Federal Reserve Bank of Chicago

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September 3, 2021

WP 2021-14

https://doi.org/10.21033/wp-2021-14

# The Impact of Covid-19 Related Policy Responses on Municipal Debt Markets

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**Abstract**

Municipal (muni) bonds are an important source of funding for state and local governments. During the Covid-19 pandemic, muni debt markets became severely distressed. In response, the Federal Reserve established the Municipal Liquidity Facility (MLF). Meanwhile, Congress enacted extensive fiscal measures that included direct aid to cities and states. To understand whether and how these policies worked, we employ a state-level regression model to estimate the relative efficacy of monetary and fiscal policy interventions for the term structure of muni-Treasury yield spreads. We find that fiscal and monetary policy together reduced those spreads by as much as 245 basis points. Fiscal policy contributed twice as much as monetary policy to the notable decline in shorter-term muni-Treasury spreads. At longer maturities, the contribution of fiscal policy was at least three times as large as that of monetary policy, suggesting that it addressed fundamental credit concerns.

Keywords: Monetary Policy, Policy Effects, Stabilization, Bond Market, Security Markets, Government Bonds, Local Government Bonds

JEL codes: E50, G51, H74.

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# 1 Introduction

Municipal (muni) bonds are a key source of funding for state and local governments. The muni debt market is large (about $3.8 trillion of debt outstanding), mostly (more than 80%) rated investment grade (IG), and characterized by extremely low default rates. Starting in mid-March 2020, the muni market became severely strained: massive outflows from municipal bond mutual funds sparked fire-sales of muni securities, muni spreads to Treasuries peaked at about 450 basis points (bps), and issuance in primary market was close to zero for several weeks.[1]

As a result, the focus of investors quickly shifted to fundamental credit concerns as many municipalities were facing fast growing pandemic-related expenditures and drops in tax and other revenues. For the first time, the Federal Reserve (Fed) decided to intervene in muni debt markets by establishing the Municipal Liquidity Facility (MLF). Simultaneously, through the passage of the CARES Act on March 27, states and municipalities were due to receive over $200 billion in federal aid, while the scope and duration of unemployment benefits were being expanded significantly without affecting state unemployment accounts.

These policy interventions could be potentially very relevant for muni debt markets because, during budget crises, the inability to issue and refinance debt at low yields could cause growing deficits to become unsustainable. This could result in widespread credit rating downgrades and defaults as well as cuts in spending and/or increases in taxes, as most states have to balance budgets. This would deprive taxpayers of valuable services and disposable income during times of economic distress, and eventually even impede the economic recovery (Auerbach, et al., 2020). This could, in turn, negatively affect the U.S. economic outlook as state and local governments contribute almost 11 percent to GDP and 13 percent to total employment.

However, there has been a lot of disagreement about the role of monetary and fiscal policy in helping states and cities facing budget crises during the pandemic. Such disagreement is particularly evident among politicians but extends also to economists, as many argue that fiscal aid remains the better option, while some want the Fed to be a more active municipal lender, and others are adamant about the Fed providing just a backstop.[2] Such claims do not seem rooted in any empirical evidence on the relative efficacy of the two types of policy during municipal budget crises. Therefore,

[1] See Cipriani et al. (2020) for more details.

[2] See reports of the Congressional Oversight Commission on the MLF.

establishing a few basic "facts" on the effects of monetary and fiscal policies in muni debt market can be helpful.

To evaluate the impact of fiscal and monetary policy interventions on states' ability to continue to cover debt service, we estimate a simple panel regression model in which daily variations in states' muni bond yields are explained by high-frequency indicators summarizing economic and public health conditions, fiscal aid allocations to states, the Fed's MLF, and key changes in state-level policies. Then, using the model's estimates, we build counterfactuals showing the projected evolution of muni yields in the absence of either fiscal or monetary policy. A key insight of this exercise is that fiscal policy contributed twice as much as monetary policy to the notable decline in shorter-term muni-Treasury spreads. At longer maturities, the contribution of fiscal policy becomes three times as large as that of monetary policy.

Our empirical model distills each state's muni yields in factors that are common to all states and components that are state-specific (Grigoris, 2020), and allows us to capture effects that are more persistent than those estimated using event studies or regression discontinuity design. Specifically, over a period that spans from March 2, 2020 to May 5, 2021, we focus on general obligation bond yields of 20 states, at maturities from one to 30 years. These states account for approximately 80% of both aggregate U.S. GDP and trading activity in the secondary market for muni debt (Grigoris, 2020). Overall, our panel regression models significantly extend the scope and sample of the empirical analysis developed by Bernhardt, D'Amico, and Sordo Palacios (2020), which examined only the impact of the pandemic on Illinois muni yields.

Since we are dealing with a pandemic that spread extremely fast, creating human and economic damages at a speed rarely observed before, it is crucial to measure changes at a very high frequency. For this reason we use a new generation of indicators (see Chetty, Friedman, Hendren, Stepner, and the Opportunity Insights Team, 2020) that measure mobility patterns, macroeconomic outcomes, and Covid-19 related variables at a daily frequency. This is ideal for explaining financial variables, such as muni yields, whose changes quickly reflect forward looking information.

To assess the effects of fiscal policy interventions, we include the dates in which major relief bills were passed by Congress interacted with the amount of federal aid received by each state as a share of general own resources as in Auerbach et al. (2020). They show that there is a great deal of variation across states in the amount of aid

received, with the smallest states getting much more generous aid. We also control for enhanced unemployment benefits that are paid by the federal government and do not affect state unemployment accounts.

To assess the effects of monetary policy interventions, we include the dates of key Fed announcements about the MLF. Those announcements span from April 9, 2020, when the Fed established the MLF to support municipalities through the purchase of up to $500 billion of short-term notes, to August 11, 2020, when the interest rate spread charged at the facility was reduced. We also include the amount issued to the MLF on the day of issuance for the few entities that accessed the facility.

To capture state-level policies we adopt the typology of shutdown and reopening policies used by Gupta, Simon, and Wing (2020). Shutdown policies consist of emergency declarations, school and non-essential business closures, gatherings recommendations or restrictions, and stay-at-home orders. Our work measures key changes in those particular policies by using the date at which these mandates were in effect.

Our estimates suggest that fiscal and monetary policy interventions account for a cumulative reduction in the three-year muni-Treasury spread of about 165 and 75 basis points, respectively. At long maturities, fiscal policy becomes relatively more effective, indicating that its transmission mechanism worked in part through the credit-risk channel. In particular, fiscal aid that extended beyond 2020 (e.g., the American Rescue Plan and expanded unemployment benefits), has been perceived by investors as alleviating more fundamental credit concerns. Despite the actual MLF issuance being limited only to Illinois and the Metropolitan Transit Authority for a total of $6.6bn, the existence of the MLF met several objectives. First, lowering muni yields helped municipalities manage cash flow pressures from the pandemic. Second, the MLF provided a backstop, keeping liquidity in the market, and encouraged private investors to reengage in muni securities.

We also analyze whether results obtained using all 20 states vary based on states' characteristics such as, pre-pandemic fiscal risk, tax revenue losses due to the Covid-19 crisis, population density/degree of urbanization, and political partisanship. We find that the most interesting cut of the data is by fiscal risk. The results indicate that fiscal policy had a greater impact on relatively higher fiscal-risk states. This is because, for these states, fiscal policy's effects were larger in magnitude and also greater than those of monetary policy, whose effects were somewhat larger for states with higher credit ratings.

Overall, our results indicate that the MLF, amid a few important extensions to its eligibility criteria, has been a helpful addition to the Fed policy toolkit. However, our findings also suggest that, although the MLF should not be a substitute for fiscal policy, it could become more effective if some of its terms were less restrictive, for instance by being more similar to those offered to corporate borrowers. Despite fiscal policy not being targeted to improve financial market conditions, we find it had a larger and more persistent impact than the MLF on muni bond yields. But the cost of fiscal policy to taxpayers is much bigger than that of monetary policy. While the amount borrowed at the MLF totaled $6.6bn and most likely will be repaid by the borrowers, fiscal aid to states totaled at least $550bn.[3] However, the larger cost of fiscal interventions could also be justified by their more direct effect on the broader economy, which is not considered by our study.

To the best of our knowledge, there are only a few studies that consider the impact of the Covid-19 pandemic on muni debt markets and those studies are mostly focused on the MLF. In particular, none of the existing papers analyzes the relative and persistent efficacy of fiscal and monetary policy interventions for US states' borrowing costs.

First of all, our work builds and expands on Bernhardt, D'Amico, and Sordo Palacios (2020) by extending their analysis to 20 states (rather than just Illinois) and by considering each fiscal and monetary policy intervention jointly. Fritsch, Bagley, and Nee (2021), similarly to Bernhardt, D'Amico, and Sordo Palacios (2020), look at the immediate impact of monetary policy announcements on the aggregate AAA muni yield curve as well as how plans to borrow at the MLF impacted Illinois and New York MTA yields. Li and Lu (2020) consider the role of emergency state declarations in explaining new muni yields and issuance while controlling for Covid-related variables and key monetary policy announcements.

A paper closely related to our study is Bi and Marsh (2021), which uses transaction-level data to analyze the impact that fiscal and monetary policy announcements had on the liquidity and credit risk of muni bonds, between March and May 2020. Our analysis differs as it uses state-level data over a longer sample period to estimate the persistent and relative efficacy of a larger set of policies, implemented in 2020 and 2021. Further, in the case of fiscal policy interventions, we consider the specific amount of aid allocated to each state, as well as expanded unemployment benefits.

[3]By the end of July 2021, Illinois had already paid back about half of the outstanding loan.

Our work is also somewhat related to Bordo and Duca (2021), which uses a monthly (or weekly) time series model of the tax-adjusted yield spread between the Baa-rated muni bond and the 10-year Treasury bond, from 1960 to early 2020, to examine the effect of MLF announcements. We also use tax-adjusted muni spreads to Treasuries in our analysis, but we exploit the entire daily term-structure for each state, and we evaluate a variety of policy interventions. Haughwout, Hyman, and Schachar (2021) exploit the MLF eligibility criteria to derive the option value of accessing the facility. They find that eligible low-rated issuers experienced a much larger decline in muni yields in the secondary market and larger issuance in the primary market, even if they did not issue through the MLF. Finally, Li, O'Hara, and Zhou (2021) highlight the role of mutual fund fragility in the muni market and show that, unlike corporate bonds, yields on muni bonds held by mutual funds had a substantial premium due to potential run risk. The authors argue that this premium could be due to the lack of a secondary market facility for muni bonds.

The rest of the paper is organized as follows. In the next section, we summarize the policy interventions. Section 3 describes the data. Section 4 details our empirical strategy and baseline results including all 20 states. In section 5, we analyze state subgroups to better understand the drivers of our results. Section 6 presents some robustness checks and Section 7 offers concluding remarks.

# 2 Policy Interventions During the Pandemic

In this section, we review the fiscal policy (FP) and monetary policy (MP) interventions that are assessed in our model. To illustrate how conditions in muni debt markets evolved as various policy interventions were announced, Figure 1 plots the unadjusted three-year muni-Treasury spread for Illinois and Minnesota, which are at the opposite end of the credit risk spectrum, BBB– and AAA respectively. We also plot the spreads that became available to both states through the MLF.[4] The FP interventions are denoted by a solid line while MP interventions are denoted by dashed lines.

With the onset of the pandemic, muni bond spreads widened for both states with Illinois reaching above 450 bps and Minnesota around 220 bps. As announcements about support to states via FP and MP started coming out in late March, spreads

[4]The MLF spreads are plotted from the period the term sheet was announced until the program ended on December 31, 2020.

for higher rated states like Minnesota came down and stabilized around substantially lower levels. Meanwhile, those of lower rated states like Illinois experienced a short-lived decline before fundamental credit concerns intensified, leading spreads to widen again. It can be noted that only for lower rated states like Illinois the MLF's pricing was below market rates. Eventually, spreads for all states were below the MLF spread– that is, states could find cheaper funding in the private market. This occurred well before the reduction in MLF spreads in mid-May 2020.

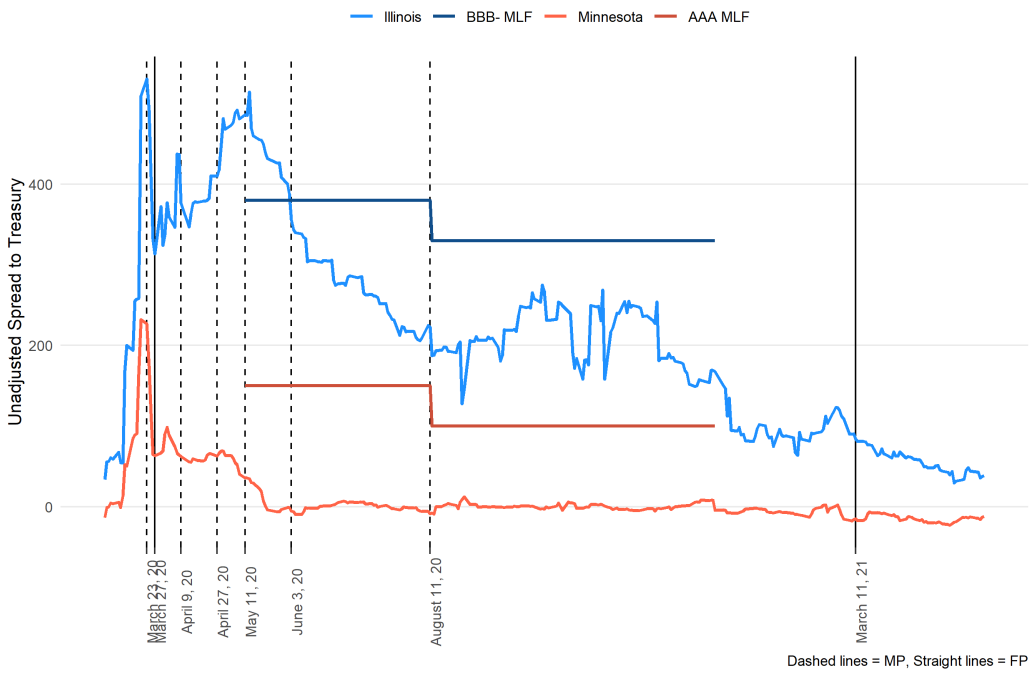


Figure 1: Illinois, Minnesota, and Policy Interventions

## 2.1 Fiscal Policy

On March 27, 2020, the Coronavirus Aid, Relief, and Economic Security (CARES) Act was signed into law after being rapidly passed by Congress. At $2.2tn, the CARES Act was an order of magnitude larger than previous response bills passed up to that point. Of the $2.2tn, states and municipalities received over $200bn in federal aid. The largest distribution was $150bn through Coronavirus Relief Fund which was required to be used for COVID-related spending not anticipated in previous budget. Other appropriations included $25bn to public transit agencies, $13bn to K-12 education and roughly $6.5bn to public colleges and universities, and $35bn estimated to go

to public hospitals and community health centers. Funds were generally distributed on the basis of population, but included a minimum cap of $1.25bn per state, which skewed aid toward smaller states.[5] Our measure for aid to each state is derived from data featured in Auerbach et al. (2020).

The CARES Act also included provisions for a variety of enhanced unemployment benefits. These also constitute federal aid to states as they are funded directly by the federal government, and do not impact state unemployment accounts. The Pandemic Unemployment Assistance (PUA) program extends benefits to self-employed individuals, freelancers, and independent contractors. The program was extended to Sept. 6, 2021 under the American Rescue Plan (ARP). Pandemic Emergency Unemployment Compensation (PEUC) extends benefits for 13 weeks after regular benefits are exhausted; further extended to 53 weeks under ARP.[6]

On March 11, 2021, the American Rescue Plan (ARP) was signed into law. This $1.9tn stimulus package included $350bn in relief to states, localities, Tribes, and territories. States' aid allocations were obtained from `https://oversight.house.gov/budget-reconciliation` and normalized by general own source revenues as in Auerbach et al. (2020). As mentioned above, the ARP also extended enhanced unemployment benefits initiated by the CARES Act.

## 2.2 Monetary Policy

In response to strains in the U.S. muni market in March, the Fed took a number of actions. On March 23, certain short-term municipal securities became eligible for the Fed's Money Market Mutual Fund Liquidity Facility and Commercial Paper Funding Facility.

On April 9, the Fed established the Municipal Liquidity Facility (MLF) to support municipalities through the purchase of up to $500bn of investment-grade (IG) short-term notes (maturing in at most 24 months) in the primary market until September 30, 2020.[7] Eligible issuers initially included states, Washington D.C., counties with

[5] Vermont's aid was 23% of its own sources general revenue (OSGR), while New York's aid was only 6% of OSGR.

[6] A third program, the Federal Pandemic Unemployment Compensation (FPUC) provided claimants an extra $600/week in unemployment benefits, later reduced to $300/week.

[7] The eligible notes were: tax anticipation notes (TANs), tax and revenue anticipation notes (TRANs), bond anticipation notes (BANs), and other similar short-term notes. See April 9, 2020 MLF Term Sheet for full details: `https://www.federalreserve.gov/newsevents/pressreleases/files/monetary20200409a3.pdf`.

more than two million residents (16), and cities with more than one million residents (10). This was perceived by some market participants as a relatively narrow scope.

On April 27, the Fed announced an expansion of the scope and duration of the MLF by making eligible counties with more than 500,000 residents (140), cities with more than 250,000 residents (87), and multi-state entities. It also increased the maturity of eligible notes from 24 to 36 months and extended the duration of the MLF from September 30 to December 31, 2020. Furthermore, the Fed indicated that loans could be used to pay principal and interest on existing obligations. Additionally, if two rating agencies had assigned an IG rating before April 8, then issuers could still access the MLF even if later downgraded up to three notches below BBB–.

On May 11, the Fed published the MLF's pricing methodology: a fixed spread over comparable maturity overnight index swap rates based on the rating of the eligible notes. For higher-rated issuers, the prevailing muni market rates were below those determined by the MLF. For borrowers rated BBB and below, the MLF rates were favorable (e.g., BBB– spread was 380 bps), most likely prompting usage of the facility. Market participants have viewed the MLF as a backstop because of these terms.

On June 3, the Fed announced the second expansion to the number and type of entities eligible to the MLF, targeting states with few or no cities or counties meeting the population thresholds. The new terms guarantee the eligibility of at least two political subdivisions and two revenue-bond issuers from each state by giving Governors the ability to designate those entities even if they did not qualify under the population threshold.

Finally, on August 11, the Fed reduced the interest rate spread on tax-exempt notes for each credit rating category by 50 bps. However, before the pricing reduction already 97% of eligible entities could find better funding in the private the market.[8]

[8]See Yale School of Management Systemic Risk Blog post: `https://som.yale.edu/blog/federal-reserve-lowers-pricing-for-municipal-liquidity-facility`.

# 3 Data

## 3.1 Tax-Adjusted Muni-Treasury Spreads

We use Bloomberg's BVAL model for General Obligation (GO) municipal yield curves to obtain yields with maturity from one to thirty years for each available state.[9] Some US states do not have enough outstanding GO bonds for Bloomberg to derive a reliable yield curve. We focus on the yields of GO bonds because their cash flows are secured by the full faith, credit, and taxing power of the issuing government. About 90% of state tax revenues derive from sales and income taxes. The weighted average maturity of GO bonds is approximately 12 years and they accounted for 68% of the trading activity in 2019 according to MSRB (Bi and Marsh, 2021).

Municipal bond holders are frequently exempt from paying federal income taxes on interest payments. Moreover, they may also be exempt from the state income tax, often if they reside in the state which has issued the debt. To properly compare muni and Treasury yields, we must adjust the former to account for their tax advantages. We follow the method used by Schwert (2017) and Grigoris (2020). Muni yields are scaled by the following formula: $\frac{1}{(1-\rho_t^{Fed})(1-\rho_{i,t}^{State})}$, where $\rho_t^{Fed}$ and $\rho_{i,t}^{State}$ are the top federal and top state income tax rates for each state. The federal tax rates are from the Tax Policy Center and the state tax rates are based off 2020 top marginal rates from the Tax Foundation.[10]

Once we compute tax-adjusted muni yields, we subtract the Treasury yields of equivalent maturity to obtain the spreads. The daily Treasury yields from one- to thirty-year maturity are from the the Gürkaynak, Sack and Wright (2007) dataset.

## 3.2 Macro Controls

We include various macroeconomic controls in our model, depending on the specification. First, to control for each state's default risk, we use either ratings from S&P or credit default swap (CDS) spreads from Bloomberg with maturities ranging from one to thirty years.[11] To create a numerical S&P rating, we map each letter rating to a

[9] Used with the Permission of Bloomberg. Some technical aspects of the BVAL model are discussed in the following paper: `https://data.bloomberglp.com/professional/sites/10/45674\_CDS\_PRI\_BVAL\_AAA\_Curves\_SFCT\_DIG1.pdf`

[10] See `https://www.taxpolicycenter.org` and `https://taxfoundation.org`

[11] Used with the Permission of Bloomberg. See Appendix A in Chen (2007) for discussion of CDS data from Bloomberg: `https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.`

value, where BBB- is 1 and AAA is 10. Then, if a state has a positive outlook, we add 0.33; if it has a negative outlook, we subtract 0.33.[12]. Overall, in our sample period, 8 out of 20 states experienced a change in rating.

In our baseline, we favor the use of ratings because they change at a frequency lower than muni and CDS spreads, hence should not be affected by endogeneity concerns while still controlling for fundamental default risk. Further, differently from CDS spreads, ratings are available for 20 rather than 18 states and are immune from liquidity issues.

Second, we include Google workplace mobility data, available daily, which measures how the number of visitors to workplaces changes relative to baseline days preceding the pandemic's outbreak (January 3, 2020 to February 6, 2020). This variable should capture future reductions in economic activity as more people stay or work from home. We interpolate these data to smooth brief discrepancies (e.g. holidays). We also considered Google residential mobility data, however the information content is very similar.

We consider also the percentage change in the number of small businesses open compared with January 2020. These are generated by Womply and sourced via Opportunity Insight's Economic Tracker.[13] This variable is a seasonally adjusted 7-day moving average, indexed to January 2020. It is available at daily frequency and captures the extensive margin of small business operation. We also experimented with the percentage change in small business revenues, which has similar information content.

Lastly, we employ Leisure-Hospitality Revenue. These data are also a 7-day moving average, seasonally adjusted, and indexed to January 2020, available at daily frequency. Inclusion in the "leisure/hospitality" category is based on NAICS definitions. They are also generated by Womply and sourced from Opportunity Insight's Economic Tracker.

## 3.3 Fiscal Policy Interventions

In order to control for fiscal policy, we gather information on the timing of key votes in Congress and passages of the relevant bills into law. We obtain this information

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[12]For example, a rating of AA+ with a negative outlook corresponds to 8.67. See https://www.spglobal.com/ratings/en/research/articles/190319-u-s-state-ratings-and-outlooks-current-list-1738758

[13]For complete definitions for all variables, see https://github.com/OpportunityInsights/EconomicTracker/blob/main/docs/oi_tracker_data_dictionary.md

by reviewing compilations of Congressional voting records and news articles.[14] These dates are then used to generate persistent indicators which take the value of one after a milestone has been reached. In our baseline, such milestone is always the time in which the bill is signed into law, because it is unlikely that investors knew the bill's details before then.

This information is necessary because these time dummies are then interacted with the specific amount of fiscal support provided to every state. We obtain these measures from two sources. For the CARES Act, each state's fiscal aid normalized by OSGR is derived from Auerbach et al. (2020). For the ARP, we use the dollar amounts from the House Oversight Committee and, for consistency, we normalize them by OSGR using data on revenue data from the Census Bureau.

Economic Tracker includes administrative data on a variety of unemployment claims variables. These data are derived from weekly reports and we assigned them to the release date, when they become known to investors. We focus only on unemployment claims arising from emergency programs implemented during the pandemic, which are funded by the federal government and do not require expenditure from state governments. Benefits, not only provide a direct stimulus to the local economy, but are potentially taxable as income by states and therefore can provide them with additional revenues.[15] Further, once benefits are spent, might generate sales tax revenues. Specifically, we incorporate measures for initial PUA claims, and continued PEUC claims. We favor initial claims, as we find they are a more responsive measure of unemployment claims, however, these are unavailable for PEUC, prompting the use of continued claims.

## 3.4 Monetary Policy Interventions

Monetary policy interventions data are based off public announcements by the Federal Reserve Board of Governors.[16] We use this information to generate persistent indicators which take the value of one starting either on the day of the announcement, or the day after if the announcement took place after market close. We focus on the events listed in Section 2.2. Data on MLF issuance is derived from reporting by the

[14] See GovTrack.us: `https://www.govtrack.us/congress/votes`

[15] Auerbach et al. (2020) estimates states receive 3.8% of unemployment benefits as income tax revenue.

[16] See `https://www.federalreserve.gov/monetarypolicy/muni.htm`

Board of Governors to Congress. These reports are featured publicly on the Board's website.

### 3.5 State-Level Responses

We obtain data on state-level virus mitigation policies, such as Stay-at-Home orders, from Economic Tracker. The variable takes the value of one when the policy is in effect and returns to zero once the mitigation policy is removed.

### 3.6 Covid-19 Public Health Controls

For each state, we include three public health indicators pertaining to Covid-19. The first is the change in new Covid-19 cases reported by the New York Times, as we want to capture the slope of the infection curve. We take the 7-day moving average and convert it to a per 100,000 individuals basis using Census state population data. Next, we include the test positivity rate, defined as the ratio of the 7-day average of new cases per 100,000 divided by the 7-day average of coronavirus tests per 100,000. Our final measure is the 7-day average of the number of daily Covid-19 deaths per 100,000 each day. Those last two measures are obtained via Economic Tracker, which itself obtains the data from the CDC before converting them to per 100,000 individuals and applying a 7-day moving average.

## 4 Empirical Strategy and Results

In this section, we first describe our empirical specification, then discuss in detail the baseline results, and finally present counterfactual trajectories of the tax-adjusted muni-Treasury spreads in the absence of FP and MP interventions.

### 4.1 Model Description

To quantify the economic impact of FP and MP interventions in muni markets, during a period dominated by the pandemic (March 2, 2020 to May 5, 2021), we estimate a simple panel regression model in which daily variations in the one- to thirty-year muni-Treasury spreads of 18 states are distilled in factors common to all states and state-specific components:

$$Y_{i,t}^{\tau} = \alpha^{\tau} + \beta_1^{\tau} X_{i,t} + \beta_2^{\tau} FP_{i,t} + \beta_3^{\tau} MP_t + \beta_4^{\tau} SLR_{i,t} + \beta_5^{\tau} C19_{i,t} + \lambda_i^{\tau} + \epsilon_{i,t}^{\tau} \qquad (1)$$

where, for each state $i$ and time $t$, $Y_{i,t}^{\tau}$ is the tax-adjusted muni spread of a bond with maturity $\tau$, $X_{i,t}$ is the set of our macro controls, $FP_{i,t}$ captures all the FP interventions, $MP_t$ captures all the MP interventions, $SLR_{i,t}$ is the variable for the state-level responses, $C19_{i,t}$ includes three Covid-19 public health indicators, and $\lambda_i$ are state fixed effects.

This state-level panel estimated over the course of 14 months allows us to capture longer-run effects of policy interventions, especially relative to event studies focused on a small time window around the policy announcement. The examination of each panel's results at different maturities can allow us to distinguish the transmission channel of each policy. It is reasonable to assume that, if a policy affected primarily short-term bonds, then it mostly worked through the liquidity-risk channel (or market functioning more in general), which tends to have short-lived effects usually concentrated in eligible bonds; but, if the same policy also affected longer-term bonds and by a larger amount, then it probably worked also through the credit-risk channel, as it addressed states' fundamental credit concerns.

In our baseline model, the macro controls include credit ratings to capture the credit risk associated with each state, workplace mobility to capture future reductions in economic activity as more people stay or work from home, and leisure-hospitality revenue to capture changes in revenues from sectors hit the hardest by the pandemic.

The FP interventions are measured by fiscal aid allocations to states and municipalities interacted with an indicator for when the specific bill becomes a law. We also include initial PUA claims and continued PEUC claims to control for federal unemployment benefits in each state.

Our MP interventions capture the introduction of and key changes to the MLF. For each announcement described in Section 2.2, we include a dummy set to one starting on the day of the announcement. We also include the amount in millions issued to the MLF on the day a deal is entered.

SLR is a dummy equal to 1 on days when the state had a stay-at-home order in effect and 0 otherwise. This controls for the economic impacts of the order.

Our Covid-19 public health variables include daily changes in new Covid-19 cases, positivity rate, and daily deaths. These indicators should control for the economic

impact of the pandemic above and beyond the macro controls, such as state-level public health expenditures; but they can also control for the fear factor and pessimism associated to Covid-19 which could translate in higher risk aversion.

## 4.2 Baseline Results

Table 1 summarizes the results of our baseline specification for the tax-adjusted muni-Treasury spread at the two-, three-, and four-year maturities. While short-term spreads behave similarly, only maturities of three years or less were eligible for the MLF. To the extent that the MLF created some discontinuity in the pricing of muni bonds, comparing the three and four-year maturities could be of interest. Table 2 instead is focused on the baseline results for longer-maturity bonds, specifically the five-, ten-, and thirty-year tax-adjusted muni-Treasury spreads. These results are important to better understand the transmission mechanism of FP and MP interventions, especially considering that the muni debt market is very active at long maturities.

Our baseline specification explains about 80% of variations in muni spreads across short maturities (Table 1) and about 84% across long maturities (Table 2). We notice first that the estimated coefficients on numerical credit ratings and workplace mobility are statistically significant and display the expected negative sign. Focusing on the three-year muni spread (the second column), a one-notch increase in the rating decreases the muni spread by about 47bps and a positive outlook change lowers it by about 15bps. A one percentage point decrease in the number of people travelling to work increases muni spreads by about 4bps. During our sample period, the average decrease in workplace mobility was 36%. This implies that all else equal, the associated decline in economic activity resulting from reduced workplace mobility increased muni spreads by about 145bps. In contrast, leisure and hospitality revenue is not significant, one possible explanation is that it is very highly correlated with workplace mobility. We also verified that all our results are robust to the exclusion of this variable (not shown for brevity).

Turning to FP, our estimates indicate that the CARES Act had a large and statistically significant impact on muni spreads. An increase in CARES aid equivalent to one percentage point of OSGR decreased spreads by 16bps. Given that, on average, aid to states equaled 8.7% of OSGR, the total reduction in spreads from the CARES act equaled almost 140bps. The effect seems to be quite similar across short maturities; but, as shown in Table 2, the magnitude of the coefficient is notably smaller at longer

maturities, implying a total effect of 83bps for the 30-year spread. This suggests that almost half of the CARES impact at short maturities was driven by lower liquidity risk, while the remaining part was mostly related to an improvement in longer-term credit concerns.

The coefficient on ARP is also negative and statistically significant, but its magnitude is increasing with maturity. On average, ARP aid equaled 13.4% of state OSGR, which decreased three-year muni spreads by a total of 11bps and 30-year spreads by 52bps. This indicates that ARP has been likely viewed by investors not just as an emergency measure addressing short-term liquidity issues, but as improving on more fundamental credit concerns.

Also PUA and PEUC unemployment claims display negative and statistically significant coefficients. An increase of one initial claim per 100 workers reduced spreads by 5.6bps for PUA (with an average total effect of 1.5bps), while the same increase in PEUC reduced spreads by 4.4bps (with an average total effect of 7bps). indicating that these expansions of unemployment benefits financed by the federal government provided some relief at the state level. Further, the magnitude of the PEUC coefficient doubles at long maturities, suggesting that this particular type of expansion was perceived as alleviating longer-term credit risk, most likely by stimulating aggregate demand beyond the pandemic crisis period. As we will show in the next section, these variables become more important in states characterized by a more strained fiscal situation.

Turning to MP, at shorter maturities, except for March 23, all announcements display statistically significant coefficients, accounting for a cumulative 75bps decline in the three-year muni spread. In particular, the April 9th, May 11th, and June 3rd announcements account for a reduction of 115bps in the muni spread. But, it seems that the MLF's first expansion on April 27th was not deemed sufficient by investors, as demonstrated by the positive coefficient. In relatively more rural states, very few additional entities qualified according to the new population thresholds, implying that the announcement was beneficial mostly to states that already benefited under the original terms. Similarly, the 50bp reduction in the MLF's spread announced on August 11th had a positive impact on muni spreads, although smaller in size. This is because, by then, muni spreads available to all states in the private market were well below the new MLF spreads (see Figure 1), making the MLF new pricing worse than

expected.[17]

It is also important to point out that the persistent impact of MP announcements at the two-, three- and four-year maturities is quite similar, suggesting that the initial (24 months) and subsequent (36 months) maturity thresholds for eligibility at the MLF did not seem to have triggered price discontinuities in muni bonds. This suggests that the MLF effects passed through to ineligible bonds making this facility more effective, as the GO muni debt market does not appear to be very segmented along the maturity dimension. Finally, these findings also indicate that the transmission mechanism of the MLF was not limited to the liquidity/market-functioning channel, as in that case effects should be localized to eligible bonds and their close substitutes.

As shown in Table 2, at longer maturities, the cumulative effect of the MP interventions is significantly smaller in magnitude, as it varies between 37 and 55bps. This is largely due to the March 23 announcement being statistically significant but with a positive coefficient that varies between 18 and 36bps. This can be related to two factors. First, on March 23rd, news emerged that negotiations for the CARES Act were deadlocked in the Senate, sending financial markets into a frenzy. This confounding event would have affected longer-term bonds more than short-term bonds if investors thought that, in the absence of fiscal aid, states' growing deficits would have become unsustainable in the longer run. Second, on the same day, the Fed announced very large purchases of Treasury securities, which based on previous QEs could have been concentrated in longer maturities, possibly causing longer-term Treasury yields to decline more than muni yields on that day, leaving muni spreads to Treasuries wider.

Finally, we also note that the MLF actual issuance is marginally significant at the 2- and 3-year maturities, which are the only maturities where MLF issuance took place. The estimated coefficients indicate that a one billion issuance at the MLF would increase short-term muni spreads by 25bps.

Our control for stay-at-home orders indicates that those Covid-19 mitigating measures had a statistically significant impact on muni spreads, increasing them by about 8 to 11bps, depending on maturity. This is consistent with the findings of Li and Lu (2020), although the size of the effects is not comparable as they use muni offering yields and we employ muni-Treasury spreads. In contrast to the large impact of workplace mobility, this finding suggest that the fear of the virus and the possibil-

[17] See Yale School of Management Systemic Risk Blog post: `https://som.yale.edu/blog/federal-reserve-lowers-pricing-for-municipal-liquidity-facility`.

ity of working from home had bigger economic effects than the stay at home orders themselves. The small coefficient also hides the fact that this is an average across states; our analysis in the next section will show the difference between low and high population density states.

Turning to the Covid-19 public health indicators, it should be noted that most coefficients are statistically significant, although the negative sign on Covid-19 deaths is extremely puzzling. However, the overall economic significance of these variables is quite small. For instance, if the rate of Covid-19 new cases per 100,000 residents increases by one, the 3-year muni spread increases by about 0.55bps, with a total effect of almost zero. Similarly, if the test positivity rate increases by one percentage point, the 3-year muni spread increases by about 0.5bps, with a total effect of about 4bps. This suggests that all the other controls in our empirical model already do a good job at explaining the economic relevance of the pandemic and related policy interventions.

| Tax-Adjusted MT Spread | 2Y | 3Y | 4Y |
|---|---|---|---|
| Numerical Credit Rating (S&P) | -47.08*** | -46.79*** | -50.29*** |
| Interp. Workplace Mob. | -4.641*** | -4.434*** | -4.279*** |
| Leisure/Hospitality Revenue | -6.407 | -2.426 | 14.54 |
| CARES Aid × Signed into Law | -16.72*** | -16.14*** | -15.94*** |
| ARP Aid × Signed into Law | -0.570*** | -0.818*** | -0.986*** |
| Init. Claims Rate PUA | -6.258*** | -5.630*** | -5.095*** |
| Cont. Claims Rate PEUC | -4.096*** | -4.383*** | -5.222*** |
| FED Ann. 3-23-20 Post Ind. | -14.10* | -3.681 | 11.74 |
| MLF Ann. 4-9-20 Post Ind. | -37.27*** | -36.79*** | -34.29*** |
| MLF Ann. 4-27-20 Post Ind. | 30.17*** | 36.21*** | 39.58*** |
| MLF Ann. 5-11-20 Post Ind. | -54.04*** | -56.45*** | -51.28*** |
| MLF Ann. 6-3-20 Post Ind. | -11.94*** | -21.62*** | -29.44*** |
| MLF Ann. 8-11-20 Post Ind. | 6.857*** | 5.824** | 3.556 |
| MLF Issuance Enter Value | 0.0246* | 0.0222* | 0.0195 |
| Stay-at-Home Order in Effect | 7.556** | 8.645** | 9.546*** |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.551** | 0.558** | 0.606** |
| Positivity Rate (Adj. Smooth) | 0.608*** | 0.503*** | 0.384*** |
| New Deaths/100,000 7d avg. | -11.95*** | -10.82*** | -11.72*** |
| Constant | 374.1*** | 375.3*** | 408.1*** |
| Observations | 5,901 | 5,901 | 5,901 |
| R-squared | 0.787 | 0.813 | 0.822 |
| State FE | Yes | Yes | Yes |

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

Table 1: Baseline 2Y, 3Y, and 4Y Results

| Tax-Adjusted MT Spread | 5Y | 10Y | 30Y |
|---|---|---|---|
| Numerical Credit Rating (S&P) | -55.57*** | -66.27*** | -75.46*** |
| Interp. Workplace Mob. | -4.359*** | -4.655*** | -4.576*** |
| Leisure/Hospitality Revenue | 33.15*** | 110.4*** | 125.3*** |
| CARES Aid × Signed into Law | -15.95*** | -13.55*** | -9.610*** |
| ARP Aid × Signed into Law | -1.350*** | -3.545*** | -3.898*** |
| Init. Claims Rate PUA | -4.744*** | -4.011*** | -4.375*** |
| Cont. Claims Rate PEUC | -6.302*** | -8.989*** | -8.720*** |
| FED Ann. 3-23-20 Post Ind. | 18.28** | 27.01*** | 36.48*** |
| MLF Ann. 4-9-20 Post Ind. | -33.27*** | -46.12*** | -23.79*** |
| MLF Ann. 4-27-20 Post Ind. | 44.15*** | 50.97*** | 31.23*** |
| MLF Ann. 5-11-20 Post Ind. | -47.81*** | -49.65*** | -63.25*** |
| MLF Ann. 6-3-20 Post Ind. | -32.74*** | -29.16*** | -36.24*** |
| MLF Ann. 8-11-20 Post Ind. | -1.422 | 10.20*** | 0.880 |
| MLF Issuance Enter Value | 0.0172 | 0.0124 | 0.0133 |
| Stay-at-Home Order in Effect | 8.992** | 9.028** | 10.69*** |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.686** | 1.048*** | 1.222*** |
| Positivity Rate (Adj. Smooth) | 0.317*** | 0.218* | -0.125 |
| New Deaths/100,000 7d avg. | -14.10*** | -23.39*** | -23.65*** |
| Constant | 455.0*** | 596.1*** | 714.3*** |
| Observations | 5,901 | 5,901 | 5,901 |
| R-squared | 0.830 | 0.839 | 0.848 |
| State FE | Yes | Yes | Yes |

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

Table 2: Baseline 5Y, 10Y, 30Y Results

## 4.3 Baseline Counterfactual

Using the estimates from our three-year adjusted muni-Treasury spread model, we consider the following counterfactual: the projected evolution of muni-Treasury spread

in the absence of FP and MP interventions.[18] Figure 2 plots the actual evolution of the average three-year muni spread in black, the one implied by our model estimates in red, and the one implied by our counterfactual in purple. The green and blue areas highlight the relative contributions of FP and MP interventions to the total counterfactual spread. From this figure, it is possible to observe that, by the end of the sample period, FP contributed twice as much as MP (about 165 versus 75 bps) to the decline in the three-year average muni spread.

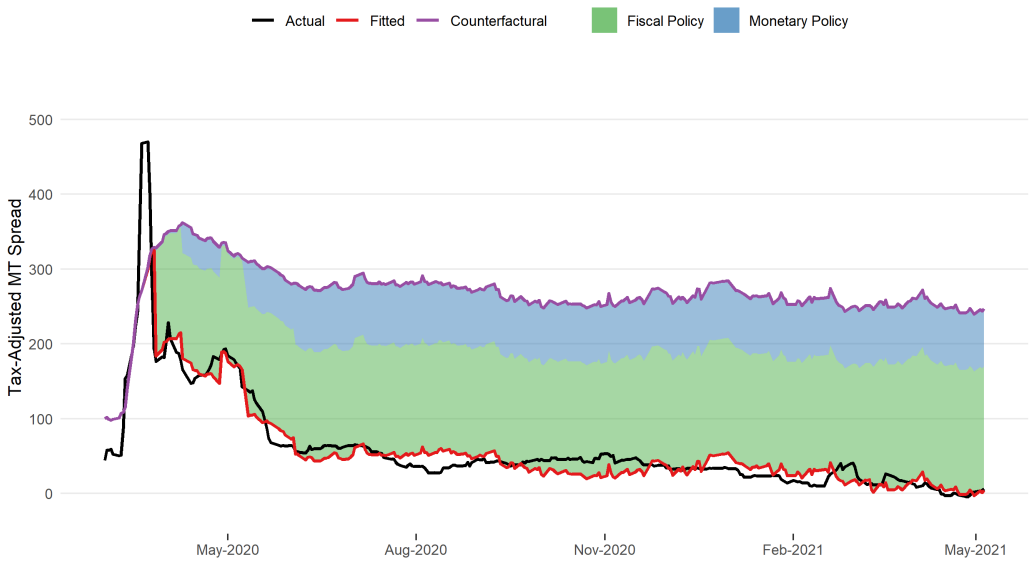


Figure 2: Baseline 3Y Counterfactual

In the case of longer-term muni-Treasury spreads, the counterfactuals (not shown) indicate that the contribution of FP to the spread reduction becomes three times as large as that of MP. For instance, at the five-year maturity FP accounts for 177bps and MP for 53bps, and at the thirty-year maturity FP accounts for 164bps and MP for 55bps. This makes sense as the MLF was designed to help states and municipalities to manage cash flow pressures during the pandemic and maintain liquidity in the market, and it was not meant to provide long-term support to those entities. Indeed, the MLF has been terminated at the end of 2020, while Congress kept providing fiscal aid to states in 2021. As shown in Section 4.2, ARP and PEUC, fiscal measures that continued to provide support well into 2021, affected longer-term spreads more than shorter-term spreads.

[18] This is done by setting to zero the effects of our FP and MP interventions in the baseline regression and plotting the resulting fitted values.

Since we consider changes caused by policy interventions during the pandemic, many factors that we keep fixed in the counterfactual would have likely evolved differently in the absence of FP and MP interventions. For example, if muni spreads had remained elevated, states would have had to take contractionary measures such as cutting expenses or raising taxes. Depending on the impact of these alternative measures on the state budget, aggregate demand, and public health, some states might have experienced different trajectories in their muni-Treasury spreads. Overall, since all of these variables are endogenous, it is hard to assess if our counterfactual is providing an upper or lower bound of the total and relative contributions of each policy.

# 5 Analysis by State Subgroups

To better understand what is driving the results from the baseline specification including all states, we investigate how our findings vary based on state characteristics potentially relevant for the efficacy of policy interventions during the Covid-19 pandemic. In particular, we continue to use the same variable specification used in the baseline, but we divide the states in two mutually exclusive subgroups, based on the following four factors.

First, we zoom in on the state's pre-pandemic fiscal risk, measured by the state's numerical credit rating as of January 2, 2020. States with lower fiscal risk at the onset of the pandemic may have been less impacted by policy interventions because they were better prepared to weather budget crisis. We divide states into two groups, one with above-median ratings (high) and the other with below-median ratings (low).

Second, to account for how a state's fiscal situation has changed during the budget crisis triggered by the pandemic, we focus on the percentage change in tax revenues from 2020:Q1 to 2020:Q2, which we use to separate states with higher tax revenues (high) from states with lower tax revenues (low). This variable should convey the extent of tax revenue declines faced by policymakers at the height of the crisis. But, it is important to keep in mind that, as detailed in Dadayan (2020), the income tax revenue picture in 2020:Q2 is complicated by the delayed deadline for income tax filing, which drastically reduced personal income tax collections. Further, some states shifted income tax revenues received in July back into June (as it falls in fiscal year 2020 in most states), making a fair state-to-state comparison harder, as some states counted

substantial amounts of revenue that others deferred.[19] Nevertheless, this variable provides a general comparison of the size of tax revenue declines faced by different states, with a message that remains similar if we use year-over-year changes instead.

Third, we consider the state's level of urbanization. Because Covid-19 is spread through close contact between individuals, a high-population density area such as urban areas may have been impacted more heavily, experiencing worse economic outcomes. In addition, urbanization might be indicative of different types of jobs that would be impacted differently by the pandemic. To separate our states into two groups characterized by different population densities, we use the "urbanization index" from FiveThirtyEight, which is based on a weighted average of the population living within 5 miles of each census tract.

Lastly, we use a state's political partisan lean because Republican-leaning "red" states and Democratic-leaning "blue" states have responded somewhat differently to the pandemic. For example, adoption of Covid-19 mitigating measures,[20] face mask utilization,[21] and vaccination rate[22] have been different. As a result, investors may have seen "blue" states' balance sheets as more vulnerable because of more rapid and comprehensive public health responses that, for example, might have led to broader business closures and therefore lower sales tax revenues. Alternatively, investors may have been more confident in the recovery of "blue" states because of the stronger public health responses. Partisan Lean, also from FiveThirtyEight, measures a state's lean relative to the country based on recent Presidential and State House elections. A lean of 0 indicates that a state votes for each party similarly to the country at large. A negative lean indicates that state's voters favor the Republican Party, while a positive lean indicates that state's voters favor the Democratic Party.

Figure 3 plots the state's percentage change in tax revenue from 2020:Q1 to 2020:Q2 along the $x$-axis, its numerical credit rating along the $y$-axis, its urbanization level is marked by the size of the circle, and its partisan lean by the color of the circle. Immediately, we can observe that Illinois is a negative outlier with respect to credit

[19] Dadayan (2020) finds that 15 states counted income tax revenues in 2020:Q2 even though they were received in 2020:Q3, while 27 states did not shift revenues from the third quarter.

[20] Gollwitzer et al. (2020) find counties which favored Republican Donald Trump in the 2020 Election featured less social distancing. See `https://www.nature.com/articles/s41562-020-00977-7`.

[21] See `https://delphi.cmu.edu/blog/2020/10/12/new-and-improved-covid-symptom-survey-tracks-testing-and-mask-wearing/`.

[22] See `https://www.nytimes.com/interactive/2021/04/17/us/vaccine-hesitancy-politics.html`.

rating and New Jersey a positive outlier with respect to changes in tax revenues. As shown in the lower left quadrant, highly-urbanized states that lean Democrat tend to have below-median credit ratings and experienced very large tax revenue declines in 2020:Q2. On the other hand, as shown in the upper right quadrant, relatively more rural states that lean Republican have the highest credit rating (10 which corresponds to AAA) and experienced little changes in their tax revenues in 2020:Q2. South Carolina is the only state in this group that registered a large tax revenue increase, which may reflect the shift in income tax revenues from July back to 2020:Q2.

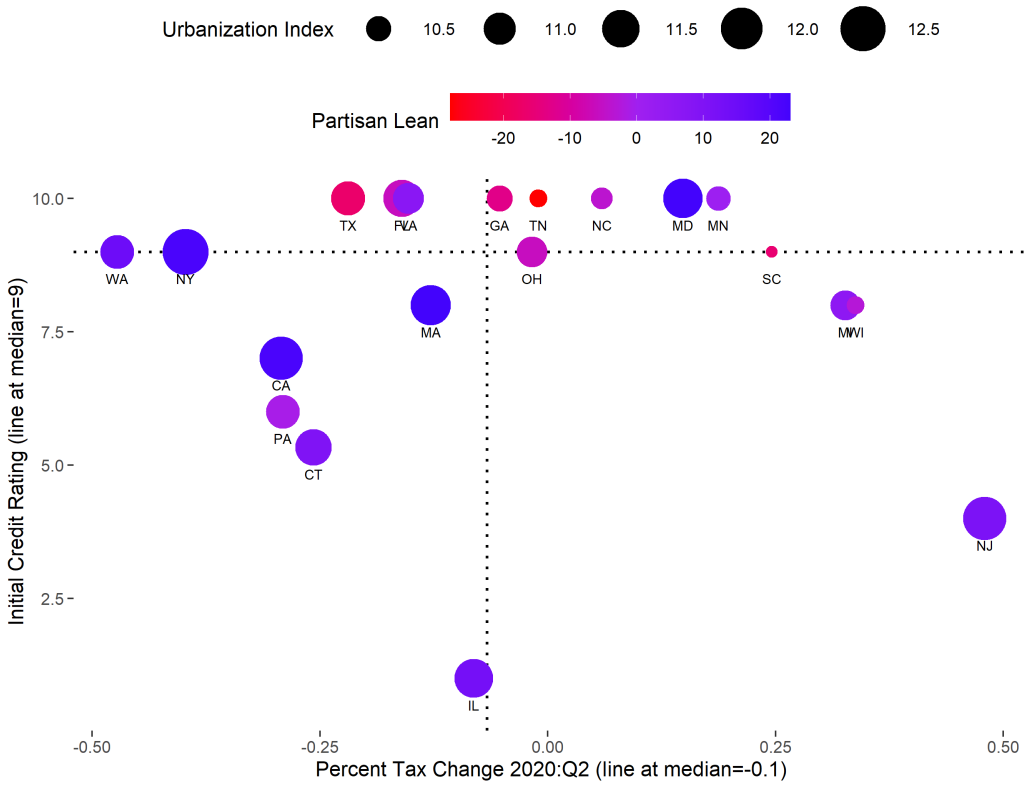


Figure 3: States and their Subgroups

## 5.1 Fiscal Risk

Table 3 summarizes the results for the low and high credit-rating subgroups, which are determined based on the credit rating as of January 2, 2020, to reflect a state's pre-pandemic fiscal situation. First, we observe that the coefficients on credit rating are large, negative, and significant only for low-rated states. This is because low-rated states experienced more downgrades and outlook changes over our sample period,

and hence the numerical variable tracking credit ratings displays more meaningful variation. In the higher-rated group, only New York and Minnesota recorded an outlook shift, hence in this group numerical credit rating and the fixed effect are almost perfectly collinear.

Second, FP was much more effective for lower-rated states as demonstrated by the larger coefficients on all policy interventions. Further, PUA and PEUC claims seemed helpful only to lower-rated staes. Finally, up until the second MLF expansion (June 3, 2020), MP interventions were more beneficial to higher-rated states; while, the last two changes to the MLF, announced on June 3rd and August 11th, were relatively more helpful to lower-rated states. This overall implies that, in lower-rated states, the relative efficacy of FP grew even larger.

For instance, as shown in Figures 4 and 5, which shows the counterfactual trajectories at the three-year maturity based on the estimates reported in Table 3, in higher-rated states (top panel) MP accounted for 105bps (blue area), while in lower-rated states (bottom panel) it accounted only for 45bps. At the 10-year maturity (not shown), in lower-rated states, the contribution of MP was a mere 17bps.

| Initial Credit Rating | Low | High | Low | High |
|---|---|---|---|---|
| Tax-Adjusted MT Spread | 3Y | 3Y | 10Y | 10Y |
| | | | | |
| Numerical Credit Rating (S&P) | -64.35*** | 3.937 | -92.88*** | 35.37*** |
| Interp. Workplace Mob. | -5.508*** | -3.439*** | -5.625*** | -3.597*** |
| Leisure/Hospitality Revenue | 60.01*** | -70.17*** | 163.1*** | 41.67*** |
| CARES Aid × Signed into Law | -20.26*** | -13.10*** | -16.65*** | -11.09*** |
| ARP Aid × Signed into Law | -2.518*** | -0.142 | -5.080*** | -3.057*** |
| Init. Claims Rate PUA | -24.09*** | 0.402 | -19.09*** | 1.655 |
| Cont. Claims Rate PEUC | -3.640*** | -0.591 | -8.470*** | -4.420*** |
| FED Ann. 3-23-20 Post Ind. | 26.46 | -17.78*** | 51.27*** | 13.54** |
| MLF Ann. 4-9-20 Post Ind. | -23.32** | -34.78*** | -30.15*** | -50.11*** |
| MLF Ann. 4-27-20 Post Ind. | 71.41*** | 18.07*** | 84.10*** | 36.68*** |
| MLF Ann. 5-11-20 Post Ind. | -42.16*** | -64.54*** | -39.97*** | -52.27*** |
| MLF Ann. 6-3-20 Post Ind. | -63.76*** | -13.64*** | -74.75*** | -15.31*** |
| MLF Ann. 8-11-20 Post Ind. | -13.64*** | 7.708*** | -5.772 | 9.506*** |
| MLF Issuance Enter Value | 0.0389 | -0.00224 | 0.0215 | -0.0104 |
| Stay-at-Home Order in Effect | -2.846 | -6.796** | -11.32 | 5.439* |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.495 | 0.662*** | 1.007** | 1.017*** |
| Positivity Rate (Adj. Smooth) | 1.346*** | -0.192** | 1.669*** | -0.804*** |
| New Deaths/100,000 7d avg. | -21.36*** | -11.45*** | -38.49*** | -22.11*** |
| Constant | 488.0*** | 55.96 | 774.0*** | -220.3** |
| | | | | |
| Observations | 2,367 | 3,534 | 2,367 | 3,534 |
| R-squared | 0.812 | 0.835 | 0.843 | 0.795 |
| StateFE | Yes | Yes | Yes | Yes |

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

Table 3: Fiscal Risk

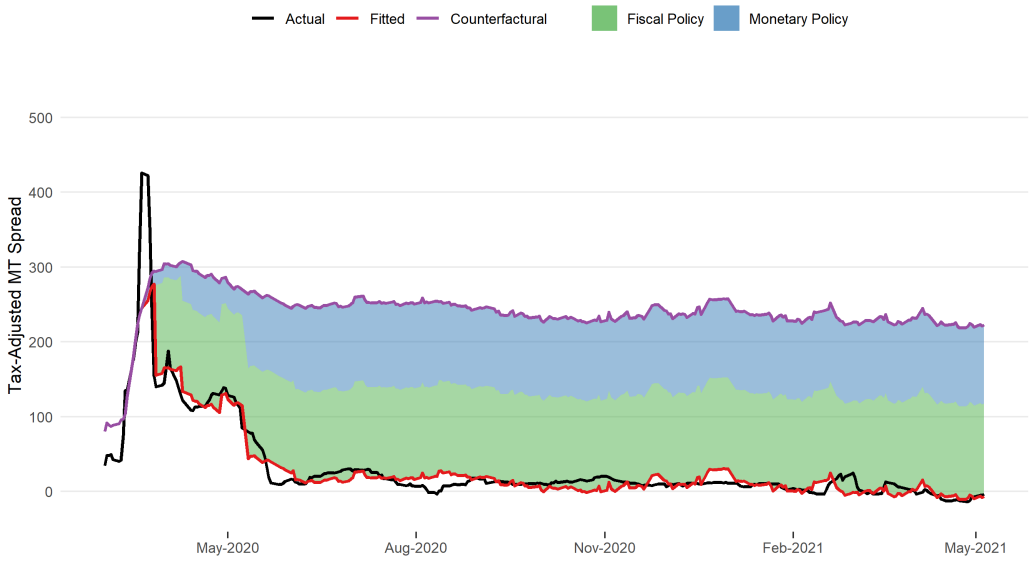


Figure 4: High Initial Credit Rating States

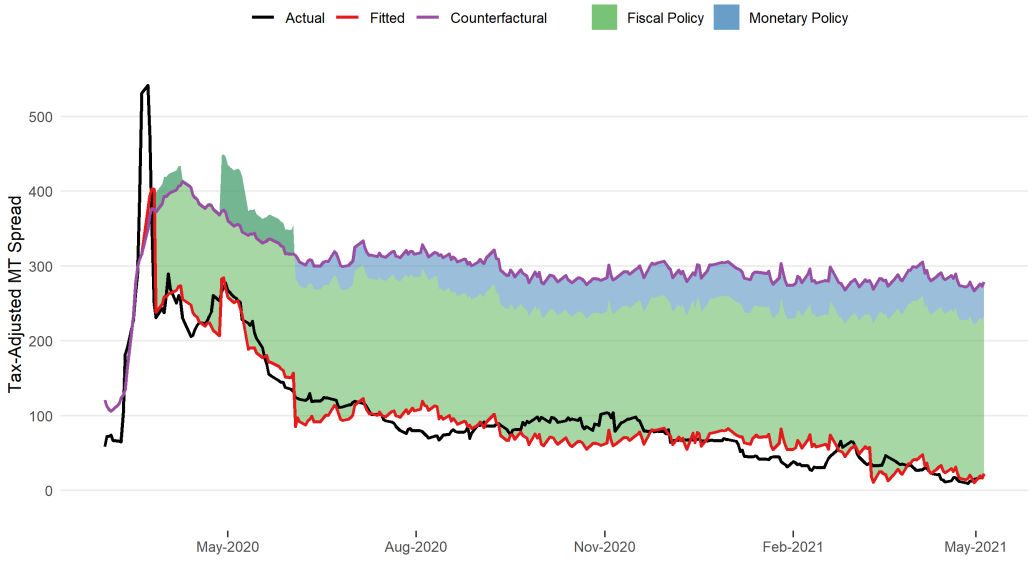


Figure 5: Low Initial Credit Rating States

## 5.2 Tax revenue changes in 2020:Q2

Table 4 summarizes the results for the low and high tax revenue subgroups. Specifically, the low group collects all states that experienced large tax revenue decreases in 2020:Q2, while the high group collects the states characterized by small tax revenue

decreases or tax revenue increases. It is possible to note that the differences in the estimates for the low and high group follow a pattern very similar to that observed for the low and high credit-rating groups. This despite the fact that high-rated states, such as Washington and New York, experienced the largest tax revenue declines in 2020:Q2. Hence, the main message is the same as Table 3: FP was much more helpful to states that experienced large tax revenue declines, while MP became somewhat more helpful to those states following the second expansion on June 3. Perhaps, the most interesting difference between Table 4 and Table 3 are the coefficients on ARP, which in the case of the subgroups based on percentage change in tax revenue, are quite similar in the low and high group. This seems reasonable as ARP was passed in 2021, after the height of the budget crisis, when most states had seen a rebound in tax revenues.

| Percent Tax Change 2020:Q2 | Low | High | Low | High |
|---|---|---|---|---|
| Tax-Adjusted MT Spread | 3Y | 3Y | 10Y | 10Y |
| Numerical Credit Rating (S&P) | -216.0*** | 87.19*** | -192.3*** | 38.98*** |
| Interp. Workplace Mob. | -5.416*** | -3.546*** | -5.682*** | -3.612*** |
| Leisure/Hospitality Revenue | 47.08*** | -94.54*** | 135.5*** | 45.49*** |
| CARES Aid × Signed into Law | -21.55*** | -12.56*** | -17.25*** | -11.05*** |
| ARP Aid × Signed into Law | -1.022*** | -0.643*** | -4.033*** | -3.167*** |
| Init. Claims Rate PUA | -8.496*** | -0.420 | -5.998** | -0.938 |
| Cont. Claims Rate PEUC | -5.663*** | 1.452** | -9.784*** | -4.456*** |
| FED Ann. 3-23-20 Post Ind. | 3.351 | -23.83*** | 16.06 | 25.86*** |
| MLF Ann. 4-9-20 Post Ind. | -23.81*** | -32.60*** | -32.64*** | -45.13*** |
| MLF Ann. 4-27-20 Post Ind. | 57.35*** | 22.71*** | 66.50*** | 41.33*** |
| MLF Ann. 5-11-20 Post Ind. | -53.45*** | -67.36*** | -45.13*** | -60.88*** |
| MLF Ann. 6-3-20 Post Ind. | -38.15*** | -13.67*** | -47.93*** | -17.90*** |
| MLF Ann. 8-11-20 Post Ind. | -1.000 | 12.46*** | 7.511* | 12.05*** |
| MLF Issuance Enter Value | 0.0271* | - | 0.0153 | - |
| Stay-at-Home Order in Effect | 10.60* | -12.41*** | 10.26* | -6.368* |
| Δ Daily Cases/100,000 7d avg. | 0.753 | 0.417** | 1.783*** | 0.674*** |
| Positivity Rate (Adj. Smooth) | 1.821*** | -0.368*** | 1.129*** | -0.426*** |
| New Deaths/100,000 7d avg. | -23.02*** | -15.32*** | -33.55*** | -27.11*** |
| Constant | 1,560*** | -771.9*** | 1,473*** | -252.0*** |
| Observations | 2,962 | 2,939 | 2,962 | 2,939 |
| R-squared | 0.833 | 0.852 | 0.853 | 0.844 |
| StateFE | Yes | Yes | Yes | Yes |

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

Table 4: Tax Revenue Changes

## 5.3 Urbanization Index

Table 5 summarizes the results for states with low and high level of urbanization. Since highly-urbanized states tend to have below-median credit ratings and experienced very large tax revenue declines in 2020:Q2, the results for the high group are very similar to

those for the low groups in Table 4 and Table 3. That is, in highly-urbanized states, FP has been much more effective than MP.

The new finding that emerged from the analysis of these subgroups is that stay-at-home orders had a positive and significant impact only on the muni spreads of highly urbanized states, with a coefficient that is much larger than that one in the baseline.

| Urbanization Index | Low | High | Low | High |
|---|---|---|---|---|
| Tax-Adjusted MT Spread | 3Y | 3Y | 10Y | 10Y |
| Numerical Credit Rating (S&P) | -3.652 | -48.96*** | 3.942 | -71.26*** |
| Interp. Workplace Mob. | -3.481*** | -5.751*** | -3.481*** | -5.835*** |
| Leisure/Hospitality Revenue | -81.31*** | 80.97*** | 41.45*** | 161.0*** |
| CARES Aid × Signed into Law | -12.53*** | -20.75*** | -10.74*** | -16.40*** |
| ARP Aid × Signed into Law | -0.274** | -2.218*** | -3.323*** | -4.665*** |
| Init. Claims Rate PUA | -0.113 | -13.87*** | -0.336 | -10.58*** |
| Cont. Claims Rate PEUC | 1.068* | -1.780* | -2.808*** | -7.451*** |
| FED Ann. 3-23-20 Post Ind. | -20.68*** | 9.196 | 22.08*** | 22.12 |
| MLF Ann. 4-9-20 Post Ind. | -37.75*** | -19.82** | -52.97*** | -25.43*** |
| MLF Ann. 4-27-20 Post Ind. | 20.62*** | 51.86*** | 40.54*** | 63.49*** |
| MLF Ann. 5-11-20 Post Ind. | -66.29*** | -49.43*** | -57.75*** | -43.88*** |
| MLF Ann. 6-3-20 Post Ind. | -13.63*** | -36.22*** | -17.28*** | -46.41*** |
| MLF Ann. 8-11-20 Post Ind. | 7.380*** | 0.321 | 8.411*** | 8.425** |
| MLF Issuance Enter Value | - | 0.0226 | - | 0.0124 |
| Stay-at-Home Order in Effect | -9.845*** | 20.29*** | -2.382 | 15.54** |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.661*** | 0.399 | 1.104*** | 0.889** |
| Positivity Rate (Adj. Smooth) | -0.223*** | 0.864*** | -0.532*** | 0.727*** |
| New Deaths/100,000 7d avg. | -13.57*** | -21.64*** | -32.42*** | -34.35*** |
| Constant | 146.8 | 375.4*** | 111.8 | 612.2*** |
| Observations | 2,948 | 2,953 | 2,948 | 2,953 |
| R-squared | 0.832 | 0.817 | 0.796 | 0.845 |
| StateFE | Yes | Yes | Yes | Yes |

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

Table 5: Urbanization Index

## 5.4 Partisan Lean

Finally, given the positive relationship between urbanization and partisan lean displayed in Figure 3, the similarities between the estimates reported in tables 6 and 5 are not surprising. Hence, the analysis of the subgroups based on partisan lean did not provide any additional insight.

| Partisan Lean 2020 | Low | High | Low | High |
|---|---|---|---|---|
| Tax-Adjusted MT Spread | 3Y | 3Y | 10Y | 10Y |
| Numerical Credit Rating (S&P) | 33.17*** | -64.43*** | 51.35*** | -92.58*** |
| Interp. Workplace Mob. | -3.739*** | -5.212*** | -3.796*** | -5.382*** |
| Leisure/Hospitality Revenue | -81.06*** | 44.19** | -0.00412 | 183.1*** |
| CARES Aid × Signed into Law | -13.32*** | -20.30*** | -11.67*** | -16.04*** |
| ARP Aid × Signed into Law | -0.134 | -2.489*** | -3.026*** | -5.237*** |
| Init. Claims Rate PUA | 2.323** | -22.69*** | -2.320* | -16.05*** |
| Cont. Claims Rate PEUC | -0.408 | -2.291*** | -5.109*** | -6.699*** |
| FED Ann. 3-23-20 Post Ind. | -17.79*** | 13.62 | 2.432 | 51.79*** |
| MLF Ann. 4-9-20 Post Ind. | -34.76*** | -16.49* | -50.23*** | -25.32*** |
| MLF Ann. 4-27-20 Post Ind. | 20.15*** | 61.29*** | 48.71*** | 65.34*** |
| MLF Ann. 5-11-20 Post Ind. | -61.05*** | -50.45*** | -48.17*** | -45.19*** |
| MLF Ann. 6-3-20 Post Ind. | -12.66*** | -63.17*** | -12.79*** | -72.54*** |
| MLF Ann. 8-11-20 Post Ind. | 11.63*** | -6.624* | 12.94*** | 2.896 |
| MLF Issuance Enter Value | - | 0.0200 | - | 0.0101 |
| Stay-at-Home Order in Effect | -4.170 | -6.521 | 6.847** | -9.925 |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.511** | 0.544 | 0.910*** | 0.976** |
| Positivity Rate (Adj. Smooth) | -0.313*** | 0.847*** | -0.653*** | 0.780*** |
| New Deaths/100,000 7d avg. | -14.60*** | -19.91*** | -39.45*** | -31.15*** |
| Constant | -256.1*** | 507.8*** | -405.3*** | 794.1*** |
| Observations | 2,951 | 2,950 | 2,951 | 2,950 |
| R-squared | 0.849 | 0.814 | 0.826 | 0.845 |
| StateFE | Yes | Yes | Yes | Yes |

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

Table 6: Partisan Lean

# 6 Robustness of the Baseline

In this section, we analyze the robustness of our results to using muni-Treasury spreads that are not tax adjusted, to control for CDS spreads rather than credit ratings, and to the exclusion of Illinois which is the state with the lowest credit ratings.

As it can be noted in Tables 7 and 8, the results obtained using unadjusted muni-Treasury spreads are very similar to those for tax-adjusted muni-Treasury spreads (Tables 1 and 2), and therefore the main message about the relative efficacy of FP and MP interventions remains the same. The only meaningful difference is the absolute magnitude of all coefficients, which in the case of tax-adjusted spreads is larger. This is somewhat mechanical because, under the assumption of no changes in state tax laws, the tax-adjusted muni-Treasury spreads are on average 1.6 times larger than unadjusted muni-Treasury spreads. However, since many states enacted tax changes for fiscal year 2020, for instance, in response to the Supreme Court's Wayfair decision to collect taxes on online sales (Dadayan, 2020), then the ratio between tax-adjusted and unadjusted coefficients will not be constant at 1.6 for all states, affecting the average ratio in the panel regressions.

Tables 9 and 10 summarize the results obtained replacing credit rating with CDS spreads in the baseline specification. The coefficients on CDS spreads are positive and significant at all maturities and their size is smaller for longer-term muni bonds. Since FP and MP interventions affect state CDS spreads and muni yields contemporaneously, even if we use lagged CDS spreads, their coefficients still capture part of the effects of the various policy interventions, that is, the portion related to credit risk. This makes the overall impact of FP on muni spreads smaller because, as shown in Section 4, ARP and PEUC have been particularly effective at reducing longer-run credit concerns. In contrast, MP interventions account for a larger share of the total decline in muni spreads. For instance, at the 3-year maturity, MP explains 117 rather than 76 bps out of 245bps. Further, MLF Issuance and stay at home orders lose their explanatory power.

Finally, Table 11 reports the estimates for the state subgroups based on credit ratings, that is, the same specification of Table 3, but without IL. The absence of this state, having the lowest credit rating, should affect only the results for the lower-rated group. While it is still true that FP interventions were relatively more effective in lower-rated states, it is interesting to note that in the absence of IL, the coefficients for PUA and PEUC claims are much smaller. This implies that these unemployment

benefits were large in IL and must have been important in reducing its muni yields. For instance, as pointed out in Dadayan(2020), "the additional $600 weekly unemployment insurance benefit not only helped many Americans continue to pay for everyday necessities, it also may have helped the 35 states with a broad-based income tax that tax unemployment benefits partially sustain withholding revenues."

Finally, without IL, the earlier MLF announcements have a larger effect, indicating that initially the MLF was not particularly helpful to vulnerable states like IL.

| MT Spread | 2Y | 3Y | 4Y |
|---|---|---|---|
| Numerical Credit Rating (S&P) | -31.69*** | -31.22*** | -32.85*** |
| Interp. Workplace Mob. | -2.853*** | -2.745*** | -2.684*** |
| Leisure/Hospitality Revenue | -5.565 | 0.791 | 15.54*** |
| CARES Aid × Signed into Law | -9.568*** | -9.164*** | -9.004*** |
| ARP Aid × Signed into Law | -0.413*** | -0.955*** | -1.481*** |
| Init. Claims Rate PUA | -3.438*** | -3.140*** | -2.931*** |
| Cont. Claims Rate PEUC | -2.201*** | -2.653*** | -3.482*** |
| FED Ann. 3-23-20 Post Ind. | -2.487 | 3.996 | 13.55*** |
| MLF Ann. 4-9-20 Post Ind. | -19.83*** | -19.14*** | -17.33*** |
| MLF Ann. 4-27-20 Post Ind. | 19.32*** | 22.54*** | 24.20*** |
| MLF Ann. 5-11-20 Post Ind. | -31.13*** | -32.49*** | -29.65*** |
| MLF Ann. 6-3-20 Post Ind. | -6.421*** | -11.83*** | -16.26*** |
| MLF Ann. 8-11-20 Post Ind. | 5.044*** | 3.857*** | 1.838 |
| MLF Issuance Enter Value | 0.0148* | 0.0138* | 0.0127* |
| Stay-at-Home Order in Effect | 3.887* | 4.543** | 5.138** |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.300* | 0.320** | 0.373** |
| Positivity Rate (Adj. Smooth) | 0.333*** | 0.276*** | 0.212*** |
| New Deaths/100,000 7d avg. | -7.116*** | -6.906*** | -8.065*** |
| Constant | 219.2*** | 216.9*** | 231.3*** |
| Observations | 5,901 | 5,901 | 5,901 |
| R-squared | 0.777 | 0.808 | 0.822 |
| State FE | Yes | Yes | Yes |

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

Table 7: Unadjusted 2Y, 3Y, 4Y Results

| MT Spread | 5Y | 10Y | 30Y |
|---|---|---|---|
| Numerical Credit Rating (S&P) | -35.52*** | -40.07*** | -46.34*** |
| Interp. Workplace Mob. | -2.770*** | -3.082*** | -2.983*** |
| Leisure/Hospitality Revenue | 31.33*** | 92.59*** | 100.4*** |
| CARES Aid × Signed into Law | -8.984*** | -7.574*** | -5.174*** |
| ARP Aid × Signed into Law | -2.089*** | -4.392*** | -4.204*** |
| Init. Claims Rate PUA | -2.823*** | -2.767*** | -3.089*** |
| Cont. Claims Rate PEUC | -4.427*** | -7.030*** | -6.626*** |
| FED Ann. 3-23-20 Post Ind. | 17.74*** | 22.99*** | 31.39*** |
| MLF Ann. 4-9-20 Post Ind. | -16.48*** | -23.96*** | -9.952*** |
| MLF Ann. 4-27-20 Post Ind. | 26.66*** | 30.51*** | 14.08*** |
| MLF Ann. 5-11-20 Post Ind. | -28.00*** | -31.20*** | -42.80*** |
| MLF Ann. 6-3-20 Post Ind. | -18.14*** | -15.93*** | -20.05*** |
| MLF Ann. 8-11-20 Post Ind. | -1.894 | 1.603 | -4.715*** |
| MLF Issuance Enter Value | 0.0118 | 0.0106 | 0.0108 |
| Stay-at-Home Order in Effect | 4.875** | 5.877** | 7.370*** |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.448*** | 0.769*** | 0.850*** |
| Positivity Rate (Adj. Smooth) | 0.177** | 0.127* | -0.0460 |
| New Deaths/100,000 7d avg. | -10.13*** | -17.99*** | -17.97*** |
| Constant | 253.9*** | 313.3*** | 351.1*** |
| Observations | 5,901 | 5,901 | 5,901 |
| R-squared | 0.834 | 0.845 | 0.854 |
| State FE | Yes | Yes | Yes |

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

Table 8: Unadjusted 5Y, 10Y, 30Y Results

| Tax-Adjusted MT Spread | 2Y | 3Y | 4Y |
|---|---|---|---|
| Lag CDS Spr. (Maturity-Matched) | 1.499*** | 1.460*** | 1.400*** |
| Interp. Workplace Mob. | -4.247*** | -3.850*** | -3.482*** |
| Leisure/Hospitality Revenue | -32.90*** | -42.31*** | -40.30*** |
| CARES Aid × Signed into Law | -16.66*** | -16.02*** | -15.68*** |
| ARP Aid × Signed into Law | 0.383** | 0.403*** | 0.472*** |
| Init. Claims Rate PUA | -6.812*** | -6.408*** | -6.273*** |
| Cont. Claims Rate PEUC | -1.014* | -0.695 | -0.850* |
| FED Ann. 3-23-20 Post Ind. | -27.96*** | -19.60*** | -5.806 |
| MLF Ann. 4-9-20 Post Ind. | -46.38*** | -48.39*** | -48.47*** |
| MLF Ann. 4-27-20 Post Ind. | -12.06** | -10.94** | -10.81** |
| MLF Ann. 5-11-20 Post Ind. | -58.16*** | -60.98*** | -56.46*** |
| MLF Ann. 6-3-20 Post Ind. | 7.692** | 2.281 | -2.034 |
| MLF Ann. 8-11-20 Post Ind. | 18.21*** | 20.58*** | 21.51*** |
| MLF Issuance Enter Value | 0.00142 | -0.00189 | -0.00517 |
| Stay-at-Home Order in Effect | 2.645 | 3.917 | 4.443 |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.222 | 0.180 | 0.188 |
| Positivity Rate (Adj. Smooth) | 0.681*** | 0.598*** | 0.479*** |
| New Deaths/100,000 7d avg. | -16.79*** | -16.30*** | -17.31*** |
| Constant | 21.14*** | 16.77*** | 17.83*** |
| Observations | 5,308 | 5,308 | 5,308 |
| R-squared | 0.846 | 0.875 | 0.889 |
| State FE | Yes | Yes | Yes |

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

Table 9: Baseline 2Y, 3Y, 4Y with CDS Spreads

| Tax-Adjusted MT Spread | 5Y | 10Y | 30Y |
|---|---|---|---|
| Lag CDS Spr. (Maturity-Matched) | 1.312*** | 0.874*** | 0.0130*** |
| Interp. Workplace Mob. | -3.377*** | -3.790*** | -4.389*** |
| Leisure/Hospitality Revenue | -36.23*** | 42.01*** | 106.1*** |
| CARES Aid × Signed into Law | -15.49*** | -13.02*** | -8.995*** |
| ARP Aid × Signed into Law | 0.209 | -2.249*** | -4.246*** |
| Init. Claims Rate PUA | -6.153*** | -6.339*** | -7.085*** |
| Cont. Claims Rate PEUC | -1.552*** | -4.327*** | -6.591*** |
| FED Ann. 3-23-20 Post Ind. | -0.512 | 11.63 | 32.96*** |
| MLF Ann. 4-9-20 Post Ind. | -49.12*** | -57.24*** | -16.41*** |
| MLF Ann. 4-27-20 Post Ind. | -7.662* | 20.13*** | 34.65*** |
| MLF Ann. 5-11-20 Post Ind. | -53.58*** | -53.51*** | -65.84*** |
| MLF Ann. 6-3-20 Post Ind. | -2.022 | -15.97*** | -42.04*** |
| MLF Ann. 8-11-20 Post Ind. | 18.50*** | 27.78*** | -0.414 |
| MLF Issuance Enter Value | -0.00792 | 0.000123 | 0.00983 |
| Stay-at-Home Order in Effect | 4.294 | 6.909** | 4.291 |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.254 | 0.685*** | 1.208*** |
| Positivity Rate (Adj. Smooth) | 0.388*** | 0.350*** | -0.279** |
| New Deaths/100,000 7d avg. | -19.57*** | -27.73*** | -22.47*** |
| Constant | 22.42*** | 75.82*** | 176.4*** |
| Observations | 5,308 | 5,308 | 5,308 |
| R-squared | 0.899 | 0.887 | 0.845 |
| State FE | Yes | Yes | Yes |

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

Table 10: Baseline 5Y, 10Y, 30Y with CDS Spreads

| Initial Credit Rating | Low | High | Low | High |
|---|---|---|---|---|
| Tax-Adjusted MT Spread | 3Y | 3Y | 10Y | 10Y |
| | | | | |
| Numerical Credit Rating (S&P) | 45.41*** | 3.937 | 4.038 | 35.37*** |
| Interp. Workplace Mob. | -4.311*** | -3.439*** | -4.514*** | -3.597*** |
| Leisure/Hospitality Revenue | -13.97 | -70.17*** | 95.75*** | 41.67*** |
| CARES Aid × Signed into Law | -19.18*** | -13.10*** | -16.04*** | -11.09*** |
| ARP Aid × Signed into Law | -0.778*** | -0.142 | -3.462*** | -3.057*** |
| Init. Claims Rate PUA | -8.170*** | 0.402 | -6.604*** | 1.655 |
| Cont. Claims Rate PEUC | -1.477** | -0.591 | -6.658*** | -4.420*** |
| FED Ann. 3-23-20 Post Ind. | 9.576 | -17.78*** | 39.93*** | 13.54** |
| MLF Ann. 4-9-20 Post Ind. | -29.02*** | -34.78*** | -34.59*** | -50.11*** |
| MLF Ann. 4-27-20 Post Ind. | 34.99*** | 18.07*** | 58.60*** | 36.68*** |
| MLF Ann. 5-11-20 Post Ind. | -65.91*** | -64.54*** | -58.02*** | -52.27*** |
| MLF Ann. 6-3-20 Post Ind. | -22.74*** | -13.64*** | -42.83*** | -15.31*** |
| MLF Ann. 8-11-20 Post Ind. | 8.820*** | 7.708*** | 9.024*** | 9.506*** |
| MLF Issuance Enter Value | - | -0.00224 | - | -0.0104 |
| Stay-at-Home Order in Effect | -3.086 | -6.796** | -14.05*** | 5.439* |
| $\Delta$ Daily Cases/100,000 7d avg. | 0.463* | 0.662*** | 0.793*** | 1.017*** |
| Positivity Rate (Adj. Smooth) | -0.341** | -0.192** | 0.0674 | -0.804*** |
| New Deaths/100,000 7d avg. | -2.733 | -11.45*** | -21.78*** | -22.11*** |
| Constant | -265.8*** | 55.96 | 108.4*** | -220.3** |
| | | | | |
| Observations | 2,070 | 3,534 | 2,070 | 3,534 |
| R-squared | 0.824 | 0.835 | 0.828 | 0.795 |
| StateFE | Yes | Yes | Yes | Yes |

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

Table 11: Fiscal Risk without Illinois

# 7 Conclusions

By the end of our sample, May 2021, tax-adjusted muni-Treasury spreads had returned to their pre-pandemic levels, after reaching a peak of about 450 bps. Our estimates suggest that fiscal and monetary policy reduced muni-Treasury spreads by about 240 bps at short maturities and 225 bps at longer maturities. Fiscal policy contributed twice as much as monetary policy to the notable reduction in shorter-term spreads. At longer maturities, the contribution of fiscal policy was at least three times as large as that of monetary policy, suggesting that fiscal policy was much more effective at reducing states' fundamental credit risk.

Despite only Illinois and the Metropolitan Transit Authority issuing $6.6bn to the MLF, the facility met several objectives. First, by reducing muni yields at the height of the Covid-19 crisis, it helped states and municipalities manage cash flow pressures from the pandemic. And second, by providing a backstop, it maintained liquidity in the market and encouraged private investors to return to municipal securities.

While fiscal policy appeared to be more effective in reducing muni spreads of states with relatively higher population density, lower credit ratings, and larger tax revenue losses due to the pandemic; the impact of monetary policy on the muni spreads of those same states was somewhat smaller. Indeed, while in existence, the MLF needed some extensions to be helpful to a larger number of states, but its terms remained more restrictive than those offered to corporate borrowers. Although the MLF should not be a substitute for fiscal policy, it could be more effective if some of its terms were to be revised. For example, the MLF was limited to the primary market, notes with no more than 36 months until expiration, and its pricing was at a significant "penalty rate" above the typical market rate.

Finally, in evaluating the relative efficacy of fiscal and monetary policy, the cost to the taxpayers should be considered by policymakers. While fiscal aid to states totaled about $550bn, if all loans are paid back to the MLF, its overall cost would mainly consist of the administrative costs of the facility. Hence, the cost benefit ratio suggests that the MLF was quite successful. However, the role of fiscal policy in muni debt market has been much larger, and we have not considered its effect on the broader economy, which could be the subject of future research.

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