market mutual funds (MMFs). This concentration is potentially problematic for the financial health of municipal entities. First, MMF shares are redeemable on demand, making MMFs susceptible to runs. Thus, investor runs can lead to liquidity problems in these municipal markets. Second, variable rate municipal instruments include periodic rate resets that were designed to lower borrowing costs for municipal issuers. Because MMFs effectively own the entire variable rate municipal universe, shocks to tax-exempt MMFs can appear very quickly in municipal balance sheets for issuers that are very exposed to variable rate markets, depending on how issuers have hedged these exposures. An evolving question is how do shocks to clientele demand filter through to the borrowing costs and issuing behavior of these municipal entities.

In this paper, we study how shocks and frictions in money markets affect municipal borrowing costs using a large negative shock to MMF demand following the 2016 SEC reform. Announced in 2014, the SEC enacted these reforms in order to reduce the risk of run-like events on MMFs that occurred during the global financial crisis. The targets of these reforms were prime funds, which hold short-term bank and commercial debt, and tax-exempt funds, which primarily invest in variable rate and short-term municipal debt issued by entities like states, cities, and hospitals. As a result, all tax-exempt funds experienced large investors outflows in the first three quarters of 2016 (see Figure 1). Prior to the reform, tax-exempt funds held about $250 billion in municipal debt, representing about 8% of the broader $3.9 trillion municipal market at the time. We therefore argue that the reform is a large shock to demand for a particular segment of municipal securities and examine how issuers and MMFs responded to the reform.

We exploit the reform's differential treatment of institutional and retail share classes in a differences-in-differences strategy in order to estimate the causal effect of a large shock to demand on borrowing costs. While all tax-exempt funds were required to institute redemption gates and liquidity fees, the SEC only required institutional tax-exempt funds to adopt a floating net asset value (NAV). This movement away from a fixed $1 per share NAV effectively eliminated the institutional tax-exempt MMF sector (see Figure 2). We test whether issuers that were more exposed to institutional funds prior to the major adjustment period of the reform experienced a decrease in MMF demand and an increase in borrowing costs post-reform. We consider both the period of industry adjustment in 2016

Figure 1: Aggregate Tax-Exempt MMF Holdings

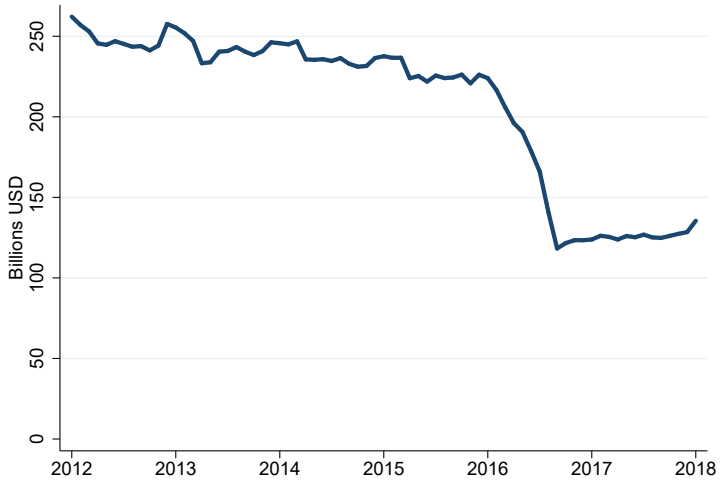

Figure 1 presents monthly aggregate tax-exempt MMF holdings.

and after the implementation of the reform in 2017. Because the portfolios of these two fund types are broadly similar and lending relationships between issuers and funds appear to be "sticky", we argue that this analysis provides a lower bound estimate of a large demand shock on municipal borrowers.

We find a significant effect of the reform. First, we show that issuers that were more exposed to institutional funds in 2015 experienced larger outflows from MMFs compared to issuers in retail fund portfolios. Second, we demonstrate that borrowing rates on MMF-held securities increased more after the reform for issuers that were more exposed to institutional funds in 2015. Third, we provide evidence that the issuers that were more reliant on institutional MMFs for their total borrowing in 2015 had higher coupon rates on *new issues* after the reform. This increase is relative to issuers that borrowed from MMFs but were either more exposed to retail funds or less reliant on funding overall. By exploiting this cross-sectional variation, we are able to account for broader macroeconomic trends in the municipal sector. Importantly, due to the limited reporting of initial coupon rates for variable rate municipal debt in our dataset, our results for new issues do not appear to be driven by secular industry issuance trends.

We explore issuer reactions to the reform that may explain our main findings. We examine whether issuers that were more reliant on institutional MMFs lengthened the maturity of their new issues and whether these exposed issuers substituted into different types of securities. We fail to find a significant effect of the reform on the term structure of new issues. However, we do find that more exposed issuers increased their issuance, but moved away from variable rate demand notes and anticipation

Figure 2: Aggregate Tax-Exempt MMF Holdings: Retail vs. Institutional

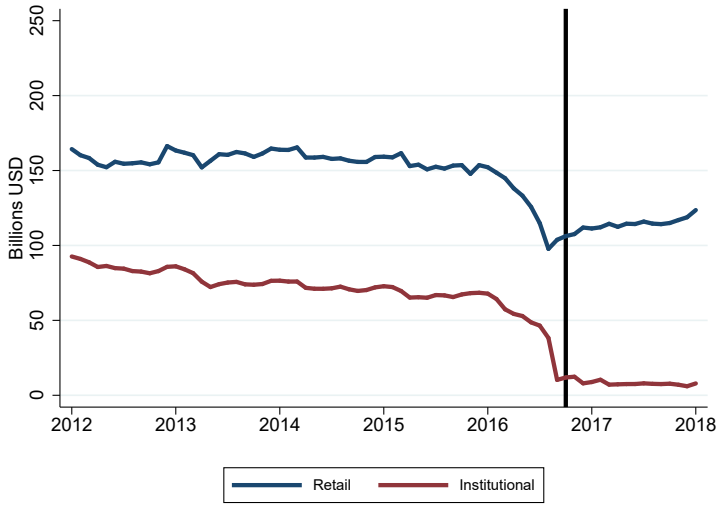

Figure 2 presents monthly aggregate tax-exempt MMF holdings by share class: retail vs. institutional.

note issuance as a share of total issuance by 2017. Importantly, we do not see the issuance response in 2016, suggesting a longer-run mechanism of adjustment.

We also document heterogeneity in effects across issuers in correlation analysis. Smaller issuers were more likely to have their issues dropped by tax-exempt funds and experienced a larger increase in borrowing costs post-reform. In addition, post-reform effects were stronger in the hospital and housing sectors than for states and cities. We also provide descriptive evidence about the composition of fund portfolios before and after the reform. After the reform, portfolios tilted more towards private and housing authority issuers. We also find that the issues that dropped out of the sample primarily had a long-term rating of "Not Rated". This evidence suggests that informational frictions may play a role for access to capital in this market in the face of a large negative shock to demand.

We also use this demand shock to study the role of financial intermediaries, and asset specific demand on public finance. Our results display the important role that intermediaries play in this market. We provide evidence that pre-existing relationships between parties in this market have a material effect on access to capital and borrowing rates for municipal governments in the aftermath of a shock to demand. As part of this analysis we calculate the elasticity of demand for issuers in this market and show that it is extremely inelastic, which is unsurprising given the structure of the market and the size of the demand shock.

Our paper makes three principal contributions. First, we provide evidence that the MMF reform had a significant impact on issuers more exposed to the demand shock. Our work shows that while

the reform broadly appears to have had minimal pricing effects, more exposed issuers experienced decreased access to an important clientele and higher borrowing costs. Second, we provide a relatively straightforward example of the effects of asset-specific demand on prices. The shock to demand from one clientele led to a significant effect on municipal borrowing more generally, which is consistent with findings in the positions-based asset pricing literature. We show that demand in this market is particularly inelastic, which has important implications for regulations' effects on borrowers. Finally, we provide a number of descriptive statistics of a relatively understudied market that is important for the smooth functioning of governments and other municipal entities.

The recent COVID-19 pandemic has led to a number of programs instituted by the Federal Reserve to provide relief to municipal governments. For example, the Fed expanded the Money Market Mutual Fund Liquidity Facility to include short-term municipal securities and VRDOs as collateral. Therefore, understanding the dynamics and role of relationships in this market is important for evaluating the efficacy of policies in times of crisis. Our results are suggestive of a positive role for policy supporting these markets, particularly for smaller issuers.

Our work relates to a long literature about frictions in MMF lending and effects on borrowers. Previous work has documented that firms can only substitute funding in times of stress if they have a preexisting relationship with a MMF (Chernenko and Sunderam (2014)) and MMFs are more likely to provide more favorable lending terms to firms in the presence of preexisting relationships (Aldasoro et al. (2018); Li (2018)). Additional work has found that MMF sponsor characteristics could predict runs during the crisis and that some sponsors provided substantial support to their MMFs during times of stress (Kacperczyk and Schnabl (2013)), as well as the importance of sponsor support and sponsor business models during times of stress (Brady et al. (2012)). We contribute to this literature by demonstrating that MMF lending relationships also matter in municipal markets. We also contribute to work examining effects of the MMF reform (Aldasoro et al., 2018; Cipriani and La Spada, 2018; Anderson et al., 2019). We extend this literature by examining the effect of the reform on tax-exempt MMFs and municipal borrowers.

Our paper also relates to the literature on positions-based asset pricing. This literature explores the role of financial institutions and individual asset demands on prices. For example, Coval and Stafford (2007) show that mutual fund outflows can lead to a significant effect on underlying asset prices. Meanwhile, Koijen and Yogo (2019) show that demand factors contribute to the majority of variation in equity prices. We explore the role of MMF investor demand on underlying municipal debt prices. We demonstrate the effect of an important clientele on asset prices following a large demand shock. We also provide first-pass estimates of the inelasticity in municipal debt markets using positions

data in an event study framework.

Finally, our paper relates to the literature on the determinants of municipal bond yields. The closet paper to ours is Babina et al. (2021). The authors demonstrate that tax-induced market segmentation creates substantial home bias in municipal bond investors' portfolio and limits risk-sharing. Meanwhile, Dagostino (2018) investigates the role of bank financing on municipal bond issuance behavior. Schwert (2017) shows that a majority of the variation in municipal bond spreads is due primarily to default risk rather than liquidity. We add on to these papers by exploring the unique role of financial intermediaries and asset-specific demand as determinants of municipal bond interest rates. Our contribution is to study a municipal bond clientele determined by the maturity structure of bonds. We are not aware of any papers looking specifically at the short-term and variable rate municipal debt market, therefore our work also serves as an overview of that sector of municipal debt.

The paper proceeds as follows. We first describe the data sources we use throughout our analysis. The second section provides background on the short-term and variable rate municipal market, while also providing preliminary estimates of the overall size of the market. We then describe the MMF sector and the 2016 SEC reform in greater detail, focusing on the institutional details that we exploit in our causal analysis. We also provide evidence on how tax-exempt MMFs reacted to the reform. Having discussed the institutional setting, we then describe our data more completely. We provide details on the funds, bonds, and issuers in our sample. This is the first description of this market in the finance literature to our knowledge. Then we analyze the effects of the reform in a causal setting. We discuss the methodology and our assumptions, and then provide causal estimates for the impact of the reform. We then document how issuers adjusted to the reform and what issuers were most affected in MMF portfolios. Finally, we use the demand shock to provide preliminary estimates of the inelasticity of muni markets.

2 Data Sources

We utilize three principal datasets in this paper. We obtain monthly data on MMF portfolio holdings from 2012 through 2017 for each MMF at the security level using Crane Data. This data is collected from fund sponsors and represents the largest tax-exempt funds. Over our sample period, the Crane data captures 85 to 97 percent of tax-exempt assets under management (AUM) in the MMF universe. We supplement this data with the fund's retail or institutional share class designation from the CRSP mutual fund characteristics database, cross-validating with fund prospectuses. The portfolio holdings data also has updated interest rate information for each holding on a monthly basis.

We merge the portfolio holdings data with the Mergent municipal securities database. This data contains bond and issue level information, which allows us to identify the issuer of each security along with more granular security-level information. We collect ratings, maturity, coupon rate, debt type, and total issue amount from Mergent. We have found important omissions in this data that impact our analysis. First, this dataset does not include commercial paper issues. We deal with this by double checking that our results hold when we eliminate commercial paper from our analysis. Second, the initial coupon rates for variable rate securities are mostly missing. Thus, our analysis of new issue borrowing costs is primarily driven by fixed rate short-term and long-dated securities. Otherwise, this database provides extensive coverage of municipal securities offerings. Finally, we use the Atlas Muni database to obtain additional issuer-level information such as obligor sector.

3 Institutional Background: Short-term and Variable Rate Municipal Debt Markets

The term "municipal" refers to a number of different entities in the U.S. States, cities, counties, school districts, hospitals, and housing authorities are all entities that may issue municipal debt. In addition, private-purpose bonds are tax-exempt securities issued to fund private projects that are believed to have public benefit (e.g. airports, sports stadiums). Municipal entities issue debt in order to fund capital expenditures or, in the case of short-term debt, to meet immediate cash flow needs. Broadly, there are two types of municipal debt: general obligation bonds (GO), and revenue bonds. GO bonds are backed by the "full faith and credit" of the underlying municipal entity, whereas revenue bonds are backed by a specific revenue stream. According to Flow of Funds data, total municipal securities totaled around $3.9 trillion outstanding in 2015.

A unique feature of municipal debt is that coupon payments are generally tax-exempt at the federal, state, and local level.[1] This exemption was created in order to help municipal entities access cheaper capital. Consequently, investors are generally willing to accept lower yields on debt as compared to a risk-equivalent corporate because of the benefit from the tax exemption. This exemption also leads to market segmentation because investors are incentivized to own debt issued by municipalities in the state in which they reside. Finally, municipal debt is held primarily by high net-worth individuals who can most take advantage of the tax breaks. According to Flow of Funds data, households and nonprofits directly hold about 46% of municipal securities, but wealthy individuals also invest through mutual funds. Other institutional investors in municipal debt include banks, insurance companies, and

[1] In most states, income from municipal bonds is tax-free if the bond is issued by the state in which you reside.

MMFs.

In this paper, we primarily focus on municipal securities that are held by tax-exempt MMFs. Tax-exempt MMFs primarily invest in short-term and variable rate debt securities, along with a substantial investment in structured financial products. We provide a detailed description of portfolios and these securities in the Summary Statistics section. Unlike corporate entities, there are often institutional frictions that make commercial paper style issuance difficult for municipal entities. Many municipal entities need approval of a local government or a vote by their constituents to approve each debt issuance. This makes issuance of true short-term commercial paper on a rolling basis cumbersome for most issuers. Nevertheless, municipalities still desire access to lower borrowing rates at the short end of the term structure. Because of these factors, some unique securities have arisen to address these issues.

The principal types of debt held by MMFs are variable rate demand obligations (VRDOs or VRDNs), short-term anticipation notes, certificates, and commercial paper. VRDOs are long-dated floating rate securities issued by municipal borrowers, particularly hospitals. As such, municipalities gain access to the lower end of the term structure without a need to issue new securities. VRDO interest rates are generally reset weekly by a remarketing agent that has a relationship with the municipality. These securities also have an embedded put option: the investor can require a repurchase by the underlying entity, which would generally be fulfilled by the remarketing agent. Finally, VRDOs are generally backed by liquidity facilities, such as letters of credit (LOC), issued by a financial institution unique from the remarketing agent. These enhancements protect investors from both default risk and liquidity risk. MMFs are allowed to invest in VRDOs because of the weekly interest rate resets and embedded put option, despite being a long-dated security. MMFs also invest in structured financial products, such as tender option bonds (TOBs). These are structured very similarly to VRDOs, with a trust issuing floating rate certificates backed by a pool of municipal securities with weekly rate resets. Market participants often refer to these as synthetic VRDOs because of these features.

Anticipation notes, as their name suggests, are short-term securities issued by a municipal entity in anticipation of a forthcoming revenue stream. The most common of these securities are tax anticipation notes (TANs) issued to fund short-term cash flow needs and are backed by future tax receipts. Bond anticipation notes (BANs) on the other hand are issued in anticipation of proceeds from a future long-term bond issuance. Municipal entities can also issue commercial paper, with a maturity of 90 to 270 days. Thus, these are a more "traditional" short-term debt issuance. In order to protect investors against a failure to rollover short-term issues, many of these securities have liquidity or credit enhancements.

We approximate that these securities in total represented about 9% of the broader municipal market, with much of the issuance concentrated in MMF portfolios prior to 2016. This exercise is purely for illustration of the rough size of this market, as it is difficult to piece together a cohesive picture from any one data source. VRDOs represented a $200 billion asset market in early 2015, according to SIFMA estimates.[2] The SEC noted in its 2014 final rule that MMFs effectively own 100% of VRDOs. We find in our own portfolio data that VRDOs and synthetic VRDOs comprise over 70% of tax-exempt MMF assets, with over 50% invested in VRDOs alone. The Flow of Funds data suggests that state and local short-term municipal liabilities amounted to $38 billion at the beginning of 2015. Using this Flow of Funds data and SIFMA statistics on variable and floating rate debt, we estimate that the total short-term and variable rate market was approximately $336 billion at the beginning of 2015. MMFs held approximately 70% of this market around the same time.[3] We will provide a careful analysis of the prevalence of these instruments in our sample in the Summary Statistics section, after describing the SEC reform and the tax-exempt MMF industry.

4 The 2016 SEC Reform and Tax-Exempt MMFs

In 2014 the SEC announced a series of reforms to the MMF industry that were enacted in October 2016, causing concern about liquidity provision in the broader financial system. MMFs are open-ended mutual funds that hold highly liquid short-term debt securities. They are designed to maintain a highly stable asset value while providing coupon income to investors. Fund shares are also eligible for redemption on demand. Because of these features, MMF shares are often treated as a "money-like" demand deposits by investors. They are considered a relatively attractive "safe" and liquid investment vehicle, which consequently provide short-term financing to corporations, banks, and municipalities. Rule 2a-7 of the Investment Company Act of 1940 restricts the quality and maturity of securities which can be held by MMFs. Funds must maintain a weighted average maturity of 60 days and cannot invest more than 5% in a single issuer (other than the US government).

The SEC implemented the reforms in order to make these funds more safe and resilient in the face of runs like those experienced during the financial crisis. During the financial crisis, there were a number of runs on MMFs as institutional investors redeemed their shares in prime and tax-exempt institutional

[2]The SIFMA statistics also provide aggregate outstanding amounts for other types of variable and floating rate debt, notably auction rate securities and floating rate notes. The total size of this market, including these securities, was estimated as $298 billion at the beginning of 2015. The SIFMA estimates do not include certain types of securities, such as TOBs, so we take these estimates to be an approximation of market size.

[3]Importantly, this is probably an underestimate of market size due to the absence of many synthetic VRDOs (TOBs) from these statistics. Our Mergent data suggests outstanding amounts of TOBs and derivatives issued since 2008 were about $80 billion. This segment also went through a notable contraction following the global financial crisis.

funds, shifting into government funds and other safe asset classes (Schmidt et al. (2016)). These government funds hold almost exclusively securities issued by the US government and its agencies or repurchase agreements backed by these securities. Prime funds hold securities issued primarily by banks, corporations, or the US government. Tax-exempt funds hold municipal securities exempt from federal and sometimes state taxes. Institutional share classes are often limited to institutional investors, with a high initial purchase and lower management fees than retail share classes. Retail fund investors are generally natural persons or omnibus accounts that cater to natural persons. While institutional funds represent most of government and prime funds' AUM, the tax-exempt sector is more equally represented by institutional and retail funds: retail funds represent approximately 60% of total tax-exempt AUM in 2015. This reflects the importance of retail investors in the broader municipal market.

The SEC reform had differential requirements for institutional and retail funds. As part of the reforms, institutional prime and tax-exempt funds would be required to use floating NAVs for daily share prices rather than a fixed $1 per share price. The reforms also implemented barriers to fund redemptions, including redemption gates and liquidity fees, for both institutional and retail funds. Retail funds were also required to verify that investors were natural persons following the reform, leading to mandatory redemptions over the course of 2016. Because of investment mandates in addition to favorable accounting and tax treatment of fixed NAV vehicles, many institutional investors do not invest in floating NAV products. Institutional investors thus redeemed shares in tax-exempt funds over 2016.

The reform resulted in outflows from the tax-exempt sector and the closing of many tax-exempt funds. Figure 1 from the introduction presents the time series of total AUM of tax-exempt MMFs in our sample. The figure shows a precipitous decline in holdings by these funds in the run-up to the implementation of the reform in October 2016. Holdings totaled over $225 billion at the end of 2015 and dropped to under $125 billion at the end of 2016. While there had been a small decline over the previous three years, this represents a drastic decline. Most work on the reform has demonstrated a similar effect in prime institutional funds. These papers use the MMF reform as a large exogenous negative shock to supply of funding for the banking sector (e.g. Anderson et al. (2019),Aldasoro et al. (2018)). We take a similar approach and argue that the MMF reform led to a large shock in demand for short-term and variable rate municipal securities.

The distribution of tax-exempt MMF assets between institutional and retail funds presents a unique opportunity to exploit the reform's differential treatment of institutional and retail funds. Figure 2 from the introduction shows the AUM time-series split by institutional and retail funds. There was

Figure 3: Weighted Average Tax-Exempt MMF Coupon

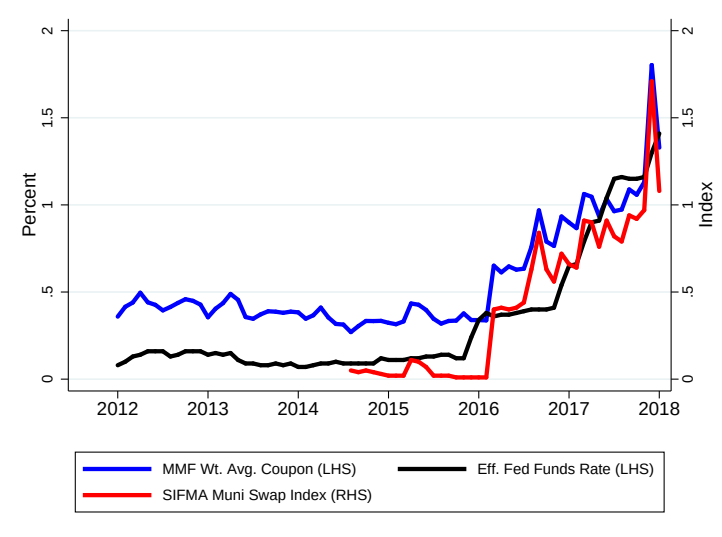

Figure 3 presents the monthly value-weighted average coupon rate for the MMF sample plotted against the effective fed funds rate and the SIFMA Muni Swap Index.

a large decline in both types of funds, but a majority of the decline in AUM was concentrated in institutional funds. There was a slight recovery in retail fund holdings after October 2016, which can be explained by institutional funds converting to retail funds after the reform. These converters still lost a substantial proportion of AUM, likely due to investor outflows and mandatory redemptions of the accounts of non-natural persons.

While the previous two figures depict a drop-off in demand for tax-exempt MMFs, they do not necessarily indicate a real impact on the underlying municipal entities. Aggregate borrowing costs also fail to show much of an effect on the broader market. In Figure 3, we plot the average value-weighted coupon for tax-exempt MMF holdings over time against the SIFMA Muni Swap Index and the fed funds rate. The chart depicts a relatively stable monthly rate prior to 2016 of around 0.5%, which increases to about 1% after the reform. Importantly, these increases appear to coincide with increases in the effective fed funds rate. However, we do see a temporary spike at the end of 2016 that coincides with the reform's implementation. This also closely tracks the SIFMA Muni Swap Index, which is an index comprised of 7-day VRDO reset rates. However, analysis of these broad trends obscures important cross-sectional variation in exposure to the reform that ultimately will impact borrowing costs.

Next, we look at how the composition of MMF portfolios changed following the reform. In Figure 4 we display the percentage of tax-exempt MMF holdings in each sector before and after the reform. We see a shift in the aggregate portfolio composition as the share of private sector and housing authority

Figure 4: Tax-Exempt MMF Holdings by Sector

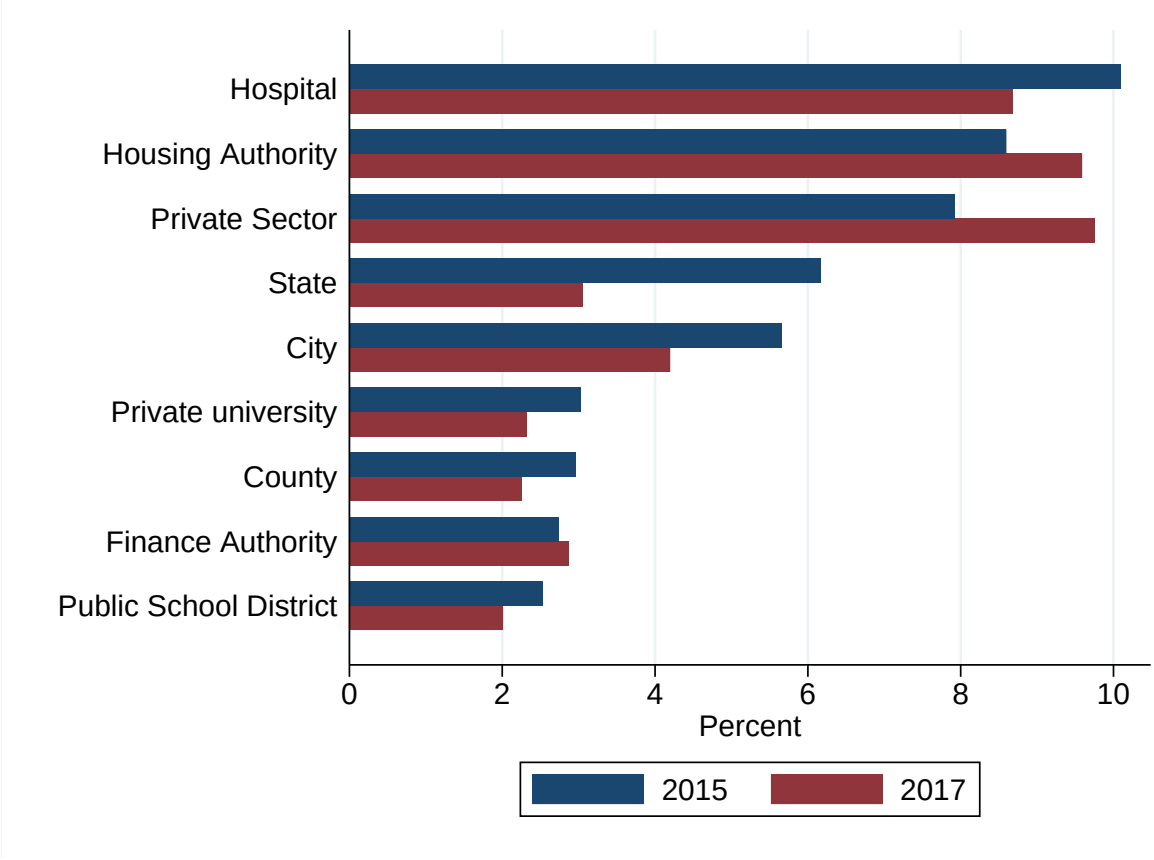

Figure 4 presents the share of the entire MMF universe by sector at the end of 2015 and 2017.

bonds increased following the reform. Meanwhile, the share of the portfolio in state, city, and hospital issued debts decreased. Finally, Figure 5 displays the portfolio compositions by the underlying issuer credit rating before and after the reform. These charts are frequency charts which represent individual holdings, rather than the value of holdings. MMFs are required to hold highly rated debt, but the short-term ratings for VRDOs and CP are based on the credit rating of the bank LOC provider. For this analysis, we use the LT rating of the issuer. The most striking change is the decrease in non-rated bonds (NR). Prior to the reform over 60% of holdings were in non-rated securities while that percentage dropped to under 20% post-reform. This reflects a direct and indirect rebalancing. The decrease in non-rated securities represents an overall decrease in the holdings of variable rate products. It may also demonstrate a decrease in the share of low information issuers in portfolios.

This analysis presents a number of facts that we use to motivate our empirical strategy. First, there was a large exogenous drop in tax-exempt MMF AUM in response to the SEC reform. Because of the institutional features of the MMF industry, we argue that this decline was exogenous and not related to

Figure 5: TE MMF Holding by Rating

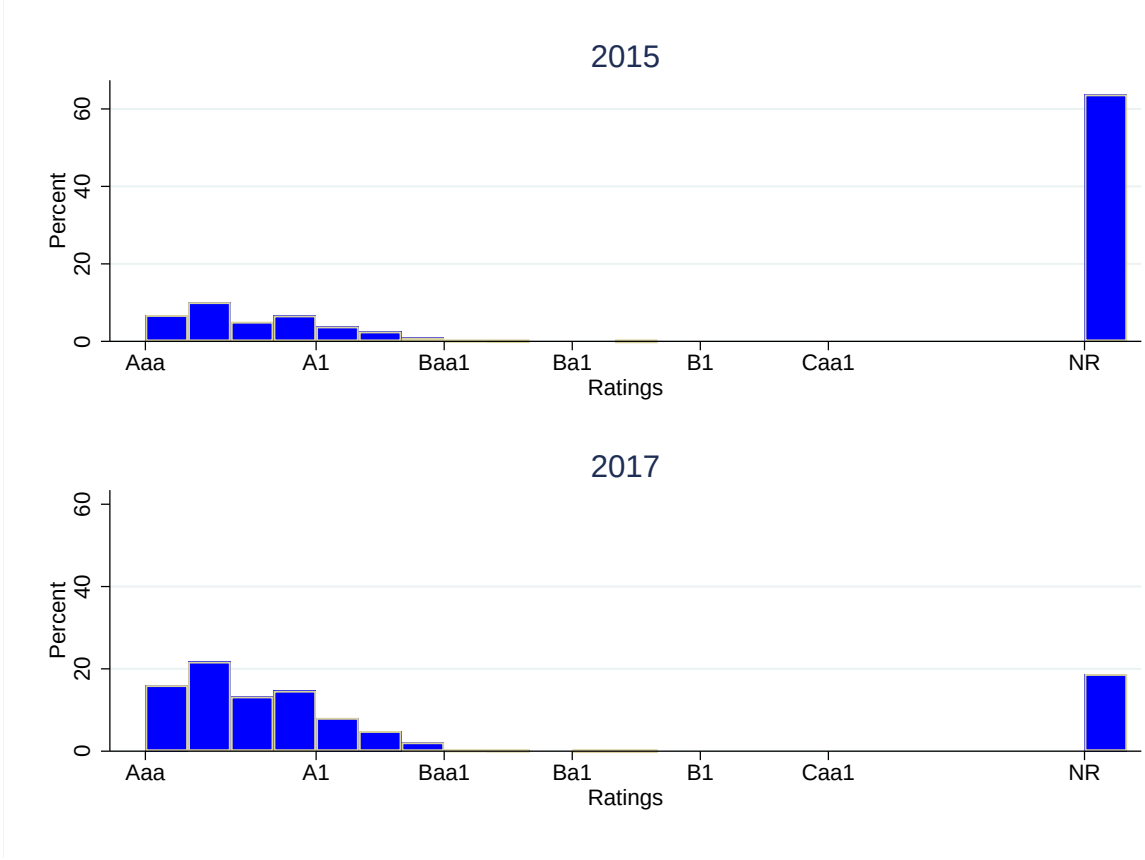

Figure 5 the percentage of the aggregate MMF universe in each underlying issuer's rating category at the end of 2015 and 2017.

portfolio characteristics. Second, we see that institutional funds represented a majority of the decline in AUM, although retail funds were also affected. We will thus use differential exposure of municipal issuers to institutional funds to proxy for heterogeneous exposure to the demand shock. Third, the primary period of industry adjustment occurred during 2016, which included both expected fund closings and mandatory redemptions as well as unexpected investor outflows. Therefore, we use 2015 as our base year and consider outcomes in 2016 and 2017, rather than using the SEC announcement date in 2014 as the treatment date.

5 Summary Statistics

In addition to our main analyses, our paper presents a novel exposition of the short-term and variable rate municipal debt market. This is the only in depth description of this market in the

Table 1: Summary Statistics

	N	Mean	Std.	p_{10}	p_{25}	p_{50}	p_{75}	p_{90}
				Panel A: Fund-Month Level				
# of Funds	124							
# of Families	27							
AUM ($B)	6,796	2.150	3.787	0.110	0.239	0.794	2.242	5.498
CUSIP Size ($M)	6,796	8.013	6.519	2.120	3.797	6.491	11.015	14.311
Weighted Average Maturity (days)	6,796	29.801	18.735	9.815	20.121	29.599	38.983	46.337
Portfolio Persistence (%)	6,672	92.758	5.914	85.396	89.987	93.950	96.870	98.793
Institutional fund	6,796	0.479	0.500	0.000	0.000	0.000	1.000	1.000
State fund	6,796	0.524	0.499	0.000	0.000	1.000	1.000	1.000
Derivative Share (%)	6,131	17.750	10.437	4.990	9.672	16.458	24.598	32.706
ARS/VRDO Share (%)	6,795	60.377	16.075	39.294	49.736	59.973	70.893	82.079
Notes/Certs. Share (%)	6,295	10.254	6.135	2.849	5.534	9.663	13.886	18.548
Other Bonds Share (%)	5,456	4.890	4.167	0.721	1.792	4.034	6.794	10.237
CP Share (%)	5,228	6.525	5.884	0.542	1.825	5.060	9.527	15.258
				Panel B: CUSIP level (Mergent sample)				
# CUSIPs	53,200							
# CUSIPs (Cleaned)	33,421							
MMF Holding ($M)	685,366	18.419	47.748	1.385	4.000	9.115	20.200	43.200
Share Held by MMFs (%), winsorized 1%	671,397	68.670	34.137	14.419	40.417	78.329	100.000	100.000
Coupon (Ratio)	685,366	0.008	0.013	0.000	0.001	0.002	0.008	0.020
Total Issue Size ($M)	33,421	120.329	340.349	4.750	9.286	25.225	99.995	311.460
Maturity (yrs)	33,421	13.259	11.901	1.000	2.000	9.000	24.000	30.000
GO	33,421	0.340	0.474	0.000	0.000	0.000	1.000	1.000
				Panel C: Issuer-level (Mergent sample)				
# Issuers (held by MMFs)	6,829							
Issue Size ($M)	1,129,248	6.394	43.915	0.160	0.425	1.290	4.370	12.770
Total Issuance 2012-2017 ($M)	4,554	435.303	1,395.401	14.032	33.545	92.765	283.535	884.130
Share of New Issuance 2012-2017								
Derivatives (%)	222	15.377	31.568	0.238	0.762	2.409	6.543	96.359
ARS/VRDO (%)	739	52.495	39.560	6.715	14.539	38.743	100.000	100.000
Notes/Certs. (%)	1,753	58.047	30.632	13.765	33.358	59.824	84.840	100.000
Share of New Issuance 2000-2017								
Derivatives (%)	1,625	10.615	20.324	0.671	1.707	4.025	9.277	22.358
ARS/VRDO (%)	2,839	58.933	37.369	7.117	23.602	57.402	100.000	100.000
Notes/Certs. (%)	2,274	46.668	31.348	3.845	18.513	46.578	71.224	95.167
Average Reliance on MMFs in 2015 as % of Total Issuance from 2000-2017								
Avg. MMF Rel. 2015 (%)	4,264	20.952	70.484	0.312	1.274	6.640	21.069	57.684
Avg. MMF Rel. 2015 (Derivatives)	1,277	9.815	20.956	0.000	0.000	0.000	8.065	35.000
Avg. MMF Rel. 2015 (ARS/VRDOs)	2,081	45.136	94.001	0.000	10.063	31.872	64.316	92.816
Avg. MMF Rel. 2015 (Notes/Certs.)	1,399	18.271	23.383	0.000	0.000	10.919	24.861	47.980
Avg. MMF Rel. 2015 (Other Bonds)	3,315	1.025	6.250	0.000	0.000	0.000	0.547	1.663
LT rating (1=Aaa,3=Aa2,5=A1)	4,160	3.425	3.855	1	2	3	3	5

Table 1 presents summary statistics for the main data sources in the paper (Mergent and the Crane MMF data). Panel A represents summary statistics at the fund-month level. Panel B presents CUSIP level statistics, and Panel C presents issuer level statistics.

literature, to our knowledge.

5.1 Money Market Funds

We have in total 124 unique tax-exempt funds from 27 fund families over the course of our sample. By the end of our sample, many of these funds had closed, leaving 65 funds from 18 families. Table 1 Panel A presents summary statistics on our sample of funds at the fund-month level. On average, funds managed around $2 billion assets throughout the sample. Some of the larger fund families managed over $20 billion prior to the reform's implementation. Most funds in the sample are retail share classes, although about 30 institutional funds converted to retail in 2016 and 2017. About 50% of funds in the sample are state-level funds, which concentrate on tax-exempt and AMT-free income from states like New York, California, and Pennsylvania. We provide a full description of how we classify portfolio holdings in the next section. The largest exposure of funds is to variable rate and adjustable rate debt. On average, funds' exposure to variable rate securities is about 60% of their portfolio value over the entire sample. Finally, the portfolios of funds are fairly stable from month to month. The amount of CUSIPs rolled over from the previous month as a percent of total value is on average 92% during the time period. As a comparison, this portfolio persistence measure is on average 66% for prime funds and 72% for government funds. This suggests that lending relationships in this market are relatively "sticky".

5.2 Portfolio Holdings

MMFs hold a variety of different municipal instruments, including tender option bonds (synthetic VRDOs), auction rate securities, variable rate demand obligations, anticipation notes, commercial paper, as well as other certificates, notes, and long-term bonds with a short time to maturity. We create a categorization scheme based on Mergent data in order to classify securities into buckets, which are listed below. For all categories, we cross-check our categorization with the holding name for a random sample of CUSIPs to check accuracy of the categorization. Our classification scheme is based on holdings in MMFs, but we also use it in our issuer analysis to categorize broader patterns in the market. We are unable to classify on average 6% of holdings over the course of the sample.

1. Derivatives: these are primarily tender option bonds in MMF portfolios and have a debt type of "Derivative" in the Mergent data. For holdings missing from the Mergent data, we classify bonds using the MMF data that have a category listed of Tender Option Bond. The holdings in our sample reflect floating rate trust receipts. Over the sample, these represent on average 18% of holdings value.

2. ARS and VRDOs: These are bonds with debt type of "Bond" and coupon codes of either:

adjustable rate; floating rate; flexible rate; floating rate at floor; inverse floater; linked inverse floater; variable rate; floating auction rate; and index linked. These are the coupon codes that Mergent uses for securities included in its Variable Rate History schedules. Over the sample, these represent on average 55% of holdings value.

3. Commercial paper: most of the issuers that we fail to match to Mergent are tax-exempt commercial paper facilities. We rely on the MMF holdings data to classify commercial paper, which primarily have categories of financial commercial Paper, nonfinancial commercial paper, other municipal debt, and other municipal securities. Much like VRDOs, commercial paper facilities rely on liquidity or credit enhancements in the event of failure to roll over paper. Over the sample, these represent on average 7% of holdings value.

4. Anticipation notes: we classify this bucket using Mergent debt types of bond anticipation notes, grant anticipation notes, revenue anticipation notes, tax anticipation notes, and tax and revenue anticipation notes. Over the sample, these represent on average 8% of holdings value.

5. Other certificates and notes: we classify this bucket using Mergent debt types of certificates of indebtedness, certificates of obligation, certificates of participation, other certificates, other notes, and promissory notes. Over the sample, these represent on average 2% of holdings value.

6. Warrants: we classify this bucket using Mergent debt type of Warrants. These are a relatively small part of the sample, and we end up grouping them with the other notes (certificates, notes, and anticipation notes). Over the sample, these represent on average .01% of holdings value.

7. Other bonds: the remaining instruments that we can match to Mergent have a debt type of bond and coupon codes that are fixed or not adjustable. These represent on average 3% of holdings value.

Table 1 Panel B contains summary statistics for the sample of CUSIPs held by MMFs during our sample. We are able to match 63% of the CUSIPs in the portfolio holdings to the Mergent database. Unmatched CUSIPs are predominantly commercial paper, as well as shares in other mutual funds, Treasuries, and agency exposures. The average value of a CUSIP held by MMFs is $18 million, but can vary from under $1 million to over $43 million. MMFs tend to hold a sizeable proportion of a CUSIP's outstanding value, with 25% of CUSIP's in sample being entirely owned by MMFs.[4] These

[4]The average and standard deviation of this measure is very high and reflects a long right tail from several important outliers. This reflects CUSIPs that have values held by MMFs that exceed principal amounts reported in the Mergent data. These CUSIPs are predominantly TOBs, and the principal amounts accurately reflect available data on EMMA. We verify results by removing these issues from analysis.

Figure 6: Issuance Trends

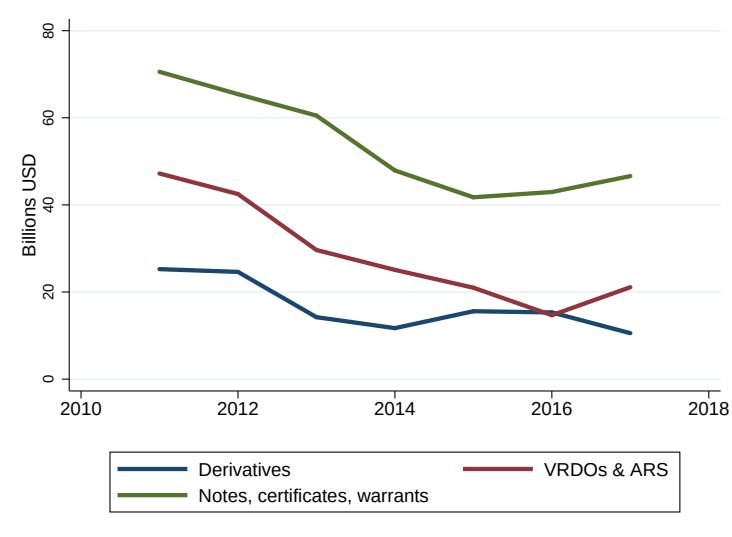

Figure 6 presents totaly yearly issuance of each type of security reported in the Mergent data from 2011 to 2017.

bonds represent issues that range in total size from $120 to over $300 million. For the most part, issuers in the MMF sample tend to have larger and more frequent issues than the rest of the muni universe. Finally, most of the sample consists of revenue-backed bonds rather than general obligation bonds. This reflects the sectoral breakdown depicted in Figure 8, where the largest holdings tend to be concentrated in hospitals, housing, and private sector issues.

We present the broader issuance trends for these securities in Figure 6 as reported in the Mergent data. Notably, we are missing commercial paper issuance (as stated previously). We also leave out fixed rate long-dated bonds for the purpose of comparison of the market. Over the time period, issuance in these market segments has been decreasing. However, issuance slightly increased in 2017 for short-term notes, certificates, and variable rate municipal debt. Issuance of new derivative securities has remained relatively flat at $15 billion per year.

5.3 Issuers

Table 1 Panel C contains statistics on the issuers that borrow from MMFs through the sample. We have 6,829 unique issuers that appear in sample from 2012 to 2017. Of these issuers, 63% borrowed from MMFs in 2015 prior to the industry's response to the MMF reform. In general these relationships tend to be sticky, and funds roll over funding continuously to issuers. These issuers tend to be large on average, issuing $435 million over the time period. The sample also contains some of the largest municipal issuers, that have issued $1 billion in bonds over 5 years. For issuers that issue variable

Figure 7: MMF Holdings Pct. by State: 2015

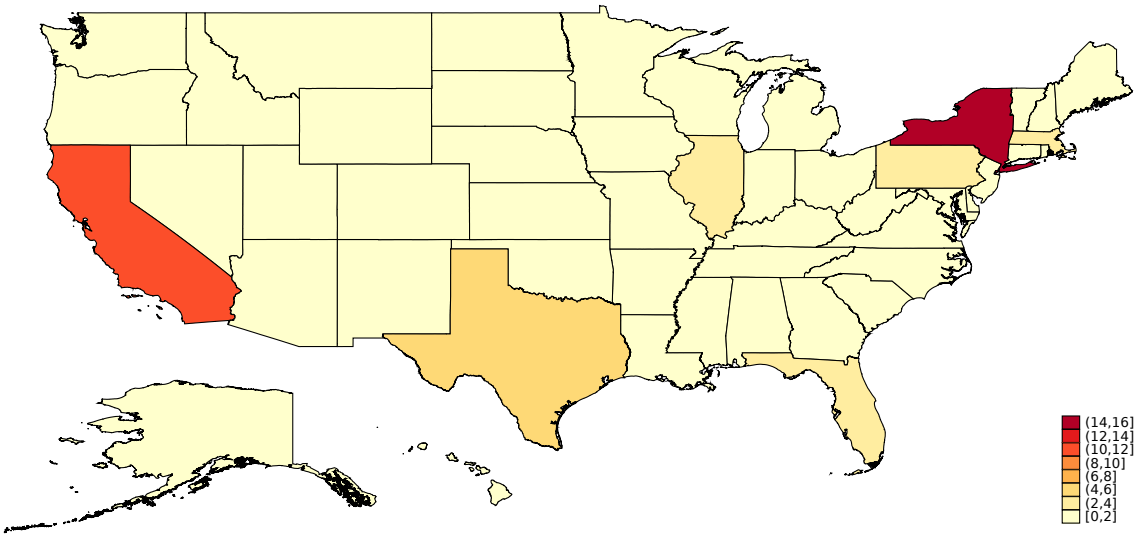

Figure 7 presents the share of all MMF holdings at the end of 2016 issued issuers in each state.

rate/adjustable rate debt, 25% of issuers only issue variable rate debt. Many more of the issuers in sample issue short-term notes and certificates, which comprise over half of new issues for half of the sample. These issuers also tend to be more highly rated than the rest of the muni universe. Most long-term ratings of issuers in the sample are Aa2 and above.

In Figure 7 we display the percentage of tax-exempt MMF holdings by state of issuer at the end of 2015. As the figure shows, holdings are highly concentrated in the states of New York and California, along with relatively large issuance by Illinois, Texas, Florida and Massachusetts. This pattern mirrors municipal markets more generally, which also skew towards these states.

In addition, we show the break down of tax-exempt MMF holdings by the obligor's sector from the Atlas Muni database in Figure 8. This chart depicts the top 5 sectors of MMF holdings and their values from 2012-2018. Hospitals, Housing, and Private Sector bonds are the top three sectors throughout the sample, while cities and states round out the top five. In total, the top 5 sectors represent over 40% of all tax-exempt MMF holdings. We also see that states have a cyclical pattern as these holdings are driven by anticipation notes issued seasonally and backed by future tax receipts. It is worth nothing that we see a steady drop off in holdings in each sector following the reform. We will analyze the cross-sectional differences in response to the reform in more detail in the following sections.

We also examine how reliant these issuers are on money market funds for borrowing. To do so, we take the average value of borrowing from MMFs in 2015 and divide by total issuance from 2000 to 2017. There is a lot of variance in the distribution, but issuers on average depend on MMFs for

Figure 8: Holdings by Sector: 2012-2018

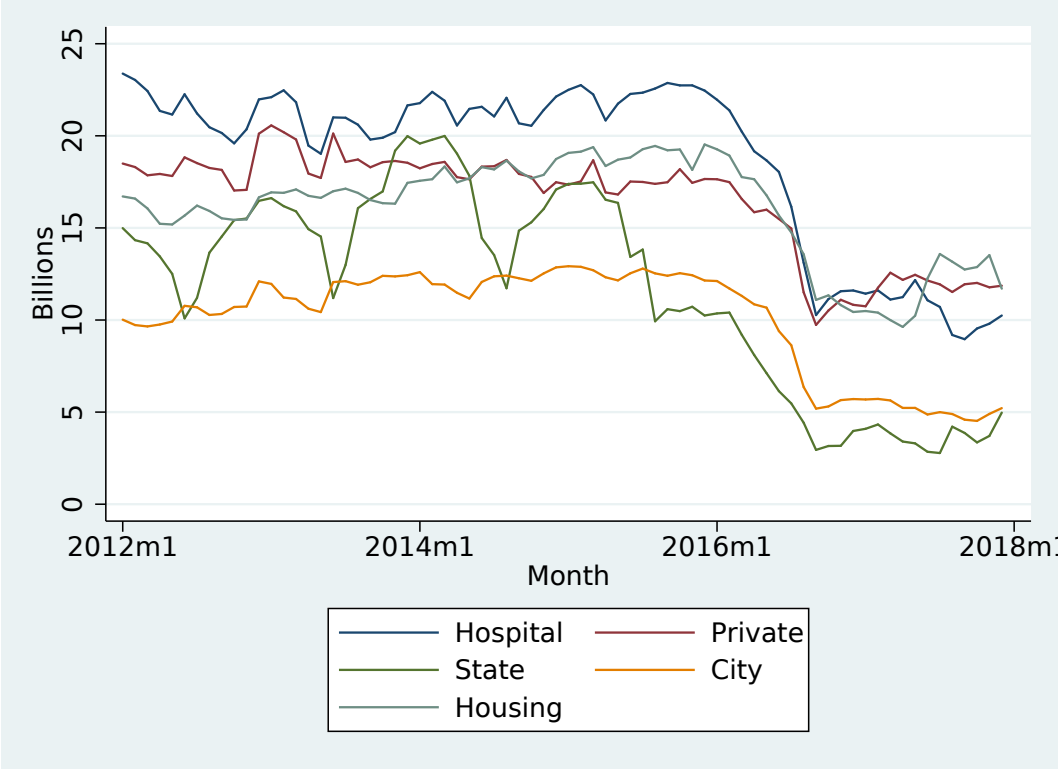

Figure 8 presents the share of all MMF holdings in each each sector at the monthly level from 2012-2018. The top five sectors (in shares of holdings) are presented.

about a fifth of their funding. This is most concentrated in variable rate borrowings, where issuers on average place about 45% of their variable rate debt with MMFs.

6 Effects of the SEC Reform on Municipal Issuers

In this section, we present our analysis of the effect of the MMF reform on municipal issuers. We start with a description of our differences-in-differences approach that exploits the differential treatment of institutional tax-exempt funds. We then examine how the reform affected MMF lending to municipal issuers and borrowing costs in MMF portfolios. We also examine how municipal issuer exposure to the reform affected issuance and borrowing costs on new issues in the years following the reform.

After documenting a causal effect, we examine other effects of the reform on issuers. We first examine potential mechanisms for municipal entities to adjust in response to the demand shock. We then discuss the types of issuers that were more adversely affected by the reform in the post-2016 period. Finally, we document the price inelasticity of these markets.

6.1 Methodology

Our main analysis relies on a differences-in-differences approach that exploits the differential treatment of institutional share classes of tax-exempt MMFs. The SEC reform's effects were concentrated on institutional tax-exempt funds, due to the additional floating NAV requirement and the subsequent large institutional investor redemptions. Our analysis thus examines whether issuers that were more exposed to these institutional funds in the year prior to the reform's implementation saw a reduction in lending from MMFs and an increase in borrowing costs from MMFs.

We construct an issuer-level variable of exposure by summing the total value of an issuer's i borrowing from institutional funds in a given month and normalizing by the total value of borrowing from all funds f:

$$\text{Institutional Exposure}_{it} = \frac{\sum_{j \in Inst.} Value_{ijt}}{\sum_{j} Value_{ijt}}$$

For the analysis, we collapse this measure by taking an average over 2015. While the reform was announced in 2014, most of the industry adjustment occurred over the course of 2016.[5] Our treatment variable is this institutional exposure measure, which compares outcomes for issuers that primarily borrowed from institutional funds to issuers that primarily borrowed from retail funds.

We run the following regression at the CUSIP-level c:

$$Y_{c,i,t} = \alpha + \beta Post_t \times \text{Inst Exposure}_i + \gamma Post_t + \lambda \text{Inst Exposure}_i + \epsilon_{c,i,t} \tag{1}$$

Y denotes our main outcomes of interest, which are the log value of each CUSIP c and the coupon rate for each CUSIP of a given issuer i. $Post_t$ is a dummy variable that is equal to 1 in 2016. We use 2015 as our baseline year and compare to outcomes in 2016. We run this specification for the full years 2015 of 2016, with Post taking a value of 1 in 2016. Because of seasonality effects, we additionally compare the last months of each year and the last quarter of each year. Finally, we eliminate other mutual fund shares and agency debt from our analysis. We predict that issuers that are more exposed to institutional funds in the base period will experience a larger decrease in total amount borrowed from MMFs in 2016 and will also see an increase in borrowing costs from MMFs. Importantly, we fill in missing borrowing values in the post period with 0s, but the coupon rate analysis depends on issuers that remain in sample in both the pre and post period. Finally, we also control for state fixed effects of the issuer; however, we find no meaningful change in results and so we do not report these regressions.

[5] This finding is consistent with previous work on the flow out of prime funds in response to the reform.

Next, we extend our analysis to issuance data from Mergent. We analyze whether a municipal issuer's reliance on institutional funds in 2015 led to an increase in borrowing costs for **all new issues** in 2016 and 2017. Thus, this analysis explores the broader effects of the reform not confounded by secular trends in the MMF universe. To construct reliance on MMFs, we take the average of the total value of borrowing from institutional MMFs in 2015 for each issuer and divide by the total amount of issuance recorded in Mergent from 2000 to 2015.

$$\text{Institutional Reliance}_i = \frac{\sum_{j \in Inst.} Avg(Value_{ijt})_{2015}}{\sum_{t=2000}^{2015} PrincipalAmount_{it}}$$

This is a different measure from the previous exposure measure, and is meant to capture how important institutional MMFs are in municipal issuers' borrowing. We run the following regression at the issue d level:

$$Y_{d,i,t} = \alpha + \beta Post_t \times \text{Inst Reliance}_i + \gamma Post_t + \lambda \text{Inst Reliance}_i + \epsilon_{d,i,t} \quad (2)$$

Where Y denotes the log value of each issue as well as the coupon rate. Post is a dummy equal to 1 if the new issue occurs in 2016 or after. We limit analysis to 2015 and 2016, but also consider the period of 2015-2017 to see if there were any longer term effects on borrowing costs.[6] Institutional Reliance is the treatment variable of interest in these regressions. This analysis compares outcomes for issuers that were more reliant on institutional funds for their total outstanding borrowing to outcomes for issuers that were more reliant on retail funds or less reliant on MMFs in total. Importantly, we limit analysis to issuers that borrowed from MMFs in the pre-period.

A Causal Interpretation: We argue that these regressions provide causal evidence of the effect of a decrease in demand from MMFs due to the SEC reform on municipal issuers. We have assumed that all issuers are exposed to an aggregate shock, but that issuers are *differentially* exposed. For this analysis to be causal, we need the following to be true:

1. The shock to MMF demand was exogenous and uncorrelated with issuer-specific risk or investment conditions.

2. There were no other variables over the time period affecting outcome variables that were correlated with institutional fund exposure.

These assumptions allow us to attribute changes in municipal borrowing and borrowing rates to the shock in the demand. The second assumption allows us to use changes in outcomes for issuers in

[6] We also collapsed this regression to the issuer level by taking weighted averages within each year. This robustness check examined within-issuer variation, but results were largely similar so we omit the regression tables. Results available upon request.

Table 2: Balancing between Institutional and Retail Tax-Exempt Funds

	Full Period			Pre Period		
	Ret.	Inst.	t-stat	Ret.	Inst.	t-stat
Panel A: Fund Level						
# Funds	49.467	51.979	-1.94	48.296	56.864	-44.60
# per Family	5.084	5.514	-0.64	4.930	5.798	-1.26
AUM ($B)	2.450	1.134	2.24	2.791	1.276	2.23
% of Total CUSIP Held (%)	86.684	28.256	1.44	109.824	30.635	1.25
WAM (days)	27.779	27.949	-0.09	31.965	31.806	0.08
Portfolio Persistence (%)	92.631	92.083	0.79	93.166	92.589	0.96
State fund	0.541	0.476	0.72	0.561	0.500	0.66
Derivative Share (%)	18.135	15.762	1.42	17.416	16.314	0.62
ARS/VRDO Share (%)	61.859	64.127	-0.83	60.991	61.298	-0.11
CP Share (%)	6.466	5.861	0.67	5.938	5.637	0.32
Certs Share (%)	9.044	9.877	-0.88	9.864	10.891	-1.06
Bond Share (%)	4.211	5.070	-1.43	4.685	5.251	-0.88
NR Share (%)	27.137	28.395	-0.73	32.456	34.003	-0.99
High Rating Share (%)	37.888	38.849	-0.45	32.715	32.501	0.11
GO Share (%)	11.470	13.83	-1.95	12.487	14.791	-1.79
Panel B: Issuer-Fund Level						
New Issuance 2012-2017 ($M)	626.224	639.632	-0.76	642.570	644.834	-0.12
Total Issuance 2000-2015 ($M)	2,905.959	3,037.146	-2.24	3,073.773	3,156.270	-1.28
Reliance on MMFs in 2015 (%)	18.185	16.631	2.47	17.412	15.709	2.71
Reliance on Inst. MMF in 2015 (%)	4.915	6.447	-5.52	4.307	6.415	-8.32

Table 2 presents means and t-stats demonstrating the difference between institutional and retail tax-exempt fund portfolios. The first three columns examine the full period 2012-2017. The last three only consider statistics in 2015. Panel B documents differences between issuers based on whether they appear in retail or institutional fund portfolios. Importantly, there may be some overlap between issuers.

retail funds as our counterfactual for what would have happened to exposed issuers absent the MMF institutional fund reform. Importantly, this means that our results are not driven by macroeconomic events that affect all issuers, such as monetary policy changes.

We provided anecdotal evidence for the first point in the previous section: many institutional investors are by mandate barred from investing in floating NAV products. Moreover, fixed NAV products have special accounting and tax treatments that are favorable for institutional investors. Finally, because retail funds had to institute requirements ensuring that all investors were natural-born persons, the institutional share classes that converted to retail share classes were still subject to large mandatory redemptions that greatly reduced fund AUM. As a result, a majority in the total $100 billion decline in AUM occurred in institutional funds. Moreover, because there was a still sizeable adjustment in retail portfolios, we anticipate that our effect is an underestimate of the true effect of MMF demand on issuers.

Next we show that the portfolios of retail and institutional funds were not statistically different in the pre-period in Table 2. We collapse the monthly data to the fund-level by taking averages in order

to examine cross-sectional variation between funds. Importantly, institutional funds and retail funds were similar in terms of composition of the portfolio by types of municipal instruments, persistence of relationships to issuers, exposure to high-rated issuers, and exposure to general obligation debt. We cannot reject no difference between the funds along these dimensions. Both retail and institutional funds' relationships with issuers is similarly persistent: 93% of fund portfolios are the same from month to month. The only meaningful difference between these two types of funds is in terms of their size: retail funds tend to be larger than institutional funds and thus hold a larger proportion of a CUSIP's total principal amount. We also see that issuers in institutional portfolios tend to be **less reliant** on MMFs for their total borrowing than issuers in retail portfolios, which would work against our predictions.

6.2 Lending by MMFs to Municipal Issuers

Table 3: Effect of Exposure to Institutional Funds within MMF Portfolios

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Log Value	Log Value	Log Value	Coupon	Coupon	Coupon
Post × Inst. Exposure (2015)	0.148***	-0.309***	-0.207**	0.189***	0.287***	0.302***
	(0.0508)	(0.0794)	(0.0824)	(0.0539)	(0.0885)	(0.0897)
Post	0.133***	0.178***	0.223***	-0.0165	0.156***	0.0132
	(0.0221)	(0.0329)	(0.0346)	(0.0330)	(0.0485)	(0.0496)
Inst. Exposure (2015)	-0.396***	-0.159*	-0.222***	-0.523***	-0.483***	-0.507***
	(0.0721)	(0.0815)	(0.0788)	(0.0877)	(0.108)	(0.106)
Constant	15.97***	15.99***	15.95***	1.002***	0.949***	1.017***
	(0.0389)	(0.0421)	(0.0409)	(0.0585)	(0.0651)	(0.0651)
Observations	220,228	15,907	18,340	220,222	15,907	18,340
R-squared	0.008	0.004	0.007	0.008	0.014	0.009
FE	None	None	None	None	None	None
Cluster	Issuer	Issuer	Issuer	Issuer	Issuer	Issuer
Sample	2015-2016	EOY 2015/2016	Q4 Avg 2015/2016	2015-2016	EOY 2015/2016	Q4 Avg 2015/2016

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 3 presents results from DiD regressions of CUSIP-month level MMF log value and coupon rates of each holding on variables related to institutional exposure of the CUSIP's issuer prior to the reform. Post is an indicator taking a value of one if the holding is after 2016 and zero otherwise. *Institutional Exposure* is measured as an average of the ratio of total value of an issuer's CUSIPs held by institutional funds over the total value of issuer's CUSIPs held in MMFs in 2015. The first four columns examine effects on log value and the last four columns analyze effects on coupon rates. We cluster errors at the issuer level in all specifications. The first columns for each variable look at the entire years of 2015 to 2016, the second column analyzes holdings in the last month of each year, and the third column analyzes the average of holdings over the last quarter.

We present estimates of regression equation 1 in Table 3. The first three columns use total log value of borrowing from MMFs as an outcome variable and the last three columns use coupon rates as an outcome variable. For the log value regressions, we fill in a value of 0 for CUSIPs that dropped out of the sample. We also condition on the CUSIPs being in the sample in 2015. Standard errors are all

clustered at the issuer level. While we find a positive coefficient when using the entire year, we find a statistically significant negative effect when we only compare the end of year portfolios. This suggests on average that an increase in the pre-reform institutional exposure share from 0 to 100% would lead to decrease in borrowing from MMFs by about 18 to 27%. The positive coefficient in the full year specification is driven by the early part of 2016, prior to the industry's adjustment.

We also find a positive relationship between exposure to institutional funds and monthly coupon rates from MMFs in the post period. For these regressions, we do not have data on CUSIPs that drop out of sample and so must condition on a CUSIP being in the sample both before and after the reform. We control generally for the interest rate environment during 2016 using a Post dummy. This is important to include because the Federal Reserve raised the target for the fed funds rate at the end of 2015. In all specifications we find a positive and significant relationship between institutional exposure and borrowing costs. This a meaningful increase of 19 to 30 basis points for an increase in the exposure measure of 100%. For the average issuer, with exposure to institutional funds of 31.5%, we estimate an increase in the cost of borrowing from MMFs after the reform of about 6 to 9 bps.

6.3 Effects on New Issues

The estimates for equation 2 are presented in Table 4. All regressions use the full issue data. We cluster standard errors at the issuer level in all specifications. The first three specifications examine changes in issuance and the last three analyze changes in coupon rates. We consider the samples of 2015 to 2016 in the top panel and 2015 to 2017 in the bottom panel. We also include specifications that control for the maturity of the issue and an indicator variable for whether an issue's rating is below Aa. These specifications are overly restrictive by controlling for potential outcomes, such as a change in the maturity profile of an issuer's borrowing or a change in the borrower's credit risk. We include them to see whether institutional fund reliance has explanatory power beyond the usual variables that determine municipal borrowing costs. The outcome of interest is the coefficient on Post $\times$ Exposure, where exposure is the proportion of total issuance from 2000 to 2015 held by institutional MMFs on average in 2015. We verify that all results are robust to dropping issuers whose MMF borrowings exceed principal amounts recorded in Mergent, which primarily targets commercial paper and TOB issuers. We also verify that results are robust to only including MMF borrowings that we can match to Mergent in the numerator of the Reliance variable, which eliminates commercial paper issuance. We also confirm, but do not report, that results are of similar magnitude and statistical significance when we collapse data to the issuer-level and examine within issuer changes in coupon rates.[7]

[7] Results available upon request.

Table 4: Reliance on Institutional Funds, Issuance, and Borrowing Costs on New Issues

Panel A: 2015-2016						
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Log Value	Log Value	Log Value	Coupon	Coupon	Coupon
Post × Reliance (inst.)	0.225	0.342	0.846	2.251***	2.011**	1.618*
	(1.505)	(1.350)	(1.583)	(0.859)	(0.807)	(0.899)
Post	-0.00421	-0.0154	0.00895	-0.108***	-0.118***	-0.126***
	(0.0396)	(0.0383)	(0.0394)	(0.0321)	(0.0315)	(0.0320)
Reliance (inst)	-2.265	-2.510**	-3.669***	-4.579***	-4.239***	-4.360***
	(1.417)	(1.210)	(1.397)	(0.705)	(0.648)	(0.690)
Maturity (years)		0.0690***	0.0793***		0.0484***	0.0433***
		(0.00257)	(0.00278)		(0.00354)	(0.00299)
Below Aa			0.411***			-0.0139
			(0.0657)			(0.0488)
Constant	14.57***	13.89***	13.67***	3.743***	3.268***	3.372***
	(0.0419)	(0.0471)	(0.0566)	(0.0307)	(0.0431)	(0.0501)
Observations	76,197	76,197	72,986	74,583	74,583	71,413
R-squared	0.002	0.089	0.112	0.009	0.071	0.061
Cluster	Issuer	Issuer	Issuer	Issuer	Issuer	Issuer
Sample	2015-2016	2015-2016	2015-2016	2015-2016	2015-2016	2015-2016
Panel B: 2015-2017						
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Log Value	Log Value	Log Value	Coupon	Coupon	Coupon
Post × Reliance (inst.)	1.959	2.188*	3.315**	1.980***	1.759***	1.503**
	(1.416)	(1.215)	(1.411)	(0.710)	(0.663)	(0.736)
Post	-0.0158	-0.0360	-0.00832	0.0106	-0.00273	-0.00774
	(0.0360)	(0.0348)	(0.0361)	(0.0274)	(0.0265)	(0.0282)
Reliance (inst)	-2.265	-2.513**	-3.669***	-4.579***	-4.271***	-4.493***
	(1.417)	(1.206)	(1.397)	(0.705)	(0.654)	(0.721)
Maturity (years)		0.0700***	0.0787***		0.0439***	
		(0.00237)	(0.00246)		(0.00285)	
Below Aa			0.432***			-0.0323
			(0.0674)			(0.0520)
Constant	14.57***	13.88***	13.67***	3.743***	3.312***	3.805***
	(0.0419)	(0.0459)	(0.0538)	(0.0307)	(0.0400)	(0.0306)
Observations	107,423	107,423	102,778	105,636	105,636	101,055
R-squared	0.001	0.091	0.113	0.008	0.063	0.008
Cluster	Issuer	Issuer	Issuer	Issuer	Issuer	Issuer
Sample	2015-2017	2015-2017	2015-2017	2015-2017	2015-2017	2015-2017

Clustered standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 4 presents results from DiD regressions of log value of borrowings and coupon rates on variables related to institutional reliance of the issue's issuer prior to the reform. All regressions are at the issue-level. The top panel analyzes changes between 2015 and 2016. The bottom panel includes 2017 to analyze long-run effects. The first three columns analyzes changes in the value of borrowing at the issue-level and the last three column analyzes coupon rates. Post is an indicator taking a value of one if the holding is after 2016 and zero otherwise. *Institutional Reliance* is measured as an average of the ratio of total value of an issuer's CUSIPs held by institutional funds in 2015 over the total amount of issuance from 2000 to 2015. This variable is meant to measure how much an issuer relies on institutional MMFs for its total funding. Maturity is the maturity of the issue. and Below Aa indicates whether the issue's unenhanced long-term rating is below Aa. We cluster errors at the issuer level in all specifications.

First, we find that institutional exposure in 2015 is not significantly correlated with the log value of issue size between 2015 and 2016. However, we do find a statistically significant increase in coupon rates associated with reliance on institutional funds. The effect we find in 2016 is quite large: an increase in the reliance measure of 1 percentage point is associated with an increase in borrowing costs of about 2 basis points in the post period. The result is still large when controlling for maturity and ratings. The results on issuance and maturity together suggest that more exposed issuers did not change their borrowing on the extensive margin in 2016, but had to accept a higher cost of borrowing compared to less exposed issuers.

This interpretation changes when we extend the time frame of our analysis. When we include 2017 issues in our analysis, we can see that more exposed issuers had to increase their borrowing. For a one percentage point increase in the reliance on institutional funds, issuers increased their borrowing by 6 to 26 percent (Panel B, columns 1 to 3). Moreover, the increases in borrowing rates are more muted. For every percentage point increase in reliance on institutional funds, borrowers saw an increase in coupon rates on all new issues of 1.5 to 2 basis points.

These results are notable primarily because they suggest that early exposure to institutional funds led to an increase in borrowing costs for all new issues of a borrower. Due to the nature of the issuance data, the issues we consider in the coupon rate specifications are all short-term notes or long-maturity bonds. This analysis suggests that losing a prominent clientele had important implications for access to other funding in the municipal bond market. It also demonstrates the mechanism of adjustment: more exposed issuers experienced a delayed reaction in issuance to the lost funding, but borrowing costs adjusted in the immediate aftermath upwards. While we see that controlling for maturity of the issues accounts for some of the increase in borrowing costs, it does not fully capture the increase in costs.

6.4 Evidence for Issuer Substitution

In this subsection, we explore how issuers changed their issuance behavior based on their exposure to the shock. In addition to affecting holdings and borrowing costs, one might expect the negative demand shock to cause issuers to substitute between different types of securities in order to meet their financial needs. This will provide additional evidence on how issuers were required to adjust after the reform. First, we look at how the term-structure of debt varies across issuers based on their differential exposure to the shock. Second, we look at how issuers varied their mix of borrowing following the reform. The specification is the same as that in equation 2 collapsed to the issuer level, but the outcome

variables are those mentioned above. Results are in Table 5.

We find little evidence to support a change in term structure for new issues. Based on previous analysis, we expect issuers that are more reliant on institutional MMFs for financing to have lengthened the maturity of their issues. This would have resulted in the increased borrowing costs we documented in the previous section. Columns 1 and 2 in Table 5 show the effect of exposure to institutional funds on the weighted average maturity of new issues after the reform. The interaction terms show that there was no significant effect on issuer term structure. While the coefficients are all positive, the standard errors on these estimates are large, so we cannot reject zero effect on maturity.

We also examine changes in the share of issuance that are VRDOs and anticipation notes. In Columns 3 and 4, we explore the effect of reliance on institutional MMFs on the percentage of annual VRDO issuance following the reform. Columns 5 and 6 look at the share of Anticipation Note issuance. Columns 3 and 5 show a negative effect on issuance of VRDNs and ANs after the reform for exposed issuers. Columns 4 and 6 do not show a significant effect in the smaller time window. This discrepancy is due to 2017: much of the change in issuance patterns occurred in 2017 across all of our specifications,

Table 5: Cross-Sectional Analysis: Holding Type

	(1)	(2)	(3)	(4)	(5)	(6)
	Wt. Maturity	Wt. Maturity	% VRDN	% VRDN	% Ant. Note	% Ant. Note
Post	0.727***	0.254	0.00256	-0.0144***	-0.0291***	-0.0232**
	(0.138)	(0.171)	(0.00413)	(0.00543)	(0.00746)	(0.00989)
Reliance (inst)	-1.591	-7.677***	0.544***	0.314***	0.620***	0.769***
	(2.518)	(2.778)	(0.103)	(0.118)	(0.158)	(0.212)
Post × Reliance (inst.)	1.714	6.506	-0.500***	0.0326	-0.621***	-0.199
	(2.497)	(3.981)	(0.103)	(0.163)	(0.158)	(0.254)
Constant	8.763***	9.002***	0.0360***	0.0351***	0.278***	0.256***
	(0.157)	(0.173)	(0.00355)	(0.00424)	(0.00900)	(0.00999)
N	7313	3721	7333	3729	7334	3730
R^2	0.00225	0.00278	0.0278	0.0173	0.00881	0.0131
FE	No	No	No	No	No	No
Sample	2014-2017	2015/2016	2014-2017	2015/2016	2014-2017	2015/2016
Cluster	Issuer	Issuer	Issuer	Issuer	Issuer	Issuer

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5 presents results from the substitution analysis. All regressions are run at the issuer level using issuance data from Mergent. The outcome variable in the first 2 columns is the weighted average maturity of new issues. Columns 3 through 4 have an outcome variable of the share of new issues that are VRDOs. Columns 5 and 6 outcomes are percent of share of new issues that are VRDOs. Post is a dummy variable that takes a value of 1 in years 2016 and after. Reliance denotes an issuer's reliance on institutional MMFs as a proportion of total issuance from 2000 to 2015. The first column for each outcome variable analyzes the time period of 2014-2017 to examine long run effects of the reform. The second column analyzes the change between 2015 and 2016. All standard errors are clustered at the Issuer level.

corresponding to the first full year the reform was enacted. Our results suggest there was some delay in the substitution response of issuers following the reform. Thus, while there is limited evidence of issuers changing their maturity structure after the reform, we do provide evidence that issuers switched their liabilities to securities that were not traditionally held by MMFs. This shows that in addition to the price effect we study in the previous section, issuers also shifted their issuance behavior post-reform.

6.5 Cross-sectional Responses

What issuers were most affected by the reform? In this section, we explore how the reform affected different types of issuers, sectors, and debt types. Unlike the previous subsection, our goal is to provide some additional depth to the analysis of the effect of reform rather than estimating a causal effect. Our analysis is based on the sample of MMF portfolio holdings. We estimate the following regression equation at the CUSIP-level c:

$$Y_{c,i,t} = \alpha + \sum_k \beta_k Post_t \times \text{Characteristics}_{ik} + \gamma Post_t + \sum_k \lambda_k \text{Characteristic}_{ik} + \epsilon_{c,i,t} \tag{3}$$

Y_{cit} denotes both the log value of the holding and the coupon rate of the holding for CUSIP c by issuer i in month t. Characteristic denotes an indicator variables for the cross-sectional dimension of interest. In our analysis, we consider the size of issuers, the sector of the obligor, and the debt type of the issue. $\text{Characteristic}_{ik}$ takes a value of 1 if issuer i has characteristic k. Post takes a value of 1 in 2016 and 0 in 2015. The coefficient of interest is the interaction terms between the characteristic indicators and the Post indicator. Thus, we investigate how the average holding value and coupon rate changed differentially across multiple dimensions between 2015 and 2016, after the reform.

First, we look at how the reform affected different types of issuers. In a market characterized by asymmetries in information and sticky lending relationships, decreases in demand could have a disproportionate effect on smaller borrowers or municipalities with larger financing constraints. Because there may be less information available regarding small issuers and they form a smaller proportion of a fund's total portfolio, we posit that funds may be more likely to drop these issuers following a shock to demand. We examine that hypothesis by exploring how the effect of the reform varies based on issuer size. We use two different samples to examine the effects. 2015/2016 indicates a sample using all holdings data from 2015 and 2016. Meanwhile, EOY 2015/2016 limits the sample to only holdings in the last month of the calendar year.

In Table 6 we look at how the reaction to the reform varied based on the size of an issuer. We measure issuer size by calculating the average annual total issuance by issuer from 2013 to 2015. We

Table 6: Cross-Sectional Analysis: Issuer Size

	(1) Log Value	(2) Log Value	(3) Log Value	(4) Coupon	(5) Coupon	(6) Coupon
Post	0.430***	0.314***	0.324***	0.0281	0.0510	0.000555
	(0.0360)	(0.0464)	(0.0453)	(0.0347)	(0.0693)	(0.0701)
Top 25pct.	0.281***	0.177**	0.159**	0.518***	0.559***	0.565***
	(0.0765)	(0.0787)	(0.0790)	(0.111)	(0.132)	(0.132)
Bot 25pct.	-0.460***	-0.503***	-0.491***	-0.462***	-0.579***	-0.577***
	(0.132)	(0.126)	(0.122)	(0.0940)	(0.111)	(0.111)
Post x Top	-0.00117	0.0834	0.114	-0.493***	-0.518***	-0.546***
	(0.0590)	(0.0782)	(0.0777)	(0.0743)	(0.113)	(0.113)
Post x Bot	-0.153*	-0.176	-0.157	0.242***	0.518***	0.517***
	(0.0922)	(0.119)	(0.113)	(0.0633)	(0.106)	(0.107)
Constant	15.62***	15.69***	14.58***	0.991***	1.184***	1.184***
	(0.0494)	(0.0433)	(0.0426)	(0.0473)	(0.0558)	(0.0558)
N	200252	17549	17549	200252	17549	17549
R^2	0.0337	0.0262	0.0277	0.0264	0.0292	0.0328
FE	No	No	No	No	No	No
Sample	2015/2016	EOY 2015/2016	Q4 Avg. 2015/2016	2015/2016	EOY 2015/2016	Q4 Avg. 2015/2016
Cluster	Issuer	Issuer	Issuer	Issuer	Issuer	Issuer

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6 presents results from regressions of CUSIP level MMF holdings value and coupon rates on variables related to issuer size. Post is an indicator taking a value of one if the holding is after 2016 and zero otherwise. Top represents issuers in the top 25% of average total issuance from 2013-2015. Bottom represents issuers in the bottom 25% of average total issuance from 2013-2015. The 2015/2016 sample includes all holdings observations in the years 2015, 2016. The EOY 2015/2016 sample includes all observations in December of 2015 and 2016. The Q4 Avg. Sample takes the average coupon or value by CUSIP in the last quarter of 2015 and 2016.

sort issuers into the top 25th percentile and bottom 25th percentile and interact this variable with the Post variable. Thus, we are testing whether the post-reform effects on holdings and interest rates varied with size of an issuer prior to the reform. The first three columns of the table show the effect on holdings by MMFs. Columns 1-3 show a modest differential effect in the post period for small issuers. That is, smaller issuers on average had a higher drop in their holdings by MMFs following the reform. This suggests they may have had less access to financing in the post period.

The results are much stronger when we consider borrowing rates in columns 4-6. We see consistent evidence that smaller issuers saw significantly higher interest rates following the reform. Moreover, large borrowers saw significantly lower effects on their borrowing costs following the reform, when compared to the rest of the sample. This suggests that MMFs were most likely to drop smaller issues, which led to an increase in their borrowing costs. This provides support to the hypothesis that informational frictions or relationships are meaningful in this market and played a significant role in the reaction to the reform.

Next, we consider how the reform affected different sectors. In Table 7, we interact the Post variable with indicators for the top 5 holdings sectors: hospitals, housing, private-sector, state, and city. For this analysis, we include an issuer fixed effect. Our identification thus relies on issuers that borrow on behalf of multiple obligor sectors.[8] Our results indicate differential effects on coupon rates post-reform. Bonds issues by the Hospital, Housing, and Private sectors all saw significant decreases in holdings and higher borrowing rates after the reform, while states and cities saw significantly lower rates as compared to the rest of the sample. Borrowers in the hospital, housing, and private sectors tend to be smaller issuers and thus the results are consistent with those in Table 6.

Finally, we look at how borrowing rates changed for different security types. In Table 8 we interact the post-reform variable with indicators for three security types described in the Summary Statistics section: derivatives, VRDOs, anticipation notes. We also include issuer fixed effects, so all variation is within issuers that have multiple types of securities in MMF holdings. We see that in these specifications, derivative securities and VRDOs saw significantly larger drops in value and higher interest rates following the reform. There is little evidence of a change of rates for anticipation notes. In specifications that do not rely on within issuer variation, we do see a significant reduction in anticipation notes and an increase in borrowing costs for these securities as well.[9] This lines up with what we see in the raw data: most of the decrease in MMF assets (about $100 billion) between 2015 and 2016 originated from a decrease in the purchase of new holdings and a decrease in lending to existing borrowers. Of the approximate $45 billion decrease in lending to existing borrowers, $37 billion was concentrated in VRDOs.[10]

[8] One might be concerned that this sets up cities and states to exhibit very little effect, due to the nature of issuers with multiple obligors. However, results are similar and slightly stronger when we do not include issuer fixed effects. Importantly, the interaction term for states and cities is still insignificant and negative for log value of MMF holdings. The coefficient is negative and significant for borrowing costs in the EOY 2015/2016 results, as in the fixed effect specification.

[9] Results available upon request.

[10] We have failed to trace the vast majority of these CUSIPs to the portfolios of other mutual bond funds during this time period, but still acknowledge it is possible that issuers engaged in large redemptions of these issues in order to access other sources of financing. Given the small issuance reaction in 2016, we think this financing was unlikely to be found in municipal bond markets.

Table 7: Cross-Sectional Analysis: Sector

	(1) Log(Value)	(2) Log(Value)	(3) Coupon	(4) Coupon
Post	0.0386***	-0.0942***	0.229***	0.547***
	(0.0133)	(0.0292)	(0.0174)	(0.0286)
Hospital	0.611***	0.621***	0.0494	0.0945
	(0.108)	(0.126)	(0.0707)	(0.0961)
State	-0.777***	-0.849**	2.013***	2.473***
	(0.282)	(0.409)	(0.393)	(0.457)
City	0.292	0.282	0.409	0.498
	(0.655)	(0.781)	(0.604)	(0.836)
Private	0.140	0.273	-0.0429*	-0.0296
	(0.170)	(0.216)	(0.0234)	(0.0369)
Housing	0.826*	0.832	0.0712	0.0142
	(0.427)	(0.540)	(0.126)	(0.166)
Post x Hospital	-0.196***	-0.393***	0.118***	0.151**
	(0.0371)	(0.0899)	(0.0358)	(0.0596)
Post x State	-0.0132	-0.105	-0.330***	-0.583***
	(0.0613)	(0.142)	(0.0706)	(0.147)
Post x City	-0.0332	0.0530	-0.0420	-0.334**
	(0.0393)	(0.134)	(0.0545)	(0.153)
Post x Private	-0.118***	-0.164**	0.169***	0.178***
	(0.0257)	(0.0781)	(0.0188)	(0.0336)
Post x Housing	-0.115***	-0.213***	0.160***	0.166***
	(0.0278)	(0.0713)	(0.0194)	(0.0306)
Constant	15.83***	15.94***	0.601***	0.515***
	(0.0625)	(0.0778)	(0.0477)	(0.0624)
N	228066	16812	228066	16812
R^2	0.518	0.406	0.633	0.615
FE	Issuer	Issuer	Issuer	Issuer
Sample	2015/2016	EOY 2015/2016	2015/2016	EOY 2015/2016
Cluster	Issuer	Issuer	Issuer	Issuer

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7 presents results from regressions of CUSIP level MMF holdings value and coupon rates on variables related to issuer sector. Post is an indicator taking a value of one if the holding is after 2016 and zero otherwise. The 2015/2016 sample includes all holdings observations in the years 2015, 2016. The EOY 2015/2016 sample includes all observations in December of 2015 and 2016.

Table 8: Cross-Sectional Analysis: Security Type

	(1) Log(Value)	(2) Log(Value)	(3) Coupon	(4) Coupon
Post	0.0484**	0.0548	0.0802***	0.425***
	(0.0242)	(0.0646)	(0.0278)	(0.0674)
Derivative	1.674***	1.479***	-3.299***	-3.443***
	(0.106)	(0.144)	(0.174)	(0.239)
VRDN	2.650***	2.476***	-3.326***	-3.540***
	(0.105)	(0.144)	(0.115)	(0.160)
Anticipation	2.586***	2.642***	-1.496***	-1.489***
	(0.145)	(0.166)	(0.173)	(0.253)
Post x Deriv.	-0.0596	-0.0477	0.386***	0.396***
	(0.0418)	(0.0777)	(0.0613)	(0.0801)
Post x VRDN	-0.185***	-0.455***	0.318***	0.299***
	(0.0261)	(0.0719)	(0.0280)	(0.0674)
Post x Antic.	-0.0409	-0.135	0.299***	-0.0388
	(0.0350)	(0.0929)	(0.0341)	(0.0949)
Constant	14.14***	14.34***	3.079***	3.215***
	(0.0679)	(0.0992)	(0.0930)	(0.136)
N	228066	16812	228066	16812
R^2	0.620	0.506	0.820	0.850
FE	Issuer	Issuer	Issuer	Issuer
Sample	2015/2016	EOY 2015/2016	2015/2016	EOY 2015/2016
Cluster	Issuer	Issuer	Issuer	Issuer

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8 presents results from regressions of CUSIP level MMF holdings value and coupon rates on variables related to security type. Post is an indicator taking a value of one if the holding is after 2016 and zero otherwise. The 2015/2016 sample includes all holdings observations in the years 2015, 2016. The EOY 2015/2016 sample includes all observations in December of 2015 and 2016.

Overall, our results suggest that the negative shock to demand had heterogeneous effects along a number of dimensions. They also show that the results in the previous sections are not solely being driven by one area of the market. Smaller issuers saw larger drops in holdings of their issues and larger increases in borrowing costs. Meanwhile, the hospital, housing, and private sector issues saw higher borrowing costs as compared to states and cities. Finally, we find some evidence that VRDOs saw a higher increase in rates compared to anticipation notes. As a whole, our results suggest that information and relationships are likely important channels for demand and pricing in this market. The issuers who were least affected were likely those for whom information about their credit-worthiness is more readily obtainable. Also, these issuers are likely to have longer-standing and more binding relationships with lenders due to the frequency of their borrowing. We posit that these attributes may aid issuers in finding financing outside of the MMF universe. Not only does this speak to the effects of this reform in particular but it also suggests that informational frictions play an important role in this market.

6.6 How Inelastic Are Muni Markets?

In this regression, we estimate the relationship between the change in average MMF holdings of each issuer and total issuance as well as change in the borrowing rate on new issues. We limit analysis to the period 2015 to 2017 in order to identify the effect of the regulation.

$$\Delta \mathrm{Y}_{it} = \alpha + \delta_t + \beta \Delta \text{MMF Hold}_{it} + \varepsilon_{it} \tag{4}$$

Outcomes Y_{it} include the change in total borrowing in the muni market (filling in zero for years where there was no borrowing from an issuer) and change in coupon rates on new issues using the Mergent data. We condition our sample to include issuers that borrowed from MMFs at any point from 2012 to 2017. We expect to see a positive relationship in the case of issuance and a negative relationship between MMF holdings and coupon rates.

Results for equation 4 are presented in Table 9. Yearly issuance and average yearly MMF borrowings is presented in millions USD. We also present the change in coupon rates in bps. Across all specifications we find a significant effect of MMF borrowing on issuance surrounding the reform. A decrease in borrowing from MMFs of $1 million over the time period is associated with a decrease in issuance of about $1.4 million from 2015 to 2016. This effect is reduced to $1 million if we include issuance in 2017. This reduction in issuance is associated with an increase in the borrowing cost for new issues by issuers that borrow from MMFs over the time period. A $1 million drop in holdings is associated

Table 9: Issuer-Level Reduced Form Analysis

VARIABLES	(1) Δ Issuance (M)	(2) Δ Issuance (M)	(3) Δ Issuance (M)	(4) Δ Issuance (M)
Δ MMF Hold (M)	1.421***	1.388***	1.098***	1.083***
	(0.283)	(0.142)	(0.311)	(0.163)
Constant	12.38**	-7.242	12.57*	11.90***
	(6.312)	(5.224)	(6.601)	(4.260)
Observations	3,562	3,562	5,202	5,202
R-squared	0.180	0.196	0.100	0.104
FE	Year	State/Year	Year	State/Year
Cluster	Issuer	State	Issuer	State
Sample	2015-2016	2015-2016	2015-2017	2015-2017

VARIABLES	(1) Δ Coupon (bps)	(2) Δ Coupon (bps)	(3) Δ Coupon (bps)	(4) Δ Coupon (bps)
Δ MMF Hold (M)	-0.0327***	-0.0456***	-0.0414***	-0.0546***
	(0.0125)	(0.0132)	(0.0140)	(0.0152)
Constant	29.83***	33.58***	29.84***	35.27***
	(2.513)	(3.464)	(2.513)	(4.029)
Observations	3,441	3,441	5,033	5,033
R-squared	0.012	0.039	0.010	0.027
FE	Year	State/Year	Year	State/Year
Cluster	Issuer	State	Issuer	State
Sample	2015-2016	2015-2016	2015-2017	2015-2017

Clustered standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9 presents results from regressions of issuer-year level changes in new issuance and changes in new issue coupon rates on changes in MMF holdings. For these regressions, we calculate total yearly issuance as the sum of new issues in a year and coupon rates as the weighted average value of coupons in a given year. The change in MMF holdings is calculated by taking the yearly average of all borrowings by an issuer from MMFs and first differencing for each year. The top panel presents results for change in issuance over the sample period indicated. The bottom panel presents results for change in weighted average coupon rates on new issues over the sample period indicated. We analyze 2015 to 2016 in columns 1 and 2, and 2015 to 2017 in columns 3 and 4. All regressions include year fixed effects and we cluster standard errors at the issuer level in columns 1 and 3. In columns 2 and 4, we include state fixed effects and cluster errors at the state level. The sample includes MMF borrowers that appear in fund portfolios at any point during the 2012-2017 period and have Mergent issuance data. We fill in zeros for missing values for both issuance levels and MMF holdings in a given month before taking values. We do not fill in coupon rates for years with no issues and allow those to remain missing.

with an increase of .03 to .05 bps. This is economically small, but statistically significant. There also appears to be a delayed reaction in borrowing costs: issuance dropped for more exposed borrowers in 2016, but the effect on borrowing costs is strongest when including 2017 issues.

An important implication of this is that demand for these municipal issues is very inelastic. Given

that the weighted average coupon rate for MMF issuers was 3.12% in 2015, this implies that selling $1 billion in the market (roughly .3 to .4% of the market, using estimates of total market size of $336 billion and $250 billion, respectively) will lead to an on average change of about 13.2% in the borrowing cost of new issues (41.4/312). This suggests an elasticity of about .02 to .03, given our market size estimates. Using the total size of the muni market suggests an even smaller elasticity, closer to .002. This is unsurprising given the structure of the market and the small size of the MMF shock relative to the overall size of the muni market.

Altogether, we take these results to suggest that policy that targets large investors would mostly support small issuers that are more exposed in terms of their overall funding structure; however, there will probably be limited overall price impact due to the segmented nature of this market. Policy interventions to support the municipal sector should therefore be much more targeted.

7 Conclusion

In this paper we explore the effects of the 2016 money market mutual fund reform on the market for variable rate and short-term municipal debt. We show that the reform led to a decrease in demand for tax-exempt funds, resulting in a decrease in fund holdings of municipal debt securities. This drop in demand was associated with an increase in municipal borrowing costs. Our difference-in-difference results provide causal evidence that issuers who were more exposed to the reform saw larger effects in their borrowings from MMFs, coupon rates from MMFs, and borrowing costs on all new issues, generally. Moreover, our cross-sectional results show that smaller issuers and sectors, which are more likely to face financing constraints, were most affected by the reform.

Our work provides a novel description of an understudied sector of municipal finance that is important for the overall financial health of governments and other municipal entities. Moreover, our results have important implications for regulators and future policies directed at this market. Policies that decrease the attractiveness of tax-exempt municipal debt for particular clienteles may lead to decreased lending and higher borrowing costs for municipal entities. Due to informational frictions, we posit that these effects may be stronger for smaller issuers who most rely on these financial intermediaries for borrowing. Finally, our results are an example of the important role of asset specific demand affecting prices. Given the importance of this market in the smooth functioning of municipal governments in the U.S., a greater understanding of the relationships in these asset markets should be primary focus for municipal finance research agendas.

References

Iñaki Aldasoro, Torsten Ehlers, and Egemen Eren. Business Models and Dollar Funding of Global Banks. 2018.

Alyssa Anderson, Wenxin Du, and Bernd Schlusche. Arbitrage Capital of Global Banks. 2019.

Tania Babina, Chotibhak Jotikasthira, Christian Lundblad, and Tarun Ramadorai. Heterogeneous Taxes and Limited Risk Sharing: Evidence from Municipal Bonds. *Review of Financial Studies*, 34 (1):509–568, 2021.

Steffanie A. Brady, Ken E. Anadu, and Nathaniel R. Cooper. The Stability of Prime Money Market Mutual Funds : Sponsor Support from 2007 to 2011. 2012.

Sergey Chernenko and Adi Sunderam. Frictions in shadow banking: Evidence from the lending behavior of money market mutual funds. *Review of Financial Studies*, 27(6):1717–1750, 2014.

Marco Cipriani and Gabriele La Spada. Investors' Appetite for Money-Like Assets: The Money Market Fund Industry after the 2014 Regulatory Reform. *Federal Reserve Bank of New York Staff Reports*, (816), 2018.

Joshua Coval and Erik Stafford. Asset fire sales (and purchases) in equity markets. *Journal of Financial Economics*, 86(2):479–512, 2007.

Ramona Dagostino. The Impact of Bank Financing on Municipalities ' Bond Issuance and the Real Economy. 2018.

Marcin Kacperczyk and Philipp Schnabl. How safe are money market funds? *The Quarterly Journal of Economics*, (1):1073–1122, 2013.

Ralph S.J. Koijen and Motohiro Yogo. A demand system approach to asset pricing. *Journal of Political Economy*, 127(4):1475–1515, 2019.

Yi Li. Reciprocal Lending Relationships in Shadow Banking. 2018.

Lawrence Schmidt, Allan Timmerman, and Russ Wermers. Runs on Money Market Mutual Funds. *American Economic Review*, 106(9):2625–2657, 2016.

Michael Schwert. Municipal Bond Liquidity and Default Risk. *Journal of Finance*, 72(4):1683–1722, 2017.