Calling All Issuers:
The Market for Debt Monitoring[*]

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ABSTRACT

Almost 95% of long-term municipal bonds have callable features, and despite low interest rates, we find that a substantial fraction of local governments exercise these options with significant delays. Using data from 2001 to 2018, we estimate that U.S. municipals lost over $31 billion from delayed refinancing, whereas U.S. corporates lost only a comparative $1.4 billion. We present evidence that these delays are related to gaps in localized debt monitoring of issuers by their underwriters. For instance, when a bond's call unlocks in the fiscal year-end calendar month of a local government – a particularly busy time for finance departments – the decision to call is delayed significantly longer. A significantly longer delay also occurs when a municipality is faced with an abnormally large number of calls all coming due at once. These effects are magnified in smaller municipalities, staffed with smaller finance departments. Moreover the market for underwriters (outside monitors), is a dispersed one exhibiting substantial variation in local specialization. While the municipality-underwriter relationship is quite sticky over time - with 87% of a municipality's bonds being issued with the same underwriter over our sample period – it is the locally specialized underwriters who are in particular associated with the least amount of delays. This positive local specialization impact is accentuated especially for the smallest issuers.

I.   Introduction

Over the last two decades, market interest rates have fallen to unprecedented levels, creating unique opportunities for borrowers to refinance at more advantageous rates. In the bond market, the optimization of this decision involves coordination from issuers and their financial underwriters. While prior literature has shown that excessive advance refunding of municipal bonds with locked call options destroys value, in this paper, we evaluate the decision to call and refinance currently callable bonds. In contrast to the corporate bond market, we find that although the vast majority of these municipal bonds contain a call feature (nearly 95%), there are systematic, and large savings left unutilized by a sizable number of issuers. Many municipals over time, location, and bond-issue size do not call their bonds in a timely manner, even *after* their bonds have become callable, resulting in significant value lost for their municipalities.

We estimate that, between January 1, 2001 and December 31, 2018, $1.74 billion USD is lost in the municipal market by issuers each year due to late calls. Over our sample period, this amounts to a total of $31 billion USD, even after accounting for conservative estimates of issuance fees and other transaction costs. This is in stark contrast to delays in the corporate bond market, where we estimate a comparably miniscule loss of $78 million per year.

Delays in municipal calling vary within and across bond issue sizes, municipal issuer sizes, geographic locations, sample periods, bond structures, bond purposes, and credit ratings. To explain why some municipals are more likely to delay calling than others, we show that issuers have varying workloads over time and are slower to call when they are especially busy – for instance, just at the fiscal year-end, and when the municipality is experiencing a wave of reissuances to manage all at once.

While competitive underwriters that monitor this market for transactions can help remedy inattentiveness, their relationships to municipal issuers vary greatly ex ante and in turn affect the efficacy of debt monitoring. We show that municipals have sticky relationships with their lead underwriters over time, and in turn, the issuers who rely heavily on underwriters that are less active in their geographic region are significantly more likely to have delays in calling.

We begin our analysis by characterizing bonds in the municipal market at the time when the bond first becomes callable- i.e. their unlock date. We find that municipal bonds tend to have coupon rates fixed at around 5% and call prices fixed at par principal value. In contrast, their average issuance yields have generally fallen over our sample. For example, the offering yields are as low as 1.5% in 2019 for AAA-rated bonds. These empirical facts imply that there may be substantial issuer savings to be gained through refinancing as soon as these bonds are unlocked.

Next, we outline our theoretical framework for valuing the call option. From the perspective of the issuer, the embedded call is an American call option on a non-callable but otherwise identical bond. The strike price is the call price of the bond. To calculate the market implied value of the call options, we assume that municipal short rates follow a one factor random walk with a lower bound at zero. For simplicity, we also assume a flat yield curve and a semi-annual volatility of 40 basis points. We calculate the expected exercise values and continuation values of the call option for a range of different market rates, coupon rates, and times-to-maturity. Then, to estimate the empirical value lost by municipals each year, we take our valuation surface to the data: we group the panel of callable bonds in each year by buckets and match them with our theoretical estimates based upon coupon rate, market yield corresponding to their credit rating, and the number of remaining coupon payment periods. Summing up across all callable bonds outstanding per year with investment grade credit ratings, we find that the value lost is roughly $1.74 billion dollars per year. We conduct a similar estimation exercise using corporate bonds in the same sample period, and find a significantly lower magnitude of $78 million per annum.

In the remainder of the paper, we explore a variety of factors associated with the municipalities, bond issues, and timing of call delays across geographies and that may explain the observed variation in the decision to delay bond calls. First, we consider a set of basic bond characteristics, controlling for state, year, bond type, and initial rating fixed effects. We find that bonds are significantly more likely to experience delays in redemptions when they receive a credit downgrade, have more time remaining until maturity, have a smaller issuance size, pay smaller coupons, or have a lower offering yield. However, even controlling for these bond characteristics and fixed effects, there is still

substantial unexplained variation in calling delays; the R-squared from the full specification regression explaining delays is only 14%. Motivated by these persistent and systematic delays, we next explore the municipal issuer and financial agents involved in the decision to call a municipal bond to attempt to better understand who – and at what points – the delays might be most closely associated with.

Calling a bond is a multi-dimensional decision (often involving a paired re-financing) that requires the time and energy of the issuers. Supporting this, over our sample period, we find that on average it takes seven months for an issuer to call a bond after its call option unlocks. We find that issuers who have a heavier workload, defined as having more bonds that are callable in a year than their average over the last ten years, take longer to refinance their bonds. During fiscal year ends, local governments face tighter time constraints as they prepare and submit their annual budgets.[1] Consistent with this, we find that general obligation bonds that become callable during the month of the fiscal year end are delayed by an additional two months (t=2.21). In contrast, revenue bonds – whose signing authorities are *not* the local government (e.g., Yankee Stadium), and so are not tied to taxpayer funding or follow the same fiscal calendar, do not exhibit these year-end patterns.

Financial underwriters are key monitors in the municipal market, as they specialize in bond valuation and can earn commissions by refinancing callable bonds. While issuers can always switch underwriters – stemming from either side of the match deciding to re-solve with a new issuer/underwriter - we find that the underwriter-issuer relationship is empirically remarkably sticky. On average, over our sample, an issuer uses the *same* lead underwriter for 87% of its bonds. Moreover, we find that an issuer who remains in the same "sticky" underwriter relationship at the time their bond becomes unlocked is 8.1 percentage points more likely to delay calling than an issuer who has switched its underwriter since issuance.

That said, we do find that there is an underlying empirically observed geographic-specialization of certain underwriters by region. In particular, while there are certain

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[1] We would like to thank Julia Cooper, Director of Finance for the City of San José, for the suggestion that fiscal calendars and workload causes calling delays at some offices, especially for smaller issuers.

underwriters with national level presence (e.g., Citibank, JP Morgan, and Merrill Lynch), we show that many other underwriters have specific regional focuses – being very active in some regions, while essentially non-existent in others. One example of this is Dougherty & Company LLC, which has written over $5.2 billion USD of municipal bonds in North and South Dakota but does not underwrite bonds in any other state. In regressions, we find that bonds using underwriters who have a larger local presence are significantly less likely to delay calling. Within each state, the largest underwriter by total volume underwritten per year is associated with a bond that is 8.4 percentage points (t=9.33) less likely to delay compared to a bond associated with the smallest underwriter.

Interestingly, however, if the issuer is tied to an underwriter (monitor) with a significant local presence, this delayed call behavior disappears. Finally, supporting the theory of sticky relationships, we examine the fall of Lehman and Bear Stearns – who themselves were significant municipal bond underwriters market while going concerns. We find that when municipal issuers who had utilized these banks as lead underwriters were forced to abruptly re-solve and find new ones following these banks' respective bankruptcies, these municipalities experienced a significant increase in their likelihood to delay (vs. all other issuers at the same time, and they themselves pre-respective-bankruptcy).

There are other players in the market for municipal debt monitoring of local governments, as well. The most central of these external agents in this market are Municipal Financial Advisors – taking the role of advisor to municipalities regarding issuance, re-issuance, calling, terms, underwriter choice, etc.[2] We explore this relationship, as well. In initial findings, we find that the relationship between the municipality and financial advisor – much like that with the underwriter – is empirically very sticky over time, and exhibits regional focus. However, the use of a financial advisor by a municipality does not seem to substantially alleviate the calling delays we observe in the data.

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[2] Specialized municipal-finance legal counsel are additional external agents utilized by certain municipalities. They commonly advise on issues including tax-efficiency, ongoing disclosure, and other considerations of the offering/re-issuance/calling. However, from our conversations with municipalities and advisors, they do not commonly take a large role in advising the decision to call.

Ultimately, the decision to refinance is a crucial one for institutions, especially in low interest rate environments, because it could save issuers billions of dollars in borrowing costs. In the municipal market, these savings could translate into improvements for public projects or could lower required future tax burdens for constituents. To our knowledge, we are the first to document the substantial value destroyed by security issuers who *delay* the decision to utilize refinancing options. Moreover, we find evidence that a number of markers of imperfect market monitoring are significantly related to these calling delays. Further exploration into the remarkably sticky underwriter-issuer relationships, their genesis, reinforcing equilibria (including the role of municipal advisors), along with the full range of their implications for states', cities', hospitals', public-works' and all municipal issuers' quantities and rates of financing has first-order implications for understanding growth more broadly.

The rest of the paper proceeds as follows. We discuss related literature in Section II, discuss our data sources in Section III, and present our findings, including on the impacts of our novel mechanisms of workload, busy-ness of the municipality, and outside debt monitoring, in Section IV. Finally, Section V concludes.

II.   Literature

Our paper contributes to several literatures. Foremost, toward the field of public finance, we document the current debt refinancing channel of inefficiencies in state and local governments. Past works have examined bonds that engage in *advanced* refunding's as spurred by short-comings in municipal cash-flows. In a paper most closely related to our work, Ang, Green, Longstaff, and Xing (2017) find that financially constrained municipals are likely to refund their debt *before* the bond's call option unlocks (i.e. employing an advanced refunding) and a substantial number of these advance refunding's occur at a net present value loss. This follows other works on advanced refundings: (Dammon and Spatt (1993), Kalotay and May (1998), and Kalotay and Abreo (2010)). Additionally, Butler, Fauver, and Mortal (2009); Gao, Murphy, and Qi (2019b); and Nakhmurina (2020) demonstrate that municipal governance is significantly related to

bond market outcomes. Other examples of municipal market inefficiencies include Garrett (2021), which studies dual advisors; Cornaggia, Hund, and Nguyen (2020), which studies bond insurance; and Dagostino (2018), which studies bank financing. We differ from these prior works by showing that a significant number of municipals delay in the utilization of bond call options after their respective unlocks (i.e. employing a current refunding), and this results in substantial implied losses for municipalities. The municipal bonds that drive this loss are well represented across time, issuer size, bond size, geography, bond structure, and funding purpose – and in recent times comprise a much larger set of bonds. We utilize these samples to give insight into how underwriter relationship in the municipal securities market affect an issuer's ability to effectively manage finances.

This issuer monitoring channel ties our study to a literature on security issuances in the financial markets. Altinkilic and Hansen (2000) and Yasuda (2005) examine underwriters and their respective issuance fees of corporate bonds. A line of research including Hansen and Torregrosa (1992), Ritter and Welch (2002), Ljungqvist, Jenkinson, and Wilhem (2003), and Drucker and Puri (2005) investigate the interactions between investment bank underwriters and their corporate clients. Additional evidences from Burch, Nanda, and Warther (2005) show that there are significant costs for issuers who switch from existing underwriter relationships. Similar to our examination of municipal underwriting relationships, Fernando, May, and Megginson (2012) examines the collapse of Lehman Brothers on their respective corporate investment banking relationships. Equity in firms that had strong ties to the aforementioned investment bank had strong abnormal negative returns in the days surrounding its respective bankruptcy.

Lastly, we add to a set of papers that specifically seeks to understand refinancing decisions by agents. There is a substantial literature on personal debt refinancing from interest rate fluctuations. For example, Agarwal, Amromin, Ben-David, Chomsisengphet, Piskorski, and Seru (2017) and Defusco and Mondragon (2020) investigate channels that prevent agents from optimally refinancing mortgage debt. In the corporate market, Becker, Campello, Thell, and Yan (2018) show that longer maturity and lower quality bonds are more likely to be issued with a callable feature. Specific to the municipal market, studies using a limited subset of available bond issues highlight the unique factors that drive bond issuances. These examples include political considerations (Vijayakumar, 1995) and issuer

characteristics (Moldogaziev and Luby, 2012). In contrast to these previous case studies of the municipal market, we utilize the most comprehensive set of U.S. bonds outstanding between 2000 and 2018. To our knowledge, we are the first paper to quantify the large and economically meaningful value lost through delays in municipal redemptions, and the underwriters' roles in monitoring for call-option delays.

III.   Data

Our main dataset comes from Mergent's Municipal Bond database, which covers the majority of municipal bonds outstanding and includes bonds dating back to the 1800s. For each bond, we observe issuance information including issuer, state, coupon, par value, issuing yield, maturity date, project type, dated date, as well as information on the underwriters and advisors. For each bond, we also observe the date in which the call option was unlocked and if it was either partially or fully redeemed at specific redemption dates.

The coverage of the Mergent data on the US municipal issuance market is comprehensive. We compare the aggregate value of bonds outstanding from Mergent against the Securities Industry and Financial Markets Association's annual report, and we find that the two time series have roughly the same magnitudes. We also verify the calling status of bonds in Mergent against Bloomberg for all bonds with over $1.5 million USD of par value outstanding. If the bond was reported to have been called in Bloomberg but not in Mergent, then we supplement the Mergent data with Bloomberg information on both the call date and called amount.

Our main analysis is conducted on the set of long term (with maturities of at least 10 years) callable bonds whose call options were unlocked between January 1, 2001 and December 31, 2018. In order to have a uniform sample, we remove all bonds that had a super sinker provision, defaulted, or were issued in one of the following territories: Puerto Rico, Virgin Islands, Guam, and Detroit. Furthermore, in order to keep the call decision straightforward, we remove bonds that were issued with variable rates, make whole provisions, as well as put options. Finally, we drop very small bonds (CUSIP level) with par amounts less than 150,000 USD; and in regression analyses, since we include credit

quality fixed effects, we only keep bonds that had credit ratings within a year of their issuance.[3] Our final sample covers 194,159 unique bonds and 25,523 unique issuers. Table 1 summarizes some of the key characteristics of our main sample. We see that in our sample, bonds on average have an offering price of $101.13, a coupon rate of 4.72%, and an offer size of $4.39 million.

Finally, our bond credit ratings come from Standard & Poor's Capital IQ database. For each bond in our main sample, we obtain the rating at the time of issuance as well as at the time when the call option was unlocked. If a rating is missing at the time of a bond's issuance, we use the rating from within one-year of the bond's issuance date.

IV.   Results

IV.1   Delays in Calling

IV.1.1 Summary

Between 2001 and 2018, we find that a large fraction of callable municipal bonds delay redemption- waiting at least one year after their call option unlocks to call. Figure 1 shows the total par value of currently callable bonds (blue line) and the portion of these bonds that still did *not* call by the end of the year (orange line). We see that while aggregate total dollar bond volume has been trending up steadily since 2001, it has declined since the financial crisis in 2008-2009. This said, the uncalled-portion remains a sizable majority of the portion-value. In 2018, for instance, roughly $75 billion USD of municipal bonds had call features which were unlocked, but most of these bonds still did not redeem their call option over the following year. This pattern is consistent over the last ten years, showing that many municipal bonds do not call promptly after their unlocking date.

While a large portion of municipal bonds do not call over our sample, this is not typical of all bond markets. As a benchmark in Figure 2, we show the estimated call-value lost from municipal bonds (blue line) compared to corporate bonds (orange line). We see

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[3] Regression results are consistent if we include these unrated bonds as a separate dummy category, and they can be shared upon request.

that, despite the much larger size of the corporate bond market (and that over half of these bonds (and rising) also contain callable features), there is comparatively significantly less value lost due to any delay in calling behavior over the same period and economy-wide interest rate trends. This is consistent with a different behavioral disposition regarding the timeliness of exercising the valuable option to call between corporate vs. municipal issuers.[4] One possible explanation for the differences between these two markets is the sophistication of issuers and the underwriters that advise them on calling decisions; we will test this hypothesis in Section IV.3.

Over our data sample period of 2001-2018, several market conditions made it optimal for municipal bonds to refinance. While issuance yields declined for all segments of credit ratings in the municipal debt market, coupon rates of the existing callable debts remained fixed around 5%, and there were significant tenors remaining after the call options were unlocked. Figure 3 shows the coupon rate at issuance (Panel A) and the remaining number of years to maturity at time of unlock (Panel B). We see that the mean and median of coupon rates centers at 5% with most coupon rates falling between 4% and 6%. In addition, Panel B shows that the number of years remaining in unlocked bonds ranged from 0 to 30, and most bonds have a significant amount of time left over so that refinancing should be a key consideration.

For refinancing to be optimal, bond yields must be low enough to offset future coupon payments. In Figure 4, we show the offering yield of bonds offered between 2009 and 2018 over different credit rating buckets. While lower rated bonds naturally have higher yields to compensate for their credit risk, we see that yields are low relative to the average 5% coupon rates and have generally trended downwards across all bond ratings. For example, while AAA bonds were issued with a yield of roughly 4.25% in 2009, they were issued with a yield of 2.5% in 2019. This implies that, over time, there is a sizable and rising premium for issuers redeeming and creating new issues.

IV.1.2 Comparison to Advance Refunding

It is important to distinguish between refunding prior to the call unlock date (an advance refunding) versus calling after the call option has unlocked (a current refunding).

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[4] We detail our method of calculating value lost in Section IV.2.

Delays to current refunding coexist with but are separate from advance refundings, which are essentially synthetic early calls and are another key feature of the municipal market, especially prior to 2018 when tax-exempt advance refundings was eliminated by The Tax Cuts and Jobs Act of 2017.[5] The set of advance refunded bonds and bonds with calling delays are mutually exclusive. Since advance refunded bonds must call at the original bond's first call date, their calls are *never* delayed by definition. Therefore, all of our results are empirically distinct (by construction) from advance refundings.

That said, we were interested to explore the two phenomena more deeply to understand any potential relationships in the data. Issuers that advance refund tend to look different from those that call with delays. They are attentive to interest rates and seek to benefit from reduced cash outflows (Ang et al. 2017). Conversely, as we find in Section IV.3, issuers that delay calling appear to be less attentive to financial opportunities and are more reliant on external financial agents to help them refund. Consistent with this, we find that while a small number of issuers do both advance refundings and delay current refundings, the overwhelming majority strongly prefer one to the other - the correlation between percent of advance refundings and percent delays within an issuer in our sample is -0.7. Finally, as we find in Tables 5 and 6, bonds which are advance refunded have characteristics which are generally the opposite of bonds that delay calling. For example, they tend to have larger coupons and have larger par amounts than bonds which are called with a significant delay.

IV.1.3 Variation across States, Bond Types, and Credit Ratings

In this section, we examine how calling delays vary within a number of observable bond characteristics. In particular, we explore whether the delay in calling exists both across and with three different dimensions: state of issue, bond type, and credit rating. While there is significant variation across each of these categories, there is also significant variation within each of them. So, across municipalities within the same state, within the

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[5] Figure A1 shows the annual par amount of advance refunded bonds over time, and we see that there is a steep drop in recent years beginning in 2018 due to the tax reform. While municipal bonds can still be advance refunded into taxable bonds, these are less attractive to some investors, and thus, less attractive to municipals as well.

same bond type, and with the same credit rating, we see a large amount of variation in calling behavior across municipalities.

To begin the exploration, Table 2 summarizes the variation in delay to calling across states, sorted by the size of each state's municipal bonds outstanding. California, New York, and Texas have the largest number of bonds outstanding with \$344.6, \$324.8, and \$232.0 billion outstanding, respectively. We see that there is significant variation in the percent of bonds which delay by at least one year (Column 4) as well as the percent that never call (Column 5). For example, while 35% of bonds are delayed in California, only 12% are delayed in Connecticut. Figure 5 visually depicts the variation in the delay to call across states. In Panel A, we show the percent of bonds that call with at least one-year delay by state, and we see that there is substantial variation. While states like California, Arkansas, and Mississippi delay more than 24% of their callable bonds, states like Nevada and Utah delay less than 19% of their bonds. In Panel B, we show the percent of bonds that never call at all, and we see a very similar pattern. States like Arkansas never call at least 14% of their bonds, while states like Nevada never call less than 10% of their bonds.

Next, we find that there is variation in the decision to call across the funding sources of municipal bonds. We see in Table 3 that 52% of bonds that are funded through special taxes experienced redemption delays of one year or more. On the other hand, 18% of General Obligation (GO) bonds, despite having the safest and lowest default probability, experience redemption delays of one year or more. In fact, 11% of GO bonds with call options unlocked between 2009 and 2018 never call.

Finally, Table 4 summarizes the delay in calling by each bond's credit rating at the time when the call option unlocked.[6] We see that despite having extremely high credit quality, over 25% of bonds with a AAA rating delayed calling over our sample. Furthermore, nearly 10% of AAA bonds never call. Likelihood of delay then broadly rises as the credit quality declines. For example, over 31% of BBB rated bonds call with delays.

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[6] We also break down the categories by whether the bond was downgraded prior to the unlock date. We find that while downgraded bonds were more slightly likely to delay, downgrades do not explain a lot of variation in calling delays. In general, for bonds with contemporaneous ratings of BBB or higher, the likelihood of delay is similar for downgraded and non-downgraded bonds.

IV.2 Calculating Value Lost from Delay

IV.2.1 Understanding the Decision to Call

In this section, we will consider the issuer's decision to call a bond after its call option has been unlocked. To begin, let's consider a hypothetical 5% coupon bond with a callable option. For simplicity, we assume that the callable option allows the issuer to call the bond at par starting from a set date, which we will refer to as the unlock date. Panel A of Figure 6 shows the expected cash flows if an issuer chooses to never exercise the call option. In this case, the issuer receives the offering price at the beginning of the bond issue and pays 5% coupon payments to the investors until the maturity date, when he also returns the principal. On the contrary, if a call option is exercised, as shown in Panel B of Figure 6, then the issuer pays off the principal before the maturity date. In this case, the issuer can reissue the remaining cash flows at the current market price. If current yields are lower than the coupon rate, then this bond can issue at a price higher than par and capture a price premium. The exercise of the option is determined by how much of a premium over par the subsequent coupon payments are currently valued at.

The issuer essentially has an American call option on a non-callable but otherwise identical bond, which pays coupons from the unlock date to the maturity date. At each coupon payment date, there is an Exercise Value for exercising as well as a hypothetical Continuation Value for not exercising the call and waiting till the next payment date (assuming that the issuer only exercise at these intervals). If the continuation value is greater than the exercise value, then the issuer should wait to redeem the bond. If the exercise value is lower than the continuation value, then the issuer should exercise the call option. If the issuer chooses to wait instead, then the differential between the Exercise Value and the Continuation Value is lost.

IV.2.2 Valuing the Call Option

We estimate the value of the call option using simple option value techniques. To start, we chose a risk neutral dynamic for the market municipal rate, where we assume that the market muni rate is a one factor random walk with a bound at zero. The yield

curve is flat, and we use 40 basis points as the volatility of the random walk.[7] In Panel A of Figure 7, we show the expected exercise values for different initial rates. The x-axis shows the number of years from the unlock date, and in this example, we assume that there are ten years left until the bond matures. Generally, for lower rates, the expected exercise value is higher at the beginning of the bond's life, because calling it captures more value from coupon payments. Calling the bond at par on its maturity date at year ten yields zero value.

Next, we calculate the value lost when not exercising a call option. In Panel B of Figure 7, for year zero, we plot the difference between the continuation value and the exercise value in blue, and we plot the difference between option value and exercise value in red. If current rates are high, then it is optimal to not exercise the option. In this case, the value of the option and the continuation value are the same, and the issuer should wait to call. On the other hand, when rates are low, then it is advantageous to immediately exercise. Therefore, the option value is the same as the exercise value. When the exercise value exceeds the continuation value, the value lost by not exercising is shown as the difference between the red and the blue lines.

Finally, we can calculate the optimal exercise bound for different rates and different tenors. To do this, we follow the simulation methodology outlined in Longstaff and Schwartz (2001). Figure 8 shows the time value of the call option for bonds with different remaining maturities. For longer tenor bonds, it is only optimal to call when the rates are sufficiently low. For shorter tenor bonds, the cost of losing a coupon payment exceeds the option value of the bond going more into the money, and therefore, it is often more optimal to exercise immediately even at higher rates. We can calculate the optimal exercise regions for a range of different durations, current market issuance rates for similar securities, and coupon rates. Figure 9 shows the two-dimensional optimal exercise region for 5% semi-annual coupon bonds in yellow. In the next section, we generate this surface for a cube of maturities, market rates, and coupon rates, and we match it to the empirical data.

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[7] This choice of volatility exceeds the physical standard deviation experienced by muni yields in the past 10 years. The semi-annual realized standard deviation of ten-year muni yields was about 30 basis per every 6 months. The options-implied volatility from the newly callable bonds is about 10 to 20 basis points.

IV.2.3 Estimating Empirical Values

In this section, we estimate the value lost from delays to exercise. We first take the panel of callable bonds outstanding each year. Then, we group them into bins matched by coupon rates (every 10 basis points), market yield (every 10 basis points), and the number of coupon payment periods.[8] Using the aforementioned Merton model, we estimate the optimal exercise value for each bin and the cost of delaying to exercise. Finally, we sum the cost of delayed exercise for all callable bonds per year with investment grade credit ratings from S&P.

We find that the value lost from not exercising call options between 2001 and 2018 is large and economically meaningful. In Figure 2, we plot the dollar value estimated loss from the delay to exercise. The annual value lost assuming a conservative 2% par value issuance fee is shown in blue.[9] We see that it begins at $0.24 billion dollars per year in 2001 and then rises to as high as $3.2 billion per year in 2012. To benchmark this figure, we also plot a similar dollar value estimate of corporate bonds in orange over the identical period, with similarly calibrated volatility and coupon rates. We estimate a significantly lower magnitude for value lost in corporate bonds. These two estimates together indicate that the variation in delays are specific to the municipal bond market.

IV.3 Explaining Variation in Delay

Thus far, we have found that across the universe of municipal bonds, a sizable percentage delay calling or do not call at all, which is generally suboptimal behavior given the low interest rate environment over our sample period. Moreover, we observe substantial variation in calling behavior across states, bond types, and credit ratings. In this section, we explore whether there are factors systematically related to the bonds, times, and agents involved in its issuance that can help understand the decisions to delay calling behavior in more depth.

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[8] For computational simplicity, we approximate all bonds as having semi-annual paying coupons.

[9] Based on issuance fees by state, our empirical data finds 1.2% fees on average, so this is a more conservative estimate.

To do this, we will use the following regression specification:

$$Delay_{i,s,t} = \alpha + \mu_s + \gamma_t + \beta X_{i,s,t} + \epsilon_{i,s,t}$$

where $Delay_{i,s,t}$ is a dummy for delay of one year or more after bond i has unlocked in state s and year t ; μ_s and γ_t refer to state and year fixed effects respectively; and $X_{i,s,t}$ is a vector of characteristics including: bond traits, proxies for issuer attention, underwriter characteristics, and the persistence in relationship between a bond's issuer and its underwriter.

IV.3.1 Explaining Delays using Baseline Bond Characteristics

In Table 5, we begin by examining how the variation in delay to call is related to an initial set of observable traits of the municipal bond, within the state of issuance, bond type, and credit rating. The dependent variable is a dummy for whether the bond, at the time when its call option unlocks, delays the decision to call by at least one year. Independent variables include: a dummy for whether the bond was downgraded prior to its unlock date, remaining days-to-maturity after unlock, log size of issuance, coupon rate, and offering yield. In these baseline regressions, based on our findings in Section IV.1, as mentioned, we additionally control for state fixed effects, project type fixed effects, and initial credit rating fixed effects, along with year of unlock fixed effects.

From Table 5, we delays are positively related to both credit downgrades and remaining months-to-maturity, while being negatively related to the size of the issuance, coupon rates, and offering yield. Thinking through these initial relations, as there is more of a premium to capture when coupon rates are higher than market rates, for instance, it may not be a surprise that coupon rates are negatively and significantly related to delays in Column 1. Next, from Column 2, as the coefficient is negative and significant, this is consistent with the market offering a premium, or lower yields, to issuers who seem less likely to call their bonds in a timely manner. However, as the R-squared is only 11%, delays are likely not expected, nor completely priced in, at the time of issuance.

When a bond is downgraded over its life, the issuer is suggested to have experienced a credit-deterioration and is thus likely to face higher yields at refinancing. As shown in Column 3, it is then not surprising that bonds with downgrades are 5.2% more likely to

delay calling. As discussed in Section IV.2, as the remaining duration of the bond becomes larger, there is more potential value in waiting to call. Consistent with this, in Column 4, the coefficient on days-to-maturity is positive; however, it is not statistically significant on its own at the 95% confidence interval (only in the multivariate full specification in Column 6). Finally, in column 5, the size of the bond issuance is negatively and significantly related to delays. This may be expected for a number of reasons – e.g., as larger bond issues are likely more financially important and salient to issuers and underwriters, one might expect them to be *ceteris-paribus* less likely to be neglected to be called.

In the last column of Table 6, we add all the baseline explanatory variables simultaneously. We find that the coefficients generally remain the same, although the coefficients on coupon and offering yield are halved in the joint specification. We interpret this as due to the positive correlation between these two variables. In addition, days-to-maturity becomes a significant predictor of delays in the multivariate specification. While the fixed effects have an R-squared of 8% on their own, we see that adding these additional factors significantly increases the r-squared to 14%.

In Table 6, we then move on to comparing the traits of delayed calling behavior of bonds with those of advance refunded bonds. Generally, we find that the characteristics of advance refunded bonds are opposite to those of delayed bonds. From Columns 1-5, we see that unlike delayed bonds, advance refunded bonds have larger coupons, have larger offering yields, are less likely to be downgraded, have fewer days until maturity, and are larger in size. These characteristics imply a bigger cash flow benefit to calling as soon as possible, and they are consistent with the advance refundings being done by more attentive municipals, which are cash constrained and looking to benefit from reduced net cash outflows in the near future.

Taken together, we find that several traits of municipal bond issuances, including their coupon rates and offering sizes, are associated with their future calling delay. These traits are quite different from advance refunded bonds. However, even after accounting for these baseline traits, there is significant variation in the decision to call. In the next section, we propose novel mechanisms that can explain calling delays: the roles of issuer

workload and attentiveness, along with variation in the scope of external-agent debt monitoring, and we will show that they both add significant richness and predictive power in explaining the observed calling delay behavior of municipalities.

IV.4   The Roles of Workload, Attentiveness, and Debt Monitoring

IV.4.1 Issuer Workload and Attentiveness

IV.4.1.1   Fiscal Year-Ends

Over our sample period, issuers on average call a bond seven months after the bond becomes callable. This implies that the calling transaction is not immediate, but rather, it may take some time to process. At a minimum, an evaluation of market rates and some financial calculus are necessary in order to understand whether and when a bond should be called. Moreover, as bonds are typically refunded through a new offering, it may take time to decide how to structure the refunding bond. If an issuer is preoccupied with other work or deadlines, they may be slower to call their bonds.

For many local governments, the end of their state's fiscal calendar is exactly this type of time. Moreover, fiscal year-end is an especially busy time specifically for the finance department, given their central role in the preparation, aggregation, processing, and revision of annual municipal budgets across each division into the municipal-wide fiscal budget. If this is the case, and it is not costless to temporarily modulate the size of its staff month-by-month to accommodate both expected and unexpected work-flow shocks, then there is a higher likelihood that the finance departments will face less time (on average, all-else-equal) to attend to other activities. They may thus be less timely in evaluating bond calls, and this may especially be true for smaller municipals with tighter staffs.

We test this hypothesis in Table 7. Namely, in Column 1, we regress the average wait time between the unlock date and the day the bond is called on Fiscal calendar dummies. *Month before FY End*, *FY End*, and *Month after FY End* are dummy variables equal to one if the month that the bond's call option unlocked was the month before its state's fiscal year end, the month of the fiscal year end, or the month after the fiscal year end, respectively. We find that, controlling for other bond characteristics and fixed effects,

bonds that are unlocked at fiscal year-end are on average delayed by an additional two months (t=2.21). This suggests that, perhaps due to limited attention, the delay is not immediately remedied in the month following the year end deadlines.

In Columns 2 and 3 of Table 7, we test the hypothesis that smaller issuers, presumably with less staff and financial expertise, are more adversely affected by fiscal year end deadlines. In these specifications, we include a dummy for small issuer, which is defined as one if it issued fewer than five bond issues over the sample period. We also interact this dummy with year-end indicators in Column 3. First, from Column 2, small issuers on average take significantly longer than others to call their bonds.

Exploring more deeply in Column 3, we see two additional patterns. First, small issuers experience roughly the same fiscal year end delays in the month of the fiscal year end as larger issues (*FY End* coefficient + *Small*FY End* coefficient – while larger in point estimate, is statistically equivalent). However, in addition to this, these small issuers experience a strong and prolonged *additional* delay starting from the month before fiscal year end (Coefficient on the interaction term of *Small * Month before FY End* of 0.449 (t=2.58)).

Stepping back, the sum of the results in Columns 1-3 suggest that the especially busy times of year for these issuers' finance departments in particular – fiscal year-ends -, coincide with delays to the exercise of call options, being especially true for smaller staffed-issuing municipalities.

Finally, in Column 4, we conduct a falsification test using revenue bonds. Revenue bonds – unlike many other categories of municipal bonds – are not governed by the local government but by the board of the project itself (e.g., hospital, road, nursing home facility).

As an example, consider a revenue bond from our sample in which the issuer was the Port Authority of NY and NJ. It is the Port Authority Board of Commissioners listed at the end of the bond issuance document, and deciding to call. Rather than following New York's fiscal year, which ends March 31, the Port Authority has a fiscal year that ends on December 31, as reflected in its annual budget as well as the bond's financial operating filings. Thus, we would not expect this bond to follow New York State's fiscal cycle but rather that of its issuing entity.

The results of this sample-wide falsification test are reported in Column 4 of Table 7. Reassuringly, we find no significant effect of local government fiscal calendars on calling delays for revenue bonds.

IV.4.1.2   Workload Shocks due to Abnormal Unlocked Volume

Depending on factors such as local budgets and bond ballot outcomes, municipal borrowing may be lumpy and thus issuers may have years in which more bonds are unlocked than normal. This leads to an even workload over time – often determined a decade or more in the past when original issuance occurred. Nevertheless, these spikes in workload could result in more calling delays, similar to the fiscal year-end result patterns in Table 7. We explore this phenomenon in Table 8.

In Table 8, for each bond at its call unlock date, we explore how a bond's calling delay is related to the abnormal workload its municipality is experiencing in the year of its unlocking vis-à-vis the municipality's normal level of refinancing. In Column 1, we define issuer workload as the difference between the number of unlocked bonds and the average number of unlocked bonds the issuer had to consider over the past ten years. When this difference is larger, it implies a larger than usual workload. We find that controlling for other bond characteristics, for each standard deviation increase in issuer workload (3.1 bonds), the bond experiences roughly half a month additional delay time. This effect is even stronger in Column 3 (roughly 30% larger), when we only consider issuers who have had at least one callable bond to consider within the last ten years.

In Columns 2 and 4, we then break down the proxy for issuer workload into its individual components. We find that issuers who have had a larger numbers of bonds unlock in recent times are significantly less likely to delay (*Prev 10y Avg of Num Issues Unlocked*), consistent with larger municipals having more experienced and familiar bandwidth for calling bonds. However, even controlling for this, we find that issuers who have more bonds to consider calling in that given year (*Num Issues Unlocked*) are significantly more likely to delay. Finally, in Column 4, we consider the subset of issuers that had at least one bond unlock within the last ten years, and again we find that the effect of the number of bonds unlocked in that given year is slightly stronger.

In sum, the relationships from Tables 7 and 8 - attempting to proxy for issuer workload and times of busy-ness using its work calendar and current workload – are

consistent with both of these impacting the calling behavior that we find across municipalities and over time. Overall, we find consistent evidence that when an issuer has more constraints on its time, it is likely to result in, and elongate, a delay in its calling decision.

IV.4.2 Debt Monitoring and the Role of Underwriters

In the municipal finance market, underwriters play a critical role in the decision to refund a municipal bond. They are not only responsible for issuing the bond, but they also have incentives to monitor the bond over time and make sure it is not leaving money on the table. When an underwriter helps a municipal call an old bond and refinance with a new bond, they can earn a commission by underwriting the new issue. In this subsection, we will consider how these key market monitors – and rich aspects of their relationships to individual municipalities – are associated with calling delays.

We begin by exploring first the basic industrial organization of municipal underwriting. Empirically, underwriters vary substantially in terms of size as well as geographic concentration. As a demonstration, in Figure 10, we plot the regional dominance of three medium to large municipal underwriters in the United States: Citigroup, Morgan Keegan, and Dougherty & Company LLC. Regional dominance is defined as the ratio of the underwriter's dollar amount underwritten in a state, divided by the amount written by the state's largest underwriter. For example, if Morgan Keegan was the largest underwriter in Tennessee, it would have a regional dominance ratio of 1. In contrast, if it did not underwrite at all in Tennessee, it would have a regional dominance ratio of 0.

As Figure 10 shows, some large firms like Citigroup (Panel A) write bonds all around the country but are especially dominant in some regions, such as on the East and West Coasts. In contrast, firms like Morgan Keegan and Dougherty are more narrowly focused but very dominant in one geographic area. In particular, Morgan Keegan is dominant in the South while Dougherty is heavily focused specifically in North and South Dakota. Figure 10 highlights the geographical segmentation that characterizes municipal finance markets. Moreover, it brings up the possibility that specialization (concentration) in a specific region – such as that which Dougherty engages in - may offer a comparative

advantage of specialized knowledge of local markets (to the extent it could be value-relevant).

To test whether underwriters' geographic concentration affects calling delays, we create a state-level measure of underwriter rank. In particular, for each state and year, we sort the active underwriters by the total dollar amount underwritten in that state, and we create a percentile measure of their size. For example, in 2009, if there were 100 active firms in Tennessee and Morgan Keegan underwrote more than all but 10 other firms, then it would be in the 90th percentile and have a rank of 0.9.

In Table 9, we explore the relationship between local underwriter concentration and the delayed calling behavior of client municipalities. From Table 9, we find significant evidence that bonds underwritten by locally dominant underwriters are less likely to delay calling, even after controlling for underwriter fixed effects. First, in Column 1 of Table 9, we regress a dummy for a bond with a calling delay of greater than one year on the percentile rank of the bond's lead underwriter. Consistent with the theory that locally dominant underwriters pay more attention to their local bonds, we find that bonds are significantly less likely to delay if they used an underwriter with a higher rank. The top underwriter in the state (with a rank of 1) is associated with a bond that is 8 percentage points (t=9.33) less likely to delay compared to a bond associated with the smallest underwriter (with a rank of 0).

Interestingly, it is not the overall national size of the underwriter but rather the *relative size* of the underwriter in the local market that matters. To test this, in Column 2 of Table 9, we add underwriter fixed effects in addition to the underwriter rank, and we still find a negative, significant coefficient on underwriter rank. This suggests that even within a given underwriter, the local specialization of that underwriter in the given market matters. For example, even if two bonds used the *same* underwriter, such as Citigroup, the bond which is located in a state that Citigroup is the top underwriter (has a rank of 1) would be five percentage points (t=3.47) less likely to delay than a bond located in a state that Citigroup is bottom (has a rank of 0).

In addition to the local size of the underwriter, we find that generally more competitive markets are associated with fewer calling delays. In Table 9, Column 3, we

include the number of active underwriters in the state as an additional covariate. We find that bonds whose call options are unlocked in markets with more underwriters are significantly less likely to delay calling. Even controlling for state fixed effects, we find that each additional underwriter is associated with a 1.2 percentage point (t=2.23) smaller probability of calling delay. Finally, in Column 4, we add in the rank of the underwriter along with the number of active underwriters, and we find that both variables are negatively and significantly related to calling delays.

IV.4.3 Persistence in Underwriter and Issuer Relationships

While some underwriters are less efficient at monitoring than others, ultimately, bond issuers can choose their agents and always have the option of switching underwriters. Relatedly, underwriters themselves are open to actively approach municipalities that use their competitor underwriters to generate new business. The decision to switch may be particularly poignant if *not* switching can cost them millions in borrowing costs. In this section, we explore the nature of municipality-underwriter relationships.

The first strong empirical regularity we find is that most municipal issuers are slow to switch lead underwriters, and these persistent, sticky relationships can help explain part of the variation in calling delays. This may be because issuers prefer the underwriter for other reasons other than refinancing efficiency (e.g., some other bundled good or service – either observable or unobservable - that the underwriter provides), or because they are not aware that there are better underwriters in the market. In addition, small or infrequent issuers may not be able to offer enough business to attract the largest underwriters.

Table 10 provides summary statistics for the market, and initial evidence of this. In particular, from Table 10, on average each municipal issues 87% of *all* of its bonds using the same lead underwriter. To control for the fact that some issuers may only sell a few bonds or sell many bonds at once as part of the same series, we restrict our sample to issuers who have issued at least 20 (Row 2), 40 (Row 3), or 60 bonds (Row 4). We see that a pattern of persistent relationships holds even after restricting our sample to issuers with at least 60 bonds: on average, they underwrite over than half of their bonds using

the same underwriter. Finally, we show that issuers who use Bear Stearns (Row 5) and Lehman (Row 6) have very persistent relationships. We will later use this observation to examine shocks to the underwriter-issuer relationship.

Next, we create a measure that captures the persistence of the issuer's relationship with its underwriter, and we show that persistence of the underwriter relationship is associated with more delays. For each issuer and underwriter pair, our measure is calculated as the dollar-weighted percentage of all bonds that are underwritten by the same lead underwriter. To ensure that this relationship is relevant at the time of the refinancing decision (i.e., no look-ahead bias), we examine data solely looking backward at each point in time from the last ten years prior to the bond's call unlock date. For example, suppose a bond's call option unlocked in 2001, and the given municipality underwrote 10 billion dollars of bonds with Lehman from 1991 to 2000. If the bond's issuer issued 40 billion dollars of bonds total over 1991 to 2000, then we would measure its persistence with Lehman as 10/40 or 0.25.

We find that bonds that use a persistent underwriter are significantly more likely to delay calling, holding as else equal. In Figure 11, for instance, we show a scatterplot of our underwriter persistence measure versus a dummy equal to one if the bond delayed calling by at least one year. We see that there is a strong and positive linear relationship. Next, we test this relationship more formally in Table 11. From Column 1 of Table 11, controlling for state, year, credit rating, and capital purpose fixed effects, we find that when a bond comes from an issuer that relies heavily on its lead underwriter (persistence of one), it is eight percentage points more likely to delay calling than if it used an underwriter that it no longer uses (persistence of zero). In column 2, we further show that underwriter persistence adds additional explanatory power even controlling for the other bond characteristics from Table 5.

Lastly, in Column 3 of Table 11 we explore to what extent local expertise - positively associated with monitoring in Table 10 – helped to mitigate the impact of sticky relationships. This is to say, if the long-standing, sticky relationship were with a locally specialized underwriter, would that attenuate this negative association of monitoring. From Column 3 of Table 11, that is exactly what appears to happen. As in Table 10, have a locally specialized underwriter (all else equal) reduces the incidence of call delays on a municipal's bonds. Moreover, the sticky relationship that results in significantly more

delays with distant underwriters is significantly attenuated if that persistent relationship is with a locally specialized underwriter.

IV.4.3 Severing the Underwriter Tie: Lehman Brothers' and Bear Stearns' Bankruptcies

Finally, we use the fall of Lehman and Bear Stearns during the financial crisis as a quasi-experiment to show that issuers are more likely to delay calls when they suddenly lose access to their main underwriter. In Columns 1-4 of Table 12, we regress a dummy for calling delay greater than one year on a dummy for use of Lehman or Bear Stearns as lead underwriter, a dummy for years after the fall of Lehman and Bear Stearns, and an interaction term between the two dummies. In Columns 5-8, we then regress the estimated value lost due to calling delays on the same covariates.

In the cross-section, we find that bonds using Lehman or Bear Stearns are generally less likely to delay (Column 1) and are associated with less value lost (Column 5), controlling for other determinants. In the time series, both the likelihood of delays and estimated value lost are also lower after the fall of Lehman and Bear Stearns (as seen in the coefficient of the Post-2009 categorical variable).[10] In contrast, bonds that specifically used Lehman and Bear Stearns as lead underwriters are both more likely to experience significantly *longer* calling delays than the average bond (Column 1) and are associated with more significantly more value lost relative to the average bond in the same period (Column 5) after their lead underwriters suddenly exit the market. This suggests that there might be an embedded relationship-value between issuer and underwriter that is not frictionless (i.e., is costly) to replace.

Table 12 not only demonstrates that underwriter relationships are sticky, but when the relationship is suddenly broken, it is difficult for an issuer to quickly find a substitute. The negative effect of losing an underwriter holds even once we control for year fixed effects (Columns 2 and 6), as well as credit rating and year fixed effects (Columns 3 and 7). This assuages the concern that the bonds underwritten by Lehman and Bear Stearns had worse credit post-crisis, and as a result, were more likely to delay.

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[10] Note that in Columns 1 and 4 that include the estimated coefficient on the Post-2009 categorical variable, we cannot include Year FE, as the estimate on the pre-, post-collapse variable would be collinear.

Lastly, in Columns 4 and 8 of Table 12, we conduct a falsification test by considering the set of bonds that used Goldman Sachs as lead underwriter. We include a dummy for use of Goldman as well as an interaction term between the Goldman dummy and the fall of Lehman and Bear Stearns. If bonds that used large, national, underwriting firms simply fared worse due to the financial crisis and were thus less likely to call – for instance, because these companies became occupied with other aspects of their business, or refocused in alternate directions post-crisis - then we would expect to find the coefficients on the interaction terms of Goldman Sachs to be positive and significant, much like Bear Stearns and Lehman. However, the coefficients are small and insignificant. This suggests that it was the sudden severing of the tie to the individual underwriters that ultimately led to delayed calling, and not a collective effect from large underwriters. Overall, this is evidence consistent with the previous patterns that the relationship between issuer and underwriter is empirically sticky, appearing difficult to replace with bearing costs.

V.   Conclusion

Despite the considerable amount of funding at stake and its potential real impact on local economies, relatively little is known regarding the refinancing decisions of municipals following their bonds become callable. This maintains even though the central reason for embedding a call option into debt is to take advantage of falling rates in realization of cheaper financing, and the fact that these call options are present in 95% of long-term municipal debt offerings. As a consequence, recent years have provided a valuable setting to study public financing decisions in this regard.

In this paper, we document the substantial value destroyed by public borrowers by delaying the decision to refinance. Using a simple Merton model of interest rates, we calculate that roughly $1.74 billion dollars per year are lost by public issuers by delaying the decision to refinance, totaling over $31 billion dollars lost between 2001 and 2018 even after accounting for the costs of issuance and other transaction costs. The sources of this value lost exhibit rich variation within *and* across many dimensions of the bonds and

municipalities themselves. Namely over time, across issuer size, across bond size, across bond structure (G.O. versus revenue), across geographies, and the types of projects funded.

Moreover, we find that there are bond-, issuer-, and underwriter-related factors that are systematically and significantly associated with this calling delay behavior. For example, bonds with larger issuance size are more likely to call in a timely manner. Moreover, we find that bonds' calling are delayed at significantly higher rates at times when a municipality is experiencing an abnormally high workload. These include when a bond has a call unlocking around the fiscal year-end of the municipality, and when the municipality is hit with an abnormally large wave of call provisions to manage in a given year.

With regard to external monitors' role, we find that issuers have sticky relationships with the main external monitor in the market – their bond underwriters. Issuers on average underwrite 87% of their bonds using the same lead underwriter. Moreover, issuers that rely on less regionally specialized underwriters are significantly more likely to delay. A further examination of these persistent relationships could significantly reduce borrowing costs and improve public financing.

Stepping back, irrespective of the reasons for - or the levels of - government spending, the optimal financial management of public debt is a first order question in public finance. We contribute by identifying an economically important channel of current missteps in this government financing market. Further exploration of this area will help remedy the uncaptured refinancing values by encouraging a more timely exercise of valuable financial options, with our initial results thus presenting a rich area for future work of public finance researchers, policy makers, and practitioners.

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Figure 1. Par Value of Immediately Callable Bonds
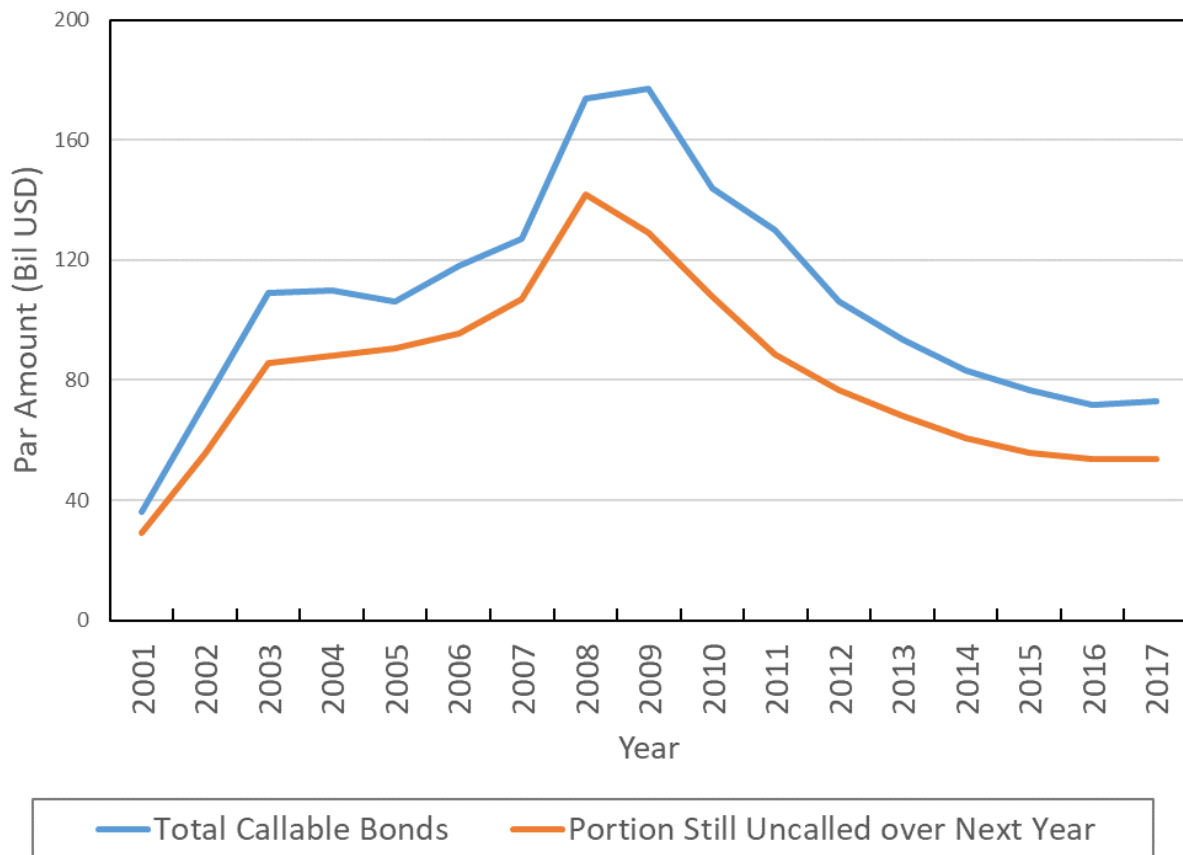
Notes: The blue line is the total par value of municipal bonds (in billions USD) outstanding that could be immediately called at the beginning of each year. The orange line represents the portion of these bonds that still haven't been redeemed by the end of that calendar year. The underlying municipal data comes from the Mergent Bond database.

Figure 2. The Estimated Value Lost of Municipal versus Corporate Bonds
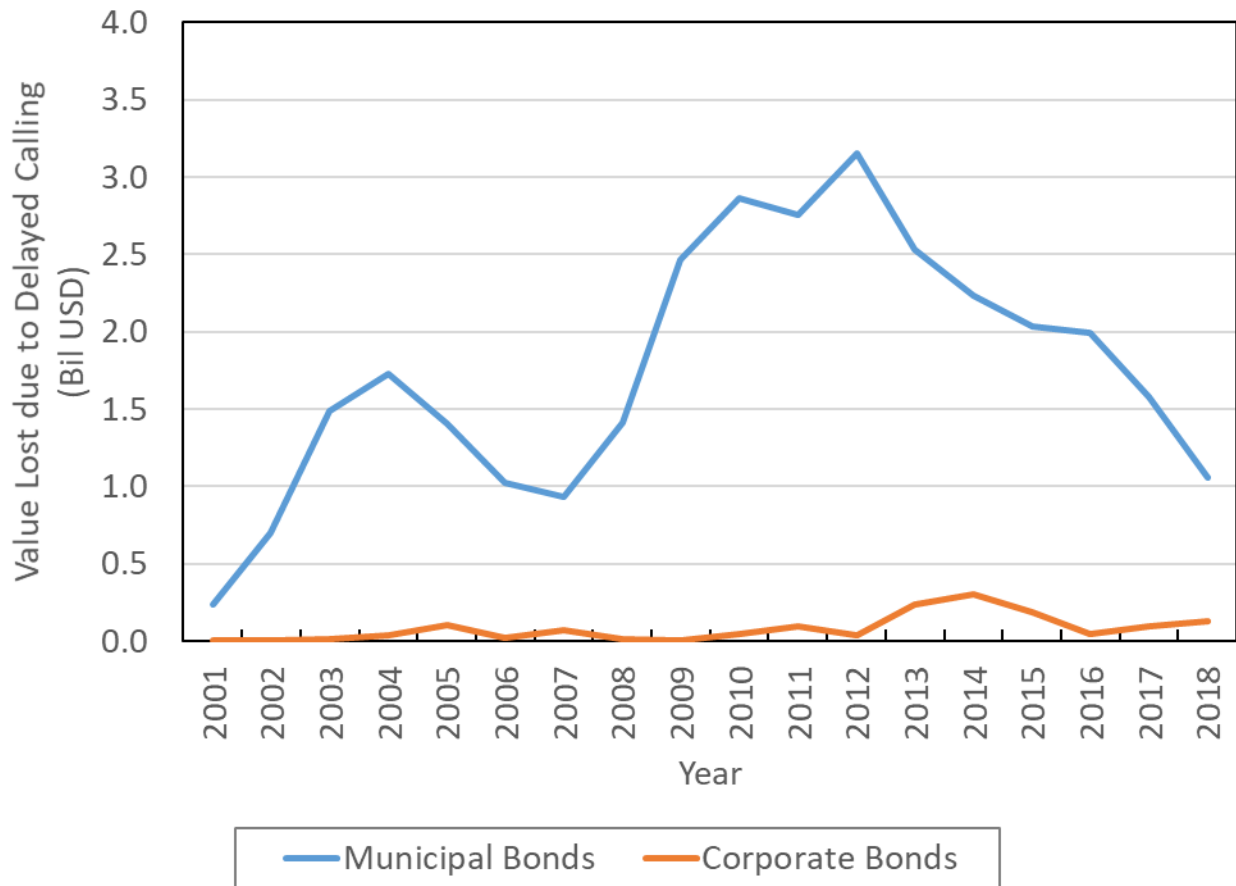
Notes: The blue line is the total par value of municipal bonds (in billions USD) outstanding that could be immediately called at the beginning of each year. The orange line represents the total par value of corporates bonds (in billions USD) outstanding that could be immediately called at the beginning of each year. For exact calculations, see Section IV.2. The underlying municipal data comes from the Mergent Bond database, and the underlying corporate bond data comes from the Mergent FISD database.

Figure 3. Characteristics of Callable Bonds

Panel A. Coupon Rates
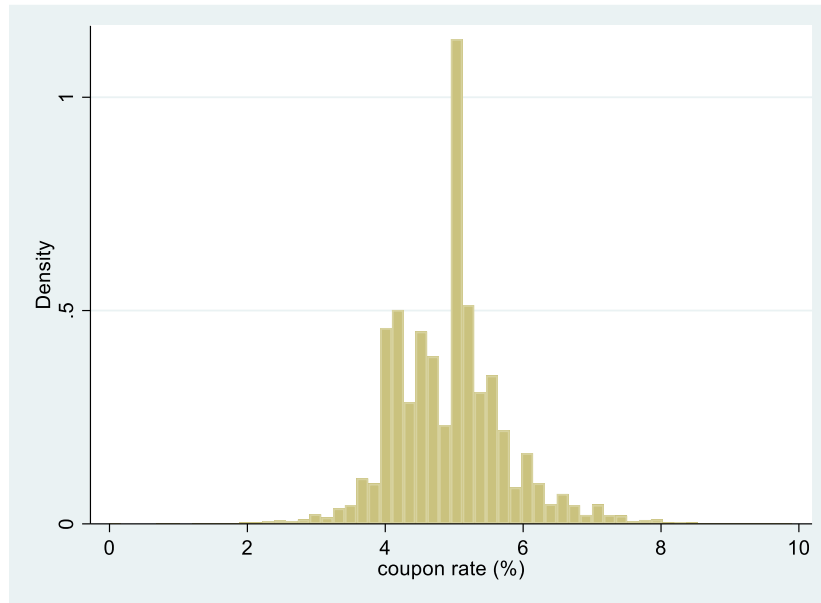
Panel B. Years Left to Maturity
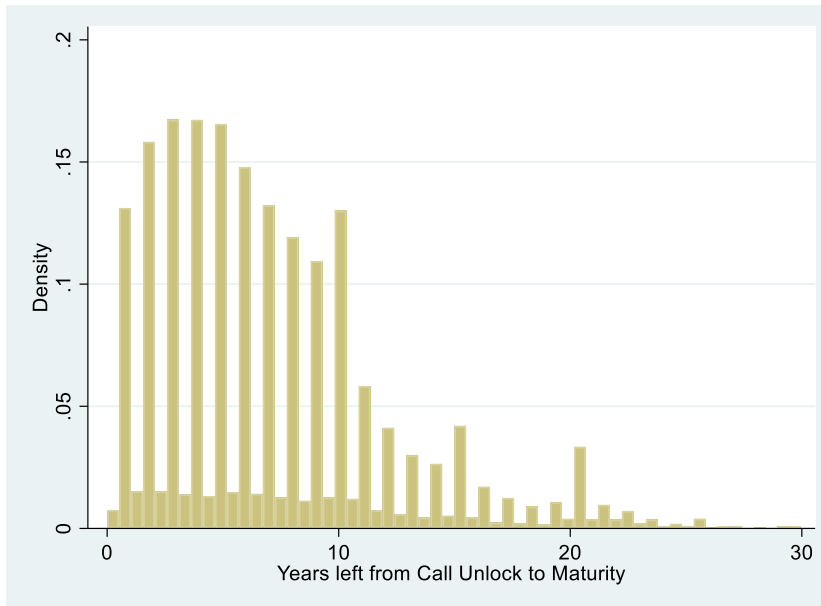
Notes: Panel A shows the histogram of coupon rates and Panel B describes the number of years left until maturity after the call unlock date (Panel B) for bonds whose call options were unlocked between January 1st 2001 and December 31, 2018. The data comes from the Mergent Bond Database.

Figure 4. Offering Yields by Rating
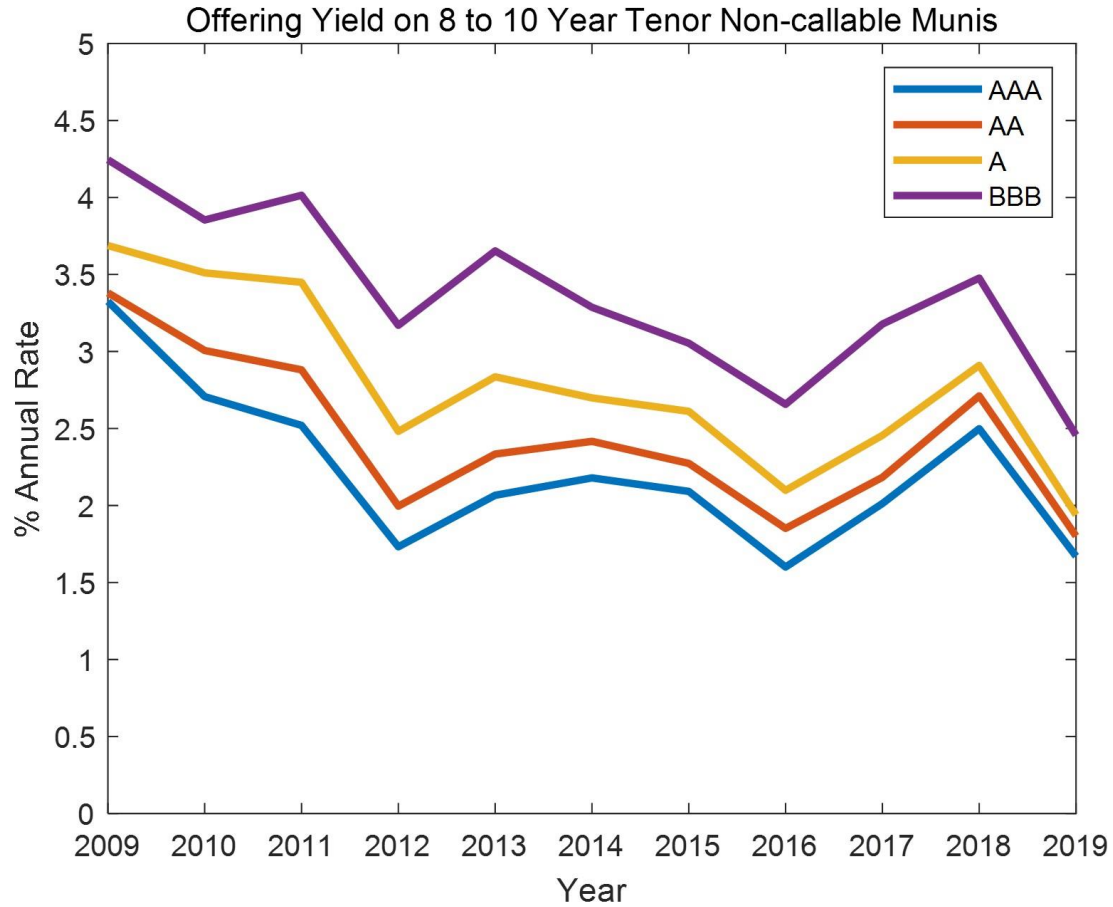
Notes: The figure above shows the time series average offering yield on all municipal bonds with eight to ten year maturity and without a callable option issued each year. Each line refers to a different rating category as reported by Standard and Poor.

Figure 5. Redemption Variation by State

Panel A. Pct of Bonds that Call with more than One-year Delay

Legend:
- (0.24,0.41]
- (0.21,0.24]
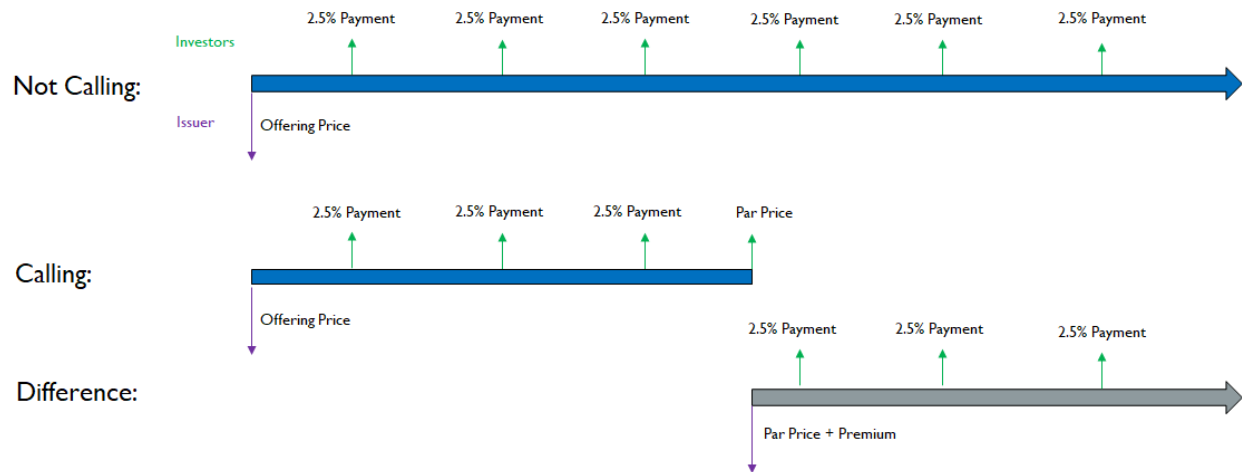- (0.19,0.21]
- [0.12,0.19]

Panel B. Pct of Bonds that Never Call

Legend:
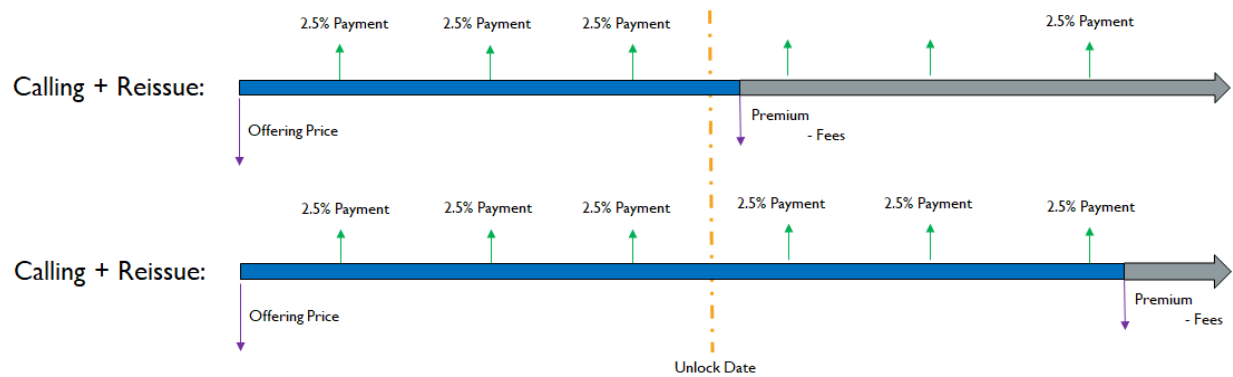- (0.14,0.21]
- (0.12,0.14]
- (0.10,0.12]
- [0.06,0.10]

Notes: The figure above shows the percent of bonds by state that call with at least one year delay (Panel A) as well as the percent of bonds that never call (Panel B). The lightest colors correspond to states that are least likely to delay (not call) and the darkest colors correspond to states that are most likely to delay (not call) in Panel A (Panel B). The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Figure 6. Example of Callable Bonds

## Panel A. Comparison of Calling and Not Calling

Not Calling:

Investors — 2.5% Payment, 2.5% Payment, 2.5% Payment, 2.5% Payment, 2.5% Payment, 2.5% Payment

Issuer — Offering Price

Calling:

2.5% Payment, 2.5% Payment, 2.5% Payment, Par Price

Offering Price

Difference:

2.5% Payment, 2.5% Payment, 2.5% Payment

Par Price + Premium

Panel B. Comparison of Calling and Waiting

Calling + Reissue:

2.5% Payment, 2.5% Payment, 2.5% Payment, 2.5% Payment

Offering Price

Premium - Fees

Calling + Reissue:

2.5% Payment, 2.5% Payment, 2.5% Payment, 2.5% Payment, 2.5% Payment, 2.5% Payment

Offering Price

Premium - Fees

Unlock Date

Notes: The figure above illustrates examples of cash flows when an issuer must choose between calling and not calling (Panel A) or choose between calling today and waiting to call in the future (Panel B).

Figure 7. Model-Implied Option Value

## Panel A. Expected Exercise Value Under Different Initial Rates
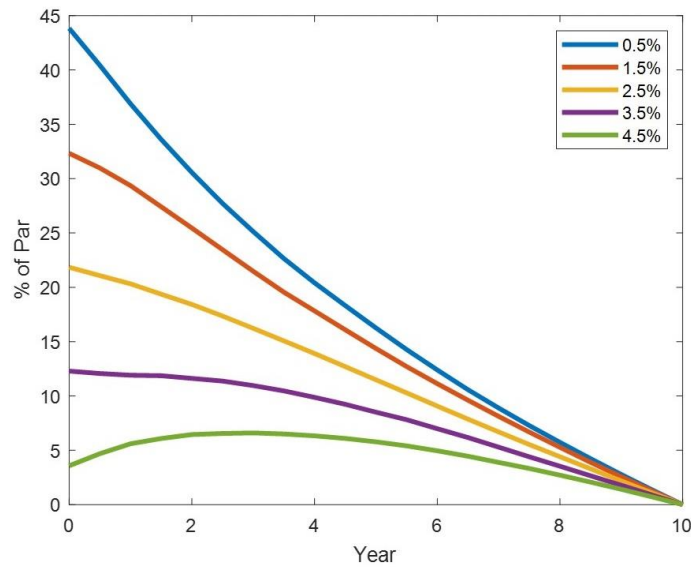

Panel B. Time Value of Call Option
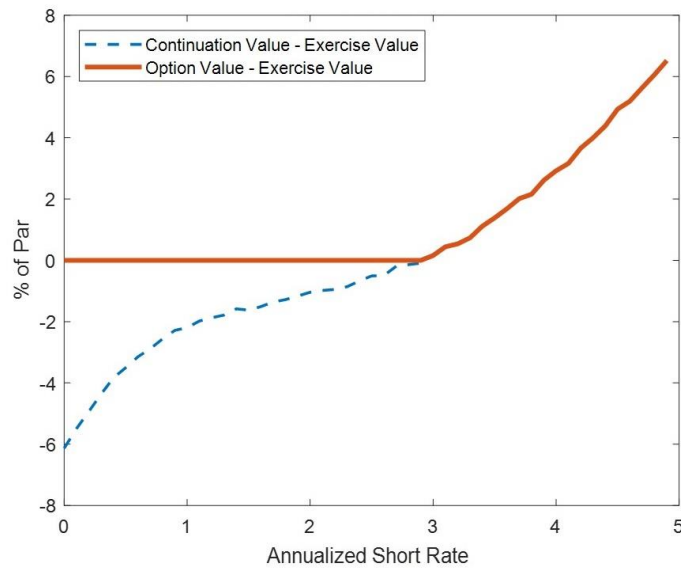
Notes: Panel A shows the expected value gained by exercising the call option (y-axis) as a function of the number of years since the call option unlocked (x-axis). Each line corresponds to a different initial interest rate at time of unlock. Panel B shows the difference between continuation and exercise value (blue-dotted line) as well as the difference between option and exercise value (red line) as a function of the initial rate in the year when the call option unlocks. These estimates assume a 5% coupon, 10-years until maturity after option unlocks, and a one-factor model with semi-annual volatility of 0.40% and a zero rate lower bound for the path of the short rate.

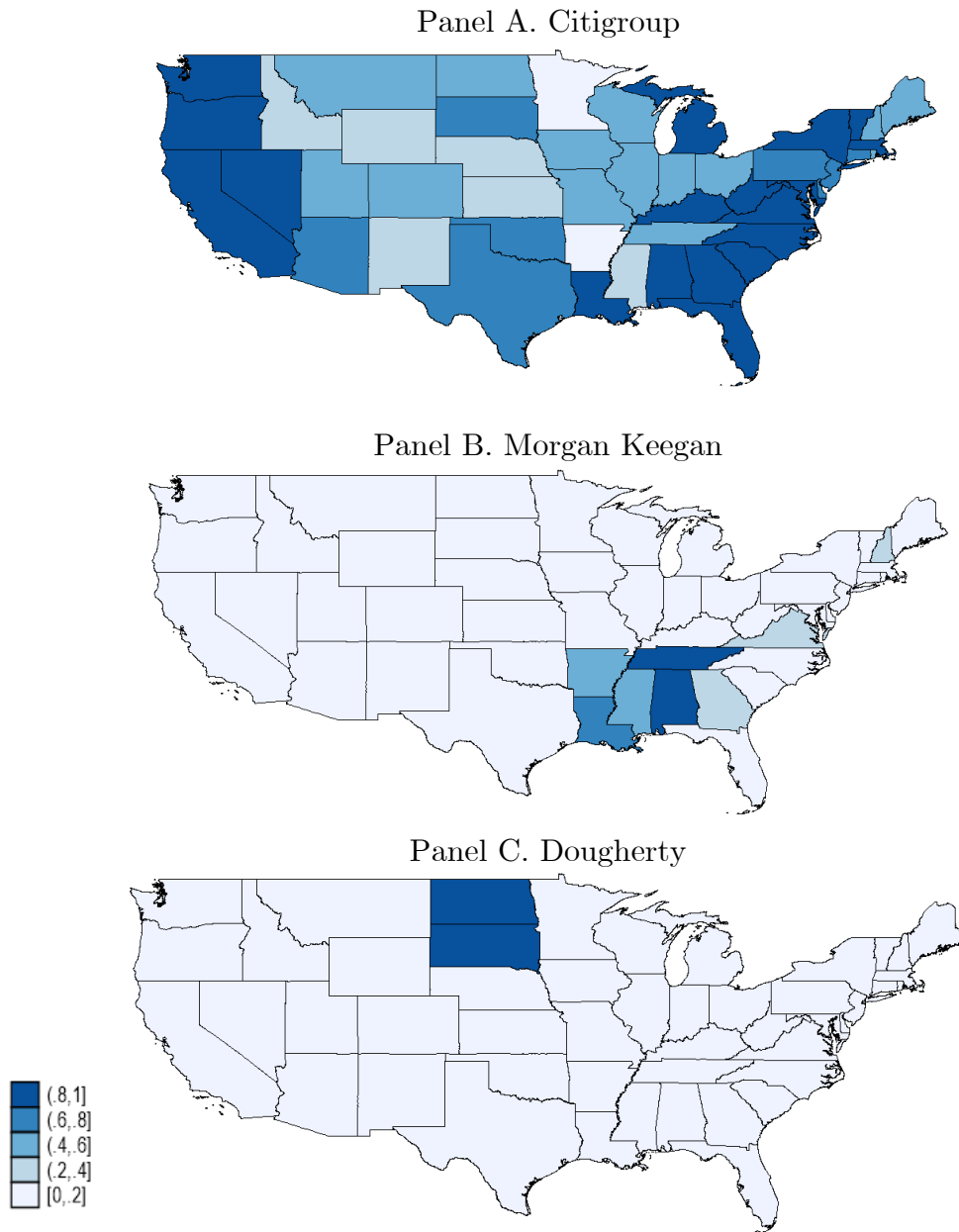## Figure 8. Time Value of Call by Tenor
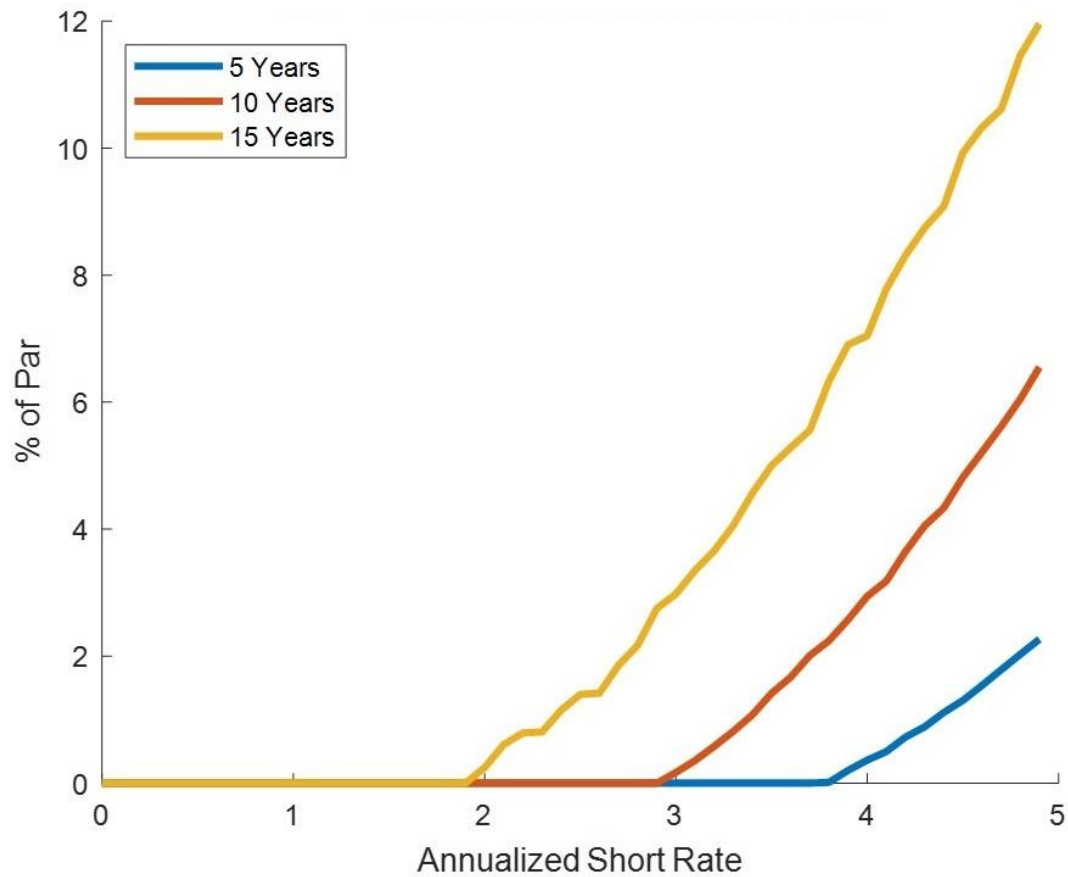
Notes: The figure above shows the value of exercising the call option (y-axis) at time of unlock as a function of the interest rate (x-axis). Each line corresponds to a different length of time between the call option s unlock date and the bond s maturity date. These estimates assume a semi-annual 5% coupon and a Merton one-factor random walk model with semi-annual volatility of 0.40% and a zero rate lower bound.

Figure 9. Model Implied Exercise Region
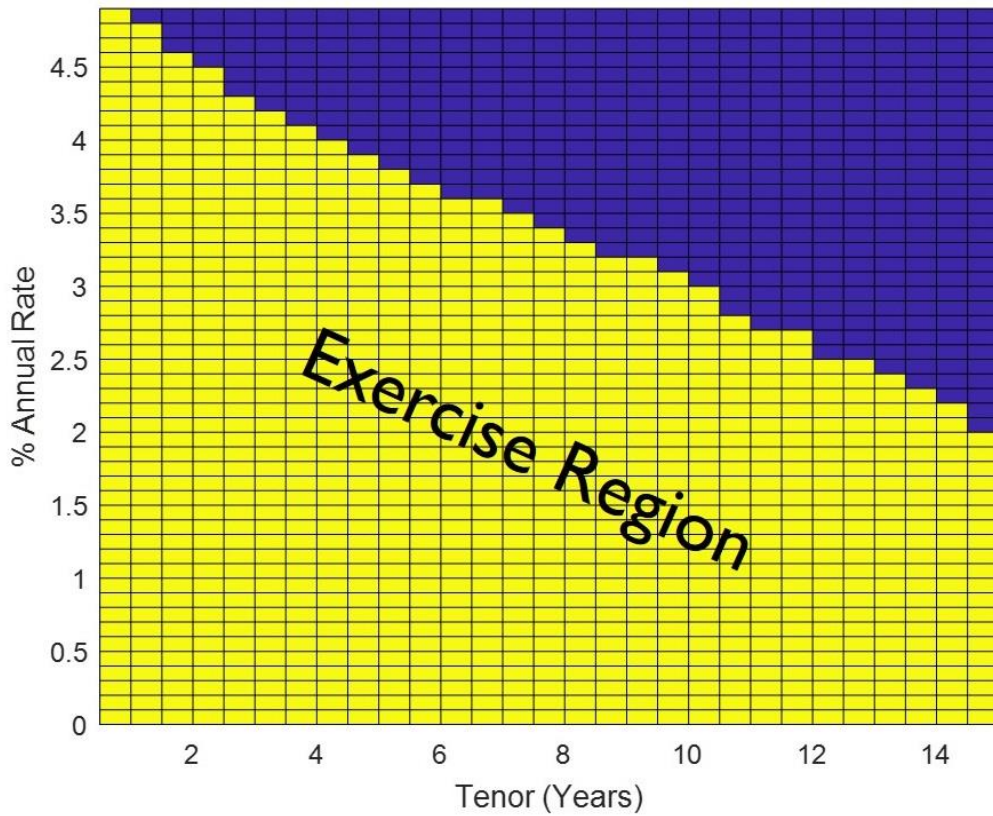
Notes: The figure above shows the region in which a bond should exercise its call option immediately after it is unlocked as a function of tenor (x-axis) and the current interest rate (y-axis). The blue region represents states in which the bond should wait to call, while the yellow region represents states in which the bond should exercise immediately. These estimates assume a semi-annual 5% coupon and a Merton one-factor random walk model with semi-annual volatility of 0.40% and a zero rate lower bound.

Figure 10. Geographic Dominance of Large Underwriters

Panel A. Citigroup

Panel B. Morgan Keegan

Panel C. Dougherty

Legend:
- (.8,1]
- (.6,.8]
- (.4,.6]
- (.2,.4]
- [0,.2]

Notes: The figure above shows the local dominance of three large municipal underwriters in our sample: Citigroup (Panel A), Morgan Keegan (Panel B), and Dougherty (Panel C). Local dominance is calculated as the total amount underwritten in each state divided by the total amount underwritten by the largest underwriter in the state between years 2001 and 2018. This variable ranges between 0 (the firm does not underwrite at all in given state) to 1 (the firm is the top underwriter in given state). The data comes from the Mergent Bond Database.

Figure 11. Relationship between Underwriter Persistence and Calling Delay
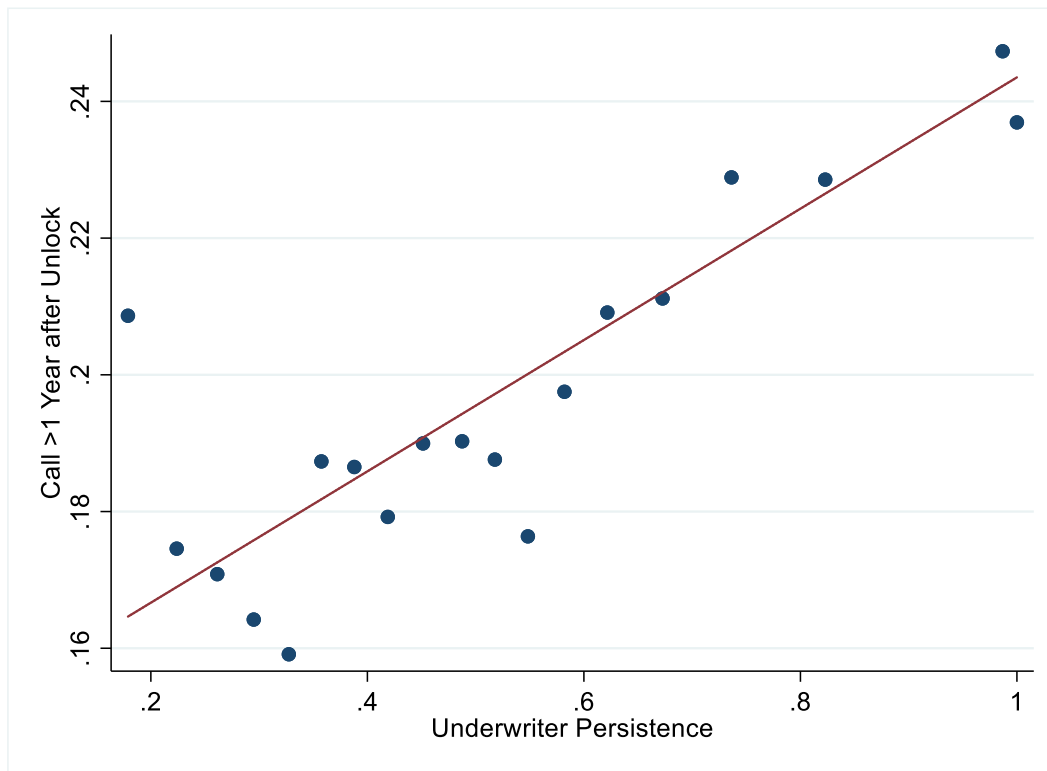
Notes: The figure is a binscatter plot, showing the relationship between underwriter persistence and the probability of a call delay greater than one year. Underwriter persistence is a measure between 0 and 1, measuring the stickiness of the relationship between the bond's issuer and its top underwriter. It is calculated as the dollar-weighted percent of all bonds issued by the same issuer over the last ten years (since the bond's call unlock date) which was underwritten by the issuer's lead underwriter. An underwriter persistence of 0 implies that no other bonds were written by the underwriter, whereas a persistence of 1 implies that all the issuer's bonds were written by the same underwriter. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and April 1, 2018.

Table 1. Summary Statistics of Municipal Bonds

Variable	Num Obs	Mean	Std Dev	Min	Max
Offering Yield (%)	186,471	4.57	0.66	0.80	69.00
Offering Price (USD)	186,472	101.13	3.79	46.92	202.54
Coupon Rate (%)	192,320	4.72	0.66	0.13	12.00
Maturity (years)	192,332	16.63	4.86	10.50	49.84
Mos from Call Unlock until Maturity	192,332	87.82	60.60	1.00	498.13
Offering Year	192,332	2003.79	3.14	1969	2019
Dummy for Delayed	192,332	0.15	0.36	0.00	1.00
Dummy for Credit Downgrade	194,159	0.13	0.34	0.00	1.00
Total Offering Amount (mil USD)	192,332	4.39	15.70	0.16	1,830.00

Notes: The table above shows summaries of key bond variables for the main sample of callable bonds with greater than ten years in maturity. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Table 2. Summary of Calling by State

State	N	Total Size (bil USD)	% Delay Year+	% Never Call
CA	60,162	344.62	35.37	13.57
NY	46,429	324.76	23.23	13.06
TX	80,368	232.02	16.07	8.19
FL	22,143	135.25	23.45	10.77
PA	39,784	111.66	20.99	10.13
IL	27,455	99.02	21.21	11.90
NJ	24,514	81.48	20.13	13.40
MA	16,252	81.11	27.19	17.79
WA	16,623	67.96	19.60	12.57
OH	19,611	67.93	19.37	12.94
MI	25,741	59.66	20.74	13.13
VA	13,082	51.12	17.83	11.11
OR	7,828	49.58	23.59	13.46
CO	9,622	45.59	16.89	10.37
AZ	8,690	43.74	23.62	15.33
MN	22,295	41.14	16.84	8.04
IN	15,914	40.53	21.39	13.25
GA	7,812	39.82	27.14	13.41
NC	8,818	38.72	20.38	13.96
MO	13,720	37.20	21.32	11.84
CT	10,818	35.40	12.22	5.75
MD	8,107	35.34	24.35	16.01
LA	7,527	31.64	20.12	12.51
SC	7,472	31.63	21.87	12.19
WI	17,782	31.15	14.02	8.26
TN	10,031	28.20	18.96	11.77
NV	4,685	25.71	18.83	9.29
KY	12,182	24.65	20.98	14.07
AL	6,446	19.03	23.10	10.58
KS	10,579	17.40	16.74	7.85
NE	9,368	15.96	30.88	9.73
AR	15,527	15.26	37.53	17.49
UT	4,813	15.00	12.43	8.66
HI	1,908	14.01	12.16	8.14
OK	4,158	13.62	22.72	12.12
IA	9,880	11.54	19.65	12.13
AK	2,406	10.94	16.19	6.13
NM	3,548	10.85	23.29	14.31
RI	3,437	10.30	30.09	16.50
MS	6,255	9.66	30.83	18.94
NH	2,624	8.29	18.53	11.94
WV	1,792	8.19	40.70	20.93
ME	3,220	7.48	17.42	10.24
DE	1,522	6.00	12.57	5.87
ID	2,842	5.94	19.34	11.76
MT	2,290	4.93	28.27	15.41
SD	1,784	4.53	17.99	11.32
ND	2,548	3.97	23.20	13.94
VT	1,117	3.37	25.72	17.80
WY	673	2.97	23.85	15.42

Notes: The table above summarizes bond characteristics and calling behavior by state. Column 4 shows the percent of all bonds which waited at least one year to call, and Column 5 shows the percent of all bonds which never called. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Table 3. Summary of Calling by Bond Type

Type	N	Total Size (bil USD)	% Delay Year+	% Never Call
Revenue	146,768	890.01	23.71	11.88
Unlimited Tax G.O.	298,547	704.98	17.79	10.56
Loan Agreement	43,667	291.70	32.73	14.21
Mortgage Loans	26,420	147.03	25.92	12.54
Lease/Rent	39,237	125.95	24.73	14.53
Limited G.O.	39,819	64.15	22.78	14.33
Sales/Excise Tax	10,226	55.24	19.25	10.58
US Government	19,374	37.36	7.23	3.71
Tobacco Agreement	387	33.61	30.39	15.84
Special Tax	9,410	33.36	52.75	15.95
Tax Allocation	7,487	20.51	51.53	22.32
Double barreled	11,024	20.13	24.42	14.24
Special Assessment	6,416	13.44	37.31	17.90
Fuel / Vehicle Tax	1,322	11.89	15.91	8.41
Loan Agreement	1,110	9.43	38.68	14.67
Tuition Agreement	2,087	5.93	20.61	9.80
Education Loans	707	4.42	32.96	19.38
Other	318	1.52	32.70	17.30
Public Improvement	125	0.44	31.20	14.40

Notes: The table above summarizes bond characteristics and calling behavior by bond type. Column 3 shows the percent of all bonds which waited at least one year to call, and Column 4 shows the percent of all bonds which never called. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Table 4. Summary by Credit Rating at Time of Call Unlock

Rating	N	Total Size (bil USD)	% Delay Year+	% Never Call
AAA	89,024	454.69	25.24	9.92
AA	168,535	797.52	13.38	6.34
A	43,391	221.00	24.34	9.06
BBB	11,668	61.60	31.55	10.31
BB	619	8.01	63.19	21.99
B	247	10.34	75.00	22.95
CCC	55	2.09	81.82	36.36

Notes: The table above summarizes bond characteristics and calling behavior by credit rating at the time the call option unlocked and whether the bond experienced a credit downgrade since issuance. Column 4 shows the percent of all bonds which waited at least one year to call, and Column 5 shows the percent of all bonds which never called. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018. Ratings data comes from Capital IQ s Standard and Poor ratings database.

Table 5. Bond Characteristics Explaining Variation in Calling Delays

	(1)	(2)	(3)	(4)	(5)	(6)
			Dummy for Delayed			
Coupon (%)	-0.128***					-0.069***
	(0.010)					(0.0157)
Offering Yield (%)		-0.112***				-0.063***
		(0.007)				(0.016)
Dummy for Downgraded			0.052***			0.047***
			(0.010)			(0.011)
Days until Maturity				0.013		0.230***
				(0.012)		(0.023)
Ln Size (USD)					-0.042***	-0.032***
					(0.006)	(0.007)
Observations	192,574	186,726	192,586	192,586	192,586	186,721
R-squared	0.122	0.110	0.083	0.081	0.104	0.140
State FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Capital Purpose FE	YES	YES	YES	YES	YES	YES
Initial Rating FE	YES	YES	YES	YES	YES	YES

Notes: The table above shows the coefficients from regressing the decision to delay calling a bond on different bond characteristics. The outcome variable, *Dummy for Delayed*, is equal to one if the bond was called at least one year after its call option unlocked, or it was never called. Explanatory bond characteristics include: the coupon rate, the listed offering yield, a dummy for whether the bond was downgraded since issuance, the number of days remaining from the date the call option unlocked until maturity, and the natural log of the issuance par size. In addition, we add fixed effects for state, year, capital purpose, and the initial credit rating of the issuer. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Table 6. Bond Characteristics Explaining Variation in Advance Refundings

	(1)	(2)	(3)	(4)	(5)	(6)
			Dummy for Advance Refunded			
Coupon (%)	0.121***					0.083***
	(0.012)					(0.013)
Offering Yield (%)		0.0873***				0.0266
		(0.010)				(0.016)
Dummy for Downgraded			-0.0413***			-0.040***
			(0.009)			(0.008)
Days until Maturity				-0.068***		-0.265***
				(0.020)		(0.028)
Ln Size (USD)					0.048***	0.041***
					(0.006)	(0.007)
Observations	192,574	186,726	192,586	192,586	192,586	186,721
R-squared	0.125	0.111	0.102	0.102	0.120	0.139
State FE	YES	YES	YES	YES	YES	YES
Year FE	YES	YES	YES	YES	YES	YES
Capital Purpose FE	YES	YES	YES	YES	YES	YES
Initial Rating FE	YES	YES	YES	YES	YES	YES

Notes: The table above shows the coefficients from regressing the decision to advance refund a bond on various bond characteristics. Explanatory bond characteristics include: the coupon rate, the listed offering yield, a dummy for whether the bond was downgraded since issuance, the number of days remaining from the date the call option unlocked until maturity, and the natural log of the issuance par size. In addition, we add fixed effects for state, year, capital purpose, and the initial credit rating of the issuer. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Table 7. Regressions Explaining Delay Time using Fiscal Calendar

DEPENDENT VARIABLES:	(1)	(2)	(3)	(4)
	Avg Wait Time (Yrs)			
Month before FY End	0.158		0.094	-0.060
	(0.149)		(0.143)	(0.132)
FY End	0.181**		0.159*	-0.088
	(0.082)		(0.084)	(0.072)
Month after FY End	-0.022		-0.050	0.067
	(0.049)		(0.052)	(0.053)
Dummy for Small Issuer		0.110**	0.102**	
		(0.045)	(0.044)	
Interaction Terms				
Small * Month before FY End			0.449**	
			(0.174)	
Small * FY End			0.086	
			(0.064)	
Small * Month after FY End			0.073	
			(0.060)	
Control Variables				
Coupon (%)	-0.071*	-0.069*	-0.069*	0.026
	(0.038)	(0.037)	(0.037)	(0.026)
Offering Yield (%)	-0.044	-0.051	-0.0563	-0.007
	(0.047)	(0.045)	(0.0448)	(0.015)
Downgraded	0.142***	0.142***	0.144***	0.115
	(0.046)	(0.047)	(0.047)	(0.080)
Months to Maturity	0.005***	0.005***	0.005***	0.006***
	(0.001)	(0.001)	(0.001)	(0.001)
Ln Size (USD)	-0.055***	-0.045***	-0.0455***	-0.082***
	(0.015)	(0.015)	(0.015)	(0.013)
Sample	Non-prerefunded GO Bonds	Non-prerefunded GO Bonds	Non-prerefunded GO Bonds	Non-prerefunded RV Bonds
Observations	95,676	95,676	95,676	97,776
R-squared	0.342	0.343	0.344	0.395
State FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Capital Purpose FE	YES	YES	YES	YES
Initial Rating FE	YES	YES	YES	YES

Notes: The table above shows the coefficients from regressing each bond's average wait time, from when its call option unlocks to when it is called, on various fiscal calendar dummies. *Month before FY End*, *FY End*, and *Month after FY End* are dummy variables equal to one if the month that the bond's call option unlocked was the month before its state's fiscal year end, the month of the fiscal year end, or the month after the fiscal year end, respectively. *Small* is a dummy equal to one if the issuer borrowed fewer than five issues over our sample period. The data comes from the Mergent Bond Database and covers all municipal bonds issued with a call option, which were not advance refunded between 2001 and 2018. Columns 1 through 3 only include general obligation bonds, while column 4 only includes revenue bonds.

Table 8. Regressions Explaining Delay Time using Proxy for Workload

	(1)	(2)	(3)	(4)
DEPENDENT VARIABLE:		Avg Wait Time (Years)		
SAMPLE:	Non-prerefunded bonds		Non-prerefunded bonds & prev 10y Avg>0	
Num Issues Unlocked - Prev 10y Avg	0.012*		0.016**	
	(0.007)		(0.008)	
Num Issues Unlocked		0.014**		0.017**
		(0.007)		(0.007)
Prev 10y Avg of Num Issues Unlocked		-0.024***		-0.024***
		(0.009)		(0.008)
Control Variables				
Coupon (%)	0.009	0.010	0.004	0.005
	(0.024)	(0.025)	(0.026)	(0.026)
Offering Yield (%)	-0.051*	-0.052*	-0.052***	-0.053***
	(0.026)	(0.027)	(0.018)	(0.018)
Downgraded	0.126**	0.127**	0.143***	0.144***
	(0.055)	(0.055)	(0.048)	(0.048)
Months to Maturity	0.008***	0.008***	0.008***	0.007***
	(0.002)	(0.002)	(0.002)	(0.002)
Ln Size (USD)	-0.079***	-0.077***	-0.091***	-0.090***
	(0.028)	(0.028)	(0.030)	(0.029)
Observations	214,925	214,925	158,050	158,050
R-squared	0.382	0.383	0.382	0.382
State FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Capital Purpose FE	YES	YES	YES	YES
Initial Rating FE	YES	YES	YES	YES

Notes: The table above shows the coefficients from regressing each bond's average wait time, from when its call option unlocks to when it is called, on proxies for issuer workload. For each bond, in the year that its call option unlocked, *Num Issues Unlocked* measures the total number of bond issues from the same issuer that became currently refundable in the same year; and *Prev 10y Avg of Num Issues Unlocked* measures the average number of bond issues that became currently refundable over the previous 10 years. When the difference between these two variables is larger, it implies that the issuer had a larger number of bonds to consider than usual, resulting in a larger workload. The data comes from the Mergent Bond Database and bonds whose call option unlocked between years 2001 through 2018. Columns 3 and 4 only include issuers which sold at least one bond issue over the prior 10 years.

Table 9. Explaining Delays using Underwriter Characteristics

	(1) Call Delay at Year+	(2) Call Delay at Year+	(3) Call Delay at Year+	(4) Call Delay at Year+
Pctl Rank of Underwriter	-0.084***	-0.052***		-0.084***
	(0.009)	(0.015)		(0.009)
# Underwriters in State			-0.011**	-0.012**
			(0.005)	(0.005)
Observations	185,079	185,079	185,079	185,079
R-squared	0.141	0.173	0.141	0.141
Control for Bond Charas	YES	YES	YES	YES
State FE	YES	YES	YES	YES
Year FE	YES	YES	YES	YES
Capital Purpose FE	YES	YES	YES	YES
Rating FE	YES	YES	YES	YES
Underwriter FE	NO	YES	NO	NO

Notes: The table above shows the coefficients from regressing the decision to delay calling a bond on two different underwriter characteristics. The first characteristic is the annual percentile rank of the bond's lead underwriter, based upon total dollar amount underwritten, in the state that the bond was sold. For example, if there are 100 underwriters and the lead underwriter was ranked as the 10th largest, it would be in the 90th percentile and its rank would be 0.9. The second characteristic is the total number of underwriters operating in the state. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Table 10. Percent of Bonds Written by Same Lead Underwriter

	% of Bonds Issued with the Top Lead Underwriter (2002 to 2007)							
	Mean	Std.	Min	25%	Median	75%	Max	N
All Issuers	86.97%	21.87%	10.20%	75.00%	100.00%	100.00%	100.00%	28,402
Issuers with at least 20 bonds issued	75.36%	25.48%	10.20%	52.94%	81.36%	100.00%	100.00%	12,313
Issuers with at least 40 bonds issued	62.85%	25.90%	10.20%	40.54%	57.38%	93.33%	100.00%	5,438
Issuers with at least 60 bonds issued	57.01%	25.59%	10.20%	35.29%	51.52%	75.89%	100.00%	2,898
Issuers with Bear Stearns as top lead underwriter	76.42%	24.33%	17.57%	56.71%	83.33%	100.00%	100.00%	141
Issuers with Lehman as top lead underwriter	81.98%	24.64%	14.96%	60.61%	100.00%	100.00%	100.00%	234

Notes: The table above shows summary statistics for the percent of bonds municipal issuers wrote using their top lead underwriter. The top lead underwriter is defined as the lead underwriter which has written the most dollar volume of bonds for each issuer. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Table 11. Regressions Explaining Calling Delay using Underwriter Persistence

	(1) Call Delay at Year+	(2) Call Delay at Year+	(3) Call Delay at Year+
Underwriter Persistence	0.081***	0.048***	0.101***
	(0.003)	(0.004)	(0.006)
Pctl Rank of Underwriter			-0.061***
			(0.010)
Persistence* Pctl Rank			-0.052***
			(0.004)
Control for Bond Charas	NO	YES	YES
State Fixed Effect	YES	YES	YES
Year Fixed Effect	YES	YES	YES
Initial Credit Score Fixed Effect	YES	YES	YES
Capital Purpose Fixed Effect	YES	YES	YES
Issuer Fixed Effect	YES	YES	YES
Observations	172,944	167,995	167,995
R-squared	0.080	0.135	0.136

Notes: The table above shows the coefficients from regressing the decision to delay calling a bond on the bond underwriter's persistence, rank, and an interaction between persistence and rank. Underwriter persistence ranges between 0 and 1, and it measures the stickiness of the relationship between the bond's issuer and its largest underwriter. More specifically, it is calculated as the percent of all issuances by part amount that was underwritten by the lead underwriter over the last ten years, starting from the bond's call unlock date. Percentile rank measures the size of the bond's lead underwriter based upon par amount underwritten in state and year; it ranges from zero (if the underwriter is the smallest in a given state and year) to zero (if the underwriter is the largest). The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Table 12. Difference in Difference Using Fall of Lehman and Bear Stearns

	Call Delayed by At Least 1 Year				Value of Par Lost			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Bear Stearns or Lehman Dummy	-0.145***	-0.140***	-0.132***		-0.006	-0.006	-0.006	
	(0.040)	(0.037)	(0.035)		(0.005)	(0.005)	(0.005)	
Year >= 2009 Dummy	-0.184**				-0.017***			
	(0.071)				(0.004)			
Diff-in-Diff Interaction	0.167**	0.163**	0.160**		0.018**	0.019**	0.018**	
	(0.054)	(0.052)	(0.053)		(0.007)	(0.006)	(0.006)	
Goldman Sachs Dummy				-0.075				0.005
				(0.098)				(0.017)
Goldman Sachs Interaction				0.058				-0.003
				(0.101)				(0.019)
State FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	No	No	No	Yes	No	No
Year X Rating FE	No	No	Yes	Yes	No	No	Yes	Yes
Observations	38,480	38,480	38,479	38,479	38,480	38,480	38,479	38,479
Adjusted R-squared	0.072	0.103	0.127	0.124	0.035	0.040	0.048	0.046

Notes: The table above shows the coefficients from either regressing the decision to delay calling a bond (columns 1-4) or the value lost from delaying (columns 5-8) on different dummies for lead underwriter. *Bear Stearns or Lehman Dummy* is equal to one if the bond's lead underwriter was either Bear Stearns or Lehman Brothers; *Year>=2009 Dummy* is equal to one if the year in which the call option became exercisable was on or post 2009; finally, *Interaction* captures the interaction between the underwriter dummy and the post 2009 dummy. The data comes from the Mergent Bond Database and covers all bonds with a call option that unlocked between January 1, 2001 and December 31, 2018.

Appendix

Figure A1. Par Amount of Advance Refundings of Municipal Bonds by Year
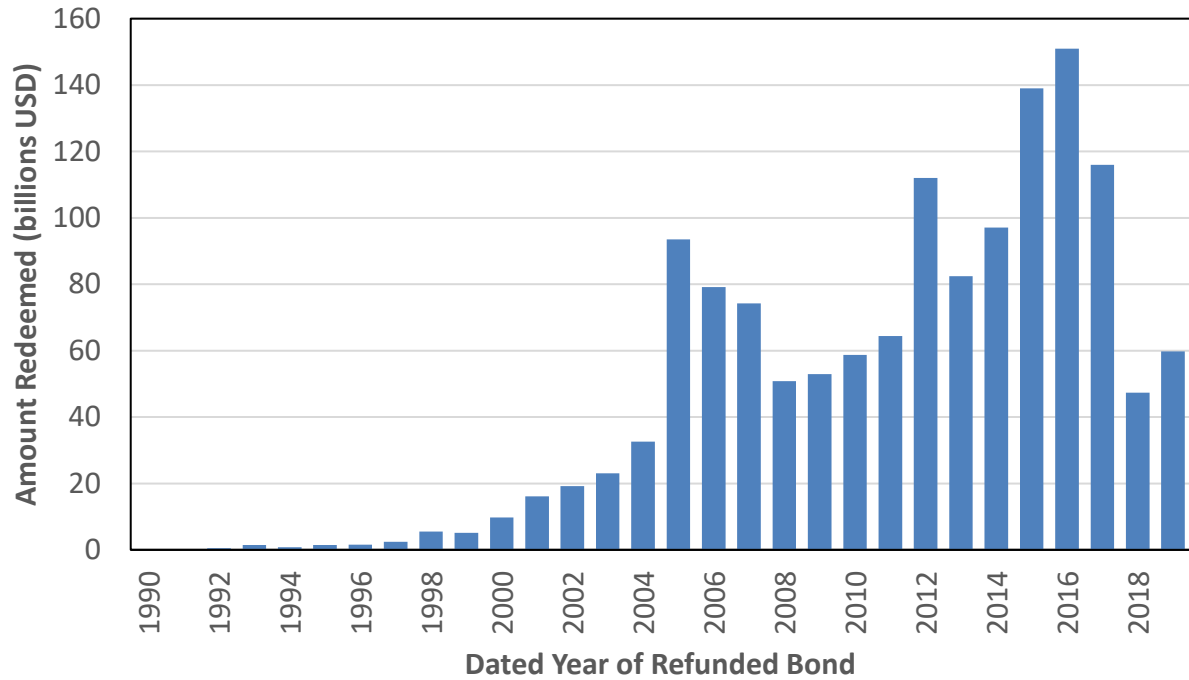
Notes: The plot above shows the annual time series of the total par amount of municipal bonds that have been advance refunded. The data comes from the Mergent Bond Database and the refunding year corresponds to the year of the dated date of the refunding bond. If no refunding bond date is provided, then the year corresponds to the call redemption year.