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Jean Burson, John Carlson, O. Emre Ergungor, and Patricia Waiwood

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States' unfunded pension obligations to their current and retired employees have exploded in recent years to levels that are estimated to be between $750 billion and $4.4 trillion. In theory, this massive debt should have implications for states' ability to meet their financial obligations and a measurable impact on funding costs. Yet we find limited evidence that municipal bond markets are pricing the risks to states' fiscal health arising from these large obligations.

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Jean Burson (jean.m.burson@clev.frb.org), John Carlson (john.b.carlson@clev.frb.org), O. Emre Ergungor (ozgur.e.ergungor@clev.frb.org), and Patricia Waiwood (patricia.waiwood@clev.frb.org) are at the Federal Reserve Bank of Cleveland.

I. Introduction

State and local governments' unfunded public pension liabilities are estimated to be between $750 billion and $4.4 trillion depending on the discount rate assumptions used in the calculations. The risk that these mounting obligations to employees and retirees will ultimately compromise state and local governments' ability to service outstanding municipal debt could in theory translate into higher yield spreads on municipal bonds relative to U.S. Treasuries. There is some empirical evidence that this is indeed the case (Munnell et al., 2011).

Yet there are also reasons why markets might choose to shrug off the pension news. As Rhode Island demonstrated in August 2011, state and local governments have demonstrated a willingness and ability to reduce their pension obligations, thus providing greater capacity to meet other financial obligations. Public pension reform is a complex legal issue, but in principle, when taxpayers are asked to increase their contributions to preserving the financial wellbeing of public sector retirees, it is conceivable that the interests of the many will prevail even if this entails attempts to rescind the strong legal protections provided to the few.

If the market views public pension obligations to state and local government retirees as non-negotiable hard debt, one would expect to observe more indebted states to incur higher borrowing costs than states with fully funded plans. If the market perceives these pension obligations as negotiable liabilities, we may not observe any impact on bond spreads.

In this paper, we investigate whether municipal bond spreads are sensitive to unfunded pension fund obligations. In the primary market, yield spreads for new bond issues were not affected by public pension underfunding *before* the financial crisis; however following the crisis, higher levels of underfunding are associated with higher spreads. Our analysis of secondary market spreads, which includes bonds issued in earlier periods but traded in our observation period, finds strong statistical evidence of sensitivity to pension fund obligations in the post-crisis period. Also, as the level of underfunding increases over time, so do the spreads, especially beyond the 9-10 year maturity range. Economically, however, the sensitivity of yield spreads to pension obligations is miniscule compared to their sensitivity to the level of BBB corporate bond spreads over Treasuries; that is, the level of overall credit risk (or risk aversion) in the economy. Finally, our analysis reveals that the measurement of pension underfunding is important. As the most commonly used approach, the percentage of Annual Required Contribution (ARC) paid, is also the least robust measure. Our preferred measure is the total size of the underfunding relative to the size of the state's economy.

These results may appear similar to the findings of other researchers, but there are in fact some fundamental differences. Munnell et al. use the percent of ARC paid as the measure of a state's public pension troubles and the difference between observed bond yields and maturity matched Treasuries as the measure of spreads. We replicate their results and show that this approach also leads to some counterintuitive findings. For example, as expected, states that are contributing more to their pension plans to fund them fully have lower spreads, but states that have large unfunded pension liabilities also have lower spreads, which is inconsistent with the notion that underfunded pensions are a liability and subject to market discipline in the form of higher borrowing costs.

We believe this result arises from the mismeasurement of spreads. Our analysis uses a zero-coupon yield spread approach (Diebold and Li, 2006), which controls for the effect of coupon differences (duration effects) among the securities and allows us to examine individual maturities separately rather than compiling them in a single sample and treating maturity effects on spreads as linear. Our sample also excludes insured bonds, which should be sensitive to the insurer's creditworthiness as well as the correlation between the creditworthiness of the issuer and the insurer. Finally, we exclude bonds with option features that require complicated price clean-up procedures, which is not a meaningful effort, given that the municipal bond market is highly illiquid.

The question we examine in this paper is related to recent work by Novy-Marx and Rauh (2012), who measure the sensitivity of state municipal bond spreads to public pension underfunding by examining public pension fund investment losses during the months surrounding Lehman bankruptcy. Novy-Marx and Rauh correct for the duration effects but their analysis uses option-adjusted bond price data obtained from Bloomberg, which relies on model prices rather than observed trading prices around Lehman bankruptcy. According to the Municipal Securities Rulemaking Board, few, if any municipal bonds were traded around that time. Therefore, there is a strong possibility that the Novy-Marx and Rauh analysis was conducted with data that originated from another model.

This paper is organized as follows: In section II, we provide some background on the current state of public sector pension plans and the fiscal and legal challenges they face. In section III, we describe our data and methodology. Section IV presents the results. Section V concludes.

II. Some Background on Public Sector Pensions

Over 27 million U.S. public sector employees and beneficiaries are covered by some 3,400 state and local government sponsored public employee pension plans.[1] As of December 2009, most state pension plans were actuarially underfunded after suffering significant losses during the financial crisis; that is, the current market value of their assets was insufficient to cover the present value of their obligations to their current and future retirees (Figure 1).

These plans, which are an important component of the total compensation contract with public sector employees, are funded by a combination of the returns from invested asset, payments from state and local government employers, and contributions from active members of the plans. Plan costs and the level of underfunding are also affected by benefit enhancements offered to public employees during the boom years, such as automatic cost of living increases, increases in plan benefits, and relaxation of eligibility requirements.

[1] United States Government Accountability Office, Report to Congressional Requestors, State and Local Government Pension Plans, Economic Downturn Spurs Efforts to Address Costs and Sustainability, GAO 12-322, March 2012

Each year, plan sponsors are required to contribute to the plan based on the current year's normal costs of providing benefits for retirees and the cost of unfunded liabilities amortized over a 30 year period. Paying the annual required contribution is not mandated in most states, and making partial payments has been one means of sidestepping state balanced budget requirements, which are in effect in some form in every state except Rhode Island.[2] Therefore, meeting pension obligations through higher employer payments could mean drastic cuts to state and local services. Higher employee contributions, on the other hand, are becoming increasingly difficult due to an aging population. Over the past twenty years, the ratio of active members to beneficiaries receiving payments has declined from 3.0 active members for each retiree in 1991 to only 1.8 members per retiree in 2011.[3]

A plan's funded status is heavily reliant on its asset returns. While public pension funds have typically held the majority of their investments in traditional investments such as corporate stocks and bonds, the weak returns that characterize the current low interest rate environment are prompting public pension fund managers to invest in higher-yielding alternative assets in order to meet their targeted rates of return. Plans that are well-funded can often take on risk by investing in alternative assets that have the potential to produce higher yield, but as pressures mount to offset years of chronic underfunding and the devastating effects of the financial crisis on investment returns, weaker funds are also turning to riskier investments. Over the past decade, on average, public pension funds have been shifting some assets away from equity and fixed income and increasing their holdings of real estate and alternative assets (Figure 2).

When faced with the realities of mounting public pension obligations, state and local government officials might also consider modifying retiree benefits as a means to alleviate fiscal stress. Legal protection for public pension benefits is not consistent among the states, and the likelihood that benefit reductions will withstand legal challenges varies according to employment status. The California Rule, the highest standard of legal protection for public pensions, protects all pension benefits including future accruals and cost of living adjustments as of the first day of employment. This rule is in effect in eight states including its namesake state of California, but it is important to recognize that each state has a unique set of constitutional provisions, state statutes, and common law that define the legal support for plan benefits.[4] Since 2008, public pension reform has been proposed in 44 states; fourteen states have enacted reform that applies only to new employees, and these reforms are most likely to be upheld by courts, as they do not impair existing contracts. Eighteen states have enacted reforms that affect both future employees and some current, typically non-vested employees. Twelve states have enacted reforms that affect retirees, and these types of laws are most aggressively challenged in court. These legal challenges that arise in the wake of enacted reform can take many years to unwind and can create significant uncertainty in the municipal bond markets.

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[2] National Conference of State Legislators, http://www.ncsl.org/issues-research/budget/state-balanced-budget-requirements.aspx.

[3] U.S. Census Bureau Annual Survey of Public Pensions

[4] See Monahan (2010) for a legal analysis of public pension reform.

How the market perceives and prices this uncertainty and whether it penalizes the more underfunded states is an important policy question that we address in this paper.

III. Data and Methodology

Our data source for analyzing primary markets is the Mergent Municipal Bond Securities Database (Mergent), which includes detailed information on the characteristics of all general obligation municipal bonds issued by state governments since January 1, 2003. Consistent with our goal to measure the impact of pension liabilities on perceived state creditworthiness and how the financial crisis affected those perceptions, we limit our sample to a period before the crisis with low financial stress, and the post-crisis period. We define the 'low financial stress' period based on the peak of the S&P 500 volatility index (VIX) in September 2002 and the bottom of the stock market in February 2003. These constraints result in a sample that begins with the universe of all general obligation (GO) bonds issued by states since January 1st, 2003. The beginning of the stress period is defined as August 2007, and the sample ends on December 31st, 2011. The resulting universe consists of 20,039 securities that represent all 50 states.

To better measure the impact of pension liabilities on state creditworthiness, we control for several factors that reduce sample size. Deleting insured bonds reduces the sample size to 16,651. Excluding bonds with options or a sinking fund feature reduces the sample size further to 10,046 observations. Eliminating floating coupon bonds (29), bonds with interest compounding periods other than six months (3), bonds for which any two of the yield, price, coupon, or maturity date information is missing (135), as well as eliminating taxable bonds (1,079), states with missing fiscal data results in a sample of 8,565 observations from 38 states.

In the secondary market analysis, we are no longer restricted to bonds issued in the sample period and can evaluate the entire universe of outstanding bonds as long as there is trading information. We use the Municipal Securities Rulemaking Board (MSRB) database to obtain the trading prices until the bond matures or is first refunded.[5] We match the trading data back to bond characteristics in Mergent through CUSIPs and exclude all bonds with credit enhancements and option features as described above, resulting in a sample of 13,254 traded bonds from 42 states and 898,342 trades.

The number of bonds issued by each state before and after the crisis is presented in Table 1. Note that some states that do not have primary market issuance data may be included in the secondary market analysis because trading data is available for bonds issued in the past.

The methodology used to refine our data results in a primary market sample considerably smaller than that used by Munnell et al. (37,500 observations). Because we exclude revenue bonds that have a dedicated payment source such as turnpike bonds and bonds that are funded by special taxes, our

[5] Even if a bond is non-callable, the issuer can take advantage of declining interest rates by issuing new bonds at a lower coupon, investing the receipts in Treasuries, and using the cash flows from the Treasuries to make the coupon and principal payments on the old bonds. Once there is a pool of Treasuries devoted to a municipal bond, it is essentially risk-free and its trading data has to be eliminated from our sample beyond the refunding point.

sample consists of securities that rely solely on the full faith and credit of the state for repayment. Therefore, we expect these bonds to be more sensitive to concerns about the creditworthiness of a state.

The downside of our selection criteria is that some states drop out of the sample completely. It is highly unlikely that a state's decision to issue insured bonds or to incorporate option features is entirely random. However, in the absence of an instrument to model this decision, our methodology introduces sample selection bias to our analysis. Therefore, we caution the reader to interpret our results only within the sample of states covered by our analysis.

Calculating Spreads

We use two techniques to calculate municipal bond credit spreads in our primary market analysis. The first is to simply subtract maturity-matched Treasury yields from the municipal yield at issuance. This is consistent with the Munnell et al. (2011) strategy. However, this methodology subtracts yields on coupon-bearing municipal bonds from yields on Treasures that also have coupons. Because the coupon rate is a determinant of the bond's sensitivity to interest rate risk, it affects yields independent of the credit risk. While not shown, our analysis suggests that financially-constrained states – those with high budget deficits or debt levels – tend to issue bonds at a discount. In other words, they may prefer to pay low coupons to minimize short-term annual costs even though this also reduces cash receipts. Yet, low coupon payments allow the states to postpone difficult financial decisions. The coupon choice is an endogenous decision that is ignored in the simple credit spread analysis and constitutes a fundamental theoretical flaw.

To circumvent this problem, we decompose risky coupon bond prices into risky zero-coupon bond prices. More specifically, we use a procedure developed by Nelson and Siegel (1987) and Diebold and Li (2006) that fits a yield curve of zero-coupon bonds for each state and in each time period that can approximate the prices observed for coupon-bearing bonds that were issued in that period. A period is one quarter; that is, we assume that economic conditions remain constant over a three-month period. This is necessary to have enough observations to generate a yield curve for each state in most, but not all periods.

Diebold and Li Zero Coupon Yields

Let $P_{i_z}^{(n)}(t)$ be the time-*t* price of a hypothetical municipal zero-coupon bond from state *i* that matures in *n* months and pays \$1. $P_{i_z}^{(n)}(t)$ can be expressed as:

$$P_{i_z}^{(n)}(t) = e^{-y_{i_z}^{(n)}(t)\,n} \tag{1}$$

where $y_{i_z}^{(n)}(t)$ is the yield-to-maturity of the *n*-period zero bond from state *i* observed at time *t*. From this point forward, we will drop the *i* subscript to simplify the notation, but it should be understood that the zero-bond yields are state-specific.

Nelson, Siegel, Diebold and Li model the zero yield curve using three factors as:

$$y_z^{(n)}(t) = \beta_1(t) + \beta_2(t)F_2^{(n)} + \beta_3(t)F_3^{(n)} \tag{2}$$

where $F_2^{(n)} = \frac{\left(1-e^{-\lambda_t n}\right)}{\lambda_t n}$ and $F_3^{(n)} = \frac{\left(1-e^{-\lambda_t n}\right)}{\lambda_t n} - e^{-\lambda_t n}$. Diebold and Li (2006) interpret $\beta_1(t)$, $\beta_2(t)$, and $\beta_3(t)$ as latent dynamic factors. The loading on $\beta_1(t)$ is 1. As a constant, it does not change with maturity and is interpreted as a long-term factor. The loading on $\beta_2(t)$ is $F_2^{(n)}$, a function which begins at 1 but decays quickly to zero. Therefore, it can be viewed as a short-term factor. The loading on $\beta_3(t)$ is $F_3^{(n)}$, a function that begins at zero, increases, and then decays back to zero. It is, therefore, a medium term factor.

One can also interpret these factors as the level, slope, and curvature of the yield curve. Notice that $y_z^{(\infty)}(t)$ is exactly $\beta_1(t)$, which means that it affects all maturities equally and shifts the level of the yield curve. If we were to define the slope of the yield curve as $y_z^{(\infty)}(t) - y_z^{(0)}(t)$, it is straightforward to show that $y_z^{(0)}(t)$ is $\beta_1(t) + \beta_2(t)$.[6] So, the slope is determined by $-\beta_2(t)$.

Let us now define the curvature of the yield curve as the change in the slope of the curve as one moves from short maturities towards long maturities. For example, if we compare the slope in the 24-month maturity to ∞-maturity range to the slope in the 0-month maturity to 24-month maturity range, the change in slope can be expressed as $y_z^{(24)}(t) - y_z^{(0)}(t) - \left(y_z^{(\infty)}(t) - y_z^{(24)}(t)\right)$ or $2y_z^{(24)}(t) - y_z^{(0)}(t) - y_z^{(\infty)}(t) = 0.051\beta_2(t) + 0.587\beta_3(t)$. Thus, the curvature depends mostly on $\beta_3(t)$.

Notice that the parameter λ_t determines the exponential decay rate and where $F_3^{(n)}$ reaches its peak. Following Diebold and Li, we fix it at 0.0609; that is, λ_t is not part of our estimation.

The price of an actual, T-month coupon bond from state *i,* observed at time *t*, $P_c^{(T)}(t)$, can be approximated by the sum of a series of zero-coupon bond prices that pay their face value of *C,* the coupon payment when they mature, with the last T-month zero paying $100+*C* at maturity.[7] Letting *m* denote the number of six-month periods in T (*m*=T/6), the estimated price of the coupon bond,

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[6] $\lim_{n\to 0} F_2^{(n)} = 1$

[7] Note that in the primary market, if the first coupon is due in more (less) than exactly 180 days, the first coupon payment is increased (reduced) by the [number of days to coupon / 180] ratio. In other words, the first coupon may not be exactly *C*. In the secondary market, the quoted prices in MSRB database must be adjusted for the accumulated interest.

$\pi_c^{(T)}(t)$, is:

$$\pi_c^{(T)}(t) = \sum_{k=1}^{m-1} C\, P_z^{(6k)}(t) + (100 + C) P_z^T(t) \tag{3}$$

Denoting the error between the estimated price $\pi_c^{(T)}(t)$ and the actual price $P_c^{(T)}(t)$ by ε, our strategy is to solve:

$$\underset{\beta_1,\beta_2,\beta_3}{\arg\min} \sum_{k}^{N_t} \varepsilon^2 \tag{4}$$

where N_t is the number of bonds issued by state i in quarter t. Once the betas are determined, the yield for any maturity zero bond can be calculated.

The next piece of the spread calculation is the zero coupon yield of U.S. Treasuries, $y_{US}^{(n)}(t)$, which has been made available to the public on the Federal Reserve Board website by Gurkaynak, Sack, and Wright (2006).[8] Using this data and our own calculations, we compute the log-spread on an *n*-month municipal zero bond over the maturity-matched Treasury as

$$s^{(n)}(t) = \ln\left(1 + \frac{y_z^{(n)}(t)}{0.62}\right) - \ln\left(1 + y_{US}^{(n)}(t)\right) \tag{5}$$

where the muni yield is adjusted for taxes assuming a 38 percent marginal tax rate, consistent with the implied marginal tax rates found in the literature (Wang, Wu, and Zhang, 2005; Longstaff, 2011).

Our first spread measure that simply subtracts Treasury yields from municipal yields will be denoted by $Spread^{SMP}$ (where SMP denotes simple) and our zero-coupon spread (5) will be denoted by $Spread^{ZER}$. In our secondary market analysis we only use $Spread^{ZER}$.

Modified Diebold and Li Procedure

In order to maintain a sufficiently large sample size, our dataset includes both rated and unrated bonds. This heterogeneity poses a challenge when fitting a yield curve, as the rated bonds may have lower yields than unrated bonds, all else equal. Hence, an adjustment to the Diebold and Li procedure is necessary. Our approach is to add a fourth factor to the model. In each state and every period, we fit a zero-coupon yield curve of the form:

$$y_z^{(n)}(t) = \beta_1(t) + \beta_2(t)F_2^{(n)} + \beta_3(t)F_3^{(n)} + \beta_4(t)Rated$$

where *Rated* is a dummy that takes the value of one if a bond is rated and zero otherwise. Note that the fourth factor is a level adjustment. While *Rated* could also affect slope and curvature, we focus

[8] http://www.federalreserve.gov/pubs/feds/2006/200628/200628abs.html

on the level effect because fitting a more complex model hits sample size limits as some states have as few as six bond issues in some quarters.

Minimum Number of Observations for Zero-Coupon Yield Calculation

In theory, three observations are sufficient to pin down $\beta_1(t)$, $\beta_2(t)$, and $\beta_3(t)$: one observation at short maturities (<2 years) to set the level, one observation at the long maturities (>5 years) to set the slope, and one observation in the middle to set the curvature. In practice, a larger sample is desirable in an illiquid market where large trades can create large swings in prices. Thus, in order to be able to calculate the zero-coupon yield curve, we impose the restriction that there must be at least one observation in each of the maturity buckets and at least eight observations in total in each month or quarter where a yield curve is calculated.

Some state-time period combinations drop out of our sample because they do not contain the sufficient number of observations. After these eliminations, we work with 5,552 bonds in the primary markets, and 269,482 trades in the secondary markets (Table 1).

Random Sampling in the Secondary Market

Not all bond maturities trade at the same frequency in the secondary markets. Therefore the observed prices are more likely to come from shorter maturity bonds (less than 5 years) than long maturity bonds (greater than 10 years). This creates a problem if all observed prices are used in fitting the yield curve. If there are dozens of observations at *each* maturity in the 1-to-5 year range but only a few observations in the long maturities, the procedure puts excessive weight on shorter maturities in minimizing the pricing error, leading to large pricing errors at long maturities.

To get around this problem, we randomly pick four bonds at each maturity and use those bonds in fitting the yield curve. The precision of the fit using a random sample is analyzed in Table 2, which shows the distribution of the pricing error [(fitted price – actual price)/actual price], where a negative error indicates underestimation of the price. The fit is most accurate in the primary market. This is to be expected as states issue a range of maturities whose yields seem to align nicely along a yield curve. In the secondary markets, bonds with very similar characteristics (except coupons) can trade at very different yields. It is not unusual to observe a range of one percentage point yield difference among bonds with the same maturity and from the same issuer observed in the same month or quarter. To get a sense of the robustness of the random sampling approach, we drew multiple random samples of four bonds per maturity as well as multiple samples with three or five bonds. We find no economically meaningful impact on our results.

Figure 3 shows the observed yields and the zero-coupon curve for three states in selected time periods. The dots are the quoted yields, and they are semi-annually compounded. The line is the fitted, continuously compounded zero-coupon curve. Note that a zero coupon curve is not a regression line across observed yields. Our procedure does not minimize the distance between the observed yields and the fitted curve; rather, it minimizes the price differentials between the observed prices and the estimated prices from the fitted curve. As such, the zero-coupon yield calculated for each time-horizon is used to discount the coupons at that time horizon of all bonds of any maturity. Therefore, ignoring the coupon effects may lead to significant errors in spread calculations, as evidenced by the deviation of the zero-coupon curve from the observed coupon-bearing bond yields.

Independent Variables

The data source for our state financial variables is CreditScope. Our main variables of interest are *PercentARC*, the percentage of the ARC paid and *Underfunding*, each state's unfunded public pension liabilities scaled by the state's Gross State Product (GSP). Our goal is to observe which measure best captures the sensitivity of bond spreads to pension underfunding. In the specifications below, we use a generic variable name, *Pension*, as a placeholder for these two variables.

We also control for several factors that could affect a state's credit spreads.

- The first factor is the state's budget deficit (or surplus) relative to its GSP. As this variable can be either positive or negative, we transform it into an ordinal variable, *Budget*, with four levels: states that are in the bottom 25^{th} percentile (highest deficits) in any year are assigned the level of 1, states in the second, third, and fourth 25^{th} percentiles are assigned levels 2, 3, and 4, respectively. The prior is that the states in the higher categories will have lower spreads.
- The second factor is *Debt*, which is the state's direct debt load scaled by GSP. States more heavily burdened with debt should have higher credit spreads.
- The third factor is *PayDay*, the log of the average number of days it takes the state to pay its bills. More cash-strapped states should take longer to pay their bills and have higher credit spreads.
- The fourth factor, *BBBSpread*, is the BBB corporate bond spread, which captures the overall level of credit risk aversion in the economy in the quarter the bond was issued. The data source is Bloomberg.
- The fifth factor is an attempt to capture the liquidity risk. *Liquid* is a bond turnover ratio calculated as the total trading volume of each state's fixed-rate, no-option, no-insurance bonds at the end of the previous year divided by the total amount outstanding of such bonds.
- The sixth factor, *Issuance*, is the total face value of all bonds issued in the previous year as a percent of GSP. It is the flow-equivalent of *Debt*. States with higher borrowing needs may have to pay higher spreads. The data source is Municipal Securities Rulemaking Board.

In addition to these six factors we also control for the state's log real GSP (*LogGSP*), year-end unemployment rate (*Unemployment*), log-population (*LogPop*) and log-median household income (*LogInc*). All these control factors will be denoted by information set X in our specification.

The annual reporting of state accounting data creates a timing challenge for the control variables. Unlike corporate data that is announced to everyone at the same time in a tightly-controlled process, state accounting data is regularly debated openly in the legislatures and in public events by politicians. Thus, there is no specific announcement date for any accounting measure. This requires an assumption about what investors know at the time of a municipal bond issue. Our assumption is that for all bonds issued by a state until June 30th of year t, the available information is from year $t-1$. For all issues after that date, the information is from year t.

Because the $Spread^{SMP}$ measure is bond-specific, we also have to have controls for bond characteristics such as the amount of issuance (*LogIssue*), maturity of the bond (*LogMat*), and whether the bond is rated (*Rated*). These bond-specific factors will be represented by information set B in our specification.

The summary statistics in Table 3 clearly convey the impact of the crisis on the states' financial health. After the financial crisis, states experienced higher rates of unemployment, further increases in the level of pension underfunding, reductions in municipal bond market liquidity, and higher debt loads.

Estimation Strategy for Primary Market Analysis

In order to replicate Munnell et al.'s analysis, we fit our data to the following model using restricted maximum likelihood with state random effects and state-level error clustering:

$$Spread_{i,j}^{SMP} = \phi_1 + \phi_2 Pension_{i,t_j(-1)} + \Phi X_{i,t_j(-1)} + \Theta B_{i,j} + \varepsilon_{i,j,t} \qquad (6)$$

where i represents the state, j is the bond issue, and $t_j(-1)$ notation reflects the fact that the state data at the time bond j has been issued may be from the current time period (e.g. *BBBSpread*) or the previous year. We also restrict our sample to 2003-2009 as in Munnell et al.

Next, using our full sample, we estimate

$$Spread_{i,t}^{ZER} = \phi_1 + \phi_2 Pension_{i,t(-1)} + \Phi X_{i,t(-1)} + \varepsilon_{i,t} \qquad (7)$$

By design, there is no issue-specific component to specification (7).

We assume that $\varepsilon_{i,t}$ and $\varepsilon_{i,j,t}$ have a state-specific random effect component. The random effects assumption arises from the fact that fiscal variables are constant for all issuances of a state between July of any year and June of the following year. It is more accurate to represent these coefficients as the expectation of a random coefficient rather than the estimate of a fixed parameter.

Estimation Strategy for Secondary Market Analysis

The relative abundance of trading data gives us more flexibility with the estimation strategy. We fit our data to the following models:

$$Spread_{i,t}^{ZER} = \phi_1 + \phi_2 Pension_{i,t(-1)} + \Phi X_{i,t(-1)} + \varepsilon_{i,t} \qquad (8)$$

$$\Delta Spread_{i,t}^{ZER} = \phi_2 \Delta Pension_{i,t(-1)} + \Phi \Delta X_{i,t(-1)} + \varepsilon_{i,t} \quad (9)$$

where the changes are calculated relative to the same quarter of the previous year. In the case of pensions and in instances where a component of *X* is annual data, we calculate the changes as follows. Suppose the spread we are observing belongs to the second quarter of year T. By assumption, the fiscal data known at the time belongs to year T-1. We calculate the change in spread as the difference of spreads in the second quarter of years T and T-1, while the changes in right hand side variables are between years T-1 and T-2 (i.e. the known information at the time the spreads are observed). The error term is treated with the same techniques we used in the primary market analysis.

IV. Results

Primary Markets

Table 4 presents the breakdown of mean and median $Spread^{SMP}$ by states' pension stress levels. We divide the sample into quartiles based on *ARC* or *Underfunding* (cutoffs at 25th, 50th and 75th percentiles) and compare the spreads across those quartiles. In Panel A, the buckets are formed based on the percentage of ARC payments made. The better maintained plans with highest percentage of ARC paid are in the bottom row. Somewhat counterintuitively, the better maintained plans seem to have higher spreads. In Panel B, when we compare the lowest and highest pension underfunding levels (*Underfunding*), we observe no relationship between the underfunding and credit spreads. Still, recall that these are bonds with various maturities, issuance amounts, and coupons, and are issued by states with different fundamentals. Therefore, the data requires further scrutiny through multivariate analysis.

In Table 5, we present the results from our multivariate analysis. Our findings are consistent with Munnell et al. (2011). A one standard deviation increase in *ARC* leads to a statistically significant but small (3 basis point) decrease in the issuance spread. This is about 1.5 percent of the average-bond spread of 2 percent. However, this specification also leads to the unintuitive finding that *Underfunding,* the scaled-size of the overall unfunded liability, is also negatively correlated with spreads. When we include both measures of pension plan stress in the same regression, neither variable is weakened by the presence of the other. Both large unfunded liabilities and demonstrated eagerness to fund those liabilities---higher *Underfunding* keeping *ARC* constant and vice versa---are seen as sources of financial strength.

Still, other independent variables have sensible coefficients. Table 5 shows that in periods when credit spreads are high in the corporate market (*BBBSpread*), municipal spreads are also high. Higher unemployment and longer maturity debt are associated with higher spreads while GO, rated, and insured bonds have lower spreads.

Overall, while the *ARC*-related results are consistent with the anticipated direction, we remain concerned that the simple-spread method might be comparing financially-constrained, low-coupon paying states to financially-healthy high-coupon paying states, all else equal. We are also interested in the question of whether pension obligations affect any maturity in particular – a question that the simple spread analysis cannot address satisfactorily.[9]

We calculate the primary market zero-coupon credit spreads for every maturity from 2 to 20 years using our fitted yield curves. In Table 6, we show the mean and median spreads for select maturities, once again divided into pension-stress quartiles. The *ARC* results in Panel A present little evidence that ARC payments had any impact on spreads. In fact, in the post-crisis period, spreads seem to be higher for states that make large contributions to their pension funds. In Panel B, we present the mean and median spreads across *Underfunding* buckets. Here the findings are more promising. Lowest underfunding (or surplus) is associated with lower spreads compared to the highest underfunding bucket across all maturities both before and after the crisis. The effect strengthens after the crisis. These results are also confirmed by our multivariate analysis, presented in Table 7, which indicates that the market pays no attention to ARC payments. The coefficients have a positive, albeit insignificant sign, which suggests that higher ARC payments are associated with higher spreads. The *Underfunding* variable seems to capture the sensitivity of spreads to pension stress more robustly. Before the crisis (Panel A), we observe some long term positive impact from *Underfunding* on spreads. After the crisis (Panel B), the sensitivity shifts to 4 – 6 year maturity range. While statistically significant, the economic impact of *Underfunding* is miniscule compared to the aversion to credit risk in the economy, captured by *BBBSpread*. Even in the post-crisis period where the *Underfunding* effect is strongest, the impact of *BBBSpread* is an order of magnitude larger than that of *Underfunding.* These results suggest that municipal bond markets are primarily driven by broad macroeconomic factors rather than state-specific factors.

Secondary Markets

Table 8 repeats the univariate analysis for secondary market zero-coupon spreads. Once again, *ARC* does not seem like a good predictor of spreads in any period (Panel A). The results are mixed for *Underfunding* in the pre-crisis period with pension plan surplus being associated with higher yields at long maturities. However, spreads do decline with increasing surplus in the post-crisis period.

On the multivariate side, Table 9 shows how spread levels across states are impacted by pension stress and Table 10 shows the analysis of spread changes over time. Table 9-Panel A finds some weak correlation between pension-stress and spreads in the pre-crisis period. There is, however, a strong indication that the bond markets started paying close attention to pension liabilities in the post-crisis period (Panel B). The states with higher pension liabilities pay higher yields at all maturities.

Once again, *BBBSpread* is the most powerful determinant of municipal bond spreads at all maturities in the post-crisis period. Pension underfunding has an economic effect comparable in magnitude to the unemployment rate, while market liquidity has a small but consistently significant negative effect on spreads. The effect of the budget surplus dummies is surprising and somewhat counterintuitive.

[9] While we could interact our pension variables with bond maturity, the interaction term would presume that the sensitivity of spreads to the pension variables is monotonically increasing (or decreasing) in maturity, which may or may not be correct. For example, if pension problems are expected to come to a head in the medium term, the impact of pension liabilities on spreads at increasing maturities could be hump-shaped.

Budget surpluses seem to be associated with higher spreads. While we do not dig deeply into this issue in this paper, we find that higher state revenues are associated with higher zero-coupon spreads, while higher state expenses are associated with lower spreads (not shown in Tables). We are able to generate a negative correlation between spreads and budget surpluses only if we do not control for any state effect (fixed or random) in the simple spread analysis.

In Table 10-Panel A, we examine the impact of changes in the state variables on changes in spreads in the pre-crisis period. There is no correlation between changes in pension underfunding levels and changes in spreads (ARC results are also insignificant and not shown). Δ*BBBSpread* suggests that an increase in credit risk aversion flattens the municipal yield curve in the pre-crisis period. While concerns about credit risk may lead to higher spreads at short maturities, municipal bonds are seen as good risks in the long term, with declining spreads. This view changes in the post-crisis period. As overall risk aversion goes up, municipal debt spreads follow suit at all maturities, with the effect strongest at the longer maturities. In other words, the municipal yield curve steepens with increasing credit risk aversion. There seems to be a consistently positive relationship between increases in underfunding and spread increases at long maturities but the effects are significant only in the 9 to 10 year range.[10]

ARC vs. Underfunding

Our finding that fiscal stress arising from pension underfunding is best captured by *Underfunding* and not by *ARC* may seem puzzling. After all, ARC is the annuity payment required to amortize *Underfunding* within a pre-determined period. Therefore, those two numbers must be closely correlated. However, any questionable assumption that goes into the *ARC* calculation but not into *Underfunding* could potentially drive a wedge between these two measures.

McCaulay (2009) argues that there is indeed such an assumption. It is common among many public employers to estimate their pension contributions as a percentage of their current payroll. The employer's total contribution in each year is the present value of the earned benefits of current employees in that particular year (normal cost rate) plus an additional fixed percentage of the payroll to amortize the underfunding (amortization rate). Note that *Underfunding* represents the liabilities accrued as of that moment in excess of pension assets; i.e., it does not depend on how many more people will be employed by the state in future years, it only depends on the current payroll and assumptions about the mortality rate, separation rate etc. of current employees. But, the amortization calculations are different. In calculating the amortization, the employer can assume that the payroll and amortization payments will grow at a sufficiently rapid pace to amortize the underfunding within the required timeframe. In other words, in a growing annuity calculation, the payroll growth rate can be made large enough (within reason) to minimize the ARC payments that the employer must report in its financial statements. The standard moral hazard concerns may reduce the information value of the ARC numbers.

[10] Changes in ARC payments have no influence on spreads.

V. Conclusion

In this paper, we investigate whether the bond market considers the states' unfunded pension obligations as a risk factor. While overall, we conclude that municipal bond markets are primarily affected by the credit risk in the broader economy rather than state-specific factors, we document a shift in bond market sentiment towards public pension underfunding in the post-crisis environment. The shift is evidenced by the increased sensitivity of spreads to pension underfunding and the reversal in the response of spreads to changes in risk aversion after the crisis, which suggests that the bond market is pricing in a decline in the states' creditworthiness.

We also find that the most popular measure of states' pension troubles, the percentage of ARC paid, is not a robust measure. We can obtain a significant impact on spreads only if we use a theoretically flawed method to calculate spreads. While the zero-coupon yield calculations most certainly incorporate some error into the analysis, they are theoretically sound. Our findings lead us to conclude that a more robust measure of pension stress is the underfunding of pension liabilities.

As unfunded public pension liabilities become a growing concern for many state and local governments, public officials face difficult choices in addressing them. Increases in investor scrutiny that lead to higher borrowing costs can be an important catalyst for gaining public support for closing pension funding gaps and restoring fiscal balance. This analysis suggests that the municipal bond market may be emerging as a source of market discipline incenting state and local governments to resolve these gaps.

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Table 1- Sample Breakdown by State

This table presents the states in the final sample before and after the crisis. 'X' indicates that the state has the necessary data to be included in the analysis of that particular market and period.

	Primary Markets		Secondary Markets		Number of Bonds Issued	
	Pre-Crisis	Post-Crisis	Pre-Crisis	Post-Crisis	Pre-Crisis	Post-Crisis
Alabama	X	X			18	24
Alaska		X		X		30
Arizona						
Arkansas	X	X	X		54	36
California	X	X	X	X	292	271
Colorado						
Connecticut	X	X	X	X	239	249
Delaware	X	X	X	X	84	122
Florida	X	X	X	X	78	49
Georgia	X	X	X	X	142	244
Hawaii		X		X	1	138
Idaho					1	
Illinois	X	X	X	X	113	76
Indiana						
Iowa	X				24	
Kansas						
Kentucky						
Louisiana		X		X		59
Maine	X	X	X	X	76	69
Maryland	X	X	X	X	88	221
Massachusetts	X	X	X	X	171	193
Michigan		X	X	X	8	30
Minnesota	X	X	X	X	70	194
Mississippi	X	X	X	X	64	88
Missouri	X	X	X	X	44	50
Montana	X	X	X		124	45
Nebraska						
Nevada	X	X	X	X	95	150
New Hampshire	X	X	X	X	47	89
New Jersey	X	X	X	X	32	39
New Mexico	X	X			21	25
New York	X	X	X	X	109	82
North Carolina	X	X	X	X	151	74
North Dakota						
Ohio	X	X	X	X	447	499
Oklahoma						12
Oregon	X	X	X	X	119	366
Pennsylvania	X	X	X	X	91	165
Rhode Island		X		X		65
South Carolina	X	X	X	X	271	78
South Dakota						
Tennessee		X	X	X	37	75
Texas	X	X	X	X	137	356
Utah	X	X	X	X	26	88
Vermont	X	X	X	X	118	118
Virginia	X	X	X	X	135	149
Washington	X	X		X	57	190
West Virginia					2	14
Wisconsin		X		X	12	163
Wyoming						

Table 2- The Fit Accuracy of the Zero-Coupon Yield Curve

This table shows the percent error of bond prices estimated with the zero yield curve compared to their actual prices. A negative error indicates underestimation. Secondary market maturities are the remaining maturities at the time of trading.

Primary Markets

Maturity	Observations	Minimum	1st Pctl	10th Pctl	Median	Mean	90th Pctl	99th Pctl	Maximum
Less than 2 yrs.	947	-1.7	-0.7	-0.2	0.0	0.0	0.2	0.5	4.7
2 - 5 yrs.	1710	-3.2	-1.3	-0.4	0.0	-0.1	0.2	1.3	7.7
5 - 10 yrs.	2681	-4.7	-1.8	-0.5	0.0	0.0	0.5	2.4	6.9
Greater than 10 yrs.	214	-2.0	-1.7	-0.6	-0.1	-0.1	0.3	1.2	2.9

Secondary Markets

Maturity	Observations	Minimum	1st Pctl	10th Pctl	Median	Mean	90th Pctl	99th Pctl	Maximum
Less than 2 yrs.	54623	-2.0	-0.2	0.4	1.1	1.1	1.8	2.5	4.8
2 - 5 yrs.	101888	-10.8	-1.2	-0.1	0.9	1.0	2.2	3.8	10.7
5 - 10 yrs.	107591	-7.0	-2.4	-0.8	0.9	1.0	2.9	5.3	11.5
Greater than 10 yrs.	5380	-5.6	-3.2	-1.1	0.9	1.0	3.1	6.0	10.7

All numbers are percentages

Table 3- Summary Statistics

Panel A – Pre-Crisis (2002-2007)

	Mean	Median	Std Dev	Minimum	Maximum
ARC (%)	89.9	96.4	18.2	19.6	112.1
Underfunding (%)	2.4	2.2	2.5	-3.9	7.3
Real GSP($Billion) †	376	293	380	22	1763
Unemployment (%)	5.1	5.0	1.1	3.2	8.8
BBBSpread (%)	1.7	1.4	0.5	1.1	2.9
Issuance ($Million) †	3.5	3.3	1.0	1.9	6.9
Budget		3			
Year		2005			
Liquidity (%) †	56.9	52.1	31.4	7.2	161.1
PayDay (Days) †	71.9	65.7	39.0	29.9	375.7
Population (Millions) †	8.5	6.3	8.1	0.1	36.0
Median Income ($000) †	43.6	43.7	9.8	22.2	63.4
Debt (%)	3.0	2.3	1.8	0.6	7.3

Panel B – Post-Crisis (2007-2011)

	Mean	Median	Std Dev	Minimum	Maximum
ARC (%)	89.4	97.0	29.1	17.9	261.4
Underfunding (%)	4.7	4.0	3.8	-3.9	14.9
Real GSP($Billion) †	343	233	367	22	1763
Unemployment (%)	7.4	7.5	2.4	2.8	12.2
BBBSpread (%)	3.4	3.0	1.6	1.7	6.4
Issuance ($Million) †	3.4	3.3	0.9	1.2	6.0
Budget		2			
Year		2009			
Liquidity (%) †	49.0	49.6	20.1	9.6	100.2
PayDay (Days) †	73.1	67.3	37.4	30.3	300.5
Population (Millions) †	7.9	5.6	7.8	0.6	37.0
Median Income ($000) †	51.8	50.5	8.0	34.5	70.0
Debt (%)	3.6	3.0	2.1	0.7	9.5

† These variables are used in the regressions in logged-form

Table 4- *Spread*^{SMP} Breakdown – Primary Markets

This table shows the mean and median simple spread of municipal bonds in our sample divided into four quartiles by the level of underfunding or the percentage of ARC paid. In Panel A, the better maintained plans are in the bottom row (***highest ARC percentage paid***). In Panel B, the first row covers the financially healthiest plans (***lowest underfunding***).

Panel A - ARC

	Mean	Median
Lowest ARC Percent Paid	2.0	2.0
2	2.1	2.0
3	2.0	2.0
Highest ARC Percent Paid	***2.3***	***2.1***

Panel B - Underfunding

	Mean	Median
Lowest Underfunding/Surplus	***2.0***	***1.9***
2	2.1	2.0
3	2.2	2.1
Highest Underfunding	2.1	1.9

All numbers are percentages

Table 5- Simple Spread Analysis – Primary Markets

This table presents estimates for the parameters in the multivariate simple spread analysis (equation (6)). Estimation technique involves state random effects and errors clustered by state. Standard errors are in parentheses.

	Dependent Variable: *Spread*^{SMP}					
ARC	-0.0011	***			-0.0011	***
	(0.0004)				(0.0004)	
Underfunding			-0.0166	***	-0.0165	***
			(0.0058)		(0.0058)	
LogMat	0.0059	***	0.0059	***	0.0059	***
	(0.0001)		(0.0001)		(0.0001)	
GO	-0.0023	***	-0.0023	***	-0.0023	***
	(0.0002)		(0.0002)		(0.0002)	
Insured	-0.0020	***	-0.0020	***	-0.0020	***
	(0.0001)		(0.0001)		(0.0001)	
LogIssue	-0.0003	***	-0.0003	***	-0.0003	***
	(0.0000)		(0.0000)		(0.0000)	
Rated	-0.0007	***	-0.0007	***	-0.0007	***
	(0.0001)		(0.0001)		(0.0001)	
BBBSpread	0.6537	***	0.6540	***	0.6543	***
	(0.0083)		(0.0083)		(0.0083)	
LogGSP	-0.0009	**	-0.0010	***	-0.0011	***
	(0.0004)		(0.0004)		(0.0004)	
Issuance	-0.0154		-0.0195	**	-0.0136	
	(0.0098)		(0.0096)		(0.0098)	
Unemployment	0.0611	***	0.0609	***	0.0605	***
	(0.0134)		(0.0135)		(0.0135)	
Budget 2	0.0005	**	0.0005	**	0.0004	**
	(0.0002)		(0.0002)		(0.0002)	
Budget 3	0.0011	***	0.0012	***	0.0011	***
	(0.0002)		(0.0002)		(0.0002)	
Budget 4	0.0002		0.0003		0.0001	
	(0.0003)		(0.0003)		(0.0003)	
Year2006	-0.0024	***	-0.0024	***	-0.0023	***
	(0.0002)		(0.0002)		(0.0002)	
Year2007	-0.0006	***	-0.0007	***	-0.0006	***
	(0.0002)		(0.0002)		(0.0002)	
Year2008	-0.0042	***	-0.0043	***	-0.0041	***
	(0.0004)		(0.0004)		(0.0004)	
Liquid	-0.0004	***	-0.0004	***	-0.0004	***
	(0.0001)		(0.0001)		(0.0001)	
PayDay	0.0006	**	0.0004		0.0003	
	(0.0003)		(0.0003)		(0.0003)	
LogPop	0.0002		0.0003		0.0003	
	(0.0002)		(0.0002)		(0.0002)	
LogInc	0.0029		0.0033	*	0.0028	
	(0.0020)		(0.0020)		(0.0020)	
Debt	0.0072		0.0080		0.0130	
	(0.0148)		(0.0150)		(0.0151)	
N	11,934					

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Table 6- *Spread*^{ZER} Breakdown by Maturity – Primary Markets

This table shows the mean and median *zero-coupon* spreads of municipal bonds divided into four quartiles by the level of underfunding or the percentage of ARC paid. In Panel A, the first row covers the financially healthiest plans (***lowest underfunding***). In Panel B, the better maintained plans are in the bottom row (***highest ARC percentage paid***).

Panel A – ARC Quartiles, percent

		Mean Spread					Median Spread				
		2-yr.	5-yr.	8-yr.	10-yr.	15-yr.	2-yr.	5-yr.	8-yr.	10-yr.	15-yr.
Pre-Crisis Period	Lowest ARC Percent Paid	0.36	0.58	0.73	0.82	1.03	0.39	0.60	0.73	0.81	1.07
	2	0.29	0.52	0.71	0.83	1.10	0.32	0.56	0.68	0.79	1.01
	3	0.31	0.52	0.71	0.83	1.13	0.32	0.56	0.70	0.81	1.10
	Highest ARC Percent Paid	***0.30***	***0.52***	***0.71***	***0.83***	***1.10***	***0.37***	***0.58***	***0.76***	***0.89***	***1.16***
Post-Crisis Period	Lowest ARC Percent Paid	0.44	0.64	0.81	0.96	1.42	0.34	0.58	0.75	0.88	1.30
	2	0.68	0.87	0.98	1.08	1.39	0.68	0.82	0.89	0.96	1.34
	3	0.58	0.75	0.84	0.93	1.24	0.53	0.77	0.81	0.86	1.10
	Highest ARC Percent Paid	***0.71***	***0.84***	***0.95***	***1.06***	***1.47***	***0.55***	***0.76***	***0.84***	***0.96***	***1.33***

Panel B – Underfunding Quartiles, percent

		Mean Spread					Median Spread				
		2-yr.	5-yr.	8-yr.	10-yr.	15-yr.	2-yr.	5-yr.	8-yr.	10-yr.	15-yr.
Pre-Crisis Period	***Lowest Underfunding/Surplus***	***0.30***	***0.51***	***0.68***	***0.79***	***1.05***	***0.31***	***0.55***	***0.67***	***0.77***	***1.03***
	2	0.34	0.56	0.73	0.83	1.06	0.38	0.58	0.73	0.80	1.07
	3	0.33	0.55	0.75	0.86	1.13	0.38	0.59	0.72	0.82	1.17
	Highest Underfunding	0.26	0.51	0.72	0.85	1.17	0.32	0.56	0.71	0.81	1.11
Post-Crisis Period	***Lowest Underfunding/Surplus***	***0.53***	***0.68***	***0.78***	***0.87***	***1.20***	***0.51***	***0.69***	***0.74***	***0.84***	***1.18***
	2	0.59	0.72	0.84	0.95	1.37	0.56	0.74	0.83	0.95	1.29
	3	0.50	0.69	0.84	0.96	1.35	0.49	0.66	0.81	0.89	1.20
	Highest Underfunding	0.58	0.81	0.97	1.11	1.50	0.47	0.73	0.85	0.99	1.40

Table 7- Zero-Coupon Spread Analysis – Primary Markets

This table presents the estimates for the parameters in the multivariate zero-coupon spread analysis of the primary markets (equation (7)). The estimation technique involves state random effects and errors clustered by state. Standard errors are in parenthesis.

Panel A. Pre-Crisis Period – Select Maturities

	2-yr		4-yr		6-yr		10-yr	
ARC	-0.0004		0.0000		0.0001		-0.0001	
	(0.0004)		(0.0005)		(0.0005)		(0.0006)	
Underfunding		0.0005		0.0022		0.0043		0.0109 **
		(0.0035)		(0.0037)		(0.0040)		(0.0044)
BBBSpread	0.3019 ***	0.3042 ***	0.3536 ***	0.3524 ***	0.2608 ***	0.2565 ***	0.1891	0.1757 *
	(0.0825)	(0.0826)	(0.0866)	(0.0868)	(0.0907)	(0.0910)	(0.1019)	(0.1016)
LogGSP	-0.0003	-0.0003	-0.0004	-0.0004	-0.0004	-0.0004	-0.0003	-0.0001
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
Issuance	0.0175 *	0.0187 *	0.0261 **	0.0246 **	0.0262 **	0.0236 **	0.0155	0.0071
	(0.0098)	(0.0102)	(0.0115)	(0.0115)	(0.0125)	(0.0124)	(0.0139)	(0.0128)
Unemployment	-0.0151	-0.0157	-0.0036	-0.0063	-0.0009	-0.0057	-0.0063	-0.0211
	(0.0113)	(0.0124)	(0.0125)	(0.0133)	(0.0136)	(0.0144)	(0.0157)	(0.0155)
Budget 2	0.0002	0.0002	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0003)
Budget 3	0.0003	0.0003	0.0002	0.0002	0.0002	0.0001	0.0002	0.0000
	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Budget 4	0.0004	0.0004	0.0004	0.0004	0.0005 *	0.0005 *	0.0006 **	0.0006 *
	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
Year2004	0.0021 ***	0.0021 ***	0.0014	0.0014	0.0005	0.0005	-0.0002	-0.0001
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0009)	(0.0009)	(0.0010)	(0.0010)
Year2005	0.0049 ***	0.0049 ***	0.0046 ***	0.0046 ***	0.0032 **	0.0032 **	0.0018	0.0017
	(0.0011)	(0.0011)	(0.0012)	(0.0012)	(0.0012)	(0.0013)	(0.0014)	(0.0014)
Year2006	0.0052 ***	0.0052 ***	0.0043 ***	0.0043 ***	0.0024 **	0.0023 **	0.0001	0.0000
	(0.0010)	(0.0010)	(0.0010)	(0.0011)	(0.0011)	(0.0011)	(0.0013)	(0.0012)
Year2007	0.0064 ***	0.0064 ***	0.0053 ***	0.0053 ***	0.0030 **	0.0029 **	-0.0002	-0.0002
	(0.0010)	(0.0010)	(0.0011)	(0.0011)	(0.0012)	(0.0012)	(0.0013)	(0.0013)
Liquidity	0.0003 **	0.0003 **	0.0001	0.0001	0.0000	0.0000	0.0000	0.0000
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)
PayDay	-0.0004	-0.0003	-0.0002	-0.0002	-0.0001	-0.0002	-0.0002	-0.0002
	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0003)
LogPop	0.0005 *	0.0005 *	0.0006 **	0.0005 *	0.0005 *	0.0005 *	0.0004	0.0003
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
LogInc	-0.0006	-0.0006	0.0011	0.0010	0.0013	0.0011	0.0001	-0.0006
	(0.0009)	(0.0009)	(0.0009)	(0.0010)	(0.0010)	(0.0010)	(0.0012)	(0.0012)
Debt	0.0004	0.0006	-0.0035	-0.0026	-0.0033	-0.0018	0.0066	0.0106
	(0.0060)	(0.0064)	(0.0070)	(0.0071)	(0.0077)	(0.0077)	(0.0087)	(0.0081)
N	169							

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Panel B. Post-Crisis Period – Select Maturities

	2-yr		4-yr		6-yr		10-yr	
ARC	0.0001		0.0002		0.0002		0.0011	
	(0.0008)		(0.0009)		(0.0009)		(0.0009)	
Underfunding		0.0042		0.0118 *		0.0161 **		0.0119
		(0.0049)		(0.0062)		(0.0071)		(0.0075)
BBBSpread	0.1191 ***	0.1194 ***	0.1331 ***	0.1370 ***	0.1307 ***	0.1359 ***	0.1074 ***	0.1142 ***
	(0.0148)	(0.0149)	(0.0175)	(0.0176)	(0.0181)	(0.0181)	(0.0184)	(0.0182)
LogGSP	-0.0014	-0.0008	-0.0011	0.0005	-0.0012	0.0009	-0.0015	-0.0005
	(0.0017)	(0.0016)	(0.0021)	(0.0020)	(0.0024)	(0.0023)	(0.0023)	(0.0025)
Issuance	-0.0214	-0.0135	-0.0097	-0.0014	-0.0062	0.0033	0.0124	0.0159
	(0.0228)	(0.0219)	(0.0284)	(0.0279)	(0.0314)	(0.0310)	(0.0278)	(0.0314)
Unemployment	0.0158	0.0174	0.0277	0.0292 *	0.0312	0.0305 *	0.0088	0.0208
	(0.0143)	(0.0126)	(0.0176)	(0.0158)	(0.0200)	(0.0182)	(0.0193)	(0.0200)
Budget 2	-0.0003	0.0000	-0.0002	0.0003	-0.0001	0.0004	0.0000	0.0001
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0005)	(0.0005)
Budget 3	-0.0009 **	-0.0007 *	-0.0009 *	-0.0006	-0.0009	-0.0004	-0.0009 *	-0.0005
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0005)	(0.0005)	(0.0005)
Budget 4	-0.0004	-0.0005	-0.0007	-0.0005	-0.0006	-0.0003	-0.0002	-0.0003
	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0007)	(0.0007)	(0.0006)	(0.0007)
Year2008	-0.0007	-0.0008	-0.0002	-0.0004	0.0003	0.0000	0.0013 *	0.0010
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
Year2009	-0.0075 ***	-0.0077 ***	-0.0073 ***	-0.0077 ***	-0.0064 ***	-0.0067 ***	-0.0031 ***	-0.0040 ***
	(0.0009)	(0.0008)	(0.0011)	(0.0010)	(0.0012)	(0.0011)	(0.0011)	(0.0012)
Year2010	-0.0069 ***	-0.0072 ***	-0.0059 ***	-0.0065 ***	-0.0043 ***	-0.0050 ***	0.0006	-0.0010
	(0.0008)	(0.0007)	(0.0010)	(0.0008)	(0.0011)	(0.0010)	(0.0012)	(0.0010)
Liquidity	-0.0001	-0.0003	0.0000	-0.0001	0.0001	0.0001	0.0000	0.0002
	(0.0004)	(0.0003)	(0.0005)	(0.0004)	(0.0005)	(0.0005)	(0.0005)	(0.0005)
PayDay	0.0004	0.0003	0.0005	0.0003	0.0004	0.0003	0.0005	0.0002
	(0.0004)	(0.0004)	(0.0005)	(0.0005)	(0.0006)	(0.0006)	(0.0005)	(0.0006)
LogPop	0.0017	0.0011	0.0014	-0.0002	0.0015	-0.0005	0.0019	0.0008
	(0.0017)	(0.0016)	(0.0021)	(0.0020)	(0.0024)	(0.0023)	(0.0023)	(0.0025)
LogInc	0.0022	0.0021	0.0024	0.0019	0.0028	0.0018	0.0017	0.0016
	(0.0018)	(0.0017)	(0.0023)	(0.0022)	(0.0026)	(0.0025)	(0.0025)	(0.0027)
Debt	0.0117	0.0081	0.0160	0.0086	0.0154	0.0078	0.0082	0.0071
	(0.0087)	(0.0084)	(0.0113)	(0.0113)	(0.0134)	(0.0135)	(0.0112)	(0.0138)
N	154							

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Table 8- *Spread*^{ZER} Breakdown by Maturity – Secondary Markets

This table presents the mean and median *zero-coupon* spreads of municipal bonds divided into four quartiles by the level of underfunding or the percentage of ARC paid. In Panel A, the first row covers the financially healthiest plans (***lowest underfunding***). In Panel B, the better maintained plans are in the bottom row (***highest ARC percentage paid***).

Panel A – ARC Quartiles, percent

		Mean Spread					Median Spread				
		2-yr.	5-yr.	8-yr.	10-yr.	15-yr.	2-yr.	5-yr.	8-yr.	10-yr.	15-yr.
Pre-Crisis Period	Lowest ARC Percent Paid	0.37	0.54	0.71	0.82	1.16	0.38	0.56	0.69	0.79	1.05
	2	0.35	0.54	0.71	0.81	1.10	0.36	0.59	0.71	0.79	1.02
	3	0.37	0.53	0.69	0.87	1.38	0.38	0.58	0.70	0.80	1.00
	Highest ARC Percent Paid	***0.34***	***0.52***	***0.76***	***0.93***	***1.42***	***0.37***	***0.54***	***0.77***	***0.91***	***1.20***
Post-Crisis Period	Lowest ARC Percent Paid	0.59	0.78	0.92	1.04	1.42	0.51	0.72	0.83	0.97	1.33
	2	0.70	0.84	0.96	1.08	1.46	0.67	0.81	0.86	0.96	1.41
	3	0.64	0.80	0.91	1.02	1.39	0.58	0.79	0.85	0.95	1.28
	Highest ARC Percent Paid	***0.73***	***0.92***	***1.06***	***1.18***	***1.56***	***0.66***	***0.88***	***1.02***	***1.13***	***1.47***

Panel B – Underfunding Quartiles, percent

		Mean Spread					Median Spread				
		2-yr.	5-yr.	8-yr.	10-yr.	15-yr.	2-yr.	5-yr.	8-yr.	10-yr.	15-yr.
Pre-Crisis Period	***Lowest Underfunding/Surplus***	***0.35***	***0.51***	***0.68***	***0.90***	***1.51***	***0.35***	***0.53***	***0.69***	***0.78***	***1.01***
	2	0.34	0.53	0.71	0.84	1.19	0.37	0.56	0.71	0.81	1.09
	3	0.39	0.56	0.72	0.83	1.13	0.38	0.61	0.73	0.83	1.05
	Highest Underfunding	0.40	0.58	0.71	0.80	1.03	0.41	0.59	0.70	0.76	0.97
Post-Crisis Period	***Lowest Underfunding/Surplus***	***0.63***	***0.78***	***0.88***	***0.98***	***1.30***	***0.58***	***0.76***	***0.83***	***0.94***	***1.13***
	2	0.66	0.83	0.93	1.02	1.34	0.58	0.79	0.86	0.95	1.27
	3	0.61	0.77	0.90	1.02	1.42	0.54	0.68	0.79	0.90	1.28
	Highest Underfunding	0.65	0.86	1.02	1.16	1.60	0.58	0.79	0.94	1.09	1.51

Table 9- Analysis of Zero-Coupon Spread Levels – Secondary Markets

This Table presents the estimates for the parameters in the multivariate zero-coupon spread analysis of the primary markets (equation (8)). The estimation technique involves state random effects and errors clustered by state. Standard errors are in parenthesis.

Panel A. Pre-Crisis Period – Select Maturities

	2-yr		4-yr		6-yr		10-yr	
ARC	0.0004		-0.0002		-0.0004		0.0015	
	(0.0006)		(0.0006)		(0.0006)		(0.0015)	
Underfunding		0.0053		0.0160		0.0164 **		-0.0198
		(0.0060)		(0.0066)		(0.0064)		(0.0128)
BBBSpread	0.3144 ***	0.3109 ***	0.2753 ***	0.2716 ***	0.1859 ***	0.1835 ***	0.1194	0.1258
	(0.0453)	(0.0453)	(0.0440)	(0.0438)	(0.0384)	(0.0383)	(0.1115)	(0.1115)
LogGSP	0.0001	0.0001	0.0003	0.0004	0.0002	0.0004	0.0003	0.0002
	(0.0002)	(0.0002)	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0005)	(0.0005)
Issuance	-0.0076	-0.0080	0.0054	0.0039	0.0125	0.0112	0.0186	0.0209
	(0.0098)	(0.0098)	(0.0099)	(0.0098)	(0.0088)	(0.0088)	(0.0230)	(0.0232)
Unemployment	0.0036	-0.0009	0.0004	-0.0097	-0.0014	-0.0101	0.0199	0.0408
	(0.0158)	(0.0165)	(0.0168)	(0.0172)	(0.0156)	(0.0158)	(0.0348)	(0.0372)
Budget 2	-0.0004 *	-0.0004 *	-0.0003	-0.0003	-0.0001	-0.0001	0.0001	0.0003
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0006)	(0.0006)
Budget 3	0.0000	0.0001	-0.0001	0.0000	0.0000	0.0000	-0.0002	-0.0001
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0002)	(0.0006)	(0.0006)
Budget 4	0.0001	0.0000	0.0002	0.0002	0.0002	0.0002	0.0004	0.0003
	(0.0003)	(0.0003)	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0007)	(0.0007)
Year2004	0.0013 **	0.0013 **	0.0018 ***	0.0018 **	0.0020 ***	0.0021 ***	-0.0072 ***	-0.0072 ***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0005)	(0.0014)	(0.0013)
Year2005	0.0039 ***	0.0039 ***	0.0039 ***	0.0039 ***	0.0036 ***	0.0035 ***	-0.0065 ***	-0.0063 ***
	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0016)	(0.0016)
Year2006	0.0049 ***	0.0049 ***	0.0045 ***	0.0043 ***	0.0034 ***	0.0033 ***	-0.0076 ***	-0.0073 ***
	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0005)	(0.0005)	(0.0015)	(0.0015)
Year2007	0.0065 ***	0.0064 ***	0.0058 ***	0.0057 ***	0.0043 ***	0.0041 ***	-0.0077 ***	-0.0074 ***
	(0.0007)	(0.0007)	(0.0006)	(0.0006)	(0.0006)	(0.0006)	(0.0016)	(0.0016)
Liquidity	0.0002	0.0003	0.0003	0.0004	0.0003	0.0004 **	-0.0008	-0.0010 *
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0005)	(0.0005)
PayDay	0.0011 ***	0.0011 ***	0.0009 **	0.0009 ***	0.0010 ***	0.0009 ***	-0.0010	-0.0012
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0008)	(0.0008)
LogPop	0.0000	0.0000	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001	-0.0001
	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0004)	(0.0004)
LogInc	-0.0012	-0.0014 *	0.0001	-0.0001	0.0006	0.0004	0.0007	0.0009
	(0.0008)	(0.0008)	(0.0008)	(0.0008)	(0.0007)	(0.0007)	(0.0018)	(0.0018)
Debt	0.0204 **	0.0203 **	0.0148	0.0141	0.0138	0.0132	-0.0021	-0.0022
	(0.0102)	(0.0101)	(0.0118)	(0.0115)	(0.0119)	(0.0115)	(0.0208)	(0.0212)
N	720							

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Panel B. Post-Crisis Period – Select Maturities

	2-yr		4-yr		6-yr		10-yr	
ARC	-0.0007		-0.0005		-0.0003		-0.0005	
	(0.0005)		(0.0004)		(0.0004)		(0.0005)	
Underfunding		0.0229 ***		0.0297 ***		0.0310 ***		0.0289 ***
		(0.0052)		(0.0051)		(0.0052)		(0.0059)
BBBSpread	0.1706 ***	0.1643 ***	0.1753 ***	0.1709 ***	0.1703 ***	0.1657 ***	0.1962 ***	0.1872 ***
	(0.0086)	(0.0082)	(0.0071)	(0.0067)	(0.0070)	(0.0066)	(0.0085)	(0.0083)
LogGSP	0.0021	0.0047 **	0.0037 *	0.0098 ***	0.0030	0.0087 ***	-0.0012	0.0011
	(0.0019)	(0.0020)	(0.0022)	(0.0024)	(0.0023)	(0.0024)	(0.0023)	(0.0024)
Issuance	0.0477 **	0.0411 **	0.0546 ***	0.0420 ***	0.0530 ***	0.0404 ***	0.0413 **	0.0302 *
	(0.0185)	(0.0174)	(0.0160)	(0.0148)	(0.0160)	(0.0148)	(0.0189)	(0.0182)
Unemployment	0.0335 ***	0.0256 ***	0.0526 ***	0.0510 ***	0.0628 ***	0.0588 ***	0.0886 ***	0.0715 ***
	(0.0086)	(0.0081)	(0.0080)	(0.0079)	(0.0082)	(0.0080)	(0.0091)	(0.0090)
Budget 2	0.0002	0.0004	0.0003	0.0005 **	0.0003	0.0005 **	0.0001	0.0003
	(0.0003)	(0.0003)	(0.0003)	(0.0002)	(0.0003)	(0.0002)	(0.0003)	(0.0003)
Budget 3	0.0007 *	0.0005 *	0.0009 ***	0.0008 ***	0.0009 ***	0.0008 ***	0.0006 *	0.0003
	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)
Budget 4	0.0004	0.0005	0.0011 ***	0.0009 **	0.0011 ***	0.0009 **	0.0002	0.0001
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0004)
Year2008	-0.0017 ***	-0.0017 ***	-0.0007 **	-0.0007 **	-0.0001	-0.0001	-0.0006	-0.0005
	(0.0004)	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0004)
Year2009	-0.0073 ***	-0.0073 ***	-0.0066 ***	-0.0066 ***	-0.0057 ***	-0.0057 ***	-0.0056 ***	-0.0055 ***
	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)
Year2010	-0.0066 ***	-0.0064 ***	-0.0054 ***	-0.0052 ***	-0.0043 ***	-0.0042 ***	-0.0037 ***	-0.0035 ***
	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)
Liquidity	-0.0041 ***	-0.0042 ***	-0.0036 ***	-0.0038 ***	-0.0028 ***	-0.0030 ***	-0.0014 ***	-0.0014 ***
	(0.0005)	(0.0005)	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0005)	(0.0005)
PayDay	0.0003	0.0001	0.0006 ***	0.0005 **	0.0007 ***	0.0005 ***	0.0006 **	0.0003
	(0.0003)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0002)
LogPop	0.0012 ***	0.0014 ***	0.0015 ***	0.0018 ***	0.0015 ***	0.0019 ***	0.0012 ***	0.0016 ***
	(0.0004)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0003)
LogInc	-0.0019	-0.0044 **	-0.0036	-0.0095 ***	-0.0028	-0.0083 ***	0.0014	-0.0007
	(0.0020)	(0.0020)	(0.0023)	(0.0024)	(0.0024)	(0.0025)	(0.0023)	(0.0025)
Debt	-0.0021	-0.0038 *	-0.0030	-0.0077 ***	-0.0022	-0.0063 **	0.0031	0.0024
	(0.0021)	(0.0022)	(0.0024)	(0.0026)	(0.0025)	(0.0027)	(0.0025)	(0.0027)
N	1015							

*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Table 10- Analysis of Zero-Coupon Spread Changes – Secondary Markets

This table presents the estimates for the parameters in the analysis of the drivers of changes in zero-coupon spreads in the secondary markets (equation (9)). The estimation technique involves state random effects and errors clustered by state. Standard errors are in parenthesis.

Panel A. Pre-Crisis Period – Select Maturities

	2-yr		5-yr		9-yr		10-yr		11-yr		15-yr	
ΔUnderfunding	-0.0329		-0.0308		-0.0238		-0.0179		-0.0131		0.0016	
	(0.0280)		(0.0242)		(0.0153)		(0.0204)		(0.0290)		(0.0735)	
ΔBBBSpread	0.2547	**	0.0674		-0.1614	**	-0.2032	**	-0.2634	*	-0.5056	
	(0.0999)		(0.0868)		(0.0633)		(0.0939)		(0.1342)		(0.3327)	
ΔLogGSP	0.0506	***	0.0214		0.0012		0.0065		0.0141		0.0391	
	(0.0187)		(0.0161)		(0.0081)		(0.0109)		(0.0157)		(0.0402)	
ΔIssuance	-0.0140		-0.0241		0.0119		0.0103		0.0033		-0.0234	
	(0.0307)		(0.0266)		(0.0145)		(0.0194)		(0.0280)		(0.0719)	
ΔUnemployment	-0.0016		-0.0497		0.0461		0.1381	***	0.2234	***	0.5351	***
	(0.0612)		(0.0531)		(0.0344)		(0.0462)		(0.0653)		(0.1640)	
ΔBudget	-0.0667		-0.1546		-0.0438		-0.0005		0.0449		0.2906	
	(0.1287)		(0.1115)		(0.0656)		(0.0895)		(0.1281)		(0.3247)	
ΔLiquidity	0.0016	**	0.0009		0.0002		0.0004		0.0004		0.0007	
	(0.0007)		(0.0006)		(0.0004)		(0.0005)		(0.0007)		(0.0019)	
ΔPayDay	0.0000		0.0006		-0.0006		-0.0011		-0.0018		-0.0045	
	(0.0013)		(0.0011)		(0.0007)		(0.0010)		(0.0014)		(0.0036)	
ΔLogPop	-0.0001		0.0001		-0.0003		-0.0005	*	-0.0006	*	-0.0012	
	(0.0003)		(0.0003)		(0.0002)		(0.0003)		(0.0004)		(0.0009)	
ΔLogInc	0.0025		0.0018		0.0014		0.0018		0.0017		0.0030	
	(0.0027)		(0.0023)		(0.0017)		(0.0025)		(0.0037)		(0.0092)	
ΔDebt	-0.2141	*	-0.2273	**	-0.0784		0.0207		0.0866		0.2881	
	(0.1176)		(0.1016)		(0.0542)		(0.0728)		(0.1059)		(0.2734)	
N							183					

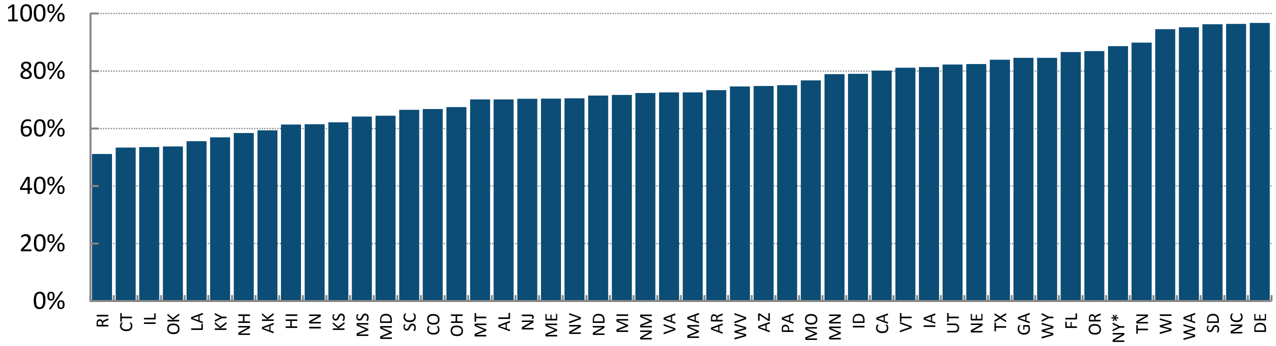
*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Panel B. Post-Crisis Period – Select Maturities

	2-yr		5-yr		9-yr		10-yr		11-yr		15-yr	
ΔUnderfunding	0.0138		-0.0031		0.0227	**	0.0258	**	0.0240		0.0368	
	(0.0186)		(0.0129)		(0.0104)		(0.0131)		(0.0170)		(0.0368)	
ΔBBBSpread	0.0974	***	0.0865	***	0.1282	***	0.1275	***	0.1207	***	0.1658	***
	(0.0168)		(0.0117)		(0.0089)		(0.0110)		(0.0144)		(0.0310)	
ΔLogGSP	0.0382	***	0.0341	***	0.0223	***	0.0132		0.0061		-0.0086	
	(0.0141)		(0.0099)		(0.0079)		(0.0098)		(0.0127)		(0.0270)	
ΔIssuance	0.0472		0.0326		0.0132		0.0222		0.0296		0.0450	
	(0.0314)		(0.0219)		(0.0167)		(0.0229)		(0.0312)		(0.0706)	
ΔUnemployment	-0.0817	***	-0.0184		0.0437	**	0.0363	*	0.0205		0.0380	
	(0.0297)		(0.0204)		(0.0168)		(0.0213)		(0.0276)		(0.0600)	
ΔBudget	0.3143	***	0.1675	***	0.2457	***	0.2787	***	0.3265	***	0.4757	**
	(0.0935)		(0.0641)		(0.0557)		(0.0694)		(0.0901)		(0.1938)	
ΔLiquidity	0.0001		0.0000		0.0000		0.0001		0.0001		0.0001	
	(0.0004)		(0.0003)		(0.0003)		(0.0003)		(0.0004)		(0.0009)	
ΔPayDay	0.0014		0.0008		0.0015	***	0.0015	**	0.0015	*	0.0015	
	(0.0010)		(0.0007)		(0.0005)		(0.0007)		(0.0009)		(0.0020)	
ΔLogPop	0.0006		0.0149		-0.0062		0.0089		0.0185		0.0360	
	(0.0405)		(0.0312)		(0.0183)		(0.0241)		(0.0325)		(0.0726)	
ΔLogInc	0.0254	**	0.0045		0.0150	**	0.0108		0.0087		0.0059	
	(0.0118)		(0.0089)		(0.0061)		(0.0082)		(0.0112)		(0.0263)	
ΔDebt	0.0919		0.0940		0.0771		0.0714		0.0784		0.0843	
	(0.1028)		(0.0730)		(0.0553)		(0.0698)		(0.0917)		(0.1990)	
N							346					

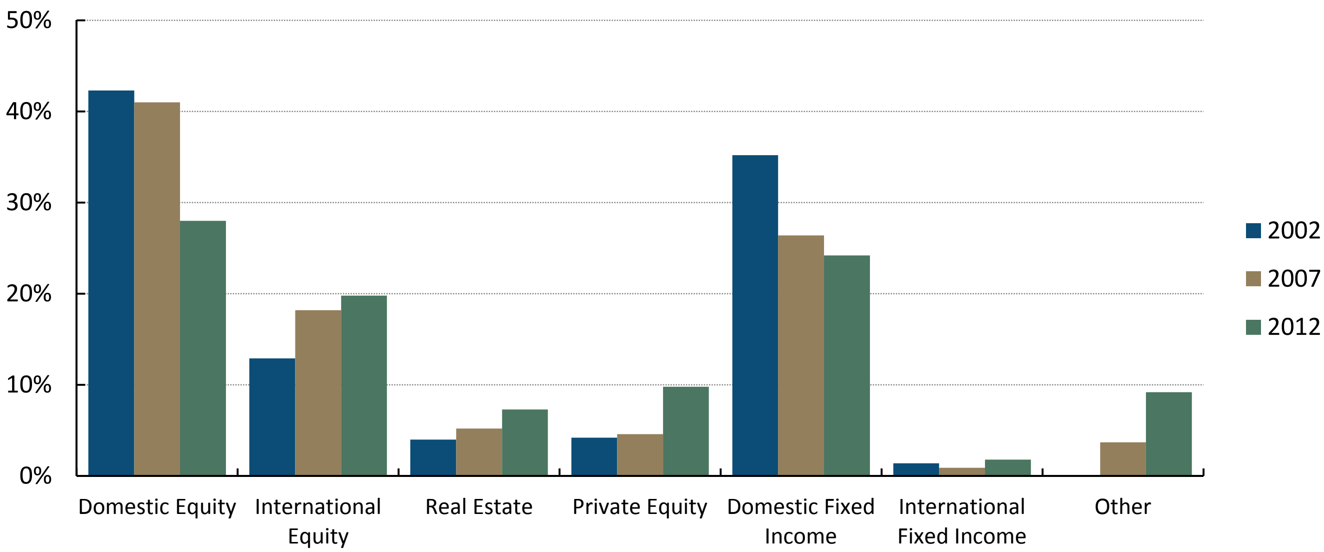
*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Figure 1 - The 2010 Funding Ratios of State Public Pension Plans



Source: Center for Retirement Research
*NY unfunded liabilities reported under the entry age normal cost method

Figure 2 - Shifts in Asset Allocations



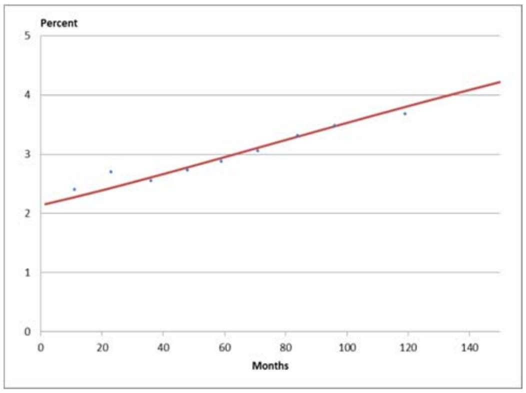
Source: Wilshire Consulting

Figure 3 - Fitted Zero Curves (Highlights)

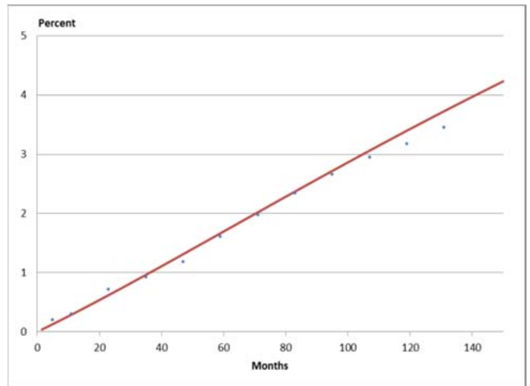
The chart presents the observed yields and the fitted zero coupon curve for three states during selected time periods. Note that a zero coupon curve is not a regression line across observed yields and a single dot on the chart may have multiple dots hidden underneath.

3. A – Primary Markets

California

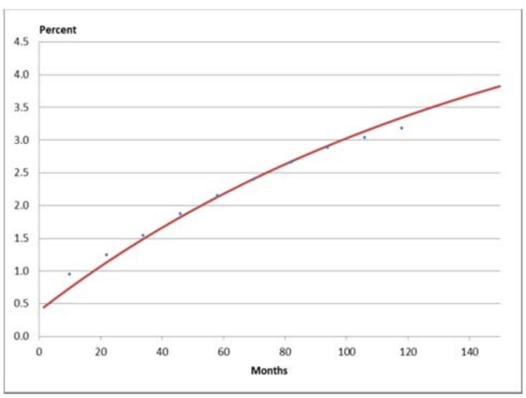


2005: QI

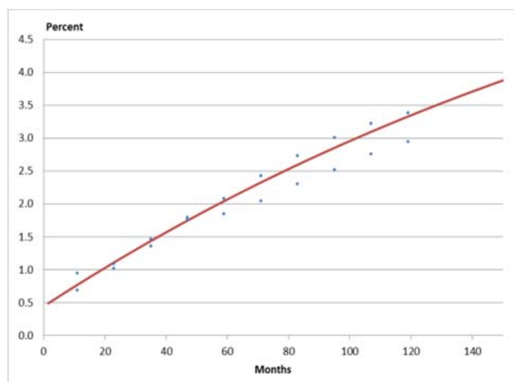


2011: QIII

Illinois

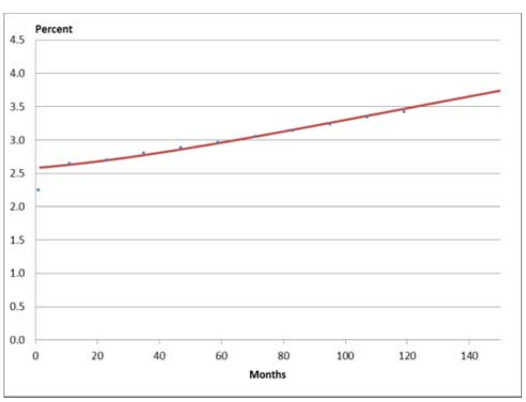


2004: QII

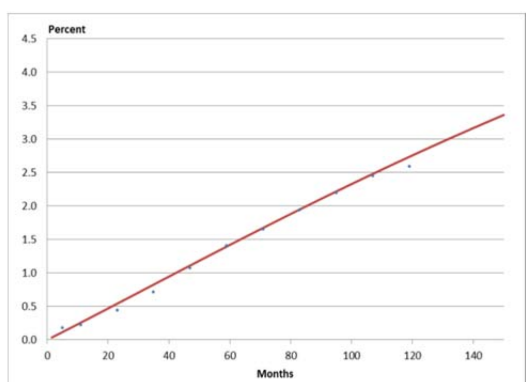


2012: QI

Connecticut



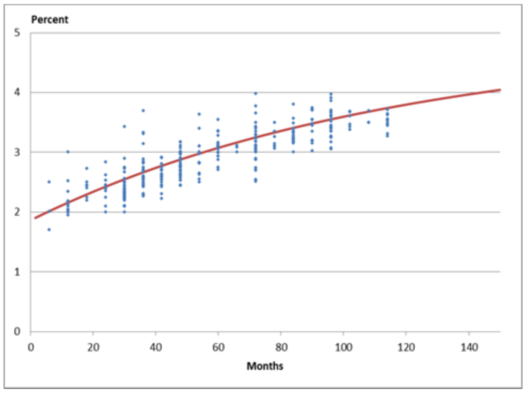
2005: QII



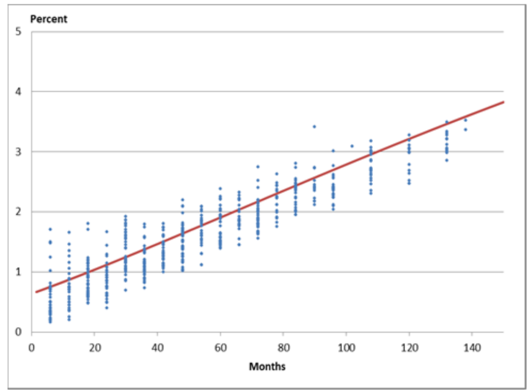
2011: QIV

3. B – Secondary Markets

California

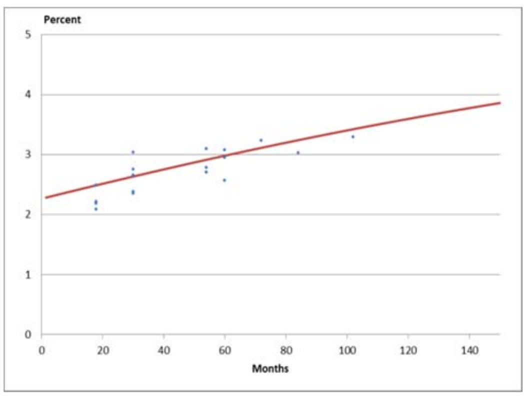


February 2005

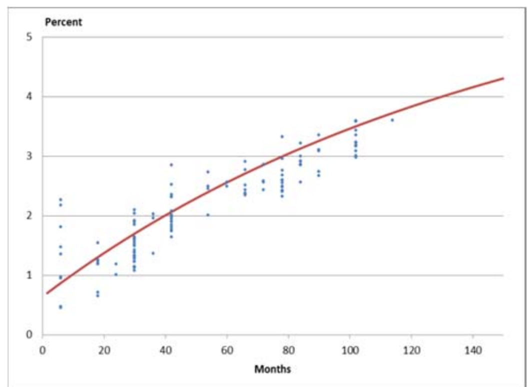


December 2011

Illinois

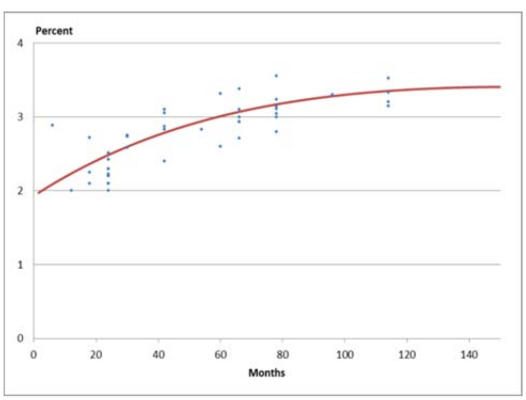


February 2005

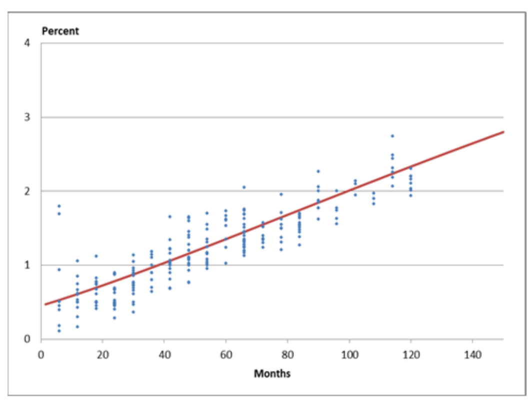


December 2011

Connecticut



February 2005



December 2011