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Advance Refundings of Municipal Bonds

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ABSTRACT

The advance refunding of debt is a widespread practice in municipal finance. In an advance refunding, municipalities retire callable bonds early and refund them with bonds with lower coupon rates. We find that 85% of all advance refundings occur at a net present value loss, and that the aggregate losses over the past 20 years exceed $15 billion. We explore why municipalities advance refund their debt at loss. Financially constrained municipalities may face pressure to advance refund since it allows them to reduce short-term cash outflows. We find strong evidence that financial constraints are a major driver of advance refunding activity.

ONE OF THE MOST IMPORTANT TRENDS in municipal finance over the past decade is the dramatic increase in the number of bonds that are advance refunded. In an advance refunding, also known as a pre-refunding, a municipality issues new debt to retire an existing callable bond issue that is not yet callable.[1] The number of municipal bond issues advance refunded per year has increased from roughly 300 in the late 1990s to more than 30,000 over the 2012 to 2013 period. Nearly 50% of the $300 to $400 billion of municipal bonds currently issued each year is associated with advance refundings.

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[1] Section 149 of the Internal Revenue Code requires that the bond being advance refunded be called at its earliest call date for the refunding bond to retain the tax-exempt status of the existing debt.

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Intuitively, an advance refunding can be viewed as an early "synthetic" call of a callable bond. The proceeds from the new debt fund a trust that defeases the remaining coupon payments on the existing bond up to the call date as well as the call price for the bond. The defeasance effectively extinguishes the existing bond issue in much the same way that calling a bond does. Thus, an advance refunding is economically equivalent to calling the existing bond early at a call price equal to the escrow amount needed to fund the trust.

Viewed this way, the decision to advance refund a bond issue turns on whether it is optimal to "call" the bond now at the escrow price or to wait and revisit the call decision at the actual first call date. Thus, the advance refunding decision closely parallels the early exercise decision for American options. A key factor complicating the advance refunding decision, however, is that the new bond can typically be issued at a lower yield than the outstanding bond, resulting in an immediate reduction in the cash flow needed to service the municipality's debt. Thus, an advance refunding can provide short-term budget relief for a municipality. This is particularly important since municipalities generally cannot borrow to finance operating activities and would otherwise be forced to raise taxes or lay off public workers.[2] A financially constrained municipality may therefore face pressure to advance refund even when a suboptimal "early exercise" results in a net present value (NPV) loss.

In this paper, we study the effects of advance refunding decisions using an extensive data set of municipal bond advance refunding transactions. Specifically, the data set includes over 206,000 bond issues that were advance refunded from 1995 to 2013, with a total par value of $582 billion. This data set, in conjunction with term structure data from the municipal bond market, allows us to estimate the NPV of each advance refunding in the sample, along with the associated cash flow incentives faced by these municipalities at the time of the transaction.

A number of surprising results emerge from this analysis. We find that, during the 1990s, a substantial fraction of the advance refundings are optimal in the sense that they create value for the municipality. Beginning with the recession of the early 2000s, however, the NPV associated with a typical advance refunding turns negative, and then becomes sharply negative following the 2008 financial crisis. As a result, nearly 85% of all advance refunding transactions during the sample period result in a loss of value for the municipality. On average, advance refundings result in an NPV loss of 2.66% of the total par amount being refunded. This represents a total loss of over $15 billion during the sample period. Furthermore, this total does not include the cost

[2] Almost all municipalities are required by statutes, charters, or state constitutions to balance their operating budgets. Municipalities can only borrow for capital projects, and then there are elaborate restrictions such as requiring approval of voters or of a state-wide board. However, municipalities are rarely restricted from advance refunding existing debt as long as the transaction does not extend the maturity of the original debt.

of the transaction fees paid by municipalities to bond underwriters to execute advance refunding transactions.[3]

In sharp contrast, we find that more than 96% of all advance refundings result in immediate but short-term cash flow savings to the municipality. On average, the advance refunding of a bond issue reduces the annual cash flow paid by a municipality to service its debt by 1.41% of the par amount of the bond issue being refunded (141 basis points).

While it is tempting to conclude that municipalities are simply advance refunding their debt to relax cash flow constraints, it is important to consider the effects of other types of financial frictions and constraints on the advance refunding decision. First, we explore whether some advance refundings may be motivated by an attempt to eliminate restrictive covenants in existing debt. We find little support for this hypothesis. Second, we examine whether the results can be explained by informational frictions about the value of the implicit American option. We show that, even under the most extreme assumption that the implicit option is ignored altogether, more than 50% of the advance refundings occur at a present value loss. Thus, the results cannot be fully explained by informational frictions that might make it difficult for a municipality to assess the value of the implicit option accurately.

We focus next on the question of what factors drive advance refunding activity. First, we examine how municipalities respond to the potential NPV gains and cash flow savings associated with advance refunding. We find that advance refunding activity increases significantly as the potential cash flow savings increases. In contrast, there is little evidence that advance refunding activity responds to the potential NPV of the transaction.

Second, we examine how advance refunding activity is affected by macroeconomic and fiscal conditions. We find that advance refunding activity increases significantly when states and local governments have current tax revenue shortfalls or face budget deficits. This evidence supports the hypothesis that financial constraints lead municipalities to advance refund bonds in order to obtain short-term budgetary relief.

Third, we examine whether macroeconomic and fiscal conditions affect the financial outcomes from advance refunding. We find that realized NPV losses increase significantly as current tax collections decline or as unfunded public pension liabilities increase. These results suggest that municipalities are compelled to absorb greater losses to obtain short-term budgetary relief as their fiscal condition deteriorates. This finding provides additional evidence that financial constraints are a major driver of advance refunding activity.

Finally, we study the cross-sectional structure of advance refunding decisions. Specifically, we conduct a probit analysis to examine how the potential NPV and cash flow savings of a transaction affect the conditional probability that a bond issue is advance refunded. We again find that the potential cash flow savings is a major determinant of the advance refunding decision. We also

[3] These transaction costs are estimated to be at least 1% to 2% of the total par amount of the transaction.

study the cross-sectional patterns of advance refunding activity across states. We find that the average NPV resulting from advance refunding activity is negative for all 50 states throughout the sample period. There is significant heterogeneity in outcomes, however, across states. An important implication of this result is that municipal credit risk may be largely nonsystematic in nature.

In summary, the results above suggest a pattern in which municipalities take advantage of short-term cash flow savings that result from advance refunding their debt. We find evidence that advance refunding activity is significantly related to the fiscal conditions facing municipalities. Taken together, these results are consistent with the view that fiscally constrained municipalities conduct advance refundings to obtain short-term budgetary relief, even if doing so might result in a present value loss.

Given these results, a natural question arises: if municipalities often advance refund debt at a loss, shouldn't this already be incorporated into the ex ante prices of municipal bonds? Clearly, in an efficient market, the prices of municipal bonds should reflect the actual advance refunding behavior expected. The reason that advance refunding matters, however, is that an advance refunding is associated with significant fees and costs, such as underwriting fees, bond insurance fees, and legal costs, that are ultimately borne by taxpayers. If advance refunding is driven by the fiscal pressures faced by municipalities, these fees can be viewed as direct costs of financial distress. Thus, even if municipal bond prices reflect the expected advance refunding strategy, the potential costs of financial distress related to advance refunding are relevant to municipalities both on an ex ante and an ex post basis. This closely parallels the situation with corporate bankruptcy. Even though default risk is already priced into corporate bond yields, the costs of financial distress play a major role in ex ante corporate capital structure decisions.

Despite the growing importance of advance refundings in the municipal bond markets, this topic has received relatively little attention in the academic literature. In an unpublished note, Dammon and Spatt (1993) explain how advance refundings can destroy option value for the issuer. Kalotay and May (1998) and Kalotay and Abreo (2010) advocate comparing the present value of interest savings over the life of the newly issued debt to the lost option value. However, these papers do not provide estimates of the actual NPV effects of a typical advance refunding. Empirical studies by Vijayakumar (1995) and Moldogaziev and Luby (2012) examine the determinants of advance refunding, but do not study the value effects. Fischer (1983) uses the public announcement of an advance refunding to examine the efficiency of the municipal bond market. Chalmers (1998) uses pre-refunded municipal bonds to show that the steeper slope of the municipal bond curve relative to Treasuries cannot be explained by credit risk. Dyl and Joehnk (1976, 1979) also discuss the advance refunding of tax-exempt bonds.

Debt defeasance is studied by academic researchers in settings other than the municipal sector. For example, Hand, Hughes, and Sefcik (1990) examine defeasance of corporate bonds and show that stock and bond price reactions are consistent with a wealth transfer from equity to debt holders. They examine possible motives for these transactions such as the avoidance of bond covenants and window dressing for earnings. Dierker, Quan, and Torous (2004) examine the defeasance of mortgages in commercial real estate. Weingartner (1967) and Kraus (1973) also study the early refunding decisions of corporations.

The paper is organized as follows. Section I describes the advance refunding of tax-exempt bonds. Section II discusses optimal advance refunding. Section III presents a case study of advance refunding. Section IV discusses the data. Section V examines the profitability of advance refunding. Section VI considers alternative frictions and constraints. Section VII explores the determinants of advance refunding activity. Section VIII considers the cross-sectional structure of advance refunding decisions. Finally, Section IX summarizes and makes concluding remarks.

I. Advance Refunding of Tax-Exempt Bonds

The advance refunding of bonds is an increasingly common practice in municipal finance whereby a municipality with an outstanding callable bond (that is not yet callable) issues a new bond with a lower coupon rate and then uses a portion of the proceeds to defease the existing bond. Defeasance of the existing bond is achieved by placing into an escrow account funds sufficient to purchase a portfolio of risk-free zero-coupon securities with cash flows that exactly match the remaining cash flows on the existing bond.[4] Once the existing bond is defeased, governmental and financial reporting rules allow the municipality to remove the liability associated with the bonds from its financial statements, effectively treating the existing bond issue as if it were extinguished or paid in full.[5]

Although the advance refunding transaction itself is relatively straightforward, the details are complicated by the necessity of the transaction complying with the Internal Revenue Code's tax-exempt advance refunding limitations in order for the new bond issue to receive tax-exempt status. Specifically, Sections 103, 148, 149, and 150 of the Internal Revenue Code outline the yield arbitrage restrictions and other tests and requirements that apply to tax-exempt advance refunding transactions. Key provisions are as follows: (1) the bond being refunded must be callable, and the call date must be more than 90 days after the refunding transaction; (2) a bond issue may only be refunded once; (3) the yield on the securities in the escrow account funding the payments on the defeased bond cannot be more than 0.001% above the yield on the refunding issue; and (4) once defeased, the existing bond being advance refunded must be called at its first call date.

[4] While the bonds in the escrow account do not have to be zero-coupon bonds, the use of zero-coupon bonds greatly simplifies the defeasance and is the standard approach.

[5] For a discussion of the basics of advance refundings, see https://www.irs.gov/pub/irs-tege/eotopicl97.pdf.

The primary economic rationale for these restrictions is to avoid the tax-arbitrage situation in which a municipality issues a new tax-exempt bond issue at a low yield and then uses the proceeds to purchase higher-yielding taxable securities to fund the escrow account. Since yields on taxable Treasury STRIPS (Separate Trading of Registered Interest and Principal of Securities) are often substantially higher than tax-exempt yields, an escrow that purchased zero-coupon Treasury STRIPS to defease a municipal bond would generally be in violation of the yield arbitrage rules described above. To avoid this problem, the Treasury created a special class of taxable securities known as State and Local Government Series or SLGS.[6] These risk-free securities are direct obligations of the Treasury. In an advance refunding transaction, the escrow purchases SLGS from the Treasury at a premium determined administratively that reduces the yield on the escrow portfolio to match that of the new tax-exempt issue refunding the original bond issue. In this transaction, the Treasury benefits by being able to issue debt at lower yields than for its other securities. Despite receiving a lower yield on these SLGS, the municipality may still be able to benefit if the escrow amount required for the defeasance is sufficiently low.

To illustrate this latter point, imagine that an existing tax-exempt bond has a 10-year maturity but is callable at par in four years. Since a defeased bond must be called at its first call date, the escrow amount required is the cost of an SLGS portfolio replicating the cash flows on a four-year bond. Because of the yield arbitrage rules, however, the replicating portfolio of SLGS can be purchased at the yield of the new 10-year bond refunding the original bond, rather than at the yield of a four-year bond.[7] This implies that if the term structure of tax-exempt yields is upward sloping, the escrow amount required may be substantially less than the value of a four-year bond. Thus, the yield arbitrage rules have the potential to create an implicit tax subsidy that may provide municipalities with strong economic incentives to advance refund debt.

The advance refunding of tax-exempt bonds has been a popular municipal finance strategy for decades. Market practitioners have offered a number of explanations for the popularity of the strategy.[8] Foremost among these is that it allows municipalities to reduce current debt service cash outflows by replacing bonds that have high coupon rates with bonds that have lower coupon rates. As discussed earlier, this feature can be attractive to a municipality facing severe cash flow constraints. Other explanations offered for advance refunding include freeing up reserve funds required by an outstanding bond issue, locking

[6] For a description of these securities, see https://www.treasurydirect.gov/govt/apps/slgs/slgs.htm.

[7] More precisely, the replicating portfolio of SLGS can be purchased at the minimum of the yield of the 10-year refunding bond or the yield on Treasury STRIPS. The mechanics of how the escrow amount for an advance refunding is determined are discussed in detail in Internal Revenue training materials available at https://www.irs.gov/Tax-Exempt-Bonds/Tax-Exempt-Bonds-Training-Materials. See, in particular, p. C-24.

[8] For an in-depth discussion of the underlying reasons offered for advance refunding, see http://www.treasurer.ca.gov/cdiac/debtpubs/primer/chapter7a.pdf.

in current interest rates, or eliminating restrictive covenants associated with existing bonds.[9]

II. Optimal Advance Refunding

Consider the case of a municipality that has an outstanding bond issue with an annual coupon rate of c and a maturity date of M years. This bond is callable at time $N < M$ at the call price of K, where N and M are integer valued. Denote the current time as time zero and let $D(T)$ be the price of a tax-exempt zero-coupon bond with maturity T. To illustrate the optimal advance refunding decision as simply as possible, we assume that the bond can only be refunded at time zero and called at time N. This assumption, however, could easily be relaxed.

As shown in the Appendix, the current value of the callable bond equals the value of an M-year bond minus a call option on the bond with expiration date N and strike price K. Alternatively, using a put-call parity result, the value of the callable bond can also be expressed as the value of an N-year bond minus a put option on a bond with final maturity date M, where the expiration date and strike price of the put option are N and K, respectively. Using the latter approach, the value at time zero of the callable bond is given by

$$\frac{c}{2} \sum_{i=1}^{2N} D(i/2) + 100\, D(N) - \text{Put.} \tag{1}$$

However, at time zero the municipality has the option to advance refund the bond issue. To do so, the municipality places sufficient cash into a trust to defease the existing bond issue. Let E denote the escrow amount required to fund this trust. As discussed above, the escrow amount equals the price of a portfolio of SLGS with cash flows that replicate those of the defeased bond, where the yield on the portfolio of SLGS equals the minimum of (i) the yield on the new M-year bond issue used to refund the existing debt or (ii) the maximum allowable yield on a portfolio of SLGS replicating the cash flows of the defeased bond. In general, the escrow amount E can differ significantly from both the call price K and the market value of the callable bond given in equation (1). Since the advance refunding transaction eliminates the debt obligation from the financial statements of the municipality, it can be viewed as the economic equivalent of a "synthetic call" of the outstanding bond at a call price of E.

Given the option to refund the existing callable bond issue at a price of E, the optimal refunding decision is made by simply comparing the value of the callable bond at time zero given in equation (1) above with the escrow amount E. Advance refunding is optimal if and only if the value of the callable bond

[9] Another rationale for advance refunding might be that municipalities use it to eliminate undesirable "contract design" features of callable bonds such as the extended lockout period before the first call date for the bond. We are grateful to the referee for this suggestion.

is greater than the escrow amount E. The NPV associated with an advance refunding is

$$\frac{c}{2} \sum_{i=1}^{2N} D(i/2) \; + \; 100 \, D(N) \; - \; \text{Put} \; - \; E. \tag{2}$$

Intuitively, the advance refunding decision is equivalent to the early exercise decision for an American option. Recall that in deciding whether to exercise an American option, we compare the continuation value of the option with its immediate exercise value. In the case of the advance refunding decision, the value of the callable bond at time zero plays the role of the continuation value. Similarly, the escrow amount E plays the role of the immediate exercise value. In this sense, the possibility of advance refunding transforms the implicit put option in the callable bond from a European option exercisable only at time N to an American option exercisable at both time zero and time N. Thus, the advance refunding of a bond issue can be viewed as the early "call" of a callable bond.[10] Note that the NPV in equation (2) can be negative if the advance refunding option is exercised when it is out of the money, that is, when the value of the callable bond in equation (1) is less than the escrow amount E.

It is also important to observe that two different options are involved in this analysis. The first is the European put option that is embedded in the price of the callable bond as shown in equation (1). The second is the American advance refunding option that results in the payoff shown in equation (2).

To value the European put option in equation (1) at time zero, we apply the widely used Black model for options on bonds. This model is the market standard for valuing European swaptions. Since receivers and payers swaptions are equivalent to call and put options on bonds, this model is directly applicable to callable bonds.[11] Let $A(0, N, M)$ denote the current value of a semiannual annuity beginning at time N and ending at time M,

$$A(0, N, M) \; = \; \sum_{i=1}^{2(M-N)} \; D(N + i/2). \tag{3}$$

Similarly, let $F(0, N, M)$ denote the current forward par rate (call price adjusted) for a bond issued at time N with maturity date M,

$$F(0, N, M) = 2 \left[\frac{K \, D(N) \; - \; 100 \, D(M)}{A(0, N, M)} \right]. \tag{4}$$

From Longstaff, Santa-Clara, and Schwartz (2001), the value of the put option can be expressed as

$$\text{Put} = \frac{1}{2} \, A(0, N, M) \, \left[F(0, N, M) \, N(d) \; - \; c \, N(d - \sqrt{\sigma^2 N}) \right], \tag{5}$$

[10] We are grateful to the referee for this insight.

[11] For a discussion of the equivalence of swaptions and options on coupon bonds, see Longstaff, Santa-Clara, and Schwartz (2001).

where

$$d = \frac{\ln(F(0, N, M)/c) + \sigma^2 N/2}{\sqrt{\sigma^2 N}}, \tag{6}$$

and σ is the volatility of the log forward par rate.

As an illustration of the optimal advance refunding strategy, Table I presents a numerical example in which a municipality has an eight-year 8% coupon bond outstanding. This bond is callable at par in three years. While the bond was originally issued at par, tax-exempt rates have fallen. Currently, three-year and eight-year municipal bonds can be issued at par with coupon rates of 5.50% and 6.00%, respectively. In each scenario, we show the cash flows over the same eight-year horizon to ensure comparability.

Scenario A shows the cash flows that the municipality pays under the assumption that the existing eight-year bond is neither called nor advance refunded. The present value of these cash flows is −112.42.

Scenario B shows the cash flows that the municipality pays under the assumption that the bond is not advance refunded, but is called at par for certain (even if the call option is out of the money) in three years and refinanced with a five-year par bond with market coupon rate of c. Note that, while c is not known at time zero, we can still compute the present value of the cash flows since c will be chosen so that the value of the refunding bond equals par.[12] The present value of these cash flows is −106.74.

Scenario C shows the cash flows that the municipality pays under the assumption that the bond is not advance refunded, but is called optimally in three years. If the bond is called in three years, then the bond is refunded with a five-year par bond with a market coupon of c. If the bond is not called in three years, the original bond remains in place. The present value of these cash flows (including the 1.77 value of the put option) is −104.97. Note that this present value is simply the value of the callable bond.

Finally, Scenario D shows the cash flows that the municipality pays under the assumption that the bond is advance refunded. Since the yield on the new eight-year refunding bond is 6%, the escrow amount required to defease the original bond is 105.35. After the advance refunding, the cash outflow paid by the municipality is only $105.35 \times 0.06 = 6.32$. Over the first three years, this cash outflow is substantially less than those paid in Scenarios A, B, and C. Thus, it is easy to understand why a cash-constrained municipality would find it tempting to advance refund the bond.

The problem with advance refunding the bond, however, is that the present value of the cash flows under Scenario D is −105.35, which is costlier than the present value of cash flows under Scenario C of −104.97. In other words, the escrow amount of 105.35 is greater than the 104.97 value of the existing callable bond, implying that the NPV shown in equation (2) is negative. Thus, the optimal decision in this case would be to forgo advance refunding the bonds

[12] We are also making the standard assumption that issuing a bond at its market value is a zero NPV transaction.

Table I

Numerical Example

In this example, there is an existing 8% bond with eight years to maturity. The bond is callable at the end of three years at a price of $100. The yields on three-year and eight-year bonds are currently 5.50% and 6.00%, respectively. Scenario A shows the net cash flows assuming that the bond will not be called. Scenario B shows the net cash flows assuming that the bond is called for certain at the end of three years, and then refinanced by issuing a new five-year bond at par with a coupon rate of c representing the five-year par rate in the market in three years. Scenario C shows the net cash flows assuming that the bond is called optimally in three years. If not called, the coupon rate remains at 8%. If called, the $100 call price is financed by issuing a new five-year bond at par with a coupon rate of c representing the five-year par rate in the market in three years. The net effect of calling the bond optimally is to reduce the coupon rate to $\min(8, c)$% after year three. The present value amount of 1.77 represents the value of the implicit put option. Scenario D shows the net cash flows from advance refunding the bond by placing $105.35 in escrow and issuing a new eight-year bond with a par amount of $105.35 at the current par rate of 6%. PV denotes the present value of the cash flows for each scenario.

	Scenario A	Scenario B	Scenario C	Scenario D
Timing of cash flow	Net cash flows assuming that bond is not called	Net cash flows assuming that bond is called for certain and refinanced by issuing new bond at par with coupon c.	Net cash flows assuming that bond is called optimally. If called, refinanced by issuing new bond at par with coupon c.	Net cash flows assuming that bond is advance refunded
0				−105.35+105.35
1	−8	−8	−8	−6.32
2	−8	−8	−8	−6.32
3	−8	−8	−8	−6.32
4	−8	−c	$-\min(c, 8)$	−6.32
5	−8	−c	$-\min(c, 8)$	−6.32
6	−8	−c	$-\min(c, 8)$	−6.32
7	−8	−c	$-\min(c, 8)$	−6.32
8	−108	−c − 100	$-\min(c, 8) - 100$	−111.67
PV	−112.42	−106.74	−106.74 + 1.77 = −104.97	−105.35

at time zero, but then make an optimal call decision in three years. Note, however, that if the value of the put option decreased and was less than 1.39, then the optimal decision would be to advance refund the bond at time zero. Thus, in this example, a relatively modest change in the value of the implicit put option could alter the optimal decision.

Finally, it is important to observe that Scenarios B, C, and D all result in significant cost savings to the municipality relative to the status quo of Scenario A. In fact, at a high level, the costs from Scenarios B, C, and D may not appear all that different from each other, relative to the costs of the status quo. Not surprisingly, however, the decision to advance refund is often framed by practitioners in terms of the short-term annual cash flow savings that result from Scenario D relative to the cash flows from the status quo. In this case, the short-term cash outflow is reduced from 8.00 to 6.32 over the next three years by advance refunding. But what the focus on cash flows misses is that the notational amount of the municipality's indebtedness also increases from 100 to 105.35 as a consequence of the advance refunding. Thus, while the advance refunding generates a short-term annual cash flow savings of $8.00 - 6.32 = 1.68$ over the next three years, the final principal amount at maturity increases significantly. Thus, focusing only on the short-term cash flow savings will result in a biased view of the economics of the transaction.

Given this, what role does the cash flow savings actually play in determining the NPV of the advance refunding? To answer this question, it is important to recognize that the cash flow savings occur precisely because interest rates have declined and municipalities can now fund themselves at lower rates. The effect of this, however, is to increase the value of the underlying callable bond. As the value of the callable bond increases, the advance refunding option becomes deeper in the money and the NPV increases. Thus, the decline in rates that generates the cash flow savings is implicitly reflected in the NPV through its effect on the value of the callable bond. These considerations underscore the importance of evaluating advance refunding transactions on an NPV basis, rather than by simply attempting to compare streams of cash flows as is done in the following case study.

III. A Case Study

A specific example may provide some sense of the political context in which advance refundings are carried out. In the spring of 2005 the City of Pittsburgh, Pennsylvania faced some difficult choices. The city's debt totaled $821 million in gross bonded debt, representing $2,456 owed for every person living in the city. Debt service amounted to a quarter of spending by the city.[13] A state board appointed under Pennsylvania state law oversaw the city's finances. The administration of Mayor Tom Murphy, in a desperate effort to balance the 2004 budget, accelerated revenues and deferred expenses. Revenue shortfalls

[13] *Pittsburgh Post-Gazette*, "City's Debt Looms: Large Principal and Interest Now 25% of Spending," April 30, 2005.

relative to that budget were $7 million, and expenses exceeded the budget by $13 million, depleting the city's cash reserves. By early 2005, the city council found itself with no funds available to continue the maintenance of city streets. The mayor had previously pledged not to increase the city's debt any further.

At this point, the city council debated two proposals aimed at generating funds for road maintenance.[14] Murphy's proposal involved advance refunding approximately $200 million of city bonds issued in 1995 and 1997. The 1995 bonds were otherwise callable in September 2005, or in roughly four months. The 1997 series was otherwise callable in August 2007. After $2.4 million in fees, the transaction would contribute $6 million in funds over the next year for street resurfacing and "fixing pot holes." The alternative, offered by the chairman of the council's Finance Committee, Doug Shields, was to borrow $5 million from a regional development authority for one year, with interest and fees of $164,000. The fees for the advance refunding included approximately $1.86 million for bond insurance, $1 million to the underwriters, Lehman Brothers and National City, and $370,000 for bond counsel and the underwriter's attorneys.

After two hours of debate, the city council voted 6 to 2 for the advance refunding. Proponents of the mayor's plan argued that it did not require the city to increase its debt. Councilman Sala Udin declared, "The $6 million is free money. I think it would be a mistake to leave $6 million on the table." Afterwards, the mayor's spokesman explained, "The mayor made a commitment that he would not increase the city's debt this year, and the Shields plan obviously would have done that."

The approved plan resulted in the refunding of 21 separate bond issues with a total par amount of $196.51 million. Of these 21 bond issues, 4 were advance refunded at a positive NPV, while the other 17 were advance refunded at a small loss. The total NPV for the 21 advance refundings was −$146,232. Thus, the NPV loss was only 0.074% of the total notional amount advance refunded. On the other hand, since many of the bond issues advance refunded were callable within a four-month horizon, the actual annual cash flow savings directly attributable to the advance refunding was likely smaller than the $6 million estimate.

IV. Data

The data used in the study come from a number of sources. We describe these sources briefly below.

A. Advance Refunding Data

The primary data used in the study consist of a database of advance refunded municipal bonds. We use a three-step procedure to construct this database.

[14] Details and quotations from *Pittsburgh Post-Gazette*, "Council OKs Bond Refinancing Plan Will Fund Paving, Other Work," April 7, 2005.

First, we use transaction data from the Municipal Securities Rule Making Board (MSRB) to identify CUSIP numbers for all municipal bonds traded during the January 1995 to December 2013 sample period. Second, we use the Bloomberg system to identify which of these CUSIP numbers are associated with advance refunded bonds. This yields a set of 362,196 advance refunded bonds with a total par value of $1.144 trillion. For these advance refunded bonds, we collect information on the bond type (callable, puttable, sinkable, etc.), coupon type (floating, fixed, or original issue discount), issue price and yield, tax status (federal and/or state tax-exempt, or subject to the Alternative Minimum Tax (AMT)), size of the original issue, an indicator for whether the bond is advanced refunded, advance refunding date, advance refunding price, and escrow security type. Third, we apply the following filters. We exclude bonds that are not exempt from federal and within-state income taxes or are subject to the AMT. We further exclude advance refunded bonds that are not escrowed by Treasury securities, SLGS, or cash; bonds not issued in one of the 50 states or the District of Columbia; and bonds with missing information on the call date, the call price, etc. Finally, we exclude bonds that are refunded with fewer than 90 days to the call date since the Internal Revenue Service (IRS) treats these transactions as current rather than advance refundings. The resulting sample of 206,418 bonds represents 56.99% of the CUSIPs and 50.86% of the total aggregate notional amount of the full set of advance refunded bonds. Thus, our estimates of the aggregate impact of advance refunding transactions are clearly conservative.

It is important to note that our sample consists only of municipal bonds that were advance refunded during the 1995 to 2013 period—we do not have information about the many other municipal bonds that were not advance refunded. Accordingly, our analysis and findings are necessarily limited to the subset of advance refunded bonds included in our sample.

Municipal bonds are typically issued in "series." In a single underwriting, bonds with a wide range of maturities are issued. As a result, advance refundings typically involve multiple CUSIPs from the same original series. We refer to bonds from the same issuer that are advance refunded on the same date as a "deal." The sample includes data on 23,001 deals.

Table II presents summary statistics for the advance refunded bonds in the sample, including par value, original coupon rate, coupon rate on the new refunding issue, age of the bond, years to first call, call price, escrow amount, and number of issues refunded on the same date as part of a deal. As shown, the average size of the advance refunded issue is about $2.82 million. The smallest advance refunding transactions tend to be those for small health care facilities and school districts. The largest advance refunding transactions involve New Jersey tobacco settlement bonds, the Los Angeles Unified School District, Long Island Power, and the Tri-Borough Bridge and Tunnel Authority. The average difference in coupon rates between the old and new bond issues is 1.81%. This large difference in coupon rates illustrates why municipalities may see advance refundings as a vehicle to reduce cash outflows. This is true

Table II

Summary Statistics for Advance Refundings

This table provides summary statistics for the advance refunded bonds in the sample. Par value denotes the notional size of the bond issue refunded (in dollars). Coupon rates are expressed as percentages. The age of the bond is expressed in years. Refunding amount is the amount per $100 needed to fund the escrow defeasing the bond issue that is being advance refunded. Number of issues refunded denotes the number of bond issues that are being advanced refunded by the municipality at the same time. N denotes the total number of observations. The sample period is April 1995 to December 2013.

	Mean	5^{th} Percentile	25^{th} Percentile	50^{th} Percentile	75^{th} Percentile	95^{th} Percentile	N
Par Value	2,818,779	100,000	300,000	735,000	2,120,000	10,995,000	206,418
Original Coupon Rate	5.022	4.000	4.600	5.000	5.400	6.125	206,418
New Coupon Rate	3.212	1.276	2.436	3.444	3.998	4.657	206,418
Difference in Coupon Rates	1.810	0.520	1.170	1.713	2.939	3.400	206,418
Age of Bond	6.684	2.579	4.947	7.086	8.493	9.656	206,418
Years to Call	2.550	0.252	0.961	1.955	3.718	6.746	206,418
Years to Maturity	8.981	2.379	5.292	8.312	11.699	18.125	206,418
Call Price	100.42	100.00	100.00	100.00	101.00	102.00	206,418
Refunding Amount	106.89	101.99	104.20	106.35	109.05	113.79	206,418
Number of Issues Refunded	8.97	1.00	4.00	7.00	11.00	23.00	206,418

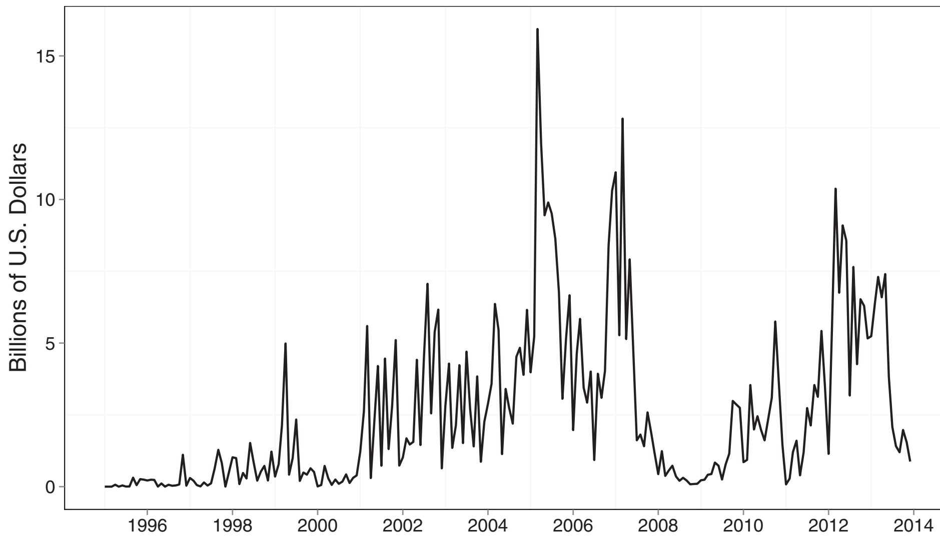

Figure 1. Total par amount advance refunded. This figure plots the monthly time series of the total par amount of municipal bonds advance refunded. These totals are based on the 206,418 advance refunding transactions in the sample over the 1995 to 2013 period. Par amounts are expressed in billions of dollars.

even after taking into account the average escrow amount of $106.89 required to advance refund a bond with a par amount of $100.

Figure 1 plots the monthly time series of the total par amount of bonds advance refunded. As shown, advance refunding activity increased dramatically beginning with the recession in 2001. Activity peaked during 2005 to 2006, but then slowed when municipal credit spreads rose in response to the credit crisis of 2007 to 2008 and the collapse of the major bond insurance firms, which played a major role in municipal markets. Advance refunding activity increased again beginning in 2009.

B. The Municipal Term Structure

In valuing an existing callable bond being advance refunded, we require information on the term structure of tax-exempt bonds. We follow Ang, Bhansali, and Xing (2010) and use zero-coupon rates inferred from the transaction prices for municipal bonds in the MSRB database. These zero-coupon yield curves are constructed using the Nelson and Siegel (1987) methodology. The curves are estimated for each day in the sample period using the transaction prices for interdealer transactions for highly rated tax-exempt bonds.[15]

[15] Details are provided in the Internet Appendix of Ang, Bhansali, and Xing (2010).

C. The SLGS Term Structure

To calculate the escrow amount for an advance refunding, we also need the maximum SLGS yields available from the Treasury each day. The reason is that the escrow amount is given by discounting the cash flows from the existing bond until and including the first call date at the minimum of (i) the yield on the refunding bond or (ii) the maximum yield on a portfolio of SLGS replicating the cash flows of the defeased bonds. The maximum SLGS rates are posted on the U.S. Treasury's website on a daily basis for maturities of up to 30 years. Typically, the maximum SLGS yield is one basis point below the yield on the Treasury STRIPS with the same maturity. We obtained the full history of the maximum SLGS rate through a request under the Freedom of Information Act.

D. Black Model Volatilities

In calculating the value of the put option embedded in advance refunded bonds, we calibrate the option pricing model to swaption market volatilities. The reason is that swaption markets are relatively liquid and prices are essentially continuously available throughout the sample period. This approach assumes that the percentage volatility of tax-exempt rates is similar to that of swap rates. This assumption, however, appears consistent with the properties of tax-exempt rates.[16]

We obtain month-end Black model swaption volatility from Bloomberg for the period 1997 to 2013. Specifically, we obtain swaption volatilities for at-the-money-forward N year into M year European swaptions for a wide range of values of N and M. In computing the put option values for advance refunded bonds, we use a simple linear interpolation of the tabulated swaption volatilities for the relevant month. Swaption volatilities for the 1995 to 1996 period are estimated from interest rate cap volatilities and a simple regression model of the relation between swaption volatilities and interest rate cap volatilities.

V. How Profitable Is Advance Refunding?

To examine the historical record on the profitability of advance refundings, we begin by first estimating the NPV of the transaction for each of the 206,418 advance refundings in the sample. From equation (2), the NPV is given by computing the value of the callable bond being advance refunded (including the value of the put option) and then subtracting the escrow amount required for the defeasance. A positive NPV indicates that the transaction was profitable for the municipality since it was able to "redeem" the callable bond for less than its continuation value, and vice versa.

We present the results on the profitability of advance refundings in three ways. First, we report results based on the NPV per $100 par amount for the individual transactions; under this approach, each advance refunding receives

[16] For example, see Green (1993), Ang, Bhansali, and Xing (2010), and Longstaff (2011).

equal weight. Second, we present results based on the total dollar NPV for the individual transactions or CUSIPs. Third, we present results based on the total dollar NPV for individual deals. A deal typically includes multiple CUSIPs advance refunded at the same time in a combined transaction.

Table III presents summary statistics for the NPVs from the advance refundings. Focusing first on the results per $100 par amount, Table III shows that the overwhelming majority of advance refunding transactions result in a negative NPV. In particular, 84.42% of the advance refundings during the sample period actually destroy value. The average NPV from an advance refunding is −1.628% of the face amount of the bond issue. The median NPV from an advance refunding is −0.897% of the face amount. The negatively skewed nature of the distribution of NPVs is also evident from the deciles shown in Table III.

The per-CUSIP results in the middle column of the NPV panel in Table III show that the average NPV from an advance refunding is just under $75,000. In contrast, the median NPV from an advance refunding is on the order of $5,000. Thus, the mean and median losses from advance refunding are relatively small in magnitude. In particular, from the deciles of the distribution, we see that, while most of the NPVs are negative, the majority of the losses are due to the worst 10% to 20% of transactions. The total NPV losses during the sample period are approximately $15.5 billion. This represents 2.658% of the total par amount of bonds advance refunded. The reason this fraction is considerably higher than the average NPV loss per $100 par amount of $1.628 is that the worst transactions appear to be among the largest transactions. Thus, the size-weighted average percentage loss exceeds the equally weighted average. Note from the distribution that some of the advance refunding transactions are very profitable. The maximum NPV from a transaction was for the advance refunding of a $554,230,000 par value bond issue of the Tobacco Settlement Financing Corporation of New Jersey, which resulted in an NPV gain of $17.192 million. On the other hand, some transactions result in very large NPV losses. The largest loss from an advance refunding was from the advance refunding of $554,975,000 par value bond issue of the Massachusetts State School Building Authority, which resulted in a loss of $57.748 million.

Figure 2 plots the monthly time series of the realized NPV of advance refunding transactions. This realized NPV is expressed as a percentage of the total par value of all bonds advance refunded each month. As shown, NPV losses are smaller during the early part of the sample period, but then become more extreme beginning around 2001. Note that the realized NPV losses are most pronounced after the 2007 to 2008 financial crisis.

Figure 3 plots the monthly time series of the fraction of advance refundings that result in an NPV gain. This fraction is calculated by taking the ratio of the total par amount of bonds advance refunded at an NPV gain each month to the total par amount of bonds advance refunded each month. As shown, NPV gains are much more common during the early part of the sample period. In some months, the majority of advance refunding transactions result in an NPV gain. Again, beginning in 2001, the fraction of positive NPV advance refundings

Table III

Summary Statistics for Advance Refunding Net Present Values and Annual Cash Flow Savings

This table reports summary statistics for the advance refunding NPVs and the annual cash flow savings. The per $100 columns present results for the NPVs or annual cash flow savings measured as a percentage of the par amount of the bond issue being refunded. The per CUSIP columns present results based on the total dollar advance refunding NPVs or annual cash flow savings for the individual bond issues being advance refunded. The per deal columns present results based on the total dollar refunding NPVs or annual cash flow savings taken over all bond issues being advance refunded by municipal issuers at the same time. The sample period is April 1995 to December 2013.

	Net Present Value			Annual Cash Flow Savings		
	Per $100	Per CUSIP	Per Deal	Per $100	Per CUSIP	Per Deal
Mean	−1.628	−74,922	−672,484	1.588	39,826	314,224
Standard Deviation	2.378	546,097	3,355,755	0.989	137,825	978,767
Percent Negative	84.42	84.42	84.82	3.68	3.68	1.81
Minimum	−46.554	−57,747,619	−131,131,923	−3.223	−985,379	−5,105,451
10th Percentile	−4.335	−112,312	−1,180,546	0.441	1,232	13,659
20th Percentile	−2.659	−40,128	−460,139	0.767	2,802	28,065
30th Percentile	−1.816	−19,040	−241,938	1.007	4,554	44,300
40th Percentile	−1.279	−10,009	−134,487	1.234	6,818	63,718
50th Percentile	−0.897	−5,381	−72,934	1.473	9,910	89,966
60th Percentile	−0.588	−2,770	−36,220	1.746	14,827	127,049
70th Percentile	−0.317	−1,203	−14,890	2.073	23,564	190,446
80th Percentile	−0.091	−254	−2,596	2.455	40,933	311,446
90th Percentile	0.129	581	3,608	2.931	88,183	647,290
Maximum	6.160	17,192,132	47,737,438	8.316	11,491,485	34,787,708
Total	−1.628	−15,465,223,391	−15,465,223,391	1.588	8,220,901,667	8,220,901,667
Total Advance Refunded	100.000	581,846,761,718	581,846,761,718	100.000	581,846,761,718	581,846,761,718
Total as a Percent	−1.628	−2.658	−2.658	1.588	1.411	1.411
N	206,418	206,418	23,001	206,418	206,418	23,001

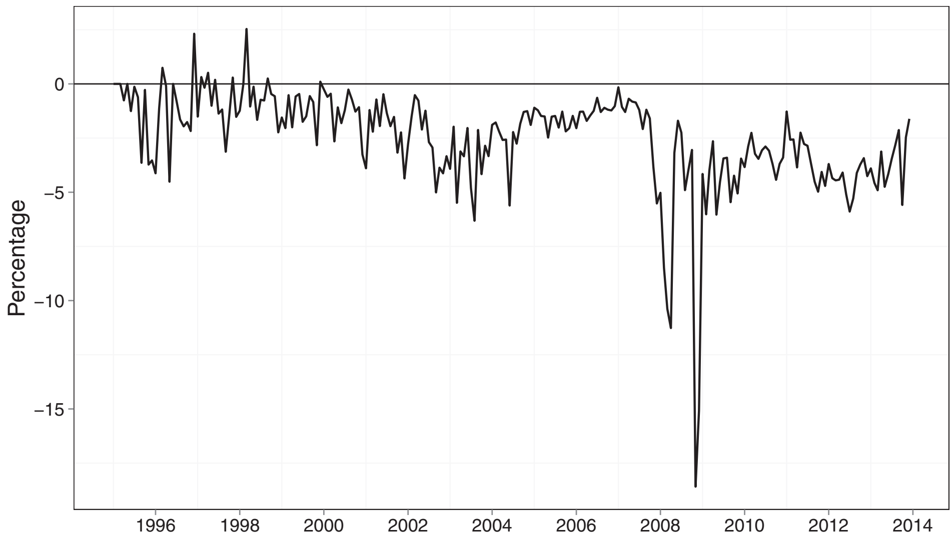

Figure 2. Net present value of advance refunding transactions. This figure plots the monthly time series of the ratio of the total NPV for all bonds advance refunded divided by the total par amount of all bonds advance refunded. The ratio is expressed as a percentage.

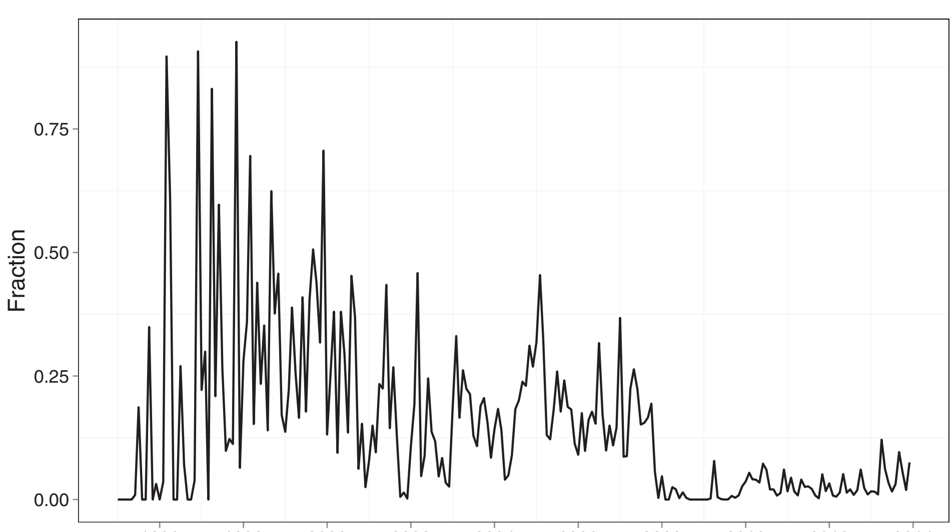

Figure 3. Fraction of advance refundings with a positive net present value. This figure plots the monthly time series of the fraction of the par amount of advance refunding transactions that results in a positive NPV.

Table IV

Summary Statistics for Informational Frictions

This table reports the percentages of positive NPV advance refundings given the indicated assumption about volatility. For example, the row denoted by 100% of swaption volatility presents the percentages of positive NPV advance refundings when the volatility used to compute the put option is 100% of the corresponding swaption volatility. The per CUSIP column reports the results based on individual advance refundings. The per deal column reports the results based on the total taken over all bond issues being advance refunded by a municipal issuer at the same time. The sample period is April 1995 to December 2013.

	Per CUSIP	Per Deal
100% of Swaption Volatility	15.58	15.18
75% of Swaption Volatility	27.34	28.06
50% of Swaption Volatility	38.48	42.14
25% of Swaption Volatility	44.18	49.27
0% of Swaption Volatility	45.70	51.03
Ignore Put Option Altogether	48.84	55.32

declines. After the 2007 to 2008 financial crisis, virtually all advance refundings result in an NPV loss.

Finally, the per-deal results are similar to the per-CUSIP results after taking into account the fact that the average deal involves about nine separate bond issues. The last column in Table IV shows that 84.82% of the deals result in a negative NPV. The maximum loss at the deal level was $131.132 million, resulting from the advance refunding of 62 bond issues of the Houston Texas Water and Sewer System with a combined par value of $1,693,360,000. The maximum gain at the deal level was $47.737 million, resulting from the advance refunding of 15 bond issues of the Tobacco Settlement Financing Corporation of New Jersey with a combined par value of $3,289,125,000.

The above results are perplexing. They indicate that only about 16% of all advance refundings result in a positive NPV outcome for a municipality.[17] This immediately raises the question of why the practice of advance refunding is so widespread.

It is also important to observe that our estimates likely understate the total losses associated with advance refunding since they do not include transaction costs. The fees associated with advance refunding an issue are numerous: fees are paid to underwriters, rating agencies, lawyers, municipal debt advisors, swap advisors in cases in which derivatives are used in the financing arrangements, among others. Furthermore, the vast majority of advance refundings are sold via negotiated sale (see Wood (2008)). Robbins (2002) and McCaskill (2005) estimate that the cost of nontendered offerings is 20 to 35 basis points higher than competitive auctions. The total transaction costs associated with advance refunding transactions are not easily estimated, particularly when

[17] In fact, since we assume that the put option embedded in the callable bond is European rather than Bermudan, our results may slightly overstate the number of positive NPV transactions. Our estimates of NPV losses are therefore likely to be on the conservative side.

derivatives are used as part of the refunding issue. However, estimates of the fees paid range from 0.375% in Kalotay, Yang, and Fabozzi (2007) to 2.00% or more by the Government Finance Officers Association.[18] We note, however, that not all the fees paid in an advance refunding can be viewed as incremental to the transaction. If the bond is not advance refunded, it is likely that in most cases the call option would be in the money eventually, and the bond refunded at that point. Only in the cases in which the original bond issue would be allowed to mature without being called would the fees be avoided completely.

As one way to shed light on these issues, we estimate the annual interest cost savings that municipalities realized from the advance refundings during the sample period. Note that it is entirely possible for a municipality to advance refund a bond issue at a negative NPV while simultaneously reducing its debt service cash outflows temporarily. This occurs because the apparent cash flow savings that the municipality achieves does not reflect either the value of the implicit put option or the present value cost of its suboptimal exercise.

Table III also presents summary statistics for the short-term annual cash flow savings generated by the advance refundings. These results are dramatically different from those for the NPVs. In particular, the results imply that 96.32% of all advance refundings result in an annual cash flow savings.[19] On average, the annual cash flow savings is on the order of 1.588% of the par amount advance refunded. In terms of dollar amount, the average annual cash flow savings is nearly $40,000. The total annual savings over all advance refundings in the sample is $8.221 billion. On a per-deal basis, 98.19% of all transactions result in an annual cash flow savings.

Figure 4 plots the monthly time series of annual cash flow savings from advance refunding transactions during the sample period. The annual cash flow savings are expressed as a percentage of the total par amount of bonds advance refunded each month. As shown, the annual cash flow savings is positive throughout the sample period. This savings trends up during the early part of the sample, begins to decline in 2003, but then accelerates dramatically following the 2007 to 2008 financial crisis.

Taken together, these results indicate that achieving cash flow savings could be a major driver of a municipality's decision to advance refund. In contrast, the incentive to realize a present value gain from the transaction either receives far less weight by municipalities or is largely eclipsed by other concerns such as the impact of financial frictions and constraints. We explore these factors in subsequent sections below.

[18] The Government Finance Officers Association estimates that transaction costs of an advance refunding include 0.50% to 1.00% for issuance fees, 0.50% to 1.00% for the underwriter's discount, 1.00% to 3.00% for the redemption premium, 0.50% to 1.00% for bond insurance, and 1.00% to 3.00% associated with the negative carry in the trust created to defease the refunding issue. See https://www.oregon.gov/treasury/Divisions/DebtManagement/Documents/OBEC/Presentation%20-%20GFOA%20De bt%20Instruments%20and%20Refundings.pdf.

[19] It is puzzling, however, that a small percentage of advance refundings occur even when there are no short-term cash flow savings associated with the transaction.

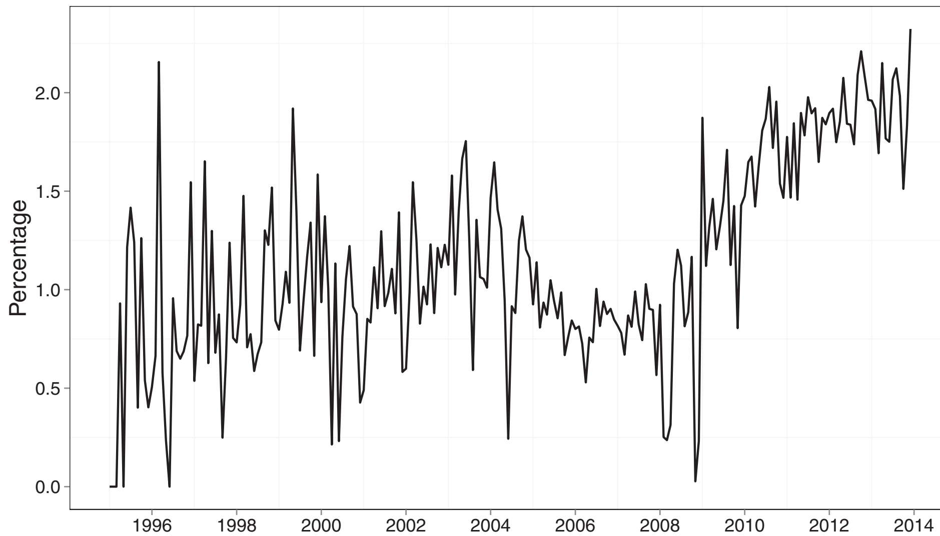

Figure 4. Annual cash flow savings from advance refunding transactions. This figure plots the monthly time series of the annual cash flow savings resulting from all advance refunding transactions in that month. The annual cash flow savings are expressed as a percentage of the total par amount of bonds advance refunded.

VI. Exploring Potential Frictions

Given the striking results above, it is tempting to conclude that the primary motivation for municipalities to advance refund their debt is to relax financial constraints by reducing their debt-service cash outflows. Before doing so, however, it is important to consider whether other types of financial frictions may play a role in influencing the advance refunding decision.

One possibility suggested by the literature is that municipalities may be willing to advance refund some bond issues at an NPV loss as part of a broader advance refunding deal in order to clean up and eliminate restrictive bond covenants. For example, imagine that a municipality has 20 bond issues outstanding that were part of the same issuance and that all share the same set of covenants. Imagine also that the total NPV from advance refunding is negative for the five shortest maturity bonds, but that the total NPV taken over all 20 bonds is positive. To eliminate the restrictive covenants entirely, the municipality must advance refund all 20 bonds—it is not sufficient to simply advance refund the subset of bonds for which the NPV is positive. A municipality facing this situation may find it worthwhile to simply advance refund all of the bonds in order to completely eliminate the restrictive covenants even though some of the individual transactions involve an NPV loss.

To explore this possibility, we revisit Table III, which presents summary statistics on the profitability of advance refunding. In particular, we focus on the last column of the table, which presents results at the deal level. If municipalities are advance refunding some bond issues at a loss simply to facilitate the profitable advance refunding of an entire deal in which all bonds share the same set of covenants, we would expect to find that the NPV is positive for most deals.

From Table III, however, it is clear that this is not the case. In particular, the third column of Table III shows that 84.82% of the 23,001 deals in the sample result in a negative overall NPV. In fact, this percentage is slightly higher than the 84.42% of the individual transactions that result in a negative NPV. As discussed earlier, the total NPV losses from all deals is on the order of $15.5 billion. In short, there is no evidence to support the hypothesis that some bond issues are being advance refunded at a loss simply to facilitate the profitable advance refunding of a broader deal that eliminates restrictive covenants.

A second possibility may be that informational frictions play a role in advance refunding decisions. In particular, it may be the case that it is costly or difficult for municipalities to obtain reliable information on the true economic costs of an advance refunding, perhaps because of the challenge of identifying the value or optimal exercise strategy for the implicit put option.[20]

To explore the informational sensitivity of the optimal advance refunding decision, we reestimate the profitability of the advance refunding transactions in the sample under a variety of assumptions about swaption volatility. Specifically, Table IV reports the fraction of individual transactions and of deals that result in an NPV gain for volatilities ranging from zero to 100% of market swaption volatilities. As shown, the profitability of advance refunding is clearly informationally sensitive. As the volatility used to compute the value of the put option decreases, the fractions of the individual transactions and deals that result in an NPV gain increase substantially.

Despite this informational sensitivity, however, informational frictions clearly do not fully explain the results. In particular, even under the extreme assumption that interest rate volatility is zero, or the even-more extreme assumption that the implicit put option can be disregarded entirely, nearly 50% of advance refunding transactions result in NPV losses. For example, when interest rate volatility is assumed to be zero, only 45.70% of all individual advance refundings are profitable and only 51.03% of all advance refunding deals are profitable. Similarly, when the implicit put option is disregarded altogether, only 48.84% of all individual advance refundings are profitable and only 55.32% of all advance refunding deals are profitable. In summary, the results provide little support for the hypothesis that municipalities advance refund bond issues at an economic loss solely because they do not have access to the information needed to make optimal advance refunding decisions.

[20] For example, rather than providing specific guidance, the Government Financial Officers Association best practices recommendation offers the simple rule of thumb that an advance refunding should not occur unless the present value of cash flow savings is on the order of 3.0% to 5.0% of the par amount of the debt. See http://www.gfoa.org/analyzing-and-issuing-refunding-bonds.

VII. What Drives Advance Refundings?

In this section, we seek to better understand the factors that drive advance refunding activity in the municipal bond markets. Specifically, we explore the role that financial frictions and constraints play in influencing municipalities to advance refund their debt.

To do so, we use simple time-series regressions in which we regress the total number and par amount of all bond issues advance refunded each month or each quarter on a number of explanatory variables. It is important to note that these time-series regressions are conducted at the aggregate level (thus, there are no cross-sectional or panel data in these regressions), as most of the independent variables included in these regressions can only be measured at the aggregate level.

As the first explanatory variable, we calculate an index of the potential NPV for the sample each month. To illustrate this, imagine that there are 100,000 bonds in the sample as of month t that have not yet been advance refunded. For each bond, we can calculate what the NPV would be (per $100 par amount) if the bond were to be refunded in month t (rather than at its actual advance refunding date). We then take the size-weighted average of these potential NPVs over all 100,000 bonds. This measure is clearly a hypothetical one, but its purpose is to provide a measure of the aggregate potential gains from advance refunding present in the market each month. We also calculate an index of the potential annual cash flow savings in the same way by calculating what the annual cash flow savings would be (per $100 par amount) for each of the 100,000 bonds in the sample in month t, and then taking the size-weighted average over all bonds. The purpose of this measure is to reflect the degree to which financial constraints could be relaxed by advance refunding existing debt.

We begin by examining whether advance refunding activity can be explained as a response by municipalities to the economic incentives available in the market. In particular, we regress the realized advance refunding activity on the lagged potential NPV and annual cash flow savings measures. We include three lags of these measures in the regressions to allow for the possibility that frictions cause municipalities to respond with a lag to advance refunding incentives. To control for persistence in the measures of realized advance refunding activity, we also include their lagged values in the regression.

Table V reports the results from this regression. As shown, the regression provides strong evidence that municipalities respond rapidly to incentives to advance refund for cash flow reasons. Specifically, the coefficient on the first lagged value of the potential annual cash flow savings is positive and significant in both regressions.

In contrast, the results in Table V provide little evidence that advance refunding activity occurs in response to changes in the potential NPV benefits from advance refunding. In particular, none of the coefficients on the first three lagged values of the potential NPV are significant at the 5% level. Although the coefficient on the first lagged value of potential NPV in the regression for

Table V

Regression Results for Advance Refunding Activity

This table reports summary statistics for regressions of the number of advance refunding transactions and the par amount advance refunded (in millions of dollars) on the lagged explanatory variables. In each regression, we regress the measure of realized advance refunding activity on the lagged number and par amount of advance refundings, and the first three lagged values of the potential advance refunding NPV and annual cash flow savings. The potential advance refunding NPV and annual cash flow savings measures are estimated by solving for what the NPV and annual cash flow savings (per $100 par amount) of each bond in the sample would be if it were to be advance refunded during the current month, and then taking the size-weighted average over all bonds in the sample for that month. The t-statistics are based on the Newey-West (1987) estimator of the covariance matrix (four lags). ** and * denote significance at the 5% and 10% levels, respectively. The sample period is monthly from April 1995 to December 2013 (225 observations).

		Number of Refundings		Par Amount of Refundings	
Variable	Lag	Coefficient	t-Statistic	Coefficient	t-Statistic
Constant		19.525	0.22	673.291	2.42**
Number of Refundings	1	0.169	0.94	0.065	0.14
Par Amount of Refundings	1	0.172	2.38**	0.642	4.59**
Potential Net Present Value	1	−95.503	−1.90*	−228.742	−1.64
Potential Net Present Value	2	108.961	1.45	229.928	1.02
Potential Net Present Value	3	−25.038	−0.57	78.147	0.54
Potential Annual Cash Flow Savings	1	1,108.911	2.58**	3,244.582	3.11**
Potential Annual Cash Flow Savings	2	−773.179	−1.34	−2,235.176	−1.36
Potential Annual Cash Flow Savings	3	35.577	0.11	−302.877	−0.32
Adj. R^2			0.556		0.554
N			225		225

the number of advance refundings is significant at the 10% level, the sign on the coefficient is negative, suggesting that municipalities may actually be less likely to advance refund as the potential NPV increases.

We next explore whether advance refunding activity is related to measures of macroeconomic conditions. Intuitively, if advance refunding is driven primarily by the efforts of municipalities to relax financial constraints during fiscally challenging times, we should expect to see advance refunding increase as economic conditions worsen. To examine this conjecture, we again regress the measures of advance refunding activity on lagged values of the potential NPV and annual cash flow savings measures. In addition, we include a number of key macroeconomic variables in the regression as proxies for the fiscal status of the municipalities making advance refunding decisions. In particular, we include the unemployment rate, the gross domestic product (GDP) growth rate, and the aggregate consumption growth rate. The unemployment rate is obtained from the Bureau of Labor Statistics. The GDP and aggregate consumption growth rates are obtained from the Bureau of Economic Analysis.

We also include in the regression several macroeconomic measures specific to the budgetary situation faced by states and local governments. From the Bureau of Economic Analysis, we obtain data on aggregate tax revenues and total budget surplus (or deficit) estimates for state and local governments in the United States, as well as estimates of the total amount of pension underfunding for states and local governments in the United States. Note that these estimates are measured at the aggregate U.S. level (not at the state or local levels). With the exception of the pension underfunding measure, all of these variables are observed quarterly. We map the annual pension underfunding estimates into quarterly values using a simple straight line interpolation. Finally, we again include the lagged values of the advance refunding measures to control for any persistence in these measures.

Table VI reports the results from these regressions. As before, the results indicate that municipalities respond to the potential annual cash flow savings available from an advance refunding. In both regressions, the lagged potential annual cash flow savings measure is positive and significant. Also as before, there is little evidence that municipal advance refunding decisions are influenced in any significant way by the potential NPV benefit. In particular, the lagged potential NPV measure is not significant in either of the two regressions.

The regression results for the macroeconomic variables confirm that advance refunding activity is significantly influenced by the fiscal condition of states and local governments. In particular, the coefficient on the budget surplus measure is negative and significant in both regressions. This implies that advance refunding activity declines as the budgetary position of states and local governments improves. Furthermore, the number of advance refundings is significantly negatively related (at the 10% level) to the current tax revenue estimate. These results strongly support the hypothesis that advance refunding increases when municipalities experience declines in tax revenues or face budgetary shortfalls.

In contrast, the other broader macroeconomic measures are not significant in the regression. A possible reason for this result may be that municipalities' finances are not perfectly correlated with the usual business cycle measures. If so, then general measures such as unemployment or GDP and consumption growth rates may not contain as much information about the state of a municipality's finances as measures that speak directly to the fiscal position of state and local governments.

Finally, we examine the implications of financial constraints on the realized NPVs per \$100 par amount advance refunded. If financial constraints are a key determinant of advance refunding activity, we would expect municipalities to accept worse NPV outcomes during more fiscally constrained times. To examine this conjecture, we regress the realized equally weighted and size-weighted NPVs per \$100 par amount on the same set of macroeconomic measures as in the previous set of regressions. We again include the lagged

Table VI

Regression Results for Effects of Macroeconomic Variables on Advance Refunding Activity

This table reports summary statistics for regressions in which advance refunding activity measures for a quarter are regressed on a vector of lagged explanatory variables from the previous quarter. The dependent variables in the regression are the number of advance refunding transactions and the total par amount advance refunded (in millions of dollars). In each regression, we regress the realized measure of advance refunding activity on the lagged values of the dependent variables, the lagged values of the potential advance refunding NPV and annual cash flow savings measures, and the lagged values of unemployment, GDP growth, consumption growth, current state and local government tax revenues and budget surplus values, and pension underfunding for state and local government defined benefit pension plans. The potential advance refunding NPV and annual cash flow savings measures are estimated by solving for what the NPV and annual cash flow savings (per $100 par amount) of each bond in the sample would be if it were to be advance refunded during the current quarter, and then taking the size-weighted average over all bonds in the sample for that quarter. Unemployment denotes the average value over the quarter of the seasonally adjusted unemployment rate reported by the Bureau of Labor Statistics. GDP growth rate and consumption growth rate denote the percentage changes in the GDP and personal consumption expenditure measures report by the Bureau of Economic Analysis. Current tax revenues and budget surplus are the quarterly measures for state and local governments reported by the Bureau of Economic Analysis and are measured in billions of dollars. Pension underfunding denotes the amount of underfunding of pension liabilities for all state and local government defined benefit pension plans reported by the Bureau of Economic Analysis (reported annually, interpolated to quarterly, measured in billions of dollars). t-statistics are based on the Newey-West (1987) estimator of the covariance matrix (three lags). ** and * denote significance at the 5% and 10% levels, respectively. The sample period is quarterly from 2Q 1995 to 4Q 2013 (75 observations).

		Number of Refundings		Par Amount of Refundings	
Variable	Lag	Coefficient	t-Statistic	Coefficient	t-Statistic
Constant		8,622.4190	1.82*	21,322.9100	1.57
Number of Refundings	1	0.5370	2.10**	0.6419	1.04
Par Amount of Refundings	1	0.0479	0.46	0.4686	2.02**
Potential Net Present Value	1	−12.4685	−0.09	493.5477	1.11
Potential Annual Cash Flow Savings	1	1,976.5530	3.02**	3,264.6770	1.99**
Unemployment Rate	1	−304.7244	−0.85	−559.1941	−0.56
GDP Growth Rate	1	67.7207	0.66	−13.1058	−0.05
Consumption Growth Rate	1	−13.1640	−0.10	−28.2069	−0.07
Current Tax Revenues	1	−7.6935	−1.95*	−16.6684	−1.55
Budget Surplus	1	−154.3768	−2.57**	−368.9083	−2.06**
Pension Underfunding	1	0.4768	0.35	1.1693	0.32
Adj. R^2			0.628		0.628
N			75		75

Table VII

Regression Results for Effects of Macroeconomic Variables on Advance Refunding Net Present Values

This table reports summary statistics for regressions in which total realized advance refunding NPVs measured quarterly are regressed on a vector of lagged explanatory variables from the previous quarter. The dependent variables in the regression are the equally weighted NPV per $100 par amount and the size-weighted NPV per $100 par amount. In each regression, we regress the realized advance refunding NPV on the lagged value of the dependent variable, and the lagged values of unemployment, GDP growth, consumption growth, current state and local government tax revenues and budget surplus values, and pension underfunding for government defined benefit pension plans. Unemployment denotes the average value over the quarter of the seasonally adjusted unemployment rate reported by the Bureau of Labor Statistics. GDP growth rate and consumption growth rate denote the percentage changes in the GDP and personal consumption expenditure measures reported by the Bureau of Economic Analysis. Current tax revenues and budget surplus are the quarterly measures for state and local governments reported by the Bureau of Economic Analysis. Pension underfunding denotes the amount of underfunding of pension liabilities for all state and local government defined benefit pension plans reported by the Bureau of Economic Analysis (reported annually, interpolated to quarterly, measured in billions of dollars). t-statistics are based on the Newey-West (1987) estimator of the covariance matrix (three lags). ** and * denote significance at the 5% and 10% levels, respectively. The sample period is quarterly from 2Q 1995 to 4Q 2013 (75 observations).

		Equally Weighted Net Present Value		Size-Weighted Net Present Value	
Variable	Lag	Coefficient	t-Statistic	Coefficient	t-Statistic
Constant		−5.2368	−2.29**	−7.6779	−3.43**
Lagged Dependent Variable	1	0.1729	0.95	0.1964	1.06
Unemployment Rate	1	0.2244	1.76*	0.3655	2.34**
GDP Growth Rate	1	0.0050	0.17	0.0026	0.06
Consumption Growth Rate	1	0.1077	1.21	0.1374	1.54
Current Tax Revenues	1	0.0030	2.14**	0.0044	3.02**
Budget Surplus	1	0.0155	1.00	0.0339	1.78*
Pension Underfunding	1	−0.0018	−2.97**	−0.0023	−3.08**
Adj. R^2			0.569		0.628
N			75		75

dependent variable as a control for persistence. However, we exclude the lagged potential NPV and annual cash flow savings measures to avoid endogeneity issues.

The results from these regressions, which are reported in Table VII, provide strong evidence that advance refunding outcomes are linked to the financial position of municipalities. In particular, realized NPVs are significantly positively related to current tax collections in both regressions. This is consistent with the interpretation that, as tax revenues decrease, municipalities may be forced to advance refund bond issues with larger negative NPVs. Similarly, advance refunding outcomes are significantly negatively related to pension underfunding. Again, this is consistent with the interpretation that municipalities are forced to make increasingly unprofitable advance refunding decisions because of the financial pressures they face as unfunded pension liabilities increase.[21]

Taken together, the results in this section provide clear evidence that municipalities respond to the annual cash flow savings incentives they face. Advance refunding activity increases when financial constraints are likely to be greatest for municipalities. Furthermore, municipalities are willing to accept worse outcomes in terms of NPV as they face more severe fiscal constraints. These results strongly support the hypothesis that advance refundings are driven to a large extent by municipalities trying to relax financial constraints by reducing their immediate debt service cash outflows, even if this results in NPV losses.

VIII. Cross-Sectional Patterns in Advance Refundings

In this section, we seek to provide insight into the cross-sectional properties of advance refunding activity observed during the sample period. Ideally, we would use information about the economic position and financial constraints faced by every municipality in the data set. Unfortunately, we do not have access to this type of data at the municipal level.

However, we can examine how the cross section of advance refunding decisions relates to the potential NPV gains and cash flow savings that would result from an advance refunding. To do so, we use a standard probit framework to estimate the probability that a bond is advance refunded conditional on the potential NPV gains and cash flow savings (results from using a logit framework are very similar).

To describe how we estimate the cross-sectional probit model, we begin by focusing first on 1995. For each bond in the sample during 1995, we construct a categorical variable that takes a value of one if the bond is advance refunded during 1995, and zero otherwise. As explanatory variables for this categorical variable, we include the age of the bond as a control variable, as well as the potential NPV and cash flow savings from advance refunding the bond (the potential NPV and cash flow savings are calculated for each bond as described in the previous section). These three variables are calculated as of the beginning of the year.[22] We then estimate the probit model using the cross section of all bonds in the sample during 1995. We repeat this process for each year from 1995 to 2012 (we omit 2013 since, by the construction of our sample, all bonds remaining in the sample at the beginning of 2013 are advance refunded during 2013). Note that these annual probit models are purely cross sectional since they are each for a specific year. Finally, we estimate the probit

[21] For example, see Novy-Marx and Rauh (2009) and Glaeser and Ponzetto (2013).

[22] We exclude other potential control variables such as time to first call, current coupon rate, or time to maturity since these variables are already included in the calculations of the potential NPV and cash flow savings measures.

model using the data for all bonds and years, resulting in a time-series/panel specification.

The empirical results are reported in Table VIII. Not surprisingly, given the large number of observations, many of the explanatory variables are highly significant. In particular, the potential cash flow savings variable is positive and significant for almost every year as well as for the overall sample. In contrast, while the potential NPV is significant for a number of the annual specifications, it is not significant for the overall specification. This pattern is consistent with the individual parameter estimates. As can be seen, the magnitude of the effect of the potential cash flow savings on the probability of the bond being advance refunded that year is generally much larger than that of the potential NPV.

These cross-sectional results are consistent with the aggregate-level time-series results reported earlier. In summary, advance refunding decisions appear to be driven more by cash flow savings considerations than by NPV considerations at both the aggregate level and the municipality level.

In interpreting these results, it is important to reiterate that our sample consists only of municipal bonds that were advance refunded—we do not have information about municipal bonds that were not advance refunded. Thus, we cannot estimate the probability that a municipal bond will be advance refunded (by definition, this probability is one for the bonds in our sample). Rather, we can only estimate the probability that a bond in our sample will be advance refunded during a specific year conditional on its characteristics.

One additional intriguing result from Table VIII is that many of the McFadden R^2 measures are relatively low. For the overall specification, the R^2 is only 0.274. This suggests that factors other than the potential NPV and cash flow savings measures may also influence the advance refunding decision.

To explore this implication from a cross-sectional perspective, Table IX reports a number of advance refunding summary statistics by state, where the results are ranked from highest to lowest in terms of the absolute value of the measure. Specifically, the table presents the total number of advance refundings, the average fraction of total state debt that is advance refunded each year, and the average size-weighted NPV and annual cash flow savings. The totals and averages are taken over all observations during the sample period. The size-weighted NPV and annual cash flow savings measures are expressed per $100 par amount.

As can be seen, there is considerable cross-sectional dispersion in these measures. Not surprisingly, larger states tend to have more advance refundings, although the ordering is not strictly proportional to either population or GDP. In rank order, Texas, California, Pennsylvania, New Jersey, and Michigan have the most advance refundings during the sample period.

In the second section of the table, “Fraction” provides a measure of the intensity with which advance refundings are used by municipalities. This measure is constructed by dividing the total notional amount of advance refundings each year by the total amount of state debt outstanding the end of the year, and then

Table VIII
Results from Estimation of a Cross-Sectional Probit Model for the Probability of a Bond Issue Being Advance Refunded

This table reports summary statistics for estimated probit models in which the dependent variable takes the value of zero if the bond issue is not advance refunded that year, and one if it is advance refunded. The explanatory variables are the age of the bond issue measured in years, the potential NPV per $100 par amount that would result from an advance refunding as measured at the beginning of the year, and the potential annual cash flow savings per $100 par amount that would result from an advance refunding as measured at the beginning of the year. z-statistics are based on the White (1980) robust estimate of the covariance matrix. R^2 denotes the McFadden (1974) R^2. Each bond issue is included in the sample from the year after it is issued until the year that it is advance refunded. The sample period is annual from 1995 to 2013 (1,357,029 observations).

	Coefficient				z−Statistic					
Year	Intercept	Age	NPV	Savings	Intercept	Age	NPV	Savings	R^2	N
1995	−2.6121	0.0244	0.0373	0.5607	−37.19	2.48	1.64	10.25	0.131	23,429
1996	−2.6505	−0.0059	−0.0113	0.5745	−37.97	−0.46	−0.65	13.03	0.093	30,698
1997	−2.4942	0.0503	0.0114	0.3530	−53.90	8.60	0.87	11.79	0.070	42,376
1998	−2.0570	0.0589	0.0338	0.3048	−71.92	12.25	3.44	13.90	0.064	53,533
1999	−2.1902	0.0631	0.0511	0.7146	−68.24	13.40	4.49	33.58	0.204	64,964
2000	−2.5973	0.0862	0.0144	0.4392	−57.43	14.27	1.34	13.23	0.170	76,958
2001	−1.9980	0.0929	−0.0216	0.7403	−107.96	27.11	−5.22	41.61	0.184	95,453
2002	−2.1728	0.1774	0.0113	0.4346	−111.66	44.18	3.03	25.09	0.215	104,428
2003	−1.3949	0.1488	0.0822	0.1326	−48.49	41.54	20.85	9.46	0.217	112,813
2004	−2.2503	0.2008	−0.0024	0.3826	−126.53	51.85	−0.86	29.58	0.236	116,198
2005	−2.0344	0.2929	0.1025	0.3888	−123.11	96.64	16.35	25.96	0.299	116,929
2006	−2.3841	0.2171	−0.0821	0.6475	−119.60	63.36	−19.10	37.75	0.194	94,495
2007	−1.9032	0.1950	0.2982	0.6347	−62.79	53.58	24.06	31.47	0.258	84,412
2008	−2.6212	0.2363	0.2025	0.1291	−44.94	31.08	12.42	4.25	0.265	74,046
2009	−1.5613	0.1666	0.0638	0.1119	−24.87	23.92	16.62	4.91	0.251	74,525
2010	−2.7819	0.3082	0.0460	0.2456	−66.01	50.95	12.68	16.57	0.247	71,403
2011	−0.5293	0.2405	0.2237	−0.4008	−9.04	43.64	43.15	−22.84	0.227	58,122
2012	0.6371	0.1361	0.0967	−0.3303	16.50	37.39	41.14	−29.27	0.074	46,354
All	−2.2463	0.1695	0.0008	0.5917	−517.56	160.84	1.44	190.42	0.274	1,357,029

Table IX
Ranked Advance Refunding Summary Statistics by State

This table presents advance refunding statistics for each state, where the statistics for the states are ranked from highest to lowest in terms of absolute value. Number is the number of advance refunding transactions during the sample period. Fraction denotes the average annual ratio of the amount refunded each year divided by the total amount of state debt outstanding that year. NPV denotes the advance refunding NPV per $100. Savings denotes the advance refunding annual cash flow savings per $100. The averages and totals are taken over all advanced refunding transactions for each state during the sample period. The sample period is from April 1995 to December 2013.

Rank	State	Number	State	Fraction	State	NPV	State	Savings
1	Texas	31,282	Nebraska	12.23	Alabama	−4.88	Wyoming	2.05
2	California	16,589	Texas	11.60	West Virginia	−3.83	North Dakota	1.83
3	Pennsylvania	13,500	Tennessee	10.18	Arkansas	−3.36	New Mexico	1.69
4	New Jersey	10,691	Nevada	10.12	Colorado	−3.33	Hawaii	1.67
5	Michigan	8,733	Arizona	9.26	New York	−3.27	Washington	1.66
6	Ohio	7,296	Kansas	8.57	Massachusetts	−3.20	Rhode Island	1.65
7	New York	6,380	Alabama	6.50	North Carolina	−3.19	Maine	1.65
8	Arkansas	6,286	Colorado	5.65	Virginia	−3.18	South Dakota	1.64
9	Washington	6,031	Arkansas	5.46	Washington	−3.17	Montana	1.60
10	Kansas	5,576	Washington	5.14	Georgia	−3.12	Iowa	1.49
11	Indiana	5,184	Pennsylvania	5.12	Idaho	−3.12	Maryland	1.48
12	Kentucky	5,067	Florida	5.03	Louisiana	−3.11	Arizona	1.47
13	Massachusetts	4,787	Georgia	5.01	Illinois	−3.10	Idaho	1.46
14	Florida	4,529	Ohio	4.50	Nebraska	−3.01	South Carolina	1.45
15	Illinois	4,483	North Carolina	4.37	Tennessee	−2.98	Louisiana	1.44
16	Virginia	4,395	Virginia	4.31	Kentucky	−2.97	Vermont	1.42
17	Connecticut	4,332	Indiana	3.93	New Mexico	−2.96	Wisconsin	1.41
18	Alabama	4,296	Oregon	3.87	New Hampshire	−2.91	Ohio	1.37
19	Missouri	3,868	New Jersey	3.76	Oregon	−2.86	Colorado	1.36
20	North Carolina	3,773	Minnesota	3.75	Maine	−2.85	Kansas	1.36
21	Colorado	3,606	California	3.73	South Carolina	−2.81	Texas	1.34
22	Nebraska	3,593	Michigan	3.72	Maryland	−2.65	Kentucky	1.34

(*Continued*)

Table IX—*Continued*

Rank	State	Number	State	Fraction	State	NPV	State	Savings
23	Minnesota	3,580	South Carolina	3.58	Delaware	−2.61	Minnesota	1.34
24	Tennessee	3,337	Utah	3.46	California	−2.56	Virginia	1.33
25	Wisconsin	3,304	Hawaii	3.30	Ohio	−2.54	Missouri	1.31
26	Arizona	3,057	Kentucky	3.08	Kansas	−2.47	Utah	1.31
27	Oregon	2,944	Maryland	3.05	Hawaii	−2.47	Nevada	1.31
28	Maryland	2,746	New York	3.01	Texas	−2.41	West Virginia	1.28
29	South Carolina	2,434	Mississippi	2.85	Mississippi	−2.34	Delaware	1.28
30	Louisiana	2,356	Louisiana	2.82	New Jersey	−2.19	Oregon	1.27
31	Mississippi	2,167	Missouri	2.60	Pennsylvania	−2.17	Mississippi	1.26
32	Iowa	1,838	Illinois	2.32	Arizona	−2.15	North Carolina	1.26
33	Utah	1,590	Iowa	2.25	Michigan	−2.14	Alaska	1.25
34	Georgia	1,548	Wisconsin	2.11	Missouri	−2.13	Connecticut	1.25
35	Nevada	1,448	Massachusetts	1.96	Connecticut	−2.12	Indiana	1.24
36	South Dakota	981	Delaware	1.93	Utah	−2.07	Nebraska	1.22
37	Oklahoma	859	Idaho	1.92	Florida	−2.06	Illinois	1.20
38	Idaho	842	North Dakota	1.91	Nevada	−1.91	New Jersey	1.20
39	Maine	816	New Mexico	1.85	Vermont	−1.89	Oklahoma	1.19
40	New Hampshire	815	Connecticut	1.78	South Dakota	−1.87	New Hampshire	1.16
41	Montana	748	Oklahoma	1.74	Indiana	−1.87	Tennessee	1.15
42	New Mexico	747	Alaska	1.48	Montana	−1.82	Florida	1.15
43	Rhode Island	737	Vermont	1.46	Rhode Island	−1.81	Georgia	1.14
44	Hawaii	688	Maine	1.37	Wyoming	−1.80	New York	1.13
45	North Dakota	605	Rhode Island	1.25	Oklahoma	−1.78	Michigan	1.12
46	Alaska	591	West Virginia	1.18	Iowa	−1.76	Pennsylvania	1.11
47	Delaware	474	New Hampshire	1.11	Minnesota	−1.71	California	1.09
48	Vermont	353	South Dakota	1.00	Wisconsin	−1.59	Arkansas	1.07
49	West Virginia	290	Montana	0.90	Alaska	−1.44	Massachusetts	1.00
50	Wyoming	85	Wyoming	0.57	North Dakota	−1.38	Alabama	0.93

averaging over all years during the sample period.[23] In rank order, the states that use advance refundings most intensively are Nebraska, Texas, Tennessee, and Nevada, while the states that use advance refundings least intensively are South Dakota, Montana, and Wyoming.

The third section of the table shows that there are dramatic differences across states in terms of NPV outcomes. The state with the worst outcome is Alabama, which experienced an average loss of 4.88% of the total amount being advance refunded. The state with the best outcome is North Dakota, which only lost 1.38% of the par amount advance refunded. It is also important to note that the average realized NPV is negative for each of the 50 states. Thus, the pattern of being willing to suffer an NPV loss to advance refund existing debt is pervasive across the United States.

The fourth section of the table shows that there are also major differences across states in terms of the annual cash flow savings. However, these differences are not as extreme as those for NPVs. The state with the largest annual cash flow savings is Wyoming with a value of 2.05%, while the state with the smallest annual cash flow savings is Alabama with a value of 0.93%. Not surprisingly, the average annual cash flow savings is positive for all 50 states.

In summary, the wide cross-sectional variation in advance refunding activity and outcomes suggests that the reasons for advance refunding may be largely idiosyncratic in nature. If advance refunding is driven by financial constraints that create municipal fiscal distress, then this also implies that municipal credit risk may have a large idiosyncratic component.

IX. Conclusion

We study the increasingly popular practice in municipal finance of advance refunding bond issues. To do so we use an extensive sample of over 206,000 municipal bonds that were advance refunded from 1995 to 2013.

In theory, a municipality should only advance refund its callable debt if the transaction results in a positive NPV. In reality, however, municipalities may face severe financial constraints and frictions that could affect their debt management policies. In particular, most municipalities are required by law to balance their operating budgets. Thus, municipalities cannot borrow to fund current operations—they can only borrow for capital projects. As a result, a financially constrained municipality may face pressure to advance refund bond issues and reduce debt-service cash outflows in the short term, even if the transaction results in an NPV loss.

We find that nearly 85% of all advance refundings result in an NPV loss for the municipality. On average, the loss is roughly 2.66% of the total par amount advance refunded. This value is likely an underestimate since it does not include the transaction costs and fees associated with an advance refunding. In

[23] Note that total state debt only reflects the debt issued by the state, that is, it does not include municipal debt. Data on total state debt are obtained from the U.S. Bureau of the Census, Annual Survey of State Government Finances.

contrast, we find that over 96% of all advance refundings result in an immediate annual cash flow savings to the municipality. The average annual cash flow savings is 1.41% of the par amount advance refunded.

Taken together, these results suggest that municipalities accept NPV losses in order to achieve reductions in cash outflows over the short term. We examine this hypothesis by studying the relation between advance refunding activity and macroeconomic and fiscal conditions facing the public sector. We find that realized advance refunding activity is strongly related to the potential cash flow savings of the transaction, but is not meaningfully related to the potential NPV of the transaction. We also find strong evidence that advance refunding activity increases when states and local governments experience declines in current tax revenues or budget deficits. These findings provide direct support for the hypothesis that advance refunding activity is driven by the financial constraints that municipalities face.

Finally, it is important to note that, while many municipalities suffer NPV losses from advance refunding, other financial market participants may benefit. First, most advance refunded bond issues are defeased using Treasury SLGS in order to avoid the IRS no-arbitrage regulations. However, because of these no-arbitrage regulations, the yields on these SLGS must often be set to values below the yields on equivalent Treasury bills, notes, and bonds. Thus, the Treasury benefits from advance refunding activity since it is able to issue debt at below-market yields. Second, municipal bondholders may also benefit from a suboptimal advance refunding. One reason is that when the bonds are defeased by using Treasury debt, their credit risk is eliminated. Thus, bondholders benefit from the resulting "credit enhancement," which increases the value of their investment. Third, in an efficient market, purchasers of municipal bonds recognize that actual advance refunding activity is often suboptimal. Since this benefits bondholders, market prices of municipal bonds should be higher ex ante.[24] In turn, this implies that municipalities may experience lower ex ante borrowing costs than would otherwise be the case. Ex post, municipalities that do not advance refund clearly would benefit from lower borrowing costs.[25] Similarly, municipalities that advance refund debt optimally would realize a double benefit ex post. On the other hand, the ex post outcomes for municipalities that advance refund suboptimally may more than offset the ex ante benefits. Thus, suboptimal advance refunding driven by financial frictions may result in a net transfer of wealth from constrained municipalities to less constrained municipalities. These considerations have important implications for policy makers, regulators, and other participants in the municipal bond markets.

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[24] This situation closely resembles the case of mortgage-backed securities in which markets price these securities to reflect suboptimal prepayment strategies by homeowners.

[25] We are abstracting from game theoretic issues such as whether municipalities can credibly pre-commit to advance refund repeatedly. If so, then the municipality might be able to lower its ex ante borrowing costs. We are grateful to the referee for this insight.

Appendix A

In this appendix, we illustrate several ways in which the price of a callable bond can be represented. To fix notation, assume that the current time is denoted time zero, the callable bond matures in M years, and the bond is callable with a call price of K in N years, where $N < M$ and both N and M are integers.

The price P_N of an N-year noncallable bond with coupon rate c can be expressed as

$$P_N = \frac{c}{2} \sum_{i=1}^{2N} D(i/2) + 100\, D(N). \tag{A1}$$

Similarly, the price P_M of an M-year noncallable bond with coupon rate c is given by

$$P_M = \frac{c}{2} \sum_{i=1}^{2M} D(i/2) + 100\, D(M). \tag{A2}$$

Let $P_{N,M}$ denote the price of an M-year bond with coupon rate c, but where the coupons for the first N years have been stripped from the bond. The price $P_{N,M}$ is given by

$$P_{N,M} = \frac{c}{2} \sum_{i=2N+1}^{2M} D(i/2) + 100\, D(M). \tag{A3}$$

These definitions imply

$$P_M = P_N + P_{N,M} - 100\, D(N). \tag{A4}$$

By definition, the value P_C of the callable bond can be expressed as

$$P_C = P_M - C(c, N, M, K), \tag{A5}$$

where $C(c, N, M, K)$ denotes the value of the option that the issuer has to call an M-year bond with coupon rate c at time N for the call price of K. Note that this call option is equivalent to a European call option on $P_{N,M}$ with expiration N and strike price K. A simple put-call parity argument gives the result

$$C(c, N, M, K) = P(c, N, M, K) + P_{N,M} - 100D(N), \tag{A6}$$

where $P(c, N, M, K)$ is the corresponding put value. Finally, from equations (A5) and (A6), we obtain the result

$$P_C = P_N - P(c, N, M, K). \tag{A7}$$

Equation (2) in the paper is given by substituting equation (A1) into equation (A7) and simplifying notation.

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