How the New Fed Municipal Bond Facility Capped Municipal-Treasury Yield Spreads in the Covid-19 Recession

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Abstract

For over two centuries, the municipal bond market has been a source of systemic risk, which returned early in the Covid-19 downturn when borrowing from securities markets became costly for many private and public entities, and some found it difficult to borrow at all. Indeed, just before the Fed announced its unprecedented intervention into the municipal (muni) bond market, spreads of muni over Treasury yields rose in line with the unemployment rate and appeared headed to levels not seen since the Great Depression, when real municipal gross investment plunged 35 percent below 1929 levels. To prevent such a calamity, the Fed created the Municipal Liquidity Facility (MLF) to purchase newly issued, (near) investment-grade state and local government bonds at ratings-based interest rate spreads over the safe OIS benchmark yield. In general, these spreads were initially about 100 basis points above average spreads under more normal market conditions and were later lowered by 50 basis points in August 2020. Despite a modest take-up, our study documents the MLF prevented muni spreads from rising much above those margins (plus a modest 10 basis point fee) and limited the extent to which interest rate spreads could have amplified the impact of the Covid pandemic. To establish the MLF the Fed needed Treasury indemnification against default losses. There were concerns about whether the creation of the MLF could induce moral hazard among borrowers and could undermine the efficiency of the bond market if the facility had lasted too long. Partly for this reason and because the muni market had settled down by yearend 2020, the Treasury terminated the MLF at that time. Future assessments of these downside aspects will help answer the question whether the program's benefits addressed here exceeded its costs.

Keywords: state and local governments, municipal finance, central bank policy, credit policy

JEL Codes: E40, E50, G21

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In the early weeks of the Covid-19 pandemic, U.S. state and local governments found it difficult to issue bonds, as reflected in increased spreads between yields on 20-year municipal and Treasury bonds (henceforth, the "muni spread," see Figure 1). We track these spreads with a single "muni spread" based on the GO-20 Bond Buyer Index average of what bond dealers perceived was the average yield on the 20-year general obligation debt of 20 highly rated municipalities.[1] Markets became concerned about and expected pandemic damage to the real economy (which can be proxied by the unemployment rate), impairing state budgets, and raising financial risk premiums. Through late March 2020, these spreads initially rose in line with the weekly, insured unemployment rate drawn from the initial claims for unemployment report (adjusted to be consistent with the more commonly used monthly unemployment report). Based on the strong positive correlation between the muni spread and the weekly unemployment rate, it appeared that spreads would have continued rising in step with the unemployment rate. To restore the borrowing ability of state and local governments, Congress passed a federal relief package that not only included some federal grants, but also directed and funded the Treasury and the Fed to buy muni debt to restore liquidity in the muni market, the effects of which are analyzed by this study.

This occurred as state and local governments needed to borrow. The governments faced large retail sales tax revenue losses arising from Covid shutdowns and slower brick and mortar retail sales, coupled with likely decreases in income and property tax revenues and higher pandemic-related medical and relief spending.[2] If state and local governments could not borrow,

[1] The ratings of these governments average AA (S&P) and Aa-2 (Moody's), respectively. This series has historically been used as a benchmark for pricing muni bonds of different ratings by bond investors and is consistently available on a monthly basis since 1953 and weekly since 1971. Earlier we had used Moody's Baa series with similar results, but Moody's recalibrated its muni ratings in 2010, making Baa spreads inconsistent over time. To match the 20 year maturity of the GO 20 index, we use the tax-adjusted 20-year yield on Treasuries to construct the muni spread.

[2] Clemens and Veuger (2020) estimated that the pandemic would reduce state revenues by an average of 11.5 percent, implying about ½ percentage point drop in GDP. Chernick, Copeland, and Reschovsky (2020) predicted 2020 revenue losses for 150 largest cities ranging from 5.5 to 9 percent under different scenarios. Capital gains on stocks and housing along with smaller-than-expected declines in GDP resulted in smaller-than-expected revenue losses.

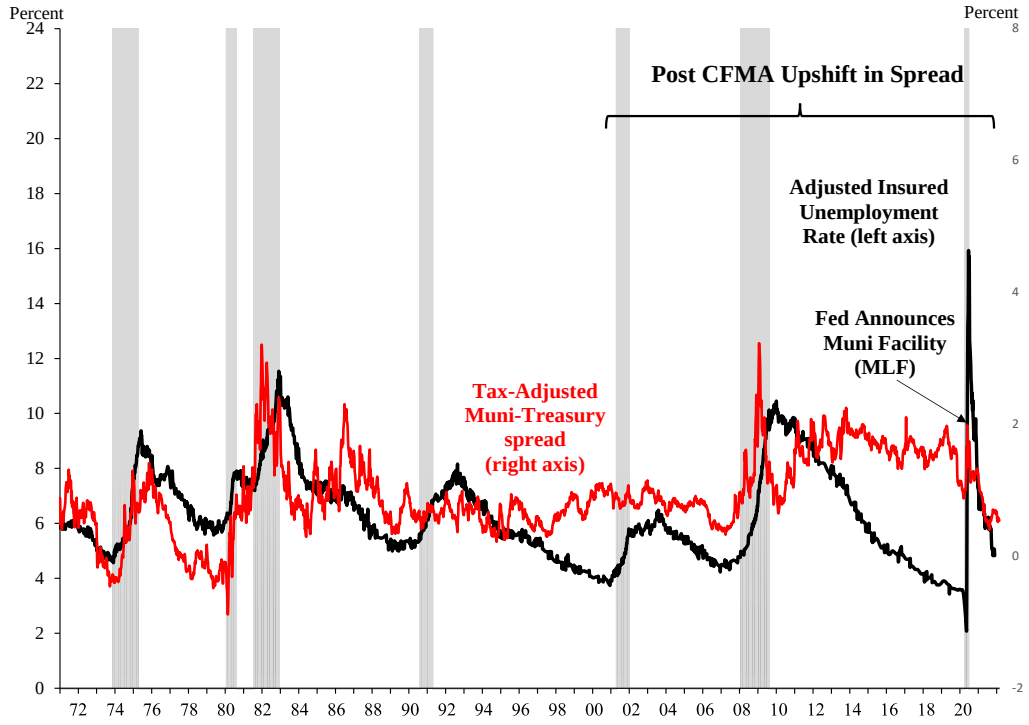


Figure 1: Muni-Treasury Yield Spread Rises with the Unemployment Rate Until Announcements of the Municipal Liquidity Facility

(NBER recessions are shaded. Sources: Department of Labor, Federal Reserve, Bond Buyer, authors' calculations)

they could have been forced into more dramatic spending cuts and layoffs than occurred.[3] Stress in the muni market goes back to the nineteenth century long before the Federal government became the dominant branch of government. Indeed, when bond market stresses—reflected in a widening of the muni-Treasury spread—occurred during the Great Depression, state and local governments slashed their investment spending and trimmed consumption spending (Figure 2).[4] As discussed in Appendix A, one lesson from the Great Depression is that distress in the municipal bond market induced spending cuts by state and local governments to avoid default (Wigmore, 1985), particularly those that had earlier borrowed heavily and were less constrained by statutory debt limits (Gunter and Siodla, 2018). These cuts, in turn, were viewed at the time as a major contributor

[3] Haughwout, Hyman, and Lieber (2020) note that state and local governments accounted for 8.5 percent of GDP in 2019, which was higher than the 3.8 percent of GDP from final purchases of the federal government.

[4] Figure 2 plots the yield spread between Aaa-rated muni and long-term Treasury bonds, whereas this study models the muni spread based off the average Baa-rated muni bond, whose yield series is not available for the 1930s.

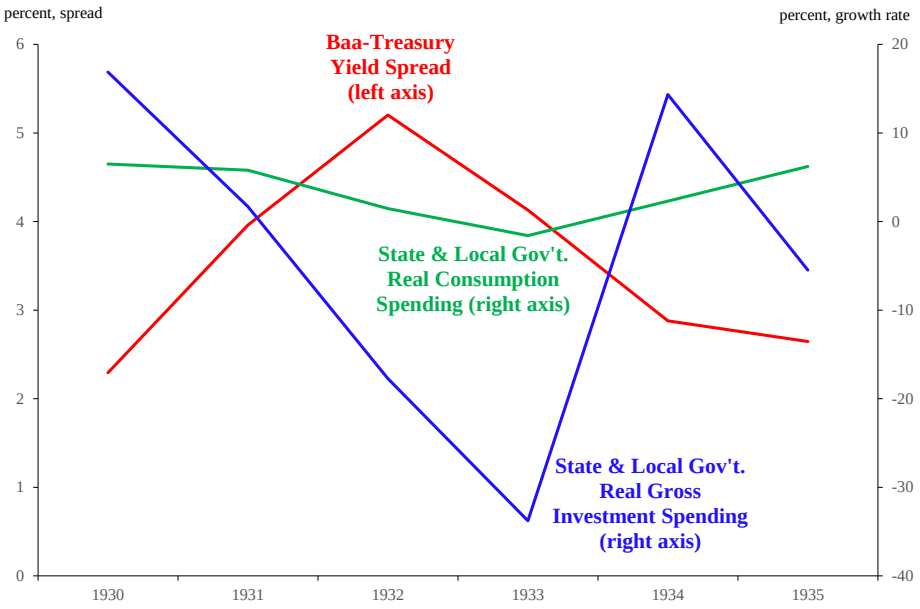


Figure 2: In the Great Depression, State & Local Governments Spending Cuts Were Mainly in Gross Investment After Default Spreads Widened
(Sources: BEA, Moody's, Federal Reserve, and authors' calculations)

to overall distress (Siodla, 2020), prompting President Hoover to lobby states and municipalities to speed up rather than reduce their planned capital expenditures (Wigmore, 1985, p. 111).

To help state and local governments avoid even deeper spending cuts and to continue to function during the pandemic, the Congress passed the CARES Act on March 27, 2020, which authorized the U.S. Treasury to provide an equity stake to cover a Federal Reserve program to backstop municipal bonds. As shown in Figure 3, muni yield spreads dipped during the week of the passage, but then after markets were disappointed that a muni facility was not announced, spreads rose in the next week peaking in early April. Spreads then dipped in the week of April 9 when the Fed announced the creation of the Municipal Liquidity Facility (MLF) through which it would buy new bonds issued by large municipalities that funded pandemic-related expenses subject to eligibility criteria. The Fed explicitly announced that it would offer to buy eligible bonds at credit-rating based spreads. The pricing would depend on the rating of the public entity with

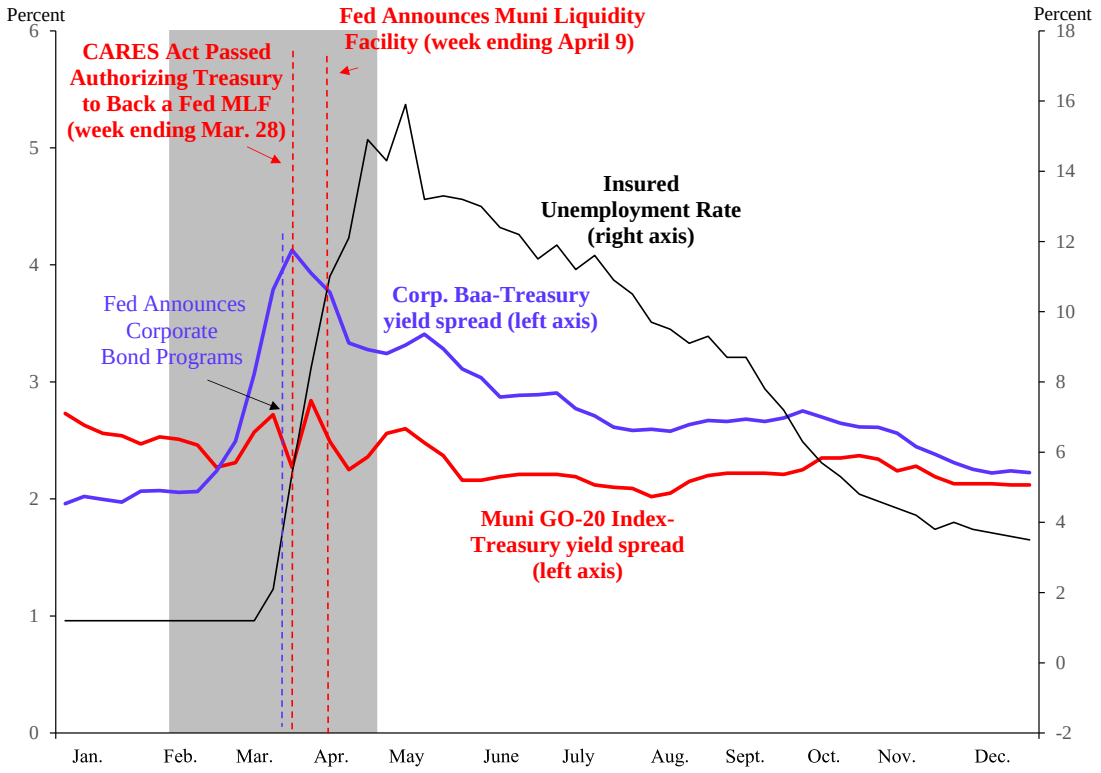


Figure 3: Muni Spreads React to MLF Announcement Effects
(Sources: Bond-Buyer, Federal Reserve, and authors' calculations)

interest rates initially set at spreads over safe OIS yields that were roughly 100 basis points higher than normal and with municipalities paying a 10-basis point fee. In accordance with the Fed's emergency lending authority under 13-3(C) of the Federal Reserve Act, this pricing was set so that the facility would serve as a backstop in which the Fed would not be the lender of first resort, which accords with Bagehot's (1873) penalty rate on lender-of-last resort provisioning of short-term liquidity in crises. Later the MLF pricing spreads were reduced by 50 basis points in August 2020. The MLF was intended to be a backstop, to help calm market conditions and allow state and local governments to access financing to provide essential services such as health services during a pandemic.[5] The aim was to stop feedback from anticipated rises in unemployment from pushing

[5] Also contributing to near-term funding pressures on state and local governments was the postponement of the federal income tax filing deadline from April 15 to July 15, 2020. As most state and local governments with income taxes use calculations based on federal provisions, normal inflow of income tax revenue in April was delayed to July that year.

muni spreads wider and preventing many state and local governments from accessing the municipal bond market. Indeed, muni spreads stopped rising in the week of the Fed announcement, well before the MLF opened on May 26. Bordo and Duca (forthcoming) find a similar pattern in the corporate bond market, where spreads over Treasury yields stopped rising when the Fed announced the creation of similar corporate bond programs (March 23), well before those facilities started buying seasoned bonds (May 12) and new issued bonds (June 29).

This paper is organized as follows. Section 2 provides a brief literature review, while Section 3 covers key institutional and historical aspects of the muni bond market and the Fed's new MLF. Section 4 lays out a framework for modeling municipal bond premia and describes the data and variables. Section 5 discusses the empirical results and counterfactual simulations, and the conclusion provides a broad perspective on our findings.

2. Related Literature

This study examines the impact of the announcement of the MLF on muni spreads, the Fed's first major intervention in the municipal bond market. In financial crises, the Fed has traditionally limited its interventions to providing short-term liquidity in money markets and to member banks via the discount window. Instead, the MLF is more of a credit policy or easing program designed to prevent financial frictions from amplifying the more direct macroeconomic effects of the Covid pandemic. In this sense and with the Fed intervening in debt with maturities beyond those of the money market, the MLF resembles the primary and secondary corporate credit facilities, which also had large backstop announcement effects (Bordo and Duca, forthcoming).

From the perspective of the Fed's price, macroeconomic, and financial stability mandates, intervention in the municipal bond market can be justified if distress in this market is widespread enough to hurt the macroeconomy or if it poses systemic risk or risk of contagion that could

undermine financial stability and thereby the macroeconomy. With respect to the former, the functionality of the muni bond market matters because it provides considerable funding ($4 trillion outstanding) for capital investment and for helping municipalities address intra-year imbalances between spending and revenues. This is crucial for these governments to provide essential services.

Regarding the second justification, there have been two instances in the Fed's history when muni bond distress posed systemic risk as discussed in section 3. In these (including the Great Depression) and two pre-Fed episodes, there was a lack of federal fiscal intervention, an absence of central bank intervention, and a large wave of muni defaults that accompanied a national depression or serious downturn. Of these, in the case of the Great Depression, the Fed did not intervene, and state and local government spending fell and hurt the macro economy until federal fiscal support was eventually provided during the New Deal. In contrast, the federal government's assumption of state debt incurred to finance the American War for Independence ended state and municipal distress and poor financial conditions that contributed to a weak economy in the 1780s and laid the groundwork for a recovery in the 1790s (Henning and Kessler, 2012).

Given the experience in five prior cases of systemic risk from municipal distress and the national nature of the Covid pandemic, the Fed's intervention in the municipal money and bond markets in the Covid pandemic seems warranted. Systemic risk was evident when a wave of mutual fund redemptions by household investors triggered large fire sales of muni bonds by mutual funds that fueled a liquidity crisis in the muni bond market in the spring of 2020 (see Li, O'Hara, and Zhou, 2020). Their findings largely reflect the behavior of households who indirectly own about 20 percent of muni securities indirectly via mutual funds and another 45 percent via direct holdings. Thus, investor vulnerability to muni bond prices largely falls on households, with some on banks and insurers who each hold about 12 percent of muni debt.

Several other papers find that the announcement of the MLF lowered muni spreads. In an event study, Bi and Blake (2020) assess the impact of MLF-related announcements on muni liquidity and credit risk premiums. Using data on a type of collateralized muni bond (prefunded bonds), they find that the negotiation and passage of the CARES Act lowered liquidity premiums on prefunded bonds between 28 and 68 basis points, with a further reduction of 17 basis points when the Fed announced the creation of the MLF. Using a diff-in-diff approach, Haughwout, Hyman, and Shacher (2021) estimate that for eligible municipalities, the MLF lowered municipal bond yields by about 72 basis points by comparing yields on the debt of municipalities that were eligible for selling bonds to the MLF versus yields on debt issued by other municipalities. This magnitude is close to the sum of impacts of the CARES passage and Fed MLF announcements of Bi and Blake (2020). In addition, Haughwout, Hyman, and Shacher (2021) estimate that the MLF helped limit declines in state and local government employment. Also reassuring are estimates from an event study by Li and Lu (2020). Using county and state level data they estimate that the Fed's announcement of the MLF lowered municipal yields by about 69 basis points controlling for county fixed and week time effects and for time variation in the frequency of COVID-19 deaths and cases. Compared to the aforementioned studies, our paper uses a more aggregated, time series approach which complements findings from diff-in-diff and event studies by quantifying how the MLF prevented a worsening economy from further amplifying the widening of muni spreads.

Our study is also related to Wei and Yue (2020b) who discuss the impact of the Federal Reserve's Money Market Mutual Fund Liquidity Facility (MMMLF) on the ability of municipal governments to access short-term interest rate financing.[6] They show that after rising during the early pandemic, yields on variable rate deposit obligations (VRDOs, floating rate bonds that are

[6] From the MMMLF qualifying banks can borrow against the collateral of short-term municipal debt and variable rate deposit obligations at the primary credit rate plus 100 bps.

rolled over) stopped rising when the Fed announced the creation of the MMMLF on March 18 and subsequently fell. This was in sharp contrast to the elevated levels of VRDO yields during the global financial crisis when there was no similar Federal Reserve facility (also see Wei and Yue, 2020a).[7] These findings accord with Cipriani, Haughwout, et al. (2020) who find that municipal money market mutual fund balances plunged prior to the announcement of the MMMLF, which expanded the eligible collateral to include VRDOs (Cipriani, La Spada, et al., 2020).

Nevertheless, the size of the debt markets directly affected by the MLF and MMMLF differ. First, the VRDO market is much smaller—about $150 billion outstanding at the end of 2018 (Securities Industry and Financial Markets Association, SIFMA)—than that of the long-term muni bond market which was roughly 20 times the size at about $3 trillion at yearend 2018, according to the Financial Accounts of the U.S. Second, the size of the short-term muni debt market is also much smaller—about $38 billion at yearend 2018, according to the Financial Accounts of the U.S.

3. Institutional and Historical Aspects of Muni Spreads and the Municipal Bond Facility

This section reviews institutional and tax aspects of the municipal bond market that affect muni spreads. It also provides background on pre-WWII episodes of systemic distress from muni debt and the post-WWII behavior of defaults and municipal yield spreads that is relevant for modeling spreads. Then prior experience with national interventions is discussed before providing details on the Fed's Municipal Liquidity Facility that relate to the recent behavior of muni spreads.

3.1 Institutional and Tax Aspects of Muni Bonds

There are two broad categories of municipal bonds. General obligation bonds fund current

[7] Wei and Yue (2020a) show that yields on VRDOs rose by less than those on less liquid auction rate securities because VRDOs benefitted from liquidity backstops from banks. Nevertheless, VRDO yields rose in the GFC perhaps owing to higher liquidity risk premiums that investors demanded on non-Treasury securities. VRDO yields remained elevated for much longer in the GFC than in 2020 owing to the creation of the MMMLF, which enhanced the liquidity of VRDOs, (Wei and Yue, 2020b). The muni-Treasury bond yield spread peak lines up with the April 9 announcement of the MLF's future creation, and not on the March 18 announcement of the impending creation of the MMMLF.

state and local government current (consumption) spending and are backed by the general taxing authority of public entities. The second feature makes such bonds less susceptible to default than so-called revenue bonds. The latter are not explicitly backed by the taxing authority of a state or local government, but rather are paid from the revenues an entity raises. Revenue bonds are often used to fund capital projects and are generally viewed as riskier than general obligation bonds.

There are important differences in the tax treatment of interest income earned on U.S. government, muni, and corporate debt. The latter is generally taxed by all three major layers of government in the U.S.—federal, state, and local entities. State and municipal governments do not tax interest earned on Treasuries and interest income on state and municipal debt is generally exempt from the federal income tax. In addition, state and local governments are largely exempt from income tax interest income on their bonds held by their citizens. As a result, the marginal federal income tax rate creates a wedge between yields on munis and Treasuries that can shift with notable federal tax changes. Accordingly, spreads between muni and Treasury rates need to be adjusted for federal tax rates, and as discussed in Section 3, we tax adjust muni spreads using a federal marginal income tax rate on interest income from Feenberg and Coutts (1993).

Another important institutional aspect is that a good number of state and local government entities purchase insurance from insurers who provide investors with insurance against default risk. These insurers are typically referred to as mono-line insurers as they are prohibited from offering other types of insurance and are very exposed to risks from this one particular market. Until 2008, muni bond insurance was provided mainly by only four insurers (see Cornaggia, et al, 2019). However, the impact of the subprime housing bust damaged the finances of many local governments that were dependent upon property taxes and retail sales taxes that were vulnerable to consumption effects of house price declines. There were downgrades of monoline insurers by

the main ratings agencies that impaired the credibility and impact of muni bond insurance[8] and in three cases had particularly notable effects on muni spreads. These troubles induced exit and mergers that reduced the number of large mono-insurers to one over 2009-12.

3.2 Pre-Great Depression Episodes of Systemic Risk From the Muni Bond Market

Before the New Deal, state and local governments were the primary fiscal actors in the U.S. and relative to the federal government, they played an even larger role in funding public-related infrastructure than today. State and local government debt helped fund U.S. economic development, with waves of muni issuance accompanying surges in investment in canals and railroads in the 1800s, that sometimes later led to waves of muni defaults and collapses in infrastructure investment (Studenski and Kroos, 1963).

Well before the Covid-19 pandemic and the Great Depression, there were four episodes in U.S. history when local debt posed systemic risk. The first involved debt issued by the original states to fund the American War for Independence, which created massive debt overhangs for the state governments. This had to be resolved before the fledgling U.S. Treasury could issue its own debt (Sylla, 2011). The debt overhang was resolved by the national assumption of Revolutionary War debt by the Hamilton-led Treasury in the 1790s (Perkins 1994). This was crucial to enable the Treasury to gain the credibility to issue national bonds. According to Rousseau and Sylla (2003) the creation of a national bond market was a key component of the fiscal revolution that fostered the remarkable growth of the U.S. economy in the nineteenth century.,

Unfortunately, this precedent may have fostered a belief that the national government

[8] In other regressions not shown, we included dummies for major downgrades of monoline insurers. While they had positive and significant coefficients on the spread, their inclusion yielded serial correlation in the model residuals. This may arise because these downgrades were at least partly an endogenous response to the depth of the Great Recession, which is tracked by the unemployment gap. Hence, monoline insurer dummies are not very exogenous shocks to the muni market and the unemployment gap unlike isolated defaults or tax-policy related events. The same patterns and issues arose for including dummies for the Carter credit controls of 1980 and Lehman's failure.

would bail out the states again encouraging and magnifying a major infrastructure boom in the 1820s, 30s and 40s in canals and later railroads, largely funded by state and local debt (Sargent, 2012). Overinvestment and overleverage led to the collapse of state bond prices and the default of 10 states in the early 1840s following the panic of 1839 and a serious economic recession (Studenski and Kroos, 1963, and Temin, 1969).

The third episode of systemic risk emanating from the muni market occurred in the depression of the 1870s, with a wave of muni defaults, this time associated with the post-civil war expansion of railroads across the continent (Advisory Commission on Intergovernmental Relations, 1973, p. 11). The fourth systemic episode occurred in the protracted economic slump in the 1890s when another wave of municipal defaults occurred, this time on a mix of railroad and general obligation bonds (Advisory Commission on Intergovernmental Relations, 1973, p. 11)

In contrast to the national assumption of Revolutionary War debt which resolved systemic risk in the 1790s, the other three instances of systemic risk from the muni market were not resolved by federal action and each was linked to an economic downturn, partly because the earlier excessive issuance of muni debt had funded overinvestment in economic development projects. In these respects, the three waves of muni defaults are similar to the wave of muni defaults in the Great Depression (see Appendix A).

3.3 Historical Aspects of Muni Defaults and Spreads Between WWII and Covid-19

Since the Great Depression, muni debt has continued to provide a large source of funding for public infrastructure, albeit to a lesser degree than before the growth of federal government expenditure in the New Deal (Wallis and Oates 1998). For example, the $1.65 trillion in muni debt issued between 2003 and 2012 for capital investment funded the construction of schools ($514 billion), hospitals ($288 billion), water and sewer facilities ($258 billion), roads ($178 billion),

power utilities ($147 billion), and mass transit ($106 billion).[9] Thus, a general and severe systemic shock to the municipal bond market could have notable real consequences for the nation.

That said, despite the continued importance of muni debt in funding investment and a generally low overall default rate on rated municipal debt, there have been some prominent muni defaults between WWII and the Covid-19 pandemic, but none of these isolated cases seemed to pose systemic risk. Of the seven largest municipal defaults since WWII, five involved general obligation debt: New York City's moratorium in late 1975, the bankruptcies of Orange County (December 1994), Detroit (December 2013), and Puerto Rico (July 2016),[10] and Cleveland's 1978 default on bank loans. In four cases, excess borrowing by these entities was underappreciated by markets and officials and increased their *individual* vulnerability to default to a major recession or prolonged economic stagnation (Cleveland, Detroit, New York City, and Puerto Rico). In the fifth case, that of Orange County, the municipality suffered a large loss on interest rate derivatives that it had issued and whose risks it did not fully appreciate. In one of the two cases involving revenue bonds, Jefferson County underappreciated the risks of relying on variable rate and short-run debt financing, whose costs rose in the GFC when the county's debt was downgraded. The remaining default, that of Washington Public Power Supply System Projects 4 and 5, involved revenue bonds of a utility rather than the debt of a city or county.

In all but one of these cases, there were substantial local but *not* national economic costs from the sudden cuts in government spending and tax increases which these municipalities imposed to restore fiscal balance.[11] In the case of New York City, there were notable cuts in police and public health spending that were followed by large increases in crime and declines in public

[9] These figures exclude refunding issues. Source: National Association of Counties (2013, p. 4).
[10] The exception is the 1983 default on bonds issued by the Washington Public Power Supply System Projects.
[11] These adjustment costs were less notable and long-lasting in relatively affluent Orange County whose bankruptcy was not a result of long-run economic decline or a downshift in future long-run economic growth.

health—including even a mini-outbreak of tuberculosis (Freudenberg, et al., 2006). Freudenberg, et al. (2006) estimate that the economic costs to New York City were five-times the short-run budgetary savings. This case highlights the point that while metro budgets need to be sustainable in the long-run, the costs of recovering from default can entail sharp short-run, disruptive cuts in essential services which could have been avoided had pre-default spending been sustainable and the composition of spending better reflected higher value-added expenditures. Details on the factors behind these defaults and the costs of short-run adjustments are discussed in Appendix B.

Although muni default rates have been low since the 1930s relative to default rates on other publicly traded debt (Moody's, 2017),[12] the tax-adjusted spread between Baa-rated municipal and Treasury bond yields (*MuniBaaTr*) is very cyclical (see Benson and Rogowski, 1978). As shown in Figure 4, the spread widens near the start of recessions and throughout most of them, and sometimes peaks after recessions before falling in the mid- and late stages of expansions, much like the unemployment rate. (Note that Moody's recalibrated its municipal bond ratings after the Great Recession, so the Baa-based muni spread is not completely consistent over time. As mentioned elsewhere in this study, we focus on the more consistently measured GO-20 index.) The combination of cyclicality and low default rates suggests that swings in—and temporary shocks to—liquidity and risk aversion are major drivers of the spread. Consistent with this view, this study later shows that the five largest U.S. municipal defaults coincided with temporary, modest rises in average muni spreads that did not persist for long.

3.4 Notable National Interventions in State and Local Debt Before the Covid-19 Pandemic

Despite the ostensible near-term success of the Federal Reserve interventions involving

[12] As Appleson, Haughwout, and Parsons (2012) stress default rates are notably higher for unrated (which are sizable in volume) than for rated muni bonds. The yield spreads that are modeled in this study are based on yields for publicly rated bonds which are available for a much longer time series sample that those on unrated (and less traded) bonds.

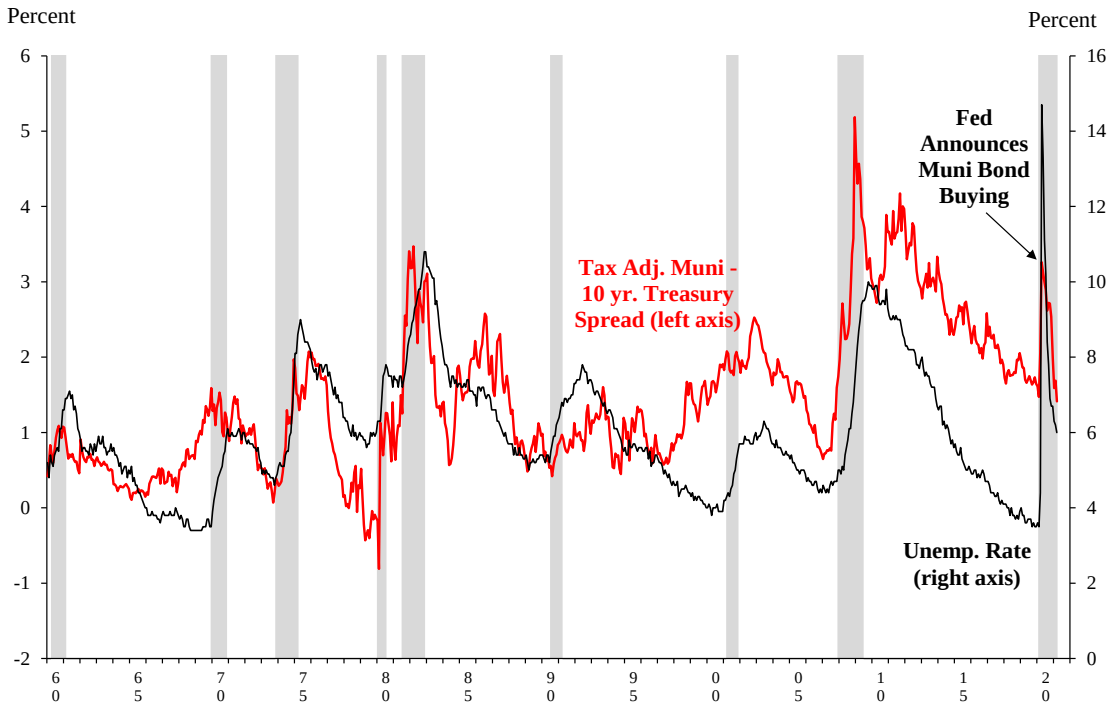


Figure 4: Since 1960, the Tax-Adjusted Baa-rated Municipal-Treasury Bond Yield Spread Moves with the Unemployment Rate Until the Fed Announced its Municipal Bond Facility
(NBER recessions are shaded. Sources: Moody's, Federal Reserve, and authors' calculations)

muni debt markets, the U.S. experience with federal bailouts of state governments suggests that such interventions could induce moral hazard for borrowing states. In his Nobel Prize lecture, Sargent (2012) reviewed the impact of the U.S. federal government's assumption of state debt that largely emanated from financing the American War for Independence, which is arguably a national rather than a state obligation. Sargent emphasizes how this assumption was feasible considering the nation's then future prospects for rapid growth that could fund the debt, as well as efforts of Hamilton and others to keep the U.S. federal debt on a sustainable downward trajectory.

Nevertheless, Sargent argues that the precedent helped take the onus off state governments to have sustainable debt paths and in the 1820s and 1830s many had borrowed in the London bond market to fund capital improvements. The states assumed that the improvements would stimulate their economies and generate the revenue needed to service and amortize the debts. A severe

economic downturn following the panic of 1839 led to disappointing tax and toll revenue, which coupled with higher interest rates, made it difficult for many states to pay. As a result, many defaulted in the early-1840s. Congress considered but did not approve a federal bailout (Sargent, 2012). The consensus in the Congress was that unlike the Revolutionary War debt, the state debt of the 1830s was not incurred in the national interest. Those defaulting states that eventually repaid later regained their ability to issue debt before the American Civil War; but those who repudiated their obligations had less if any access (English, 1996). Sargent (2012) maintains that this sobering experience ultimately induced the states to enact balanced-budget requirements in their constitutions to help restore their credibility and reputations.[13]

Moral hazard from national government bailouts of regional governments is not limited to the early U.S. experience. Bordo, Jonung and Markiewicz (2011) review the history of five countries with federal unions. In the Canada and the U.S. since the 1840s markets have generally disciplined state and local government borrowing. By contrast, Bordo, Jonung and Markiewicz (2011) stress how national government bailouts of state and local governments have prevented such market discipline in Argentina and Brazil, and how the moral hazard that such bailouts have engendered has contributed to national defaults and bouts of high inflation. Partly to avoid unduly supplanting market discipline in the future, the Federal Reserve has limited MLF purchases of state and local government debt to fund Covid-pandemic related shortfalls, limited the maturity of debt it would buy to two-years, and limited the time frame when the MLF would purchase debt.

3.5 The Fed's Municipal Bond Facility

In the early stages of the pandemic in the U.S., heightened cyclical risks as tracked by the

[13] These are critical for states when issuing long-term debt to fund capital projects and short-term debt to smooth out intra-year imbalances in their current spending budgets. This shift may help explain why, while there were more state defaults in the nineteenth century, only one state has defaulted since the 1840s (Arkansas in 1936).

monthly and weekly unemployment rates pushed up muni spreads by over 100 basis points. Further rises in unemployment and spreads were expected after March (e.g., Morath and Kiernan, 2020). To prevent additional increases in muni spreads, the Fed announced on April 9 that it would purchase up to $500 billion in revenue notes and other short-run debt (under 2 years in maturity) newly issued by states or cities to offset revenue losses or increased expenses related to Covid's impact.[14] The facility was limited to cities of at least 1 million residents and counties with at least 2 million residents Later, the maximum maturity was raised to three years and eligibility was expanded to include multi-state agencies. Population thresholds were subsequently lowered (250,000 for cities and 500,000 for counties) as few cities were eligible and at one point, only two entities had borrowed from the facility.

To shield the Fed from investment losses the MLF is structured as a special purpose vehicle, funded by Treasury equity stakes of up to $35 billion and up to $465 billion in debt held by the Fed. Portfolio exposure to any one entity is limited to 20% of an issuer's annual revenue. The pricing at which purchases are made was designed to prevent muni spreads from rising too far above more typical levels, with the pricing designed to make the MLF more of a backstop than a first stop source of finance for nonfederal public entities.

Muni-Treasury spreads abruptly stopped rising in the week when the Fed announced that it would set up MLF, well before the MLF opened in May and despite a rising unemployment rate. Nevertheless, total MLF borrowing was $6 - ½ billion, below the $17 billion equity stake provided by the Treasury and the $500 billion limit on the facility's size. Instead of reflecting a balance sheet effect as with QE, this pattern suggests a strong "backstop" effect similar to that of the Fed's corporate bond buying program on corporate spreads (Bordo and Duca, forthcoming.)

[14] Governors of each state can designate a limited number of cities and counties that can borrow from the MLF.

4. Modeling the Muni-Treasury Spread

The municipal spread analyzed in this study tax-adjusted spread (*MuniGO20*) between the yield on the Bond Buyer's GO-20 index (*GO*-20) and the 20-year Treasury yield (*TR20*). This is the only consistently measured muni bond series with continuous data over long time series samples. The main reason is that Moody's recalibrated its municipal bond ratings in 2010, which shifted the distribution of ratings across municipalities. The GO-20 index tracks the average yield on 20 investment grade 20-year general obligation municipal bonds based on a survey of municipal bond trader estimates of yields on bonds in the index. Its big advantages are that the *MuniGO20* series is unaffected by Moody's recalibration of bond yields, and is used as a benchmark for pricing lower rated muni securities.

Our weekly sample starts in 1971, when weekly data on muni yields and our weekly macro-control variable that is based on the national weekly insured unemployment rate start. The after-tax muni return equals the nominal municipal yield since municipal interest income is exempt from federal income tax and because state and municipal entities exempt interest on their bonds from taxation for local residents.[15]In contrast, federal income tax is levied on Treasury interest. Hence to calculate a tax-adjusted spread between 20-year muni and Treasury yields, the return on 20-year Treasuries is multiplied by 1 minus the marginal federal income tax rate on interest income, t^f:

$$GO20TR_t \equiv MuniGO20 - (1- t^f)\ TR20 \qquad (1)$$

The tax series is the average marginal rate from Feenberg and Coutts (1993) labeled "Same 1984 Sample for all Years." Because there were no major changes in the federal income tax code after 2018, we extended the 2018 value to cover 2019-2021.

[15] Local residents are treated as the marginal muni investors owing to the local state and municipal tax exemption.

4.1 An Empirical Model of Muni Spreads, Pre-MLF

The main cyclical variable used in this is an adjusted weekly, insured unemployment rate from the initial claims for unemployment report. The unadjusted weekly insured unemployment rate has not consistently moved over time with the monthly unemployment rate. As stressed by Cleary, Kwok, and Valletta (2009), the major reason is that the eligibility for—and the taxation of—UI benefits has evolved. This stems partly from shifts in the regional and unionized composition of employment that have affected the proclivity of the unemployed to file for benefits and count in the weekly unemployment rate series. To address this we multiply the seasonally adjusted weekly series by the centered, 12-week moving average of the ratio of the weekly unemployment rate to the monthly unemployment rate from the household survey.[16] Although the adjusted and unadjusted weekly unemployment rates are each significantly related to (cointegrated with) the muni-Treasury spread and the actual spread significantly error-corrects toward its equilibrium value, the adjusted series yields short-run residuals that are not significantly correlated, in contrast to residuals from a model of the unadjusted series. Accordingly, we use the adjusted insured unemployment rate in weekly models.

As shown in Figure 5, the muni spread (*GO20TR*) widens in recessions and tends to be coincident with business cycle peaks and troughs. The cyclical effect is nonlinear, with a stronger correlation between the spread and the square of the unemployment gap than with the level, plausibly reflecting the tail risk nature of defaults and default risk, or because labor-hoarding tends to make swings in unemployment more muted than swings in GDP as argued since Okun (1970). Before the Fed announced its new municipal bond facility, tax-adjusted muni spreads mainly reflected cyclical risks for municipal debt. Time series measures or proxies of cyclical risks are

[16] The smoothing of the adjustment parameter limits noise in the weekly series.

limited by data availability and endogeneity.[17] Cyclical risk is proxied by the extent to which the unemployment rate exceeds its natural rate multiplied by its absolute value, which for notational simplicity we will denote by *UGap*^{2} and which is expected to be positively correlated with the muni spreads. The gap times the absolute level of the gap captures nonlinearity when the labor market is overheated, and the unemployment rate gap is negative. The correlation of the *muni* spread is stronger with the square of the unemployment gap than with its level.[18]

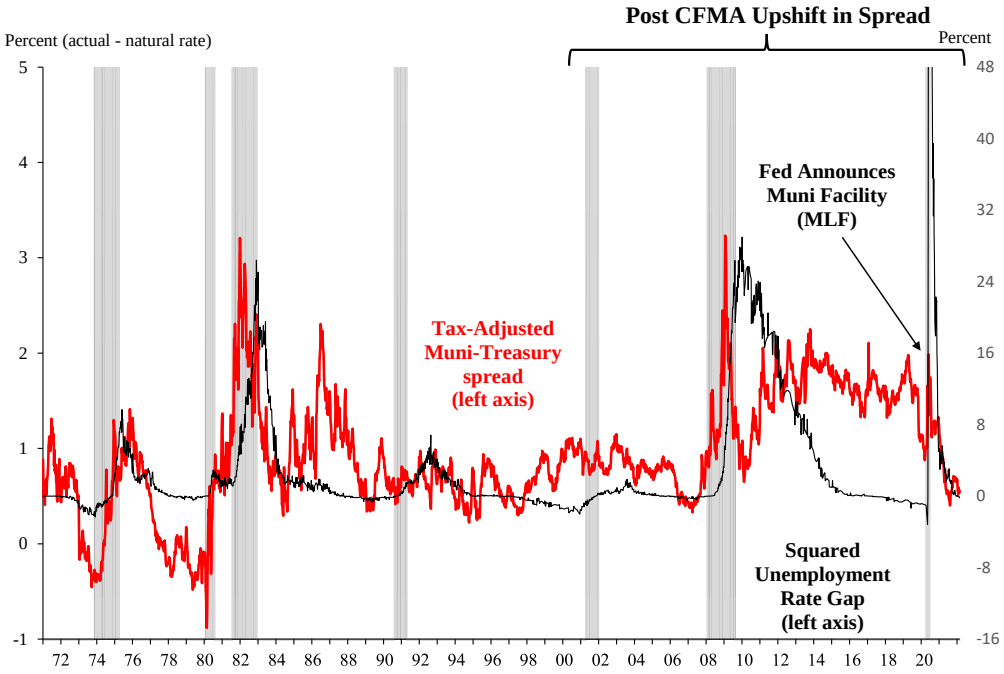


Figure 5: Since 1960, the Tax-Adjusted Muni Spread Moves with the Squared Unemployment Rate Gap Until the Fed Announced its Municipal Bond Facility
(NBER recessions are shaded. Sources: Bond-Buyer, Federal Reserve, and authors' calculations.)

[17] For example, widespread central bank interventions prevent using the commercial paper bill spread (made famous by Friedman and Kuttner, 1992) for post-2007 samples or using corporate spreads for tracking risk in modeling commercial paper (Duca, 2013) or municipal-Treasury spreads after February 2020. Endogeneity concerns also raise doubts about using the yield curve as long-term Treasury yields directly affect its slope and the base off which corporate and muni spreads are measured. In addition, large holdings of long-term securities following the Fed's use of quantitative easing starting in 2008 affect the consistency of the yield curve over time. The post-2007 Fed balance sheet also limits the usefulness of the TED spread (LIBOR-short-term Treasury interest rates) as the high excess reserves used to fund Fed bond holdings limits the ability of the TED spread to track more general market risk premia.
[18]Swings in output around trend are larger than rises in the unemployment rate, as noted Okun, 1970) who argued that labor market frictions gave firms incentives to adjust employment less than output. This is consistent with our finding that cyclical shifts in muni spread are more correlated with the square of the unemployment gap rather than its level.

A major shift since the late 1990s has affected the muni-spread. Such a shift can be tracked by either controlling for long-lasting changes in regulations, or by time trends. The latter provides little insight and coefficient estimates on time trends can suggest omitted variable bias from not controlling for other factors. With respect to the former, we found one significant upshift in the tax-adjusted muni spread after 1960. This was an upshift that we link to the Congress' December 2000 approval of the Commodity Futures Modernization Act (CFMA). As Bolton and Oehmke (2015) and Stout (2011) show, the CFMA exempts derivatives counterparties from the automatic stay in bankruptcy, enabling immediate collection from a defaulted counterparty, providing them a senior claim over most other bankruptcy claimants. The passage of CFMA was quickly followed by a surge in credit default swaps (Duca and Ling, 2020). By giving bankruptcy priority to derivatives (mainly credit default swaps), the CFMA lowered the priority of bonds and made bonds riskier (see Bolton and Oehmke 2015). CFMA can be viewed as a shift in which the use of hard-to-detect derivative positions became more acceptable for state and municipal finance authorities, while posing greater risks to bond investors.[19] We find that a shift dummy (*CFMA* =1 since December 15, and 0 otherwise) captures an upward level shift in the muni-Treasury yield spread.

These considerations imply the following specification for the equilibrium muni spread:

$$MuniTR^{*}_{t} = \alpha_0 + \alpha_1 \, UGap_t^2 + \alpha_2 \, CFMA_t \qquad (2a)$$

where *MuniTR* denotes either muni spread and each coefficient α_i has an expected positive sign. According to KPSS tests (Appendix B), muni spreads and $UGap^2$ are nonstationary in levels but are stationary in first differences. By construction, so is the regulatory shift variable, *CFMA*. Accordingly, we estimate equation (2) with weekly (1971-2021) data using a cointegration

[19]The famous 1994 bankruptcy by Orange County owed to county government losses on interest rate derivative positions, while the 2011 bankruptcy of Jefferson County, Alabama also arose from taking much interest rate risk.

approach (Johanssen's, 1995). Allowing for some lags in the adjustment of muni spread to equilibrium implies this error-correction model of the change in the spread:

$$\Delta MuniTR_t = \beta_0 + \beta_1 EC_{t-1} + \sum^{n}_{i=1} \beta_{2i} \Delta muniTR_{t-I} + \sum^{n}_{i=1} \beta_{3i} \Delta UGap_{t-i}^2 + \sum^{n}_{i=1} \beta_{4i} \Delta CFMA_t + \Omega X_t, \quad (2b)$$

where $EC_{t-1} \equiv MuniTR_{t-1} - MuniTR^*_{t-1}$ (the error term from (2a)), lag lengths minimize the SIC subject to yielding serially uncorrelated errors, X is a vector of exogenous shock variables, Ω is a vector of coefficients for the X vector of shocks and the estimation allows for each of the variables in the long-run equation to have time trends but not a trend in the long-run relationship.

The estimated coefficient β_1 on the error-correction term is expected to be negative (so that the actual spread converges toward its equilibrium level), with the absolute magnitude implying the speed of error-correction. Note that the model implicitly imposes an almost instantaneous reaction of the municipal bond yield to the long-term Treasury yield, reflecting the Treasury yield's role as a benchmark rate. The speed of error-correction (i.e., the speed at which the spread adjusts), really indicates lags in how the perceived relative risk and degree of risk aversion for municipal bonds adjust in response to the business cycle and the CFMA regime shift in the bankruptcy priority and relative risk of municipal versus Treasury bonds.

4.2 Models Accounting for the Municipal Liquidity Facility

Equations (2a) and (2b) comprise a baseline model of the muni-Treasury yield spread before the Fed announced in early April 2020 that it would intervene by being willing to buy newly issued municipal bonds at somewhat elevated spreads. If the Fed prevents the spread from rising past a threshold, its policy intervention breaks the normal equilibrium relationship. In particular, as illustrated in Figures 1 and 3, the Fed's announced intervention prevented a further (and expected) cyclical deterioration after late March from further elevating muni spreads.

Accordingly, to account for the MLF's effect in our cointegration framework, we run

alternative models in full samples (through December 2021) in which the squared unemployment gap is adjusted to reflect the cap-like impact of the MLF from the week that the MLF was announced until it ended at year-end 2020. In particular, starting in the week when the MLF was announced through the end of 2020, we replaced $uGap^2$ with the square of the maximum of the unemployment gap and the average unemployment gap in the last two weeks of March 2020. This variable, $UGapMLF_t^2$, enables the unemployment rate gap to push up muni spreads to levels no higher than those seen in early April 2020, but also allows later declines in the unemployment gap below that average to reduce spreads before the MLF ended. In this way, $UGapMLF_t^2$ is defined to capture the essential backstop role of the MLF in capping muni spreads. In earlier versions of our study, we had zeroed out the coefficient on the slightly different squared unemployment rate during the MLF period and found that this specification was superior to poorly performing models that ignored the MLF. This qualitative finding continued to hold when we updated our earlier estimates through March 2021, but that earlier framework did not allow for muni spreads to recede with declines in the unemployment gap when the MLF cap was not binding.

4.3 Accounting for Prominent Municipal Defaults, Unusual Government Policies, and Covid

In addition to the MLF, our framework includes some controls for the impact of the Covid pandemic and allows for variants that control for some other effects such as unusual government policies and prominent municipal defaults. The first difference equation (2b) includes an error-correction term (t-1 gap between the actual and equilibrium spread), lagged first differences of long-run variables and a vector X of exogenous shocks. X includes impact dummies for the Covid pandemic and also dummies for unusual government policies and five prominent episodes of municipal bond distress. The former, include lags of *dCovid* (=1 only in one period, 0 otherwise) for each of the fourteen weeks since the onset of the Covid Pandemic (March 6, 2020). In other

runs, we tested a dummy, *dVaccine*, equal to 1 in the business weeks of November 20 and December 4, 2020 when Pfizer and Moderna announced successful stage 3 trial results for their Covid-19 vaccines. The variable is insignificant and is not included in the reported models.

Among the other controls are impact dummies for unusual government policy surprises that are plausibly exogenous to the muni spread and the squared unemployment gap (see footnote 14). One set of variables control for five large and generally unexpected municipal defaults. Two approaches were tried. The first includes separate dummy variables for each: the moratorium on New York City debt payments (*NYCDef* = 1 in September 26, 1975 and October 31, 1975, and 0 otherwise (see Municipal Assistance Corporation for the City of New York, 1976, p. 1129, and Gramlich, 1976), and impact dummies for the bankruptcies of Cleveland (*DCleve* = 1 in December 22, 1978, and 0 otherwise),[20] Orange County (*DOrange* = 1 in December 9. 1994, and 0 otherwise), Jefferson County (*DJefferson* = 1 in November 18, 2011, and 0 otherwise), and Detroit (*DDetroit* = 1 in December 6, 2013, and 0 otherwise).[21] The second approach includes *DNYC* and a dummy summing the other default dummies into one series, *MuniDefxNYC*,

Results from both approaches are similar, with similar estimated coefficients on the major variables and with estimated coefficients on the individual dummies bracketing the single point estimate using the second approach. The second approach is adopted as it is more parsimonious and better illustrates the important finding that isolated municipal defaults may temporarily affect the broader muni market, but do not really pose a systemic risk unlike a correlated shock such as the Covid-19 pandemic. The *X* vector, which also includes exogenous variables for events that affected the municipal bond market but not the macroeconomy. Of these potential events, we tested

[20] Cleveland's default occurred after markets closed on Friday, Dec. 15, 1978, which showed up more in the monthly average for January partly because of thin trading during the holiday-heavy second half of December and because the default was on bank loans and likely had a slightly lagging effect on the muni bond market.
[21] In the first week of December 2013, a court ruled that Detroit was eligible to file for bankruptcy under Chapter 9.

dummies for the bankruptcies of Cleveland, Detroit, Jefferson County, and Orange County. However, none were significant for modeling the muni-Treasury spread using the GO-20 index but were jointly significant for the spread using Moody's Baa-rated yield.[22] Apparently the size of these entities' debt and the indicator properties of their credit quality lacked importance to affect the top tier-rated debt covered by the GO-20 index. Reflecting that each muni shock variable tracks a development associated with higher default or liquidity risk, positive coefficients are expected.

In addition to dummies for isolated municipal defaults, another shock variable include a dummy variable for the passage of multi-year tax cuts in 1981 (*TaxCut81Pass* = 1 week of August 14, 1981, otherwise) which occurred well ahead of three phased in cuts in marginal federal income tax rates that would lower the after-tax returns on muni relative to Treasury bonds. Another tax expectation dummy variable controls for the prospect of a large cut in federal income tax rates following the November 2016 election of President Trump. Different tax proposals were being floated, one of which occurred in late November and early December and was for a much larger cut in marginal income tax rates than was eventually passed. This proposal quickly fell from favor the next week. This speculation caused a large 40-50 b.p. rise in the muni spread in the week ending December 2, 2016 which reversed the next week. To control for this unusual expectation-related spike in muni spreads, *PotTaxCut2016*, equals 1 in the week of December 2, 2016, -1 in the week ending December 9, 2016, and 0 otherwise. It's coefficient is expected to be positive as the expectation of a large tax cut would widen the muni spread notably and well ahead of the prospective tax rate reduction.

[22] These impact dummies covered the bankruptcies of Cleveland (*DCleve* = 1 in January 2020 in monthly models or December 22, 1978 in weekly models, and 0 otherwise),[22] Orange County (*DOrange* = 1 in December 1994 in monthly models or December 9. 1994 in weekly models, and 0 otherwise), Jefferson County (*DJefferson* = 1 in November 2011 in monthly models or November 18, 2011 in weekly models, and 0 otherwise), and Detroit (*DDetroit* = 1 in December 2013 in monthly models or December 6, 2013 in weekly models, and 0 otherwise.

5. Empirical Results

Given the short post-Covid sample, using high frequency weekly data has the advantage of helping identify the effects of the pandemic and Fed interventions into the municipal bond market. Results from estimating weekly models of the tax-adjusted GO-20 spread through March 20, 2020—prior to the late March passage of the CARES Act—and December 31, 2021 are reported in Table 1. The long-run results of modeling the level of the muni spread are shown in the upper panel and short-run results for modeling the changes in the spread are reported in the lower panel. Lag lengths on the first difference terms in the short run section of each model (11 to 13 weekly lags) were selected to minimize the Schwartz Information Criterion among lag lengths that yield serially uncorrelated errors in the first difference model (eq. (4b)).

The models in Table 1 are organized as follows. Models 1 and 2 are estimated over a pre-CARES Act sample ending March 20, 2020) and respectively exclude and include the municipal shock variables in the vector X. Recall that the CARES Act, which was passed on March 27, 2020, permitted the Fed and the Treasury to create the MLF, whose creation was not announced until April 9. Models 3 and 4 respectively correspond to Models 1 and 4 except that they are estimated over a sample ending in the last full business week of 2021 (Dec. 25). Models 5 and 6 respectively correspond to Models 3 and 4 except that they replace the squared unemployment gap ($UGap^2$) with the squared MLF-adjusted unemployment rate ($UGapMLF^2$).

5.1 Estimates of Long-Run Relationships, Comparing MLF-adjusted and unadjusted Models

As shown in the upper-panel of Table 1, the estimates for the long-run relationships favor accounting for the MLF. For all of the models, significant and unique long-run cointegrating relationships are found among the variables in levels (we use Johansen's (1995) method) and both long-run unemployment gap and CFMA variables are statistically significant with the expected

positive signs. However, the estimated long-run (equilibrium) effects of these two important drivers of the muni spread are nearly identical for the corresponding pre-CARES Models 1 and 2 and the full sample Models 5 and 6 that account for the MLF. For example, the coefficient on the squared unemployment gap is in a range between .0520 and .0582 across these 4 models. In contrast, this coefficient ranges between .0280 and 0.0773 across the two pre-CARES Act and two nonMLF adjusted full sample models (1-4).

While differences between the unemployment gap coefficients are not statistically significant, the differences are visible, and hint at misspecification. The estimated long-run relationships from the better specified models 5 and 6 imply the importance of accounting for the impact of the MLF. This can be illustrated in Figures 6 and 7 with the estimated equilibrium long-run spreads from Model 6 using the unemployment gap adjusted for the MLF and a counterfactual using the unadjusted gap. The equilibrium implied by the MLF-adjusted unemployment gap is much more in line with the actual spread than the counterfactual equilibrium constructed from an unemployment gap that does not account for the MLF.

5.2 Estimates of Short-Run Relationships, Comparing MLF-adjusted and unadjusted Models

As reported in the lower-panel of Table 1, the evidence from the short-run models of the change in the muni spread also favors controlling for the MLF. For the pre-CARES Models 1 and 2 and for full sample Models 5 and 6 that account for the MLF, the error-correction terms are significant with the expected negative sign and imply the actual muni spread tends to change to close the gap between it and its equilibrium level by about 1 percent per week or by about 40 percent per year. In the full sample models that ignore the MLF (Models 3 and 4), the speed of adjustment is slower than in the pre-CARES sample, dropping to about 30 percent per year which is notable as this arises adding just two years to the end of a 50-year sample period. While the

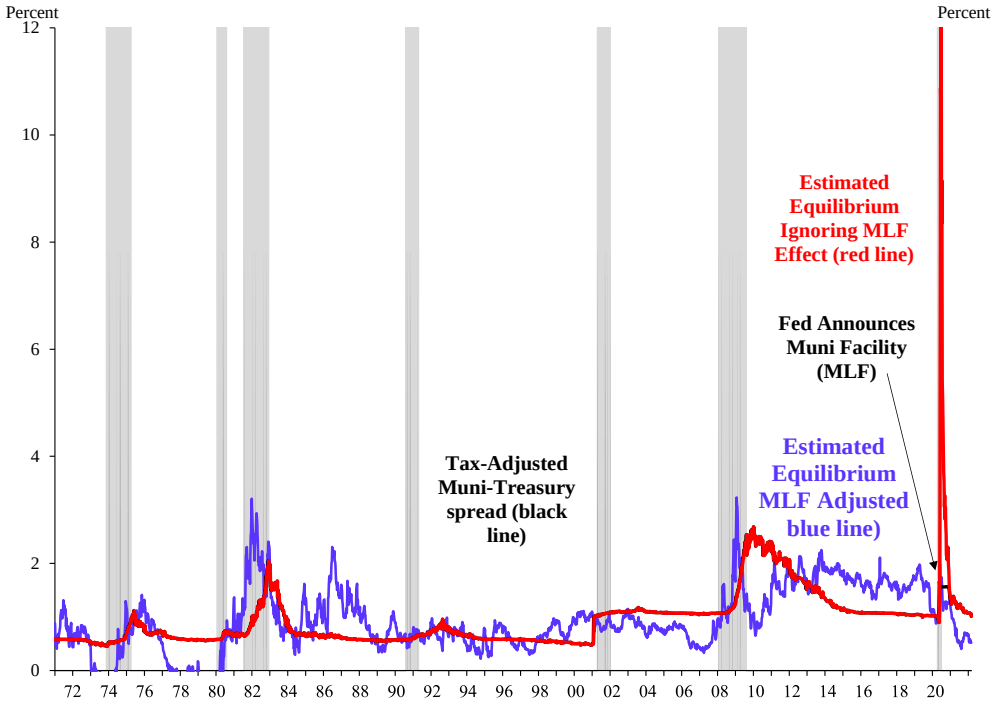


Figure 6: Equilibrium Spreads Track Muni-Treasury Spread Trends until March 2020
(NBER recessions are shaded. Sources: Department of Labor, BLS, Bond-Buyer, Federal Reserve, and authors' calculations)

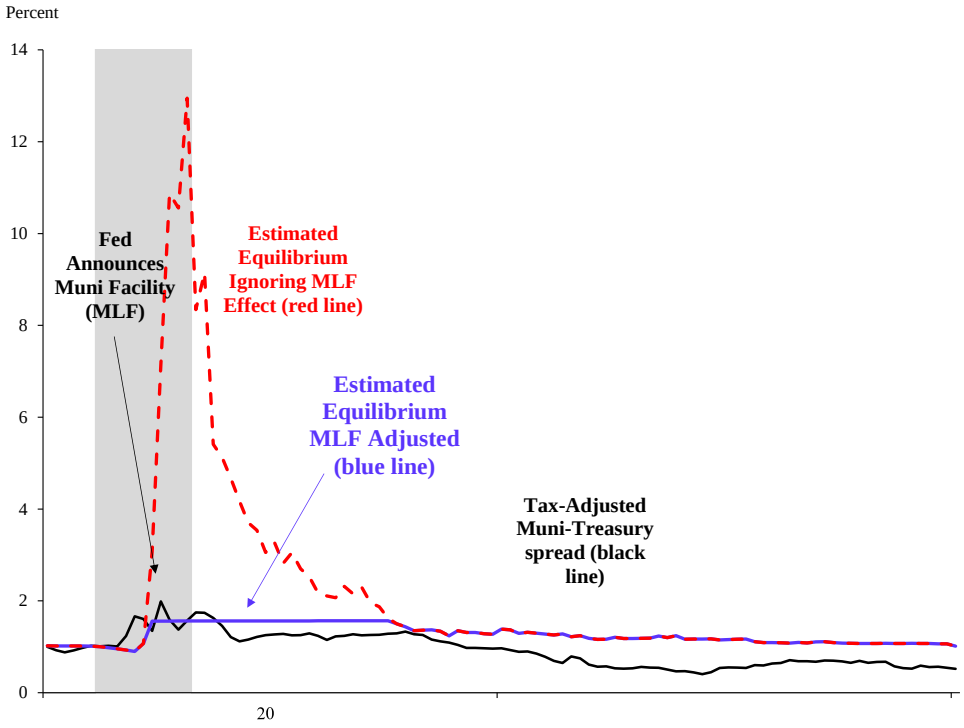


Figure 7: Equilibrium Spreads Track Actual Muni-Treasury Spreads until March 2020
(NBER recessions are shaded. Sources: Department of Labor, BLS, Bond-Buyer, Federal Reserve, and authors' calculations)

difference is statistically significant, the noticeable differences between corresponding models (3 vs. 5 and 4 vs. 6) imply that less information is being gleaned from divergences in actual from equilibrium levels of the muni spread as reflected in the slightly lower fits of nonMLF models relative to their corresponding MLF adjusted counterparts. A decline in the estimated speeds of adjustment from adding less than 2 years of sample to the nonMLF models hints at problems in those specification. More telling evidence of misspecification from the short-run models is the residuals are largely free from serial correlation for the pre-CARES Models 1 and 2 and for full sample Models 5 and 6 that account for the MLF, but not for the full sample models (3 and 4) that do not account for the MLF.

The patterns of long-run (muni spread levels) and short-run (changes in the muni spread) results imply that the full sample models (3 and 4) that do not adjust for the MLF are miss-specified. This is not surprising because the MLF was intended by the Fed and the Treasury to prevent the deepening of the Covid Recession from further amplifying the March widening of muni-Treasury yield spreads and from further disrupting the muni bond market.

5.3 The Effects of Muni Defaults and Expected Future Tax Cuts

Also reported in the lower-panel of Table 1 are the estimated impact of prominent—but isolated—municipal bond defaults and some controls for noticeable expectations effects surrounding major changes in tax policy that can affect the muni-Treasury spread. First, there is a statistically significant, albeit contained effect of the technical default of New York City, which elevated the national GO-20 muni Treasury spread by 19 – 20 basis points. These are smaller than estimates from an earlier NBER working paper version of the paper which analyzed the spread based on the average Baa-rated municipal bond yield, which has a lower rating than the typical A to Aa-rating of most state and local government debt that is covered by the G0-20 index. In

contrast, the dummies for defaults of 5 other, but less prominent, municalites were insignificant. Collectively, a dummy = 1 for a default in any one of them is marginally significant, with and estimated effect of only 7 basis points. This is evidence that isolated municipal defaults tend not to pose systemic risk, unlike instances when many state and local public entities are in distress. It is plausible that the latter, more systemic risk, is largely tracked by the unemployment gap variable.

5.4 Assessing Covid and Fed Muni Market Intervention Effects on the Muni Spread

The above results and figures strongly suggest that the Fed's announced intervention into the muni bond market notably affected the muni spread by preventing further increases in the unemployment rate from further elevating municipal bond interest rates after early April 2020. To gauge the effects of the MLF, we use coefficients from full-sample, MLF-adjusted Model 6 to trace out the equilibrium spread implied by the long-run coefficients and compare that to the equilibrium spread that instead replaces the MLF-adjusted unemployment gap with the unadjusted version of that variable. As illustrated in Figure 8, the resulting difference between the equilibrium and counterfactual equilibrium implies that the equilibrium muni spread would have risen further in the absence of the MLF, with the difference peaking by a notable 11.4 percentage points in the business week ending April 24, 2020 and by a monthly average of 8.8 percentage points.

5.4 Possible Impact of Muni Market Intervention on State and Local Government Spending

To our knowledge, there are no available, published econometric models that can gauge the interest rate impact of the MLF on spending by state and local governments, let alone the MLF's indirect spending effects via reducing uncertainty and credit constraints facing these public entities.[23] Nevertheless, while balance budget requirements limit most municipal debt to finance long-term capital projects, interest payments on such debt are a current expense and limit

[23] Haughwout, Hyman, and Shacher (2021) find that the MLF helped limit declines in public employment.

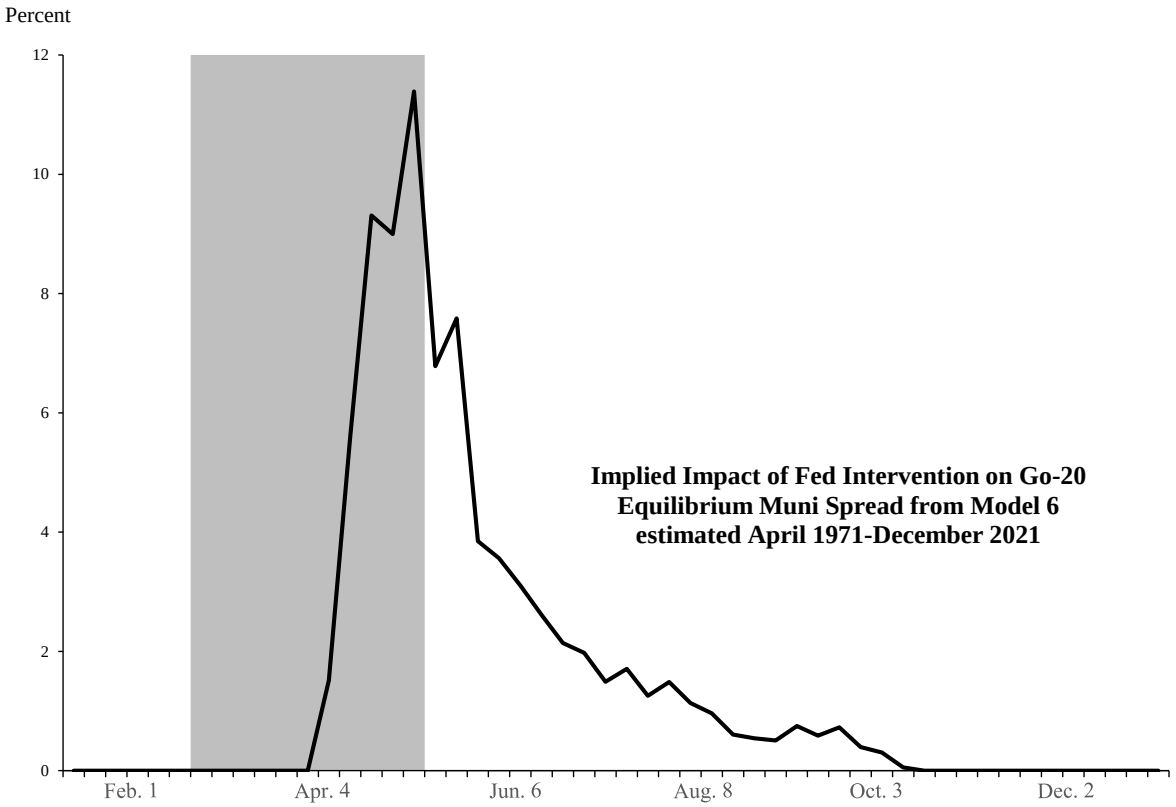


Figure 8: Weekly Model Estimates Suggest a Substantial Effect of the Announced Fed Intervention on the Municipal-Treasury Spread in 2020
(NBER recessions are shaded. Sources: Moody's, Federal Reserve, and authors' calculations)

nonfederal government purchases of goods and services—especially in a deep recession. This implies that debt service savings from lower interest costs on normal annual borrowing can cushion state and local government spending on final goods.

Model estimates indicate that the announcement of the MLF lowered municipal bond yields by around 4 ½ percentage points in the second quarter of 2020, and by an average of about 3 percentage points from April to September 2020. Municipal bond debt outstanding is about $3.1 trillion, with issuance of about 1/8 of that per annum or roughly $400 billion a year. This translates into $12 billion in annual interest rate savings or 0.05 percent of GDP. This figure does not include the effects of the MLF on increasing the short-term ability of nonfederal governments

to issue tax anticipation notes to avoid sharp, near-term reductions in spending during the second and third quarters. These potential effects on state and local consumption expenditures also appear to be modest. In the first quarter of 2020, short-term muni issuance was only $670 million less than in the first quarter of 2019, while quarterly issuance since the MLF was announced exceeded year-ago quarterly levels by $1.8 and $3.5 billion in the second and third quarters, respectively. These figures may understate the overall effect of the MLF as they likely omit some long-term investment projects that would have

otherwise been cancelled had the MLF not been created to help restore normal market conditions.[24]

Although the MLF was not designed to directly support investment by the nonfederal public sector, its impact as a backstop may have indirectly done so. Just before the MLF was announced, long-term muni bond issuance fell in March 2020 from its February pace and was about 30 percent below its March 2019 levels. Then, long-term issuance surged, outpacing its 2019 rates by $13.0 billion and $30.4 billion in the second and third quarters of 2020, respectively. These amounts are close to the $14 to $20 billion quarterly savings in debt service from lower interest rates, though they may reflect some greater issuance induced by lower interest rates. These figures imply that the potential effect on state and local government investment expenditures could have been more notable than those on nonfederal government spending on consumption items.

Nevertheless, the impact on investment spending of the MLF may have been greater to the extent that it prevented declines in gross issuance that could have otherwise occurred. On the other hand, much of the second and third quarter issuance likely reflected refinancing of long-term debt and to that extent did not boost state and local government spending in the middle quarters of 2020.

[24] To address its budget crisis in the mid-1970s and to repay its creditors and restore access to bond financing, New York City not only cut spending on services that had contributed much to its earlier deficits, but also cut long-run infrastructure projects (see Ferretti, 1974, and Reagan, 2017) that hurt its long-run economic growth.

It seems plausible that the overall effect of the MLF on state and local government spending likely bolstered those expenditures by about 0.1 percentage points through interest rate saving effects on current purchases plus a small multiple of that by preventing tighter liquidity constraints on these public entities. In sum, a plausible 0.1 to 0.3 percentage point macro effect of the MLF on state and local government purchases of final goods (coupled with a government spending multiplier of near unity) seems more modest than the 1 to 1 ¼ percentage point beneficial effect on GDP of the Fed's corporate facilities calculated by Bordo and Duca (forthcoming).[25] Nevertheless, the contribution of the MLF may be understated as it could omit some infrastructure project cancellations that the creation of the MLF may have prevented.

6. Conclusion

In early April 2020, it was becoming more difficult for state and local governments to issue debt, evidenced in rapidly widening muni spreads and sharply lower municipal bond issuance in March compared with both February 2020 and its year-ago pace. The Fed's April 9th announcement of a future muni bond buying program through creation of the Municipal Liquidity Facility stopped spreads from further rising, triggering an ebbing of spreads and a sharp revival of muni bond issuance. Other studies more focused on identification, document how the announcement of the MLF had pronounced impact effects on muni spreads of those municipalities that were eligible versus ineligible for MLF support (notably, Haughwout, Hyman, and Shacher, 2021). Our time series study complements such micro-studies by quantifying how the MLF prevented a worsening economy from further amplifying the widening of muni spreads.

[25] It is difficult to assess the relative local impact of the backstop effects of these programs which are harder to pinpoint than the impact of direct lending which has been very modest so far given limited take-up by borrowers.

Analysis of a half-century of weekly bond yield data indicates that the MLF kept municipal bond rates from rising by an average of nearly 9 percentage points further for April 2020 as a whole and by an average of 3 percentage points over the second and third quartes of 2020. That these effects occurred far in advance of the opening of the MLF and given the very modest borrowing by municipal entities at the MLF together imply that the announcement of this new facility had a pronounced and rapid backstop effect. These results along with others imply that there was systemic risk in the muni bond market in the Covid-19 pandemic, that was not the case for the isolated, but prominent, muni defaults in the prior half century.

In so doing, the MLF prevented the deepening of the Covid-19 Recession from further pushing up muni rates and amplifying the downturn. From this perspective, the MLF has been very successful, much like the Money Market Municipal Liquidity Facility that helped stabilize short-term funding sources for municipal governments (Wei and Yue, 2020b). Such effects occurred well before the announcement effects of successful vaccine trials lowered spreads in November and December 2020. Nevertheless, the net effects of the MLF (and MMMLF) on state and local government purchases of final product appear to be modest in absolute terms and relative to estimates of the cushioning effects of the Fed's corporate bond programs, which are more notable.

For at least two reasons, the net impact of the MLF may not be as positive as the upfront benefits may suggest. First, its creation may have lessened pressure on the Congress to provide federal fiscal relief to state and local governments. Second, the precedent set by the MLF may create moral hazard that induces municipal authorities to worry less about downside tail effects. For example, the precedent of the MLF could reduce the incentives for many states to build up "rainy day" surpluses that could be used to bolster muni spending and avoid tax hikes. Evidence from other countries suggests that moral hazard could be a problem. Notable examples are

Argentina and Brazil, where excess borrowing by state governments has been bailed out by the national government that later was forced to default (Bordo, Jonung and Markiewicz, 2011).[26] To restore market forces as the primary determinant of muni rates and the allocation of finance to the nonfederal public sector it was important to close the MLF. Partly on this concern and amid signs that developments were inducing muni spreads to further move toward pre-pandemic levels,[27] the Treasury ended the MLF near yearend 2020.

In sum, the net benefit of the MLF will depend on whether it was correctly unwound and the extent of any moral hazard effects that it induces relative to the notable benefits of stopping a municipal liquidity crisis in the spring of 2020 and capping muni spreads.

[26] On the other hand, one could point to the successful example of the U.S. federal government's assumption of the revolutionary war debt issued by states (Sargent, 2020) which was for a national purpose, and argue that in the Covid pandemic, state and local governments have de facto borne the burden of a national emergency.

[27] Since December, muni spreads subsided for several plausible reasons. First, 2020 municipal budget shortfalls were smaller than forecasted in the spring of 2020, when most forecasters predicted larger declines in the national economy than had later occurred. Other factors included increased optimism related to the approval of new vaccines as well as increased prospects for further federal fiscal aid to state and local governments and for potential changes to the federal tax code that could enhance the value of the tax exemption on most municipal bond interest income.

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Table 1: Half-Century Weekly Models of the GO-20 Muni-Treasury Spread, 1971-2021

Sample:	**April 21, '71 - Mar. 20, '20**		**April 21, 1971 – Dec. 31, 2021**			
	Pre-CARES/MLF Models		**Using $UGap^2$**		**Using $UGapMLF^2$**	
Model No.	1	2	3	4	5	6
Long-Run Equilibrium: $MuniTR^*_t = \alpha_0 + \alpha_1 UGap_t^2 + \alpha_2 CFMA_t$						
Constant	0.6055	0.6050	0.4896	0.4926	0.5810	0.5809
$UGap_t^2$	0.0528*	0.0520*	0.0280**	0.0773**	0.0582**	0.0557**
	(2.59)	(2.56)	(5.68)	(3.65)	(2.88)	(2.82)
$CFMA_t$	0.4830*	0.4896*	0.4896+	0.4637+	0.4748*	0.4908*
	(2.02)	(2.06)	(1.73)	(1.86)	(2.04)	(2.16)
unique coint.	Yes*	Yes*	Yes*	Yes*	Yes*	Yes*
vec. # lags	11	12	12	12	11	11
trace no vec.	29.86*	30.58*	31.90*	32.99*	30.83*	32.09*
trace only 1	9.63	10.26	10.40	10.88	9.19	9.76
Short-Run: $\Delta MuniTR_t = \beta_0 + \beta_1 EC_{t-1} + \sum^n_{i=1} \beta_{2i} \Delta MuniTR_{t-i} + \sum^n_{i=1} \beta_{3i} \Delta UR_{t-i}^2 + \sum^n_{i=1} \beta_{4i} \Delta CFMA_t + \Omega X_t + \mu_t$						
$EC_{t-1,}$	-0.010**	-0.011**	-0.007*	-0.008*	-0.009*	-0.010*
	(2.87)	(3.12)	(2.31)	(2.47)	(2.74)	(2.90)
ann. adjustment speed:	41%	43%	31%	33%	39%	40%
$\Delta MuniTR_{t-1}$	0.117**	0.121**	0.113**	0.120**	0.115**	0.122**
	(5.83)	(6.17)	(5.73)	(6.20)	(5.82)	(6.29)
$\Delta UGap_{t-i}^2$	-0.008*	-0.001*	-0.005+	-0.006*	-0.007*	-0.007*
	(2.39)	(2.33)	(1.91)	(2.03)	(2.14)	(2.26)
$\Delta CFMA_{t-1}$	-0.074	-0.077	-0.074	-0.074	-0.074	-0.074
	(0.82)	(0.86)	(0.83)	(0.85)	(0.83)	(0.85)
Constant	0.000	-0.000	0.000	-0.000	0.001	-0.000
	(0.22)	(0.11)	(0.13)	(0.07)	(0.07)	(0.28)
NYCDef		0.196**		0.194**		0.195**
		(3.11)		(3.11)		(3.13)
$MuniDefxNYC_t$		0.076+		0.077+		0.077+
		(1.71)		(1.74)		(1.75)
$TaxCut81Pass_t$		0.613**		0.613**		0.614**
		(6.88)		(6.95)		(6.98)

PotTaxCut2016$_t$		0.442**		0.443**		0.442**
		(7.03)		(7.11)		(7.11)
DCovid$_t$		0.236**	0.239**	0.239**	0.236**	0.236**
		(2.66)	(2.66)	(2.72)	(2.64)	(2.70)
DCovid$_{t-1}$		0.397**	0.402**	0.399**	0.399*	0.397*
		(4.47)	(5.85)	(4.53)	(4.45)	(4.52)
DCovid$_{t-2}$		-0.097	-0.093	-0.097	0.092	0.096
		(1.08)	(1.03)	(1.09)	(1.03)	(1.09)
DCovid$_{t-3}$			0.222*	-0.221*	-0.216*	-0.214*
			(2.45)	(2.49)	(2.38)	(2.42)
Adj. R^2	0.037	0.084	0.073	0.110	0.078	0.114
S.E.	0.091	0.089	0.090	0.088	0.089	0.088
VEC Auto (1)	15.72	13.95	79.73**	55.77**	14.12	8.34
VEC Auto (2)	8.18	9.78	74.37**	70.95**	6.94	5.14
VEC Auto (4)	5.95	5.09	18.12*	15.82^{+}	5.57	4.47

Notes: Absolute t-statistics are in parentheses. ** (*) denoted significant at the 99% (95%) confidence level. (i) Coefficients for the UR^2 terms are multiplied by (1 – *Muni*) in models 3-4. (ii) Absolute t-statistics in parentheses. (iii) Long-run: Maximum likelihood estimates of the long-run equilibrium relationship using a two-equation system with at most one cointegrating vector. (iv) EC_{t-1} = $MuniTR_{t-1} - \alpha_0 + \alpha_1 UR_{t-1}^2 + \alpha_2 CFMA_{t-1}$. (v) First difference terms of elements in the long-run cointegrating vector. (vi) Lag lengths chosen to minimize the SIC criterion. (vii) significance of the trace and VEC Auto statistics reflects lag length. (viii) Coefficients and t-statistics on Covid dummy lags longer than 3 weeks omitted to conserve space).

Appendix A: The Muni Bond Market in the Great Depression

This appendix reviews the main developments affecting muni spreads, volumes, and issuance in the Great Depression.[28] As noted by Wigmore (1985, pp. 110-11), before the Great Crash of 1929, muni bonds were considered very safe (all but two states had Aaa-ratings and all major cities were rated Aaa), and this segment of the overall bond market was large; indeed, the volume of existing muni bonds was nearly the size of outstanding Treasuries and was about 50 percent larger than the amount of outstanding non-railroad corporate bonds, as well as of that of utility bonds and also railroad bonds. In the few weeks immediately following the October 1929 Crash, muni yields fell reflecting their earlier, highly safe reputation.

But by yearend many cities' financial condition weakened and could not issue bonds nor could they speed up—let alone sustain—their planned capital projects for 1930 as President Hoover had requested (Wigmore (1985, p. 111). Muni spreads widened near yearend 1929. In 1930 there had been some recovery in the overall muni market despite defaults by Miami and several municipal entities in Florida. But by late 1931, a number of states and cities were once again unable to issue bonds and began cutting expenditures (Wigmore (1985, p. 290-91). Reflected in increases in muni spreads (particularly for lower rated securities), pressures on state and local budgets intensified in 1932, when many municipal governments were downgraded, had difficulty issuing bonds—some turning to bank loans as a substitute, and greatly cut spending (Wigmore, 1985, pp. 400-09).

[28] Aside from the wave of municipal defaults in the 1840s, there were many defaults in the slump of the 1870s when about one-quarter of municipal debt was in default. Defaults were concentrated in railroad bonds, particularly in the South and to a lesser extent, in the Midwest (Advisory Commission on Intergovernmental Relations, 1973, p. 11). According to the same source, another wave occurred in the downturn of the 1890s, which was not as large. and which included more general obligation debt and was not as concentrated in railroad debt.

To limit further cuts by state and local governments (whose combined expenditures were twice those of the federal government in 1932), Congress authorized the Reconstruction Finance Corporation (RFC) in mid-1932 to make loans to state and local governments to fund both capital projects and current spending. Nevertheless, conditions worsened in the first half of 1933 with several more state and local governments defaulting (e.g., Arkansas, Detroit, and Cook County (home to Chicago) or being unable to issue debt (particularly Southern states), and many cutting spending (especially on investment) amid further declines in revenues which amplified increases in debt service burdens. Between 1929 and 1933, 33 of the 48 states had seen their bond ratings downgraded.[29] In contrast, the federal government was much better able to debt-finance spending. Partly in response, Congress funded transfers from the Roosevelt-run federal government to fund state and local government spending and the RFC greatly expanded lending to fund construction projects, such as the Golden Gate Bridge in San Francisco and the Lincoln Tunnel in New York City (Wigmore, 1985, pp. 511-17).

Between these measures and other steps to stimulate the macroeconomy, muni market conditions improved by the end of 1933 and into 1934, which allowed some better rated state and local governments the opportunity to refinance older, higher yield bonds and helped support a rebound in real investment by state and local governments in 1934 (see Figure 2 in the main text). The rebound is particularly evident in the annual pace of bond issuance by state and local governments for funding capital projects (Table A-1), especially when deflated by the investment spending price index for state and local governments.

[29] Sources: Table A-11 from Wigmore (1985, pp. 598-99) who derived his figures from annual Moody's Governments Manuals. The 33 downgraded states include Florida, which defaulted in 1930 losing its bond rating and erasing its debt. Of the 15 states not downgraded, 7 maintained their Aaa debt rating from 1929 to 1933 and had outstanding debt in 1933; one had no debt outstanding between 1929 and 1933 and no rating; 3 had debt outstanding but no rating in 1933, while not seeing a change in their Aaa rating between 1929 and 1932; and 5 had eliminated their debt between 1929 and 1933 and had not seen their Aaa rating in 1929 downgraded between 1929 and 1933.

One lesson from the Great Depression is that distress in the municipal bond market affects the spending of more than just entities that declare default. Indeed, only one state (Arkansas) out of 48 defaulted between 1929 and 1933,[30] but many states had cut spending partly in response to being unable to issue municipal debt either at reasonable interest rates and several states sought federal aid to fund their spending (e.g., see Wigmore 1985, pp. 400-09). This is not to say that defaults did not directly result in spending cuts by bankrupt municipalities. There were about 4,800 state and municipal government entities that defaulted on principal or interest payments during the Great Depression (1929-37), including many cities and towns, capital and water-related improvement districts, school districts, and counties as reported by Joffe (2013, see p. 68 for a tabulation between 1920 and 1939). Nevertheless, the amount of municipal debt affected by defaults in the Great Depression ($2.5 billion cumulative, Hempel (1964) was a fraction of

Year	Nominal State & Local Government Bond Issuance for Capital Projects, billions	Real State & Local Government Bond Issuance for Capital Projects, $2012 billions
1928	1.33	n.a.
1929	1.42	24.90
1930	1.43	26.73
1931	1.24	25.65
1932	0.76	19.43
1933	0.48	10.82
1934	0.80	15.49
1935	0.86	17.15
1936	0.74	13.64
1937	0.73	13.22

Table A-1 State and Local Municipal Bond Issuance to Fund Capital Projects
(Sources: Wigmore (1985, Appendix Table A-27), BEA, and author's calculations)

Appendix B: Major Post-WWII Defaults by Local Governments and Their Impact

[30] Arkansas's default owing, in large part, to high borrowing before the Great Depression (Joffe, 2012).?

outstanding municipal debt and of the declines in state and local spending. This too implies that reduced or more costly access of non-defaulting state and local governments to the municipal bond market could induce lower spending.

This appendix provided details on the factors driving several notable defaults by local governments in the last half century and discusses the short-run costs and disruption from these governments adjusting their budgets in a sharp and sudden way.

I. Major Post-WWII Episodes of Municipal Defaults

There have been six noteworthy defaults of local governments since 1975[31], one on bank loans (Cleveland, 1978) and five on bonds: New York City (1975), Orange County (California, in 1994), Jefferson County (Louisiana in 2011), Detroit (2013), and Puerto Rico (2016). Five of these cases (Orange County being the exception) plausibly fit Winegarden's (2014, p. 6) characterization that, "Typically, those municipalities that are pushed into insolvency by an economic shock have been stagnating economically for a long time."

Although **New York City** did not declare bankruptcy and eventually paid its bond holders in full, New York City technically defaulted in 1975 when it did not make timely payments to its bond holders. The city's default stemmed from several factors (see Greenspan, MacAvoy, and Malkiel, 1975). First, the city's spending was unsustainable given its tax base whose long-run growth suffered from shifts in economic activity to lower cost metropolitan areas and higher income residents to outlying suburbs. Second, this imbalance was compounded by the city amassing increasing amounts of short-run debt to mask and fund a series of budget deficits. Third, the unsustainability of spending and borrowing practices became apparent to bond investors, who demanded higher risk premiums on the city's debt. Higher service costs, especially on short-run

[31] Between the Great Depression and 1975, the only major municipal default was that by New York City's Urban Development Corporation in 1974 (see Moody's, 2017).

debt, further worsened its imbalances and the city lost access to both bond issuance and bank loans. The state of New York stepped in to provide temporary funding and put the management of the city's budget under the auspices of the Municipal Assistance Corporation, which mandated a series of deep cuts to city spending and some tax hikes to bring the city's budget into long-run balance.

Cleveland's default in 1978 was lesser known, partly because of its size but also because the city defaulted on bank loans rather than bonds. After the city's tax base and population was hurt by negative short- and long-run shocks to its manufacturing-oriented economy in the 1970s, Cleveland lost its ability to fund its prior spending path. In the short run, the city borrowed from local banks to fund deficits. In late 1978, its mayor and city council could not agree on selling a utility to cover some of its short-run imbalances and on spending cuts and tax increases to address its longer-run budget problems. At that point, when local banks refused to roll-over the city's maturing short-run bank loans, the city declared bankruptcy and was put under the financial supervision of the state of Ohio. The next mayor and city council agreed to spending cuts and tax increases that restored budget balance and the city emerged from bankruptcy in late 1980.

Orange County, California, declared bankruptcy after the municipality's county investment pool suffered a large loss (over $1.5 billion) on interest rate exposures that had generated enough interest income to cover 12 percent of county expenditures in 1994, above the 3 percent average for all other California counties that year (Orange County Grand Jury Report, 2013, p. 1). However, the risks entailed were not appreciated or understood by local leaders and "circumvented" the fiduciary responsibilities of the county investment pool (Orange County Grand Jury Report, 2013, p. 1). When interest rates rose quickly following the slow recovery from the moderate-sized recession of the early 1990s, Orange County suffered losses for which it was

unprepared. This example highlights how financial innovations have given rise to new, less visible downside risks to holders of municipal and other bonds. While the short-run adjustment was notable, this affluent county recovered, largely because its default did not partially arise from a failure to adjust to a downshift in long-run economic prospects.

Detroit missed a scheduled debt payment in June 2013 and the next month filed to declare bankruptcy. This followed a long period of decline in the city's population and auto-oriented manufacturing base, which left it with a municipal workforce and pension liabilities more suited for its earlier, larger population. The impact of this long downtrend on the city's solvency was, according to Winegarden (2014, p. 8) exacerbated by financial mismanagement and an overhang of unfunded retiree benefits. In November 2014, Detroit emerged from bankruptcy after it was able to cut its debt load and cut pension benefits, as well as cut current spending and raise revenues.

Jefferson County, Alabama's bankruptcy stemmed, in large part, not from unfunded pensions, but rather from the debt burden of repairing and improving its sewer system to meet previously neglected federal mandates. According to Winegarden (2014, pp. 14-15), these costs were amplified by corruption and financial mismanagement. The latter included a high reliance on variable rate and short-term debt that repriced upwards when the county's debt rating was downgraded during the subprime and global financial crisis. The county filed for bankruptcy in November 2011 and emerged from it two years later when it issued new debt.

The default of the U.S. territory **Puerto Rico** in July 2016 ended a drawn-out fiscal crisis, reflecting unsustainable budgeting practices and the long-run relative decline of the territory's economy (see Yglesias, 2016). Compounding these structural ailments were the impact of two severe hurricanes that damaged the island when the local government lacked access to tax revenues and debt finance. The number of public pronouncements and warnings that predated its 2016

default also make it difficult to pinpoint discernible short-run effects on the muni market in general. As a result, it is difficult to discern any impact of Puerto Rico's default the timing of shocks and expectations to muni spreads in contrast to the more unexpected defaults of other municipalities.

II. Some Real Consequences of Financial Distress on Municipal Governments

This section reviews some evidence on the impact of sudden cuts in spending by state and local governments in response to episodes of default and acute financial distress. The focus is not on the size of the public sector which needs to be sustainable in the long-run, but rather on the cost of sudden spending cuts and tax hikes to address fiscal imbalances that may stem from poor budgeting (e.g., New York City in the mid-1970s), fiscal uncertainties from unexpected economic shocks (e.g., oil busts or the Covid-19 pandemic), or combinations of the two (e.g., Detroit, 2013).

Four noteworthy cases of post-WWII defaults of municipal governments include those of New York City (1975), Cleveland (1978), Jefferson County (2011), and Detroit (2013) whose size and structural problems has made analysis more feasible than the defaults of more well-off municipalities (Orange county) or revenue bonds issuers (e.g., Washington Public Power Supply System Projects 4 and 5). The impact on Puerto Rico is not reviewed here given its more recent occurrence and the difficulties in distinguishing between the impacts of spending cuts from those of the hurricanes and earthquakes that have hurt the island.

The social and economic costs entailed by default are considerable in several dimensions. For one, debt costs usually rise as investors demand higher risk premia and municipality bond ratings are often lowered. In cases of outright bankruptcy, municipalities can incur large legal expenses, amounting to $178 million in the case of Detroit (Reuters, 2014). These costs cut into funds available for city services and capital expenditures, such as in the case of New York City (Reagan, 2017). Second, spending cuts can impair public infrastructure as in the cases of New

York (Reagan, 2017) and Jefferson County—where street repaving was even suspended (Braun, 2020). Third, cuts to social services can be dire. In the case of Jefferson County, 1,300 public employees were fired, hospital services were cut, courthouses were closed, and even a new jail could not be staffed (Braun, 2020). As noted by Freudenberg, et al. (2006), cuts in public health spending hurt efforts to address drug addiction and even contributed to an outbreak of tuberculosis in New York City. Furthermore, there were sizable reductions in the city's police force (Corman and Mocan (2006, p. 588) of about 25 percent between 1974 and 1980, whose size negatively affects burglaries and robberies (Corman and Mocan, 2006). While many—but not all—of the spending cuts were eventually reversed, Freudenberg, et al. (2006), estimate that the economic costs ($50 billion) outweighed the short-run budgetary savings ($10 billion) of the cuts enacted.

Aside from the impact of direct cuts on municipal spending is the impact of budgetary uncertainty on how local governments perform. This issue is especially pertinent to the Covid-19 pandemic given the uncertainty about spending and revenues that the outbreak has posed for state and local governments. In a pre-Covid study, Lavertu and St. Clair (2018) find that unexpected revenue shortfalls for Ohio school districts lead to statistically significant declines in future student performance on math and reading exams, but that positive revenue surprises have much smaller effects. Plausible explanations include that when faced with revenue uncertainty, school districts preemptively reduce spending partly to build reserves to avoid more drastic and disruptive cuts, and that such precautionary cutbacks are also motivated by the incentive to head off ratings downgrades on debt or paying higher risk premiums on debt. Reminiscent of the classic adage, " be careful what you hope for," Lavertu and St. Clair (2018) ironically wrote, "More generally, we hope to see a growing body of research examining the impact of revenue uncertainty on service delivery." Clearly these public economists neither hoped for nor expected the tragedy of Covid.

While the Fed's Municipal Liquidity Facility has plausibly ameliorated revenue uncertainty from the Covid-19 Pandemic, municipal revenue uncertainty unfortunately abounds and will likely impair the ability of state and local governments to limit the human cost of the pandemic.

Appendix B: KPSS Stationarity Tests

(with time trend)

Weekly (January 8, 1971 – Dec. 31, 2021)

	Stationarity	***(bandwidth)***		***Stationarity***	***(bandwidth)***
GO20TR	0.3797**	(15.9)	Δ *GO20TR*	0.0263	(15.9)
UGap	0.3629**	(15.9)	Δ *UGap*	0.0176	(10.3)
$UGap^2$	0.2400**	(15.1)	Δ $UGap^2$	0.0074	(16.9)
UGapMLF	0.3888**	(16.0)	Δ *UGap*	0.0598	(1.98)
$UGapMLF^2$	0.3652**	(16.1)	Δ $UGap^2$	0.0535	(9.46)

Notes: +, * and ** denote 90%, 95% and 99% significance levels, respectively. Lag lengths for the KPSS stationarity tests are based on the Newey-West bandwidth selector using a Quadratic Spectral kernel for the spectral estimation method (see Hobijn, et al. 2004). The combination of a significant KPSS stationary test statistic on the level of a variable (rejecting that it is stationary) and a significant test statistic on its first difference (accepting it is stationary) is evidence against trend stationarity.