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Municipal Liquidity Facility**

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Nicholas Fritsch, John Bagley, and Shawn Nee

Municipal bond markets experienced a significant amount of strain in response to the COVID-19 crisis, creating liquidity and credit concerns among market participants. During the economic shutdown resulting from the pandemic, income tax revenues were deferred and sales tax revenues decreased beginning in spring 2020, while the cost of borrowing significantly increased for municipal issuers. To aid municipal borrowing needs, the Federal Reserve implemented the Municipal Liquidity Facility (MLF) on April 9, 2020. In this analysis we describe the municipal market conditions as they evolved during 2020, we document the response by the Federal Reserve to municipal market distress with a focus on the MLF, and we conduct an event study to examine MLF-related impacts on market index yield spreads. We detail two case studies that compare yield spreads for two issuers that had sold debt to the MLF and find that yield spreads in secondary market transactions for these two issuers were notably reduced after a public announcement of intent to sell debt to the MLF. Our results present additional evidence that the MLF had a positive impact on municipal market functioning during the pandemic period.

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1. Introduction

Municipal bond markets experienced a significant amount of strain in response to the COVID-19 crisis, creating liquidity and credit concerns among market participants. During the economic shutdown resulting from the pandemic, income tax revenues were deferred and sales tax revenues decreased beginning in spring 2020. This created shortfalls in municipal budgets (Whitaker 2020), while simultaneously the cost of borrowing significantly increased for municipal issuers alongside increased demand for liquidity in markets (Wu and Ostroy 2020). To aid municipal borrowing needs, the Federal Reserve announced the creation of the Municipal Liquidity Facility (MLF) on April 9, 2020.¹ The MLF allowed eligible municipal issuers to sell certain newly issued short-term debt directly to the Fed in order to assist with cash flow pressures caused by the COVID-19 pandemic.

In this analysis we describe the municipal market conditions as they evolved during 2020. We find a correlation between the MLF and improvement in municipal markets during the pandemic. We conduct an event study using methods similar to those of Gagnon et al (2011) and Neely (2015) to examine MLF-related impacts on market index yield spreads. We focus on news announcements related to the MLF and find that correlations between municipal market-level improvements and MLF-related events are driven by the announcement of the facility and the publication of facility pricing. We also detail two case studies that compare yield spreads for two issuers that had sold debt to the MLF and find that yield spreads in secondary market transactions for these two issuers were notably reduced after a public announcement of intent to sell debt to the MLF. Other work has reached similar conclusions (Bernhardt, D’Amico, and Palacios, 2020; Bi and Marsh, 2020; Cipriani et al, 2020; Haughwout, Hyman and Shachar, 2020; Wei and Yu, 2020). Our work contributes to this literature by focusing specifically on MLF-related events from April through August 2020, and we include issuer-specific analysis for the two municipal issuers that sold debt to the MLF. Our results present additional evidence that the MLF had a positive impact on municipal market functioning during the pandemic period.

The remainder of this paper proceeds as follows: Section 2 presents an overview of municipal markets. Section 3 describes the dynamics of the municipal market prior to and during the pandemic and municipal market interventions by the Federal Reserve. Section 4 describes the municipal liquidity facility in further detail. Section 5 lays the groundwork for our event-study analysis, presenting descriptive detail on specific Federal Reserve actions in municipal markets and associated market yield levels. Section 6 describes the data used for our event study around municipal market improvement and MLF-specific news announcements. Section 7 presents the results of our event study at the market level and for specific issuers that sold debt to

¹See <https://www.federalreserve.gov/monetarypolicy/muni.htm>.

the MLF. Section 8 concludes.

2. Overview of Municipal Markets

As of the third quarter of 2020, there was approximately \$3.9 trillion in outstanding municipal securities and loans, comprising approximately 7.5 percent of total outstanding securities in the United States.² The municipal market represents an important source of funding for the infrastructure needs of state and local governments, which historically account for 75% of public financing for infrastructure (MSRB, 2019). Municipalities primarily issue municipal debt to finance long-term capital expenditures that translate into public goods and services such as roads, public transit, and schools. Additionally, municipalities may borrow to address short-term needs that stem from the irregular nature of certain cash flows relative to expenses, providing liquidity to state and local governments in anticipation of future revenue receipts such as income tax payments. Total primary market municipal bond issuance in 2019 was approximately \$426 billion, and this issuance had an average maturity of 18.2 years, demonstrating the long-term nature of municipal borrowing.³ Total municipal market trading volume in 2019 was \$2.9 trillion, and average monthly secondary market trading volume was approximately \$241 billion.⁴

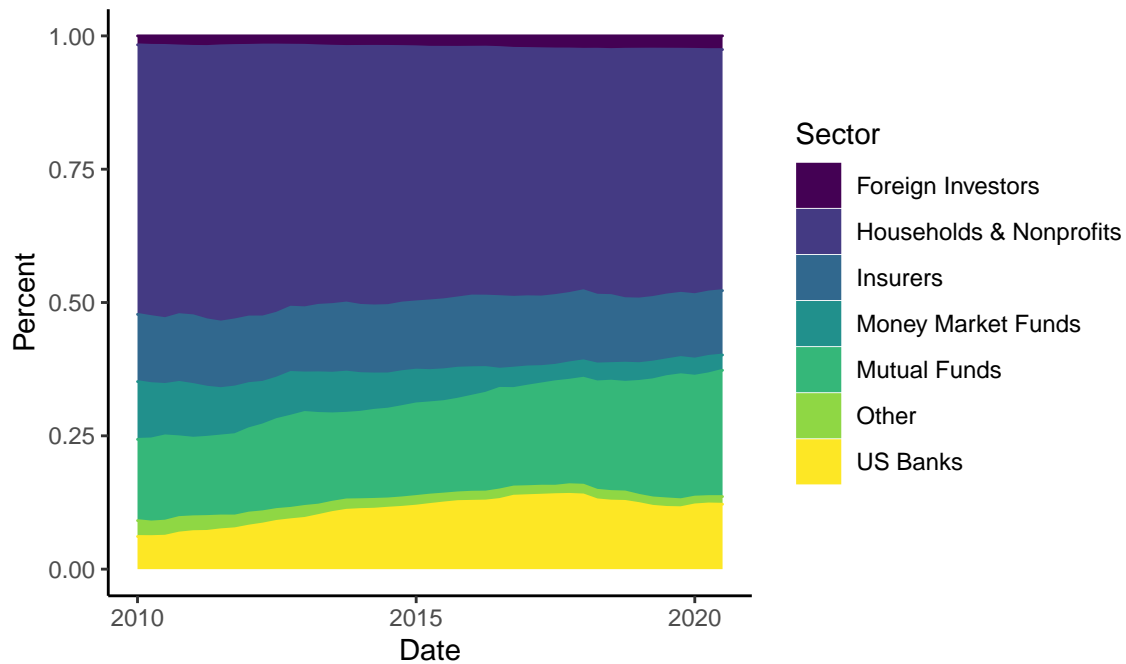
Municipal debt is primarily held by household investors; however, mutual fund holdings had grown significantly over the past decade. As of Q3 2020, households and nonprofits held 50 percent of municipal debt outstanding. Mutual funds, insurance companies and banks held most of the remaining debt, at 23 percent, 12 percent, and 12 percent, respectively. As shown in Figure 1, the share of debt held by household investors has remained relatively flat over the past decade, while mutual fund ownership increased from 15 percent of municipal debt outstanding in 2010 to 24 percent in 2020.

²Source: Federal Reserve System, Financial Accounts of the United States

³Source: SIFMA/Thompson Reuters. Note that this figure is based on issuance with maturity of 13 months or greater.

⁴Source: SIFMA/MSRB

Figure 1: Percent of Municipal Debt Holdings by Investor



Source: Financial Accounts of the United States, Z.1., as of Q3 2020

The majority of municipal debt is tax-exempt, meaning that interest earned on debt held by investors is exempt from federal taxes, and often the debt is also exempt from state and local taxes.⁵ Tax-exempt debt provides an advantage to both investors and issuers, as it allows issuers to offer lower interest rates to investors, who are willing to accept lower yields because they don't have to pay taxes on interest from the debt. The tax-exempt status of debt is constrained by federal tax laws, based on details of the debt, amount of debt outstanding, and other factors. If a needed financing does not qualify for federal tax exemption, the issuer may instead choose to issue taxable debt for these financing needs. In 2020, approximately 85 percent of municipal debt outstanding was tax-exempt, but the amount of new taxable debt as a share of total new issuance increased from 15 percent in 2019 to 27 percent in 2020.^{6,7}

Credit ratings for municipal bonds are higher on average relative to corporate bonds. As of Q4 2020, 79 percent of outstanding municipal debt was rated A- and above and less than 8 percent of outstanding municipal debt was rated BBB+ and below, and approximately 13 percent of outstanding municipal debt was unrated. Historically, issuers in the municipal market have represented a very low default risk, with Moody's estimating an average five-year default rate of 0.13 percent since 2010 for municipal bonds rated by Moody's

⁵This can vary by state and locality depending on local laws and regulations. Often state-tax exemptions are offered to investors that reside in the state of issuance.

⁶Source: Bloomberg

⁷This is largely due to the combination of municipal market dynamics during 2020 and the Tax Cuts and Jobs Act of 2017, which prohibited issuers from using the proceeds of a new tax-exempt bond issuance to pay the remaining principal and interest payments of an outstanding tax-exempt bond issue set to mature or be called more than 90 days after issuance of the new bonds. This practice is known as advance refunding.

(Moody's, 2020). To benchmark this, Moody's estimated the global average five-year corporate default rate to be 6.3 percent over the same period for corporate bonds rated by Moody's.

3. Municipal Markets and the Pandemic

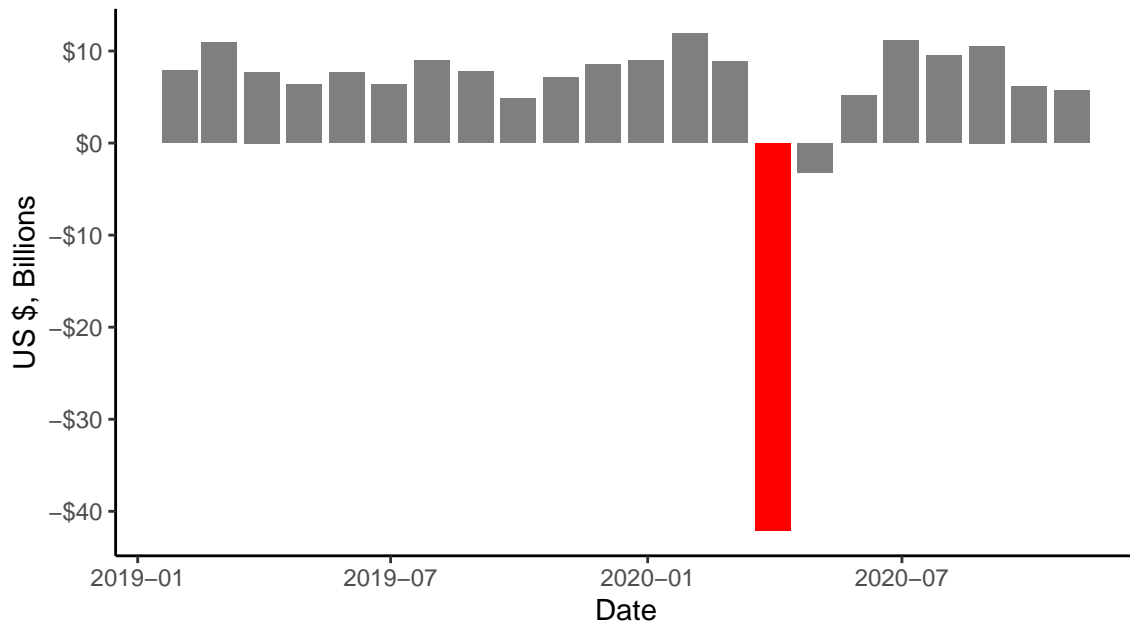
Prior to the pandemic, there was increased demand for municipal bonds relative to previous years and municipal markets were well-functioning. Changes to the tax code for 2018 that capped state and local tax deductions for individuals increased demand for tax-exempt municipal bonds from high-earning household investors, especially in US states with relatively high tax rates. Household investors in municipal markets may invest by purchasing municipal debt directly or via mutual funds. In 2019, municipal bond mutual funds experienced inflows of more than \$92 billion, which was 26 percent larger than the sum of total inflows from 2015 to 2018. Consistent inflows into mutual funds were paired with decreasing municipal yields for most of 2019, and these trends continued into the beginning of 2020.

A change in mutual fund flows was one of the first indicators of pandemic-related stress in municipal markets. It is common to use trades of \$1 million or more as a proxy for trades by institutional investors, including mutual funds. Using trade data from the MSRB and mutual fund flows data from the Investment Company Institute, we identify some important turning points in trade volumes of this size.⁸ During January and February 2020, the daily average selling volume in blocks of \$1 million or more was approximately \$1.5 billion per day. Starting on March 10, 2020, concerns over the pandemic caused many individual investors to redeem municipal bond mutual fund shares as demand for liquidity increased. These investor redemptions caused dramatic outflows from municipal bond mutual funds. Total outflows from long-term municipal bond mutual funds were greater than \$40 billion in March 2020. Figure 2 shows the dynamics of long-term mutual fund flows.

⁸See <http://www.msrb.org/msrb1/pdfs/Municipal-Securities-Market-Trading-Summary.pdf>.

Figure 2: Long-Term Muni Bond Mutual Fund Net New Cash Flow

Note: March 2020 in Red

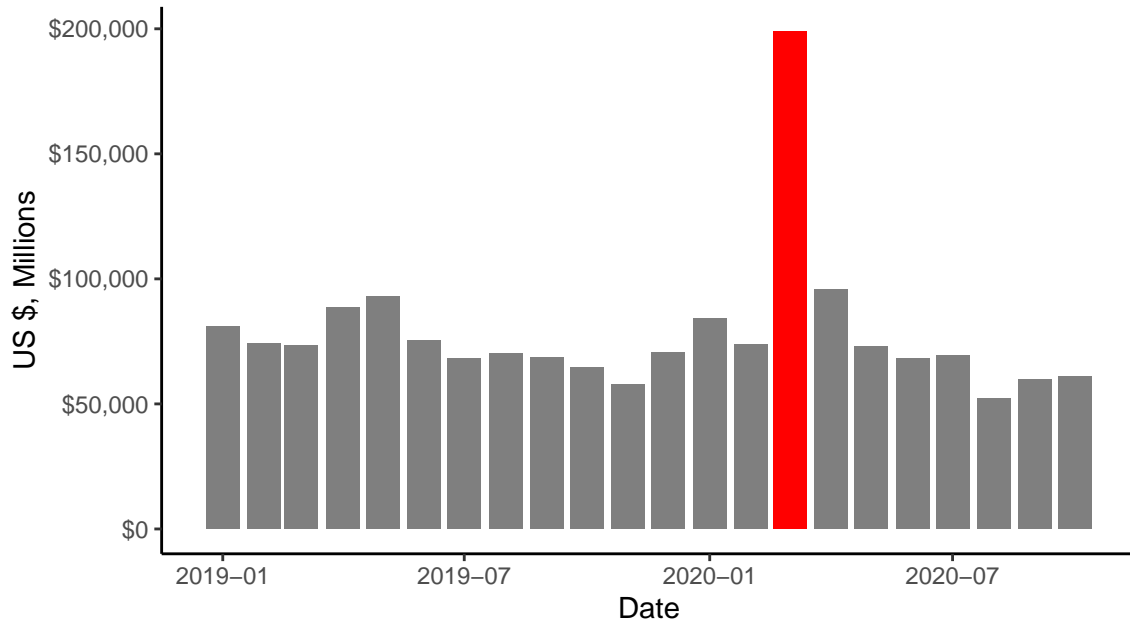


Source: Investment Company Institute, as of December 30, 2020

Mutual funds and other institutional investors were forced to sell municipal securities in order to meet the unprecedented amount of outflows from their funds, placing a great deal of stress on liquidity in municipal markets. During the week of March 16, the daily average for investor sales in amounts of \$1 million or more reached \$5.6 billion. On three consecutive trading days, March 20, 23, and 24, daily average selling volume of at least \$1 million was greater than \$6.5 billion, a 330 percent increase from levels in January and February. Total selling volume in municipal trading during March 2020 was approximately \$199 billion, which was 169 percent greater than February 2020 and 171 percent greater than a year prior in March 2019. Figure 3 shows the par value increase of sales by municipal investors during March 2020.

Figure 3: Total Monthly Municipal Investor Sales Volume (Par Amount)

Note: March 2020 in Red

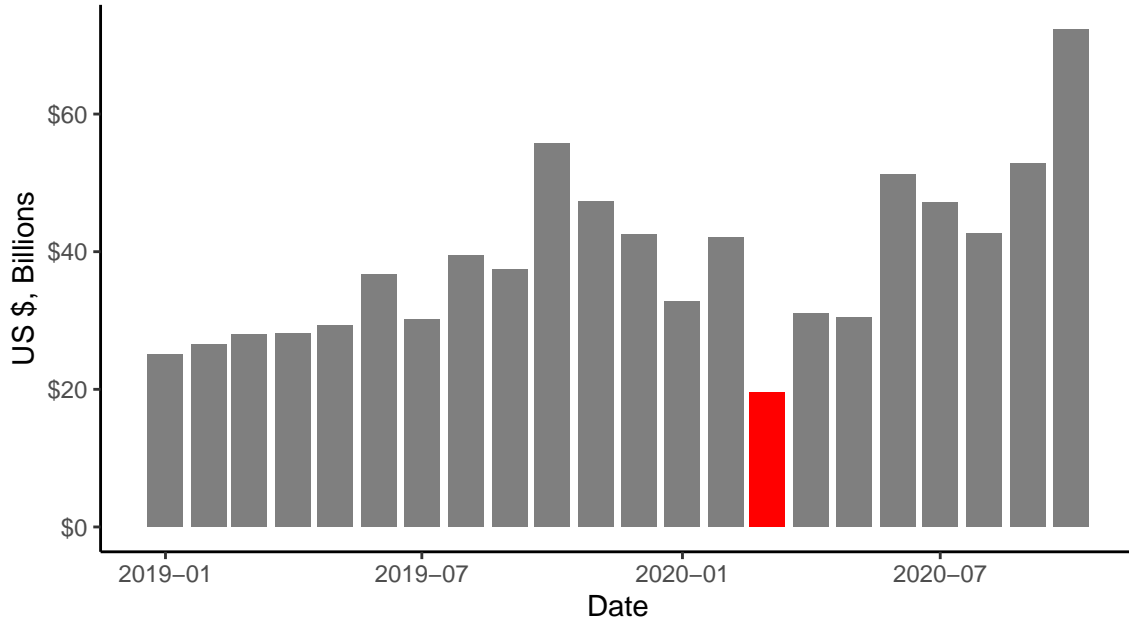


Sources: SIFMA/MSRB

New municipal issuance dramatically decreased at the same time that municipal markets were strained due to these pandemic-related conditions. After more than \$42 billion of total new issuance in February, total new issuance in March was less than \$20 billion, with much of that occurring prior to the market dislocation. Total municipal bond issuance in March 2020 was 30 percent lower than a year prior in March 2019 and 53 percent lower than a month prior in February 2020. Figure 4 shows the decrease in municipal issuance during March 2020.

Figure 4: Monthly US Municipal Bond Issuance

Note: March 2020 in Red

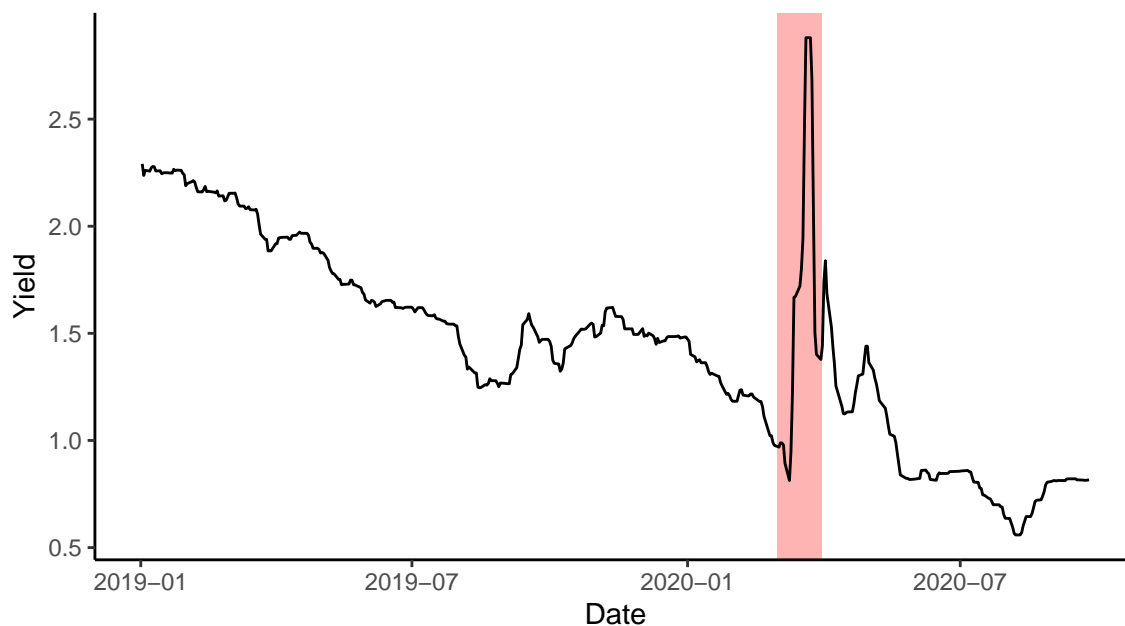


Sources: SIFMA/Thompson Reuters

These pandemic-related dynamics in municipal markets resulted in a dramatic increase in municipal market borrowing rates from March 10 to March 20, even for issuers of the highest credit quality, shown in Figure 5. On March 20, 2020, 10-year BVAL AAA municipal benchmark yields reached 2.88 percent, an increase of 193 basis points from only 10 days prior. The swift and significant upward movement in municipal yields made borrowing prohibitively expensive for municipal issuers.

Figure 5: BVAL AAA 10-Year Municipal Index

Note: March 2020 shaded in red



Source: Bloomberg

These yield increases were soon followed by monetary and fiscal policy interventions. During the first two weeks of March, the Federal Reserve issued statements that ultimately resulted in a decrease in the target range for the federal funds rate, setting the target between zero and a quarter of 1 percent.⁹ Next, lending and liquidity facilities created by the Fed in response to the pandemic, including the Money Market Mutual Fund Liquidity Facility (MMLF) and the Commercial Paper Funding Facility (CPFF), announced the Fed's intention to begin accepting of certain short-term municipal debt as collateral. Importantly, the CARES Act was passed into law on March 27, which included \$150 billion of direct financial support for states and municipalities and a provision that allowed the Secretary of the Treasury to make emergency loans to municipalities, administered by the Fed, signaling the creation of what would eventually become the Municipal Liquidity Facility (MLF).¹⁰ Investor demand also rebounded significantly in late March, signaling an appetite for yield against the backdrop of market interventions. Over the month of March 2020, MSRB trade data show that municipal security purchases eventually surpassed sales by \$1.7 billion.¹¹

By the end of March 2020, municipal markets began to improve and there was a significant reversal in yield movements. From March 23 to March 30, 10-year BVAL AAA municipal yields declined from 2.88 percent to 1.38 percent. Over the next several months, these BVAL yields continued to decline below

⁹See <https://www.federalreserve.gov/newsevents/pressreleases/monetary20200315a.htm>.

¹⁰See section 4003(b)(4) of the CARES Act Loan Program. While we do not consider the CARES Act explicitly in our analysis, it likely contributed to the visibly sharp decline of yield spreads in Figure 5 immediately after March 23 due to its various measures of relief for municipalities.

¹¹See <http://www.msrb.org/msrb1/pdfs/Municipal-Securities-Market-Trading-Summary.pdf>.

pre-pandemic levels, and short-term yields dropped to the lowest levels observed since BVAL estimates began in 2009 by August. During the summer months, issuer access to markets began to improve, first for highly rated issuers and later for lower-rated issuers as well. As a result, municipal primary market issuance increased, driven by a large increase in municipalities refunding outstanding debt with taxable bonds in order to take advantage of historically low interest rates, as the Tax Cuts and Jobs Act of 2017 prohibited the issuance of tax-exempt advance refunding bonds.¹² This allowed issuers to realize up-front savings to help with revenue shortfalls caused by the pandemic. Increased issuance continued over the next five months, with issuance levels near \$50 billion each month from June to September, and over \$70 billion in October. By the end of 2020, municipal issuance had reached an all-time record level of \$475.5 billion, a 5 percent increase from the previous record amount of issuance in 2016.¹³

4. The Municipal Liquidity Facility

Despite initial market improvements at the end of March 2020, pandemic-related uncertainty still remained in municipal markets. Income tax collections were deferred for federal, state and local governments until July 2020, causing a disruption in cash flows for municipalities, and additional fiscal support after what was already provisioned in the CARES Act was not guaranteed. Many municipalities are constrained by balanced-budget requirements, so that carrying debt across fiscal years is not possible. Issuers with lower ratings prior to the pandemic or those with budgets that were disproportionately affected by the pandemic had difficulty accessing the market at levels close to where they could issue prior to the pandemic. One way that the Federal Reserve addressed this issue was to create the MLF in order to improve the ability for such issuers to borrow in municipal markets.

The MLF was announced on April 9, 2020, one of several facilities established under section 13(3) of the Federal Reserve Act in response to municipal market strains resulting from the pandemic. While the CPFF and MMLF had the capacity to either purchase or accept as collateral specific short-term municipal debts, the MLF is the first Federal Reserve facility designed exclusively to help state and local governments better manage the pandemic-related cash flow pressures by raising capital directly through the facility, while purchasing at maturities longer than were accepted by the MMLF and CPFF. Under the MLF, the Federal Reserve would lend funds to a special purpose vehicle (SPV), and the loan would be secured by assets of the SPV. The SPV was also funded by an initial equity investment of \$35 billion provided by the Department of Treasury from funds appropriated to the Exchange Stabilization Fund under the CARES Act. The facility

¹²Advance refunding refers to an issuer using the proceeds of a new tax-exempt bond issuance to pay the remaining principal and interest payments of an outstanding tax-exempt bond issue which is set to mature or be called more than 90 days after issuance of the new bonds.

¹³Source: SIMFA/Thompson Reuters

was designed to purchase up to \$500 billion of municipal securities from issuers, with defined constraints on eligibility for issuers and security types.

Eligible municipal issuers consisted of US States, cities, or counties that met a certain population threshold or those that were designated as eligible issuers by the governor of the state in which the issuer resides.¹⁴ All issuers must also have met certain credit rating thresholds, which depended on the source of revenue used to repay borrowing. Once an issuer was determined to be eligible, the MLF placed limits on the amount that could be borrowed: (i) 20 percent of general revenue from own sources and utility revenue for states, cities, and counties, and (ii) 20 percent of gross revenues for multi-state entities or designated revenue bond issuers. This allowed most state-level issuers to be able to borrow in amounts of greater than \$1 billion. The terms also allowed for issuers to hold a continuously callable option on the debt so that they may retire the debt with no penalty when their financial conditions improve or refinance the debt to private investors if market conditions became relatively more favorable.

Securities eligible to be purchased by the MLF were constrained to be no greater than three years in maturity and consisted of short-term municipal securities commonly referred to as notes.¹⁵ The various types of eligible notes for purchase included tax anticipation notes (TANs), revenue anticipation notes (RANs), tax and revenue anticipation notes (TRANs), and bond anticipation notes (BANs). Though these different note types may differ in the specific use of proceeds and sources of repayment, they all allow municipalities to finance short-term expenditures for essential public goods and services and are repaid through expected future revenues.

MLF pricing interest rates were composed of a fixed credit spread applied to a base risk-free interest rate.¹⁶ The fixed credit spreads were set at interest rates that were generally above historical market levels during normal periods but below some of the dramatically high market yield levels seen during March 2020. These credit spreads were publicly announced on May 11, so that MLF pricing was transparent to all market participants. With this pricing methodology, the MLF would act as a lender of last resort to municipalities by imposing a publicly visible upper bound on borrowing rates for eligible issuers that chose to participate with the facility, thus acting as a backstop in eligible municipal market transactions.

¹⁴The ability for the governor of a state to designate a within-state issuer as eligible was a policy addition to the original facility terms, implemented on June 3, 2020.

¹⁵At the onset of the facility, the maturity constraint was set to be two years. On April 27, 2020, this was extended to three years.

¹⁶The MLF used the fixed-rate portion of the OIS as the base rate.

5. Federal Reserve Actions in Municipal Markets

While we focus on the MLF in this paper, it is instructive to note the broader set of Federal Reserve interventions in municipal markets as a response to the strain from the pandemic, as well as passage of the CARES Act. Table 1 outlines key events in municipal markets relevant to the MMLF, CPFF, CARES Act, and MLF from March through August 2020.

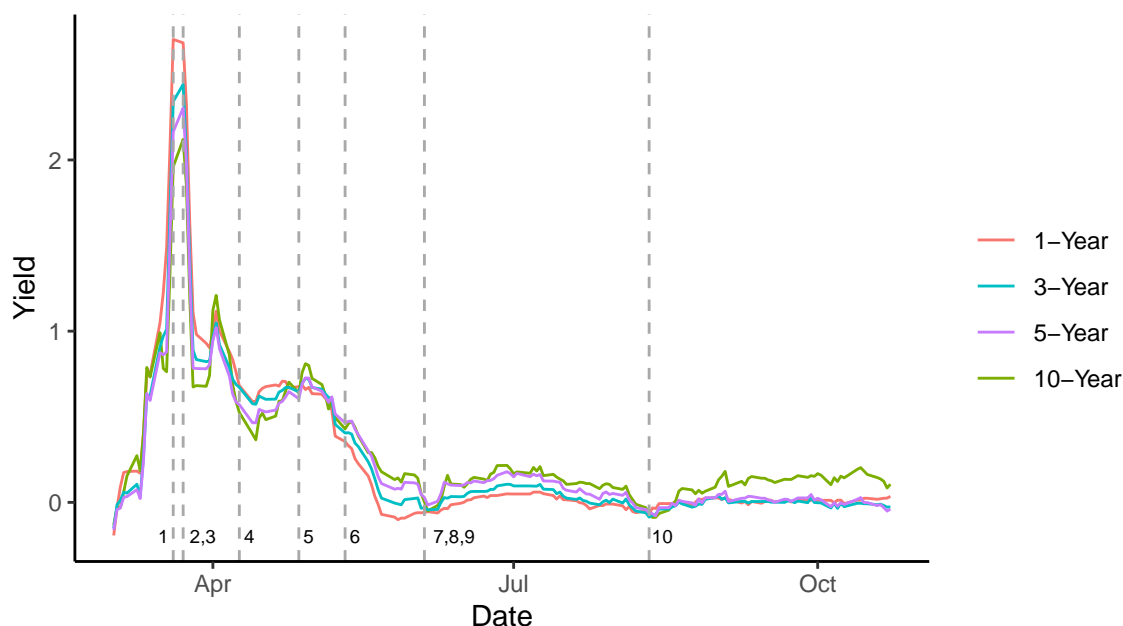
Table 1: Federal Reserve Events in Municipal Markets

Event	Title	Date	Description
1	MMLF Includes Select Munis	2020-03-20	Expansion of MMLF to make loans available to eligible financial institutions secured by certain high-quality assets purchased from certain tax-exempt municipal money market mutual funds.
2	MMLF and CPFF Expand	2020-03-23	Expansion of CPFF to purchase tax-exempt paper and expansion of MMLF to purchase VRDOs
3	CARES Act Becomes Law	2020-03-27	Included direct support for state municipality financial and a provision that allowed the Secretary of the Treasury to make emergency loans to municipalities, administered by the Fed
4	MLF Announced	2020-04-09	Announcement of the MLF Facility
5	MLF Expands	2020-04-27	Expansion of MLF to purchase notes up to 36 months in maturity, decrease population thresholds for eligibility, include certain multistate entities, and extends life of facility to Dec 31, 2020.
6	MLF Pricing Published	2020-05-11	MLF publishes expanded term sheet and FAQs to detail pricing information
7	Illinois announces plans to sell to the MLF	2020-06-02	Media reports on the announced intention of the State of Illinois to sell municipal notes to the MLF.
8	MLF Expands	2020-06-03	The MLF expands again by allowing U.S. States to designate additional eligible borrowers.
9	MTA Designated as Eligible Revenue Bond Issuer for the MLF	2020-06-04	The state of New York designates the MTA as an eligible issuer for the MLF and announces intent to sell to the MLF.
10	MLF Reduced Pricing	2020-08-11	The MLF lowers pricing interest rates by 50 basis points for all credit ratings.

We examine the spread of municipal yields to Treasury yields of the same tenor to account for the effects of monetary policy on observable municipal yield estimates. Figure 6 plots the BVAL yield spreads to

Treasuries data along with the events outlined in Table 1 identified by the associated event numbers. Since the BVAL and Treasury yields used are the last quotes from each trading day, event overlays occur where spreads ended on each event day.

Figure 6: BVAL AAA Municipal Index Spread to Treasuries by Tenor with Fed Events



Sources: Bloomberg, Board of Governors of the Federal Reserve System (US)

As mentioned previously, the Federal Reserve introduced three facilities with the ability to help facilitate the flow of credit in municipal markets during the pandemic crisis: the CPFF, the MMLF, and the MLF.¹⁷ The CPFF and MMLF facilities were announced on March 17 and March 18, respectively. These facilities were not originally designed to purchase or accept as collateral municipal tax-exempt securities. The CPFF was designed to directly purchase commercial paper from eligible issuers through the Federal Reserve Bank of New York’s primary dealers.¹⁸ Commercial paper is a short-term promissory note, primarily issued by corporations. The MMLF was designed to make loans to eligible financial institutions that were secured by eligible high-quality assets purchased from money market mutual funds.¹⁹ As of Q1 2020, 5 percent of money market funds’ total holdings were in short-term municipal debt.²⁰

On March 20, 2020, the MMLF was expanded to make loans to select financial institutions secured by certain high-quality assets purchased from tax-exempt municipal money market mutual funds with maturity

¹⁷The Primary Dealer Credit Facility (PDCF), announced on March 17, 2020, accepted certain short-term municipal debt as collateral to provide credit to primary dealers of the Federal Reserve Bank of New York. We do not focus on this because the PDCF did not directly provide credit or liquidity support to municipalities.

¹⁸<https://www.federalreserve.gov/monetarypolicy/cpff.htm>.

¹⁹<https://www.federalreserve.gov/monetarypolicy/mmlf.htm>.

²⁰Source: Federal Reserve System: Enhanced Financial Accounts

no greater than 12 months.²¹ On March 23, the MMLF again expanded the set of eligible securities to include Variable Rate Demand Obligations (a specific type of municipal security), and the CPFF was expanded to include high-quality, tax-exempt commercial paper as eligible securities.²² On March 27, the CARES Act was signed into law.

There were immediate improvements in municipal markets at the time of these announcements as shown by the steep decline of spreads in Figure 6. From March 20 to March 30, 1-year and 10-year BVAL AAA municipal benchmark spreads to Treasuries decreased by 1.8 and 1.3 percentage points, respectively, almost completely driven by decreases in BVAL yields. There were also notable improvements in short-term variable rates associated with a type of municipal security called Variable Rate Demand Obligations (VRDOs). Municipal debt issuers rely on VRDOs as long-term sources of funding while paying short-term variable interest rates, and these securities are primarily held in money market funds.²³ Deterioration in municipal markets caused a large increase of the SIFMA Municipal Swap Index (SIFMA MSI) shown in Figure 7, which is used to price VRDOs during rate resets.²⁴ On March 18, the SIFMA MSI index increased from approximately 1.3 percent to 5.2 percent within one week. The previously highest observed SIFMA MSI rate observed was in 2008.²⁵ A significant reversal in this increase occurred as the MMLF was amended to accept VRDOs and the CARES Act was passed. By April 1, SIFMA MSI rates decreased to 1.8 percent and continued to decline for several months afterward below pre-pandemic levels.

²¹See the press release: <https://www.federalreserve.gov/newsevents/pressreleases/monetary20200320b.htm>.

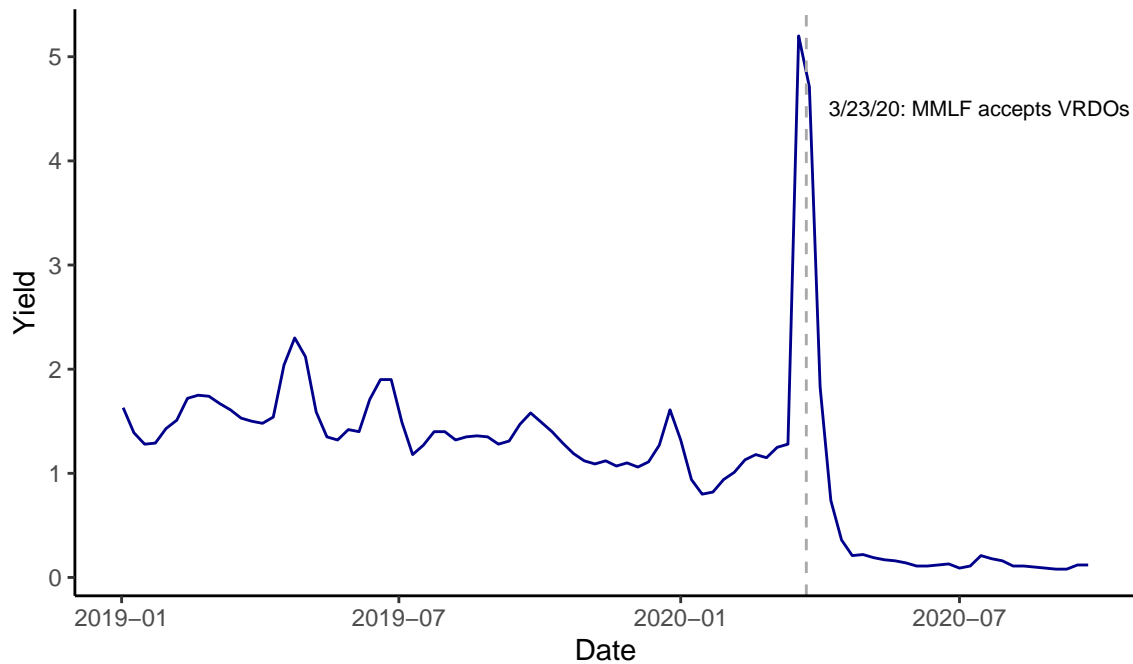
²²See the press release: <https://www.federalreserve.gov/newsevents/pressreleases/monetary20200323b.htm>.

²³Note that not all VRDOs sit in money market funds, but the majority have historically. As of December 2018, a SIFMA report estimated that there were approximately \$139.5 billion in total VRDOs outstanding (<https://www.sifma.org/resources/research/us-municipal-vrdo-update-december-2018>). The Enhanced Financial Accounts collected by the Federal Reserve Board of Governors estimate that in December 2018, \$110 billion of VRDOs were held by money market funds (<https://www.federalreserve.gov/releases/efa/efa-project-money-market-funds-investment-holdings-detail.htm>).

²⁴The SIFMA Index is the Municipal Swap Index compiled from weekly interest rate resets of tax-exempt variable rate issues reported to the Municipal Securities Rulemaking Board's (MSRB) Short-term Obligation Rate Transparency (SHORT) system. The SIFMA Index is generally determined on Wednesday of each week and published and effective for the one-week period beginning on Thursday.

²⁵The previously highest observed SIFMA MSI rate observed was in 2008, when the index jumped from approximately 1.8 percent to 8 percent over the course of two weeks, largely attributed to market conditions from the Lehman bankruptcy in September 2008.

Figure 7: SIFMA Municipal Swap Index



Sources: Bloomberg, SIFMA

Events 3 through 9 in Table 1 are all specific to the MLF. The MLF was announced on April 9. On May 11, the MLF first published the facility pricing levels of the fixed credit spread to be applied to eligible issuers.²⁶ On June 2, the State of Illinois publicly announced its intention to work with the MLF, becoming the first issuer to sell debt to the facility.²⁷ On June 3, the MLF announced another facility expansion that allowed US states to nominate political subdivisions and revenue bond issuers as additional eligible issuers for MLF participation.²⁸ This was immediately followed by the New York Metropolitan Transportation Authority being designated an eligible issuer for MLF participation by the State of New York and a public announcement of intent to sell debt to the MLF on June 4.²⁹ On August 11, the MLF revised the facility pricing interest rates, lowering them by 50 basis points for all credit rating categories.³⁰ Importantly there are no further developments in which other facilities interact with municipal markets beginning in April 2020. We exploit this fact in an event-study setting to better understand the potential impacts that the MLF had on municipal markets.

²⁶See <https://www.newyorkfed.org/medialibrary/media/markets/municipal-liquidity-facility-pricing>.

²⁷See <https://www.bloomberg.com/news/articles/2020-06-02/illinois-becomes-first-to-tap-fed-loans-after-bond-yields-surge>. This is the first widely available publication on the transaction that the authors found.

²⁸See the press release: <https://www.federalreserve.gov/newsevents/pressreleases/monetary20200603a.htm>.

²⁹See the press release: <http://www.mta.info/press-release/mta-headquarters/statement-mta-chairman-and-ceo-patrick-j-foye-0>.

³⁰One additional pricing change occurred in late August, which applied a 50 basis point penalty to issuers with a large disparity in credit ratings. This penalty would not have applied to the vast majority of issuers eligible to sell to the MLF, and thus we do not consider market effects resulting from this change in our analysis.

6. Data

We study the impact of the MLF on municipal markets within the framework of event-study analysis at the market level and at specific issuer levels.

For market-level analysis, we use the Bloomberg BVAL Municipal Benchmark yield curves. These curves are industry-standard estimates used to proxy for current market conditions facing the issuers of highest credit quality (AAA-rated), generated by a proprietary Bloomberg model. BVAL benchmark curves are produced on an hourly basis each trading day during the hours from 9 am to 4 pm ET and are based on underlying securities that must meet a set of criteria to be included in Bloomberg’s proprietary model.³¹ Bloomberg BVAL benchmark yield curves work well because they account for pricing variability due to call options, which are common in municipal bond data. Importantly, these estimates are used by market participants when pricing outstanding and new issues, and thus they represent a benchmark in municipal markets.

To control for the effects of monetary policy during the period we study, we examine spreads between BVAL yields and Treasury rates of the same tenor. We calculate spreads for 1-, 3-, 5-, and 10-year tenors using the last quoted BVAL yields from each trading day and the daily constant-maturity Treasury interest rate data provided by the H.15 release from the Board of Governors of the Federal Reserve System. We analyze movements in these spreads over a sample period from April 1, 2020 to September 30, 2020. This window extends from a week prior to the creation of the MLF to a month after the last MLF-related event that we document. With these data, we highlight correlations that occur between BVAL yield changes and documented MLF-related events. Table 2 presents summary statistics for BVAL and Treasury yields used in the market-level analysis.

Table 2: Market-Level Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
BVAL AAA 1Y	127	0.31	0.31	0.08	1.26
BVAL AAA 3Y	127	0.38	0.32	0.09	1.34
BVAL AAA 5Y	127	0.52	0.29	0.20	1.41
BVAL AAA 10Y	127	0.91	0.25	0.56	1.84
Treasury 1Y	127	0.15	0.03	0.11	0.27
Treasury 3Y	127	0.20	0.05	0.10	0.36
Treasury 5Y	127	0.31	0.06	0.19	0.48
Treasury 10Y	127	0.67	0.06	0.52	0.91

Note: BVAL and Treasury yield sample period from April 1, 2020, to September 30, 2020.
Sources: Bloomberg, Board of Governors of the Federal Reserve System (US)

For issuer-level analysis, we collect secondary market trade data for the most commonly traded State of

³¹See documentation on Bloomberg municipal BVAL AAA curves at https://data.bloomberglp.com/professional/sites/10/45674_CDS_PRI_BVAL_AAA_Curves_SFCT_DIG1.pdf.

Illinois General Obligation bonds and New York Metropolitan Transportation Authority bonds (NY MTA), identified by CUSIP-6 numbers 452152 for the State of Illinois and 59261A for the NY MTA, respectively. We collect trade data from the MSRB during the period from January 1, 2020 to September 30, 2020.³² We limit our sample to fixed coupon bonds that do not contain call or insurance features and that are traded in amounts of at least \$1 million.³³ If the bond was taxable, we convert the yield to a tax-free equivalent by multiplying the observed trade yield by $(1-\tau)$, where τ is the highest marginal tax rate. After cleaning the data in this way, we lose observations for trades of longer tenors throughout the sample.

For the State of Illinois, we remove trades greater than 30 years in tenor, as the cleaned data do not contain observable trades in this tenor range for most months we study; so we can make no comparisons over time in this category. For the NY MTA, we remove trades greater than 20 years in order to make meaningful comparisons over time. This leaves us with 478 observable trades for the State of Illinois and 742 observable trades for the NY MTA. For each of the remaining trades, we calculate a tenor-matched spread to Treasuries by fitting the Treasury yield curve with the Svensson model (Svensson, 1994) using daily parameters collected from the Federal Reserve Board of Governors.³⁴

To provide a comparison against market movements for borrowers that are relatively lower rated, we collect daily yields from the 5-Year Bloomberg US General Obligation Muni BVAL BBB Yield Curve. These yields are produced by Bloomberg and reflect market yields for noninsured bonds from issuers with credit ratings of BBB+, BBB, and BBB-. We calculate spreads to the 5-year Bloomberg BVAL BBB yields using daily constant-maturity Treasury interest rate data provided by the H.15 release from the Board of Governors of the Federal Reserve System. Table 3 presents summary statistics for the issuer-level analysis, which includes the coupon, par, tenor, and yield information for Illinois (IL) and the New York Metropolitan Transportation Authority (MTA), and also the Bloomberg BVAL BBB yields.

7. MLF Event-Study

7.1 Market-Level Event-Study

To examine potential impacts of the MLF at the market level, we analyze five MLF-related news announcements and associated movements in BVAL benchmark municipal yield spreads to US Treasury

³²We focus on credits of the most commonly traded State of Illinois general obligation bonds and NY MTA Transportation Revenue Bonds. These issuers also have less frequently traded credits that we exclude in our analysis. This helps to control for credit risk variation, as different credits are assigned different credit ratings. This also controls for liquidity effects in pricing that would stem from less frequent trading.

³³Research has documented that for trade size matters when measuring transaction costs. For example, see Harris and Piwowar (2006). Smaller trades include larger mark-ups, which are unobservable in our data. To minimize the effects of the unknown mark-up and mark-downs, we remove these smaller trades.

³⁴See <https://www.federalreserve.gov/data/nominal-yield-curve.htm>.

Table 3: Issuer-Level Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Max
BVAL BBB 5Y Yield	189	1.86	0.48	1.06	3.21
IL Coupon	581	5.40	0.79	3.25	7.35
IL Par (M)	581	5,160.11	5,390.40	1,000.00	39,255.00
IL Tenor	581	7.19	4.14	1.00	18.00
IL Yield	581	4.08	1.21	0.99	6.55
MTA Coupon	742	4.82	0.38	4	5
MTA Par (M)	742	6,616.26	13,697.09	1,000	232,075
MTA Tenor	742	2.91	1.62	1	9
MTA Yield	742	2.80	1.33	0.60	6.26

Note: Trade Data and Bloomberg BVAL BBB yields span from January 1, 2020, to September 30, 2020. A small portion of the trade data included taxable yields, we convert to a tax-exempt equivalent yield using the formula: $\text{yield} \times (1 - 0.037)$. 'Par' refers to the par value of the outstanding securities. 'Tenor' refers to the remaining maturity of outstanding maturities. Source: Bloomberg, MSRB

securities using an event study methodology similar to Gagnon et al. (2011) and Neely (2015). This analysis relies on the following assumptions:

1. To exclude any possible simultaneity, it must be that policymakers decided upon event announcements prior to observing changes in yields that would occur during the event windows. This condition seems reasonably met given the set of announcements considered and relatively short length of event windows.
2. All changes in expectations about policy interventions are captured during the event windows, and these changes are fully priced in by market participants during the event window. It could be that expectations about future events were anticipated to any degree by market participants, but these anticipations must have occurred during prior event windows. This is plausible as we could find no news announcements that successfully anticipated an MLF-related announcement between event dates. It is worth noting that market participants did more generally call for the facility to be broader in scope, which relates to events 5 and 8 in Table 1. However, this was general commentary and critique by market participants, not announcements of expected future changes.
3. The net cumulative effect of other news during the event windows needs to be arbitrary. One such announcement that one might say would break this assumption is the announcement by the IRS on June 29, 2020 that the deadline to file income taxes would not be extended past July 15. Examining market benchmark yields around this announcement shows no apparent changes from several days prior to several days after this announcement. Other than this, there is only one event window in which an FOMC announcement occurs on April 29, 2020. This announcement was not associated with any changes in benchmark interest rates for the economy. That being said, we conduct additional robustness checks that shorten our event window so that the FOMC announcement is excluded.

We calculate changes in BVAL municipal yield estimates using an event window around each news

announcement. For an event that occurs on trading day t , we utilize a window from $(t-2)$ trading days to $(t+2)$ trading days, for a total of five days in each event window. Specifically, for each tenor i on day t , we calculate a spread (Δ) using BVAL AAA Municipal Index yields ($BVAL$) and Treasury yields (TRS), shown in Equation 1. We then sum each $\Delta_{i,t}$ from two days prior to each announcement to two days after each announcement to get the cumulative five-day change in spreads around each announcement.

$$\Delta_{i,t} = (BVAL_{i,t} - BVAL_{i,t-1}) - (TRS_{i,t} - TRS_{i,t-1}) \quad (1)$$

We calculate the cumulative five-day spread change for events 3 through 9 in Table 1. For the three events in Table 1 that occur over successive days on June 2, June 3, and June 4, we treat these as one large event by comparing spreads from two trading days prior to June 2 to two trading days after June 4. In this instance, it would be difficult to attribute yield changes to any one of the three events given their close proximity.

The choice of length in our event window contains a tradeoff. A shorter window will give a better sense of MLF-related yield changes that are not also a result of other market, policy, or macroeconomic factors. A longer window will capture MLF-related effects that do not absorb into markets immediately but may also contain spillover effects from non-MLF-related dynamics. Although many financial market event studies typically look at intraday movements in yield changes, unexpected or unusual news announcements associated with novel interventions may cause markets to take longer to react to news announcements (Gagnon et al., 2011; Neely, 2015). In addition, the illiquidity and lack of price transparency that exist in municipal markets may further slow the absorption of news announcements into market prices.³⁵ Our method more closely resembles Neely (2015), Gagnon et al. (2011) and Gao, Lee, and Murphy (2019) in using a longer event window. The five-day window length we choose is the longest possible such that our event windows remain nonoverlapping. This event window does not allow us to identify causal relationships between MLF events and observed spread changes; rather, we note observed correlations that imply a relationship.

Table 4 includes the spread associated with each five-day event window, the cumulative change across all events listed for each tenor, and the total change over the sample period from April 1 to September 30. The set of numbers next to each event shows the cumulative change in spreads for various tenors during the event window. Following the methodology of Neely (2015), the numbers in parenthesis below each yield change represent the proportion of observed spread changes on consecutive nonoverlapping five-day periods outside of the event windows that are greater than the spread change for a given five-day event window. This can be thought of as a measure of probability of occurrence during the sample period. The numbers in parenthesis

³⁵The illiquid and informationally opaque nature of municipal markets is well documented. For example: Harris and Piwowar (2006), Green, Hollifield, and Schürhoff (2007), Green, Li and Schürhoff (2010), Schultz (2012).

below the cumulative event change show the probability that the sum of four randomly chosen spread changes that occur over five consecutive trading days not overlapping with MLF events windows would exceed the sum of spread changes over the five event windows. In statistical terms, we can think of these numbers in parenthesis as similar to p-values, which allow us to test a null hypothesis that the spread changes related to each MLF event are not statistically different from other spread changes during the period from April through September 2020. A smaller p-value indicates that the magnitude of a given spread change is less likely to be observed during the period, supporting a conclusion to reject the null hypothesis.³⁶

Event	Date	1-year spread	3-year spread	5-year spread	10-year spread
MLF Announced	April 9, 2020	-0.29*** (0.0)	-0.21* (0.06)	-0.27*** (0.0)	-0.49*** (0.0)
MLF Expands	April 27, 2020	-0.05 (0.35)	0.07 (0.18)	0.14 (0.12)	0.22* (0.06)
MLF Pricing Published	May 11, 2020	-0.28* (0.06)	-0.21* (0.06)	-0.11 (0.18)	-0.07 (0.29)
Illinois Announcement, MLF Expansion, MTA Designation*	June 2-4, 2020	0.04 (0.35)	-0.06 (0.18)	-0.13 (0.18)	-0.22* (0.06)
MLF Reduced Pricing	August 11, 2020	0.02 (0.65)	-0.04 (0.29)	-0.08 (0.18)	-0.10 (0.24)
All Events		-0.56** (0.02)	-0.45** (0.05)	-0.45* (0.06)	-0.67*** (0.01)
Total Change from April 1 to September 30		-0.89	-0.83	-0.79	-0.59

Notes: We combine three events that occur on consecutive days from June 2-June 4, and compare spread changes from two trading days prior to June 2 to two trading days after June 4.

P-values in parentheses: *p<0.1; **p<0.05; ***p<0.01

Table 4 shows that the largest of the window period changes for all tenors occur around the announcement of the creation of the MLF and the first publication of pricing. The MLF announcement is associated with a

³⁶Some studies perform similar analysis using a regression rather than manually calculated yield differentials and p-values. We also perform regression analysis and find results similar to those in Table 4; we show these results in Appendix B.

21 to 29 basis point decrease in spreads for tenors of 1 year through 5 years, and a 50 basis point decrease for the 10-year tenor. The first expansion of the MLF terms is associated with a large increase in spreads at the 10-year tenor. Publication of pricing is associated with a 21 to 28 basis point spread decrease for 1-year and 3-year tenors, and smaller spread decreases for longer tenors. The events from June 2 to June 4 show a 22 basis point decrease for 10-year yields, but smaller and mixed effects for shorter tenors. Summing across all events, yield changes span from a decrease of 56 basis points to a decrease of 67 basis points as we move from 1-year spreads to 10-year spreads. To put this into context, 1-, 3-, 5- and 10-year changes associated with the event windows represent 57, 63, 75, and 151 percent of total spread changes during the sample period, respectively.

The p-values show that the magnitude of changes in spreads at the announcement of the MLF is rarely observed across all tenors in the sample, and the effects of the facility pricing publication are rarely observed in the sample for 1-year and 3-year tenors. The magnitude of changes in spreads for the first expansion and the events from June 2 to June 4 are also relatively rarely observed for the 10-year tenor, but not so for shorter tenors. The remaining MLF-related two-day yield changes are not so rarely observed, and seemingly had little short-term effect on municipal markets.

The p-value for the cumulative change of all MLF events is relatively close to zero for all tenors, indicating that the listed MLF events seem to have had a statistically significant effect on municipal yields. Our results indicate that decreases in spreads are most correlated with the announcement of the facility and pricing publication. Additionally, the spread decreases associated with the announcement of the MLF seems to have had a broad impact on yields of short and long tenor, suggesting that the facility announcement had a generally positive impact on the municipal market. The publication of facility pricing mainly impacted yields of short tenor. This makes sense as the MLF was only designed to purchase debt of up to three years in tenor, so pricing publication impacts seem to be directly reflected in spread changes for tenors in the allowable facility purchase range. The effects associated with the expansion and the period from June 2-June 4 are less clear as to why they would primarily impact only spreads at longer tenors and may be influenced by other market factors. These results should be interpreted as a correlation, as it is possible that our five-day window period allows for events not related to the announcements studied to influence spread movements.

7.2 Issuer-Level Event Study

To provide additional evidence of MLF effects on municipal markets, we consider two issuer-level event studies. As of September 30, 2020, the MLF had purchased debt from both the State of Illinois and the New

York Metropolitan Transportation Authority (henceforth referred to as Illinois and NY MTA, respectively).³⁷ Both of these issuers were experiencing difficulty accessing the market at yields similar to pre-pandemic levels and found it economically beneficial to utilize the pricing offered by the MLF. We compare spreads to maturity-matched Treasuries of bonds traded in secondary markets. To deal with the variation in trade yields across various tenors and points in time, we aggregate trade observations by looking at the median yield across all trades that occur within a month for various tenor groupings. We consider the period from January 1, 2020 to October 31, 2020, noting the times at which the public announcement of intent by the issuers to interact with the MLF was made. Illinois issued a statement on June 2, 2020 of intent to sell to the MLF. The NY MTA’s intent to borrow from the MLF became publicly known when a press release noted that New York Governor Andrew Cuomo had designated the NY MTA as an MLF-eligible revenue bond issuer, allowing the NY MTA to refinance existing short-term debt with the MLF.³⁸

Figures 8 and 9 plot the median yield spreads of various tenor categories for Illinois and the NY MTA. The issuer plots show a striking correlation between spread movements and these announcement dates. For both issuers, median yield spreads across all tenor groupings increased sharply during the first five months of the year by approximately 3-5 percentage points. This steep increase illustrates the adverse market conditions faced by each issuer as a result of the pandemic. We plot a horizontal line showing the credit spread applied to each issuer as defined by MLF pricing standards, which applied a 3.8 percent interest rate to Illinois and a 1.9 percent interest rate to the NY MTA. In the month after the public announcement of intent to interact with the MLF, median spreads decreased notably for both issuers.³⁹ From May through June, median spreads for Illinois declined between 1.1 and 2.3 percentage points across tenor groupings, and median spreads for the NY MTA declined between 1.6 and 3.5 percentage points across tenor groupings. Median spreads for Illinois flatten slightly in the months after announcement, while the NY MTA median spreads increased quickly after announcement. In both cases, spreads did not recover to pre-pandemic levels. Additional work could study persistence of the announcement effect on yields for these issuers.⁴⁰

To address the concern that the spread decreases at the time of announcement for IL and the NY MTA may in part reflect market-level movement, we also plot 5-Year Bloomberg US General Obligation Muni BVAL BBB yield spreads to Treasuries. The BVAL BBB yields are reflective of market yields for five-year tenor noninsured bonds that come from general obligation municipal issuers with credit ratings of BBB+, BBB, and BBB-. Both IL and the NY MTA had ratings lower than AAA at the time they announced their

³⁷In December 2020, the MLF made additional purchases from both Illinois and the NY MTA. We do not include these in our analysis due to data availability.

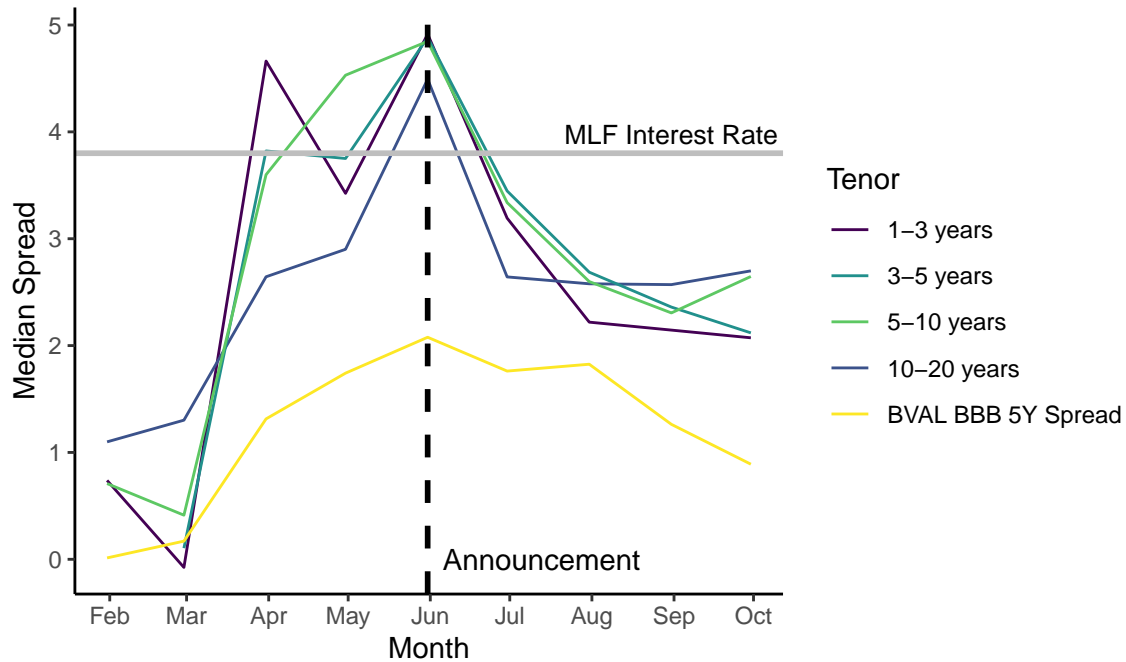
³⁸See <https://www.mta.info/press-release/mta-headquarters/statement-mta-chairman-and-ceo-patrick-j-foye-0>.

³⁹Due to our data being aggregated to a monthly level, we set the announcement dates for both issuers to be at the nearest month-end date for purposes of plotting, which is May 31, 2020 for both issuers.

⁴⁰See additional work that describes the MLF’s impact on the State of Illinois in Bernhardt, D’Amico, and Palacios (2020).

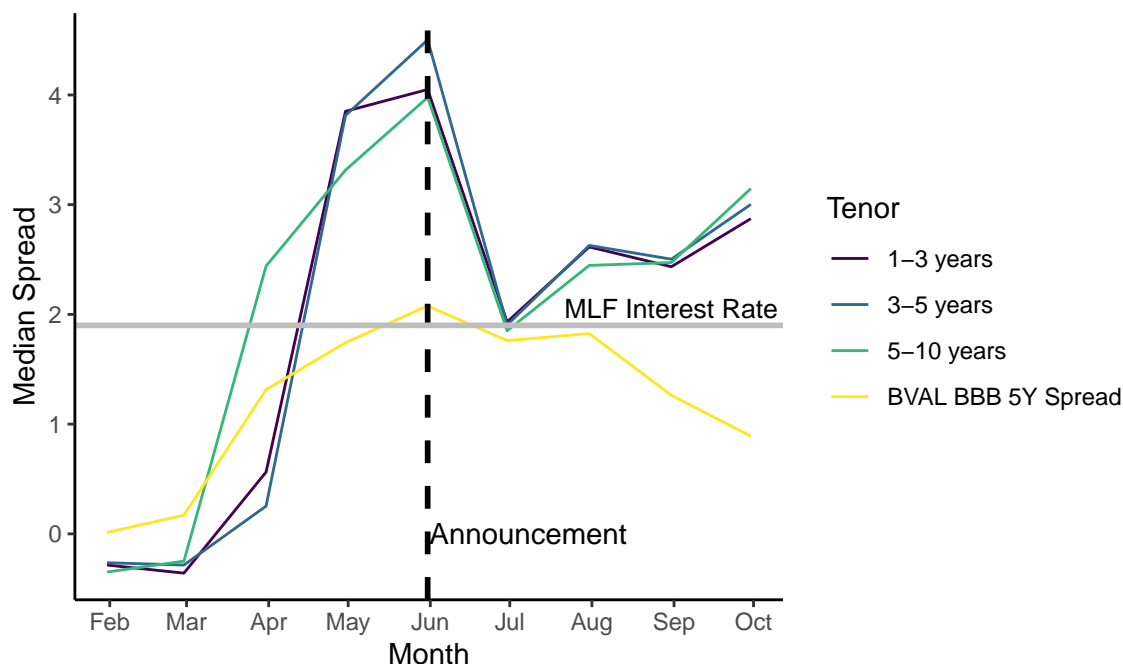
intent to borrow from the MLF. If yield spreads for the BVAL BBB index proxy for yield spread movements of relatively lower-rated issuers at the market level, then we can check if the decrease in spreads observed for these issuers also correlates with changes in general market spreads. Figures 8 and 9 show that while there is a decrease in BVAL BBB yield spreads beginning in May 2020, the magnitude of the decrease is much smaller than the decrease observed for IL and the NY MTA, especially at the time of announcement by IL and the NY MTA. This provides additional evidence that the decreases in the spread for IL and the NY MTA are correlated with the announcement of intent to borrow, and not primarily driven by general market movements.

Figure 8: Illinois Monthly Median Yield Spreads by Tenor



Sources: Bloomberg, Board of Governors of the Federal Reserve System (US)

Figure 9: NY MTA Monthly Median Yield Spreads by Tenor



Sources: Bloomberg, Board of Governors of the Federal Reserve System (US)

These results suggest that spreads for these issuers improved sharply after the public learned of intent to utilize the MLF, although spreads remain elevated relative to pre-pandemic levels. It is tempting to compare magnitudes of the issuer-level case studies and the market-level analysis. Although the magnitude of improvements at the issuer level appears larger than that at the market level, we cannot directly compare the two sets of results for several reasons. First, the market-level analysis represents an index reflecting AAA-rated municipal securities, and some of the differential can be due to the credit risk variation across Illinois and NY MTA bonds, neither of which were AAA-rated at the time of purchase by the MLF. Additionally, conditions during the pandemic may have caused investor sentiment to worsen for issuers of a certain credit quality that were disproportionately affected by social distancing restrictions.⁴¹ Additional work is required to compare issuer improvements to overall market improvements.

8. Conclusion

Municipal markets have greatly improved since the sharp deterioration that occurred in March 2020. These improvements can be shown by such factors as decreased market yields and a record amount of issuance in primary markets. We document the municipal market dynamics as a result of COVID-19 and the response of the Federal Reserve to aid issuers in these markets, focusing on the MLF. We conduct an event study

⁴¹It could be argued that social distancing had a different impact on revenues for the New York Metropolitan Transportation Authority relative to revenues collected by any US State of a similar credit quality.

to analyze correlations between market improvements and MLF-related events in municipal markets. Our results show that certain MLF interventions in municipal markets correlate with a reduction in municipal market spreads. These reductions are driven by the announcement of the facility and the publication of facility pricing, where the former impacted yields of both short and long tenor, and the latter impacted yields of a short tenor of less than five years. Our issuer-level event studies suggest that Illinois and the NY MTA were able to improve borrowing costs by announcing their intent to sell debt to the MLF. Taken together, these results and their associated magnitudes provide some evidence that the MLF had a notable impact on municipal markets and issuers that utilized the facility. These results should be interpreted as suggestive evidence, but not causal analysis.

There are various issues we do not address here, but further work should address them. First, the Federal Reserve implemented a large number of policy tools spanning multiple types of financial markets during the pandemic, and we do not control for all of the complexities from correlated movements across markets that may have influenced movements in municipal markets. We also do not compare yields for the issuers that borrowed from the facility to comparable issuers that did not borrow from the facility. Also, the MLF is a primary market facility, and we do not account for potential differential impacts on primary versus secondary municipal markets. Though this list is not comprehensive, it does suggest some starting points to better identify a relationship between the MLF and improvements in municipal markets.

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Appendix A: Three-Day Event Window

We check the robustness of our market-level event-study results by using a three-day event window in the context of the analysis shown in Table 4. This addresses the concern that our five-day event windows may be polluted by other market news, so that the observed yield changes associated with each event window are not solely due to a given MLF-related news announcement. For an event that occurs on trading day t , we utilize a shorter window from $(t-1)$ trading days to $(t+1)$ trading days. All other interpretations remain the same. Table A1 shows our results. The general implications of our analysis remain: The announcement of the facility is associated with decreases in market spreads across all tenors considered, and the publication of pricing associated with the MLF are associated with decreases in market spreads at shorter tenors. The p-values also tell a similar story in terms of the statistical significance of these results, with significance observed for announcement of the facility at all tenors, and pricing publication at shorter tenors.

Event	Date	1-year spread	3-year spread	5-year spread	10-year spread
MLF Announced	April 9, 2020	-0.25*** (0.0)	-0.14* (0.06)	-0.17** (0.03)	-0.29** (0.03)
MLF Expands	April 27, 2020	-0.02 (0.5)	0.02 (0.56)	0.07 (0.15)	0.11 (0.18)
MLF Pricing Published	May 11, 2020	-0.20*** (0.0)	-0.20*** (0.0)	-0.14* (0.06)	-0.14* (0.09)
Illinois Announcement, MLF Expansion, MTA Designation*	June 2-4, 2020	0.01 (0.82)	-0.05 (0.18)	-0.09 (0.15)	-0.16* (0.09)
MLF Reduced Pricing	August 11, 2020	0.03 (0.32)	-0.02 (0.53)	-0.03 (0.44)	-0.08 (0.29)
All Events		-0.44*** (0.0)	-0.40*** (0.0)	-0.36*** (0.0)	-0.55*** (0.0)
Total Change from April 1 to September 30		-0.89	-0.83	-0.79	-0.59

Notes: We combine three events that occur on consecutive days from June 2-June 4, and compare spread changes from one trading day prior to June 2 to one trading day after June 4.

P-values in parentheses: * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Appendix B: Regression Results

To provide further robustness around our event-study results, we perform regression analysis similar to that of Campbell et al. (2011). We estimate the effect of the MLF announcements on spreads by regressing daily spread changes, defined in Equation (1), on five dummy variables associated with the five announcement periods listed in Table 4.

Specifically, we estimate the following regression equation for a given tenor:

$$\Delta = \alpha + \beta \text{Event}_t + \varepsilon_t$$

We use Δ as defined in equation (1): the daily change in BVAL AAA Municipal Index yields for a given tenor spread to Treasuries. *Event* is a vector of dummy variables for a given event window, set equal to one for each trading day from two trading days prior to each announcement to two trading days after each announcement. The coefficient associated with each event window variable can be interpreted as the average spread change during the five-day window period associated with each announcement. We estimate this regression separately for spreads of 1-, 3-, 5- and 10-year tenors. The results are shown in Table A2.

The regression results shown agree with the findings from Table 4. We find decreases in spreads associated with MLF announcement at all tenors that we include, and these decreases are statistically significant at the 1 percent level. The average effect associated with MLF announcement spans from 5 basis points for 1-year spreads to 10 basis points for 10-year spreads. We also find that the publication of MLF pricing has statistically significant effects at shorter tenors, with average effects between 4 to 5 basis points. The remaining events either do not show a common theme at short or long tenors, are not associated with average spread changes of the same magnitude, or are not statistically significant.

Table A2: Regression Including Each Event, 5-Day Window

	Daily Change in BVAL Spread to Treasuries by Tenor			
	1-Year (1)	3-Year (2)	5-Year (3)	10-Year (4)
MLF Announced	-0.055*** (0.014)	-0.039** (0.015)	-0.051*** (0.017)	-0.100*** (0.026)
MLF Expansion	-0.007 (0.014)	0.018 (0.015)	0.031* (0.017)	0.043 (0.026)
MLF Pricing Published	-0.052*** (0.014)	-0.039** (0.015)	-0.018 (0.017)	-0.015 (0.026)
IL and MTA Announcements, MLF Expansion	0.011 (0.014)	-0.008 (0.015)	-0.023 (0.017)	-0.044* (0.026)
MLF Reduced Pricing	0.007 (0.014)	-0.004 (0.015)	-0.012 (0.017)	-0.021 (0.026)
Constant	-0.003 (0.003)	-0.004 (0.003)	-0.003 (0.004)	0.001 (0.006)
Observations	127	127	127	127
R ²	0.197	0.106	0.114	0.149
Adjusted R ²	0.164	0.069	0.077	0.114
Residual Std. Error (df = 121)	0.031	0.034	0.037	0.057

Note:

*p<0.1; **p<0.05; ***p<0.01

Standard errors in parentheses.

Sample Period from April 1 to September 30.