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Do Public Pension Obligations Affect State Funding Costs?

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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 no evidence that municipal bond markets are pricing the risks to states' fiscal health arising from these large obligations.

Keywords: State pensions, unfunded obligations, municipal bond markets.

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I. Introduction

The financial crisis and subsequent Great Recession led to a frustratingly sluggish recovery, which has left deep scars on the economy that are only slowly beginning to heal. Among the many casualties of these historic events is the weakened fiscal condition of many state and local governments. Falling property, income, and sales tax revenues, increasing demand for social safety net services including unemployment insurance, and the exhaustion of federal stimulus significantly weakened the financial conditions of a number of municipalities. And while state and local government tax revenues are beginning to recover, years of chronic underfunding of public pensions and the devastating effects of the financial crisis on investment returns on public pension fund assets have resulted in unfunded liabilities that have swelled to amounts that are estimated to be between $750 billion and $4.4 trillion. The risk that these mounting obligations to employees and retirees will ultimately compromise state and local governments' ability to service outstanding municipal debt should in theory translate into higher yield spreads on municipal bonds. There is some empirical evidence that this is indeed the case (Munnell et al., 2011).

Yet there are also reasons why markets should be shrugging 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. As we discuss in the next section, public pension reform is a complex legal issue, but in principle, when taxpayers are asked to pay higher taxes to preserve 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.

In this paper, we investigate whether municipal bond spreads are sensitive to unfunded pension fund obligations. If the market views these public pension obligations to state and local government retirees as non-negotiable hard debt, one would expect to observe more indebted states to pay higher spreads. If the market perceives these pension obligations as soft debt, we may not observe any impact on bond spreads.

Our analysis suggests that markets are taking the latter view since the crisis. Before the crisis, states with high unfunded pension obligations paid higher spreads in the primary municipal bond market. After the crisis, we find scant evidence of a relationship between the degree of pension underfunding and yield spreads at issuance. In addition to a state's overall debt load, the liquidity of its municipal bonds is a strong determinant of interest rate spreads. The financial crisis appears to have changed the market's view of the importance of liquidity, as states with bonds that traded infrequently did not have to pay a premium before the crisis, but after the crisis, they were required to do so, especially for longer-term securities. Our analysis also suggests that changes in state funding costs are strongly associated with BBB-rated bond spreads, which we interpret as the overall degree of risk aversion in the municipal bond market.

This analysis also uncovers evidence that municipal bond yields may not be the only variable sensitive to pension funding levels, as some states with underfunded pension plans stop issuing bonds, change

the characteristics of the bonds they issue, or use private placements. An analysis of the secondary market spreads, which includes bonds issued in earlier periods by states currently avoiding the primary markets, finds some weak evidence that secondary market spreads may still be sensitive to pension fund obligations. Given the severe but unavoidable selection problems, any analysis of yield spreads should be interpreted with extreme caution.

Our results pertaining to the effects of pension underfunding are similar to but much weaker than the findings of Munnell et al., who use the difference between observed bond yields and maturity matched Treasuries. Our approach uses a zero-coupon yield spread approach (Diebold and Li, 2006), which takes out the effect of coupon differences among the securities and allows us to examine individual maturities separately rather than compiling them in a single sample. Replicating the technique of Munnell et al., we do find that pension obligations have an impact on yields; however, we believe that our methodology results in a more accurate estimation.

Our paper is also 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. The data for this study (Bloomberg) often relies on model prices rather than observed trading prices, so we consider the possibility that the data if being fitted to 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, can be re-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. Alternatively, some of the pension 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, may be rolled back. Whether pensions are soft or hard obligations depends on which path offers the least resistance.

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

[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

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 are becoming increasingly difficult due to 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]

The last option on the re-funding side is to improve the 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).

For states that are facing significant funding gaps, there are also incentives to incur additional debt by issuing pension obligation bonds to cover their annual required contributions or commingling the proceeds with pension fund assets in the hope of generating returns in excess of interest costs. These bonds, which are issued at a rate that is *assumed* to be lower than the expected return on public pension asset returns projected over the long term, exploit a loophole in federal law that enables plan sponsors to issue taxable bonds without obtaining approval from voters. But this is a risky strategy that does not always work. Munnell et.al. (2010) find that pension obligation bonds issued since the early 1990s and reinvested in a mixed portfolios of stocks and bonds would have returned an accounting profit if all the assets were liquidated at the peak of the market in 2007. Unfortunately, no such liquidation took place. Pension funds that rode the stock market down took losses on the investments they made with borrowed funds by mid-2009, increasing the pension funding gap and placing additional burden on state and local government resources.

All these efforts to boost investment returns involve additional risk taking, and if the plans incur losses, the sponsors would be subject to higher annual payments to pension funds, which could further contribute to the financial burden placed on distressed state and local governments.

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. While it sounds simple, in many states, reducing benefits for even new and existing employees is either prohibited or subject to lengthy legal challenges. The California Rule, the highest standard of legal

[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

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.

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

III. Data and Method

Our data source for analyzing primary markets is 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 crisis is defined as September 15, 2008 – the Lehman bankruptcy, and the sample ends on December 31st, 2011. The resulting universe consists of 20,070 securities.

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 16,159. Excluding bonds with options or a sinking fund feature reduces the sample size to 9,732 observations. Eliminating taxable bonds (1,367 observations), floating coupon bonds (27 observations), bonds with missing yields, coupons and maturity dates, as well as eliminating bonds from states that have fewer than ten issues outstanding before or after the crisis results in a sample of 5,896 observations from 32 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

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

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 8,035 traded bonds and 254,552 trades.

From this dataset, 5,810 bonds are common to both primary and secondary market samples. That is, the primary market sample has 86 bonds that do not trade and the secondary market sample has 2,225 bonds that were issued earlier but have trading data in our sample period. 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 sample is considerably smaller than that used by Munnell et al. (37,500 observations). Because we exclude revenue bonds that have a devoted payment source such as turnpike bonds and bonds that are funded by special taxes, our sample consists of securities that rely solely on appropriations by state legislatures 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.

[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.

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-

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

month maturity to ∞-maturity range to the slope in the 0-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. Letting *m* denote the number of six-month periods in T (*m*=T/6), the estimated price of the coupon bond, $\pi_c^{(T)}(t)$, 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:

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

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.

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 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.

The precision of the fit is analyzed in Table 2, which shows the mean and median squared-errors (fitted price – actual price) of the coupon-bearing bonds in our sample. The fit is most accurate at shorter maturities. Put differently, our results should be interpreted more cautiously at long maturities and especially in the post-crisis secondary market. For example, a lack of significant findings could mean that our estimation error is masking small influences a factor may be having on spreads.

The next piece of the spread calculation is the zero coupon yield of U.S. Treasuries, $y_{US}^{(n)}(t)$. Fortunately, this data has been made available to the public on the Federal Reserve Board website by Gurkaynak, Sack, and Wright (2006).[7] Using the GSW data and our own calculations, we compute the spread on an *n*-month municipal zero bond over the maturity-matched Treasury as

$$s^{(n)}(t) = \frac{y_z^{(n)}(t)}{0.65} - y_{US}^{(n)}(t) \tag{5}$$

where the muni yield is adjusted for taxes assuming a 35 percent marginal tax rate. The tax rate is consistent with the implied marginal tax rates found in the literature (Wang, Wu, and Zhang, 2005).

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 will be denoted by $Spread^{ZER}$. In our secondary market analysis we only use $Spread^{ZER}$.

Independent Variables

The data source for our state accounting statements is CreditScope. Our main variable of interest is *Pension*, each state's unfunded public pension liabilities scaled by the state's Gross State Product (GSP). We also control for several other 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 take positive and negative values, we transform it into an ordinal variable, $Budget$, with four levels: states that are in the bottom 25th percentile (highest deficits) in any year are assigned the level of 1, states in the second, third and fourth 25th 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 data source is Municipal Securities Rulemaking Board. In addition to these five factors we also control for the state's log GSP ($LogGSP$), year-end unemployment rate ($Unemployment$), log-population

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

(*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

We fit our data to the following generalized linear models:

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

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

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. 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. Residuals are further clustered by state inside year groups because accounting variables are constant for all issuances of a state between July of any year and June of the following year.

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 generalized linear models:

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

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

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 median $Spread^{SMP}$ by the bond's timing relative to the crisis and pension underfunding levels. We divide the pension underfunding levels into quartiles (cutoffs at 25th, 50th and 75th percentiles) before and after the crisis and compare the spreads across quartiles. When we compare the lowest and highest pension underfunding levels, the relationship between the underfunding and credit spreads seems non-existent before the crisis, and weak after it. Only the worst underfunding levels seems to be associated with higher 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.

In Table 5, we present the results from our multivariate analysis. Our findings are consistent with our earlier observations as well as Munnell et al. (2011). In the pre-crisis period, a one standard deviation increase in pension obligations leads to a statistically significant but small 3.3 basis point increase in the issuance spread of a median bond issued by a median state. This is about 2.8 percent of the average-bond spread of 1.2 percent. In the post-crisis period, markets seem to become more sensitive to pension fund obligations. Now, a one standard deviation increase in underfunding leads to a 1.6 basis point increase in spread, which is about 17 percent of the average-bond spread of 10 basis points.

We also attempt to capture the nonlinear relationship between spreads and pensions (that only the worst underfunding level seems to be associated higher spreads) with a squared-$Pension$ variable. The findings confirm our observation from univariate statistics. The squared-term is positive and significant in both periods but especially in the post-crisis period.

In Table 5, some control variables appear with expected signs while others have questionable implications. For example, in periods when credit spreads are high in the corporate market ($BBBSpread$), municipal spreads are also high. States that take a long time to pay their bills ($PayDay$) also pay higher yields. However, some of the coefficients have counterintuitive implications. High unemployment rates are associated with lower yields. High debt ratios (*Debt*) are associated with lower spreads in the pre-crisis period.

To capture the nonlinear relationship between spreads and pension underfunding – that states with the worst levels of pension funding are associated with higher spreads – we include a squared-*Pension* variable. The findings confirm our observation from univariate statistics, as the squared-term is positive and significant in both periods, but especially in the post-crisis period.

Table 5 also presents control variables, although only some result in the expected signs. For example, in periods when credit spreads are high in the corporate market (*BBBSpread*), municipal spreads are also high. States that take a long time to pay their bills (*PayDay*) also pay higher yields. However, some of the coefficients have counterintuitive implications. High unemployment rates are associated with lower yields, and high debt ratios (*Debt*) are associated with lower spreads in the pre-crisis period.

Overall, while these results suggest that the market is paying closer attention to states' pension liabilities, 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.

We calculate the credit spreads for 12, 24, 36, 48, 60, 72, 96, 120, 180, 240, and 360 months using our fitted yield curves. We show the univariate results for select maturities in Table 6, which indicate little evidence that pension obligations have any impact on spreads. These results are also confirmed by our multivariate analysis, presented in Table 7, which indicates that the market pays no attention to pension obligations, except perhaps at the longest maturities. The latter finding disappears in the post-crisis period. The only significant result obtained post-crisis is at the 12-month maturity but the coefficient has the wrong sign. While not shown, the results for the squared-*Pension* variable are also insignificant at all maturities. The benefit of using the zero-coupon-spread approach is apparent in control variables that had counterintuitive implications in the simpler analysis. *Debt* now has a consistently positive impact on spreads. One interesting observation to note is that the market started paying attention to the liquidity of the bonds traded after the crisis. *Liquid* was negative but insignificant before the crisis. The post-crisis coefficients are larger by an order of magnitude and statistically significant.

Secondary Markets

Table 8 shows the results from our analysis of spread levels across states and Table 9 shows the analysis of changes in spreads. There is some indication in the secondary markets that pension liabilities may matter. The states with higher pension liabilities seem to be paying more in the three-to-seven year maturity range before the crisis and seven-to-ten year range post-crisis. Yet these observations may be driven by omitted, time-invariant state factors correlated with pensions.

The changes in spreads avoid this trap. The 72-month maturity is indeed sensitive to changes in pension liabilities before the crisis. However, this sensitivity disappears in later years. The strongest determinant of spread changes is the change in the overall risk aversion. As overall risk aversion (Δ*BBBSpread*) goes up, municipal debt spreads follow suit.

The inconsistent sensitivity to pension obligations in the primary (insensitive) and secondary (sensitive) markets could be the result of sample selection. There are three states (AK, WI, and WV) that did not issue much plain vanilla debt in the post crisis period, and thus dropped out of the primary market sample. However, these states had a sufficient number of plain vanilla debt outstanding to be included in the secondary market sample. Among the three, AK, and WV have pension funding ratios below 70 percent. While the results are not shown for the sake of brevity, when we delete those three states from the secondary market sample, the significance of the results disappears. This suggests that *some* states with high levels of pension underfunding may have stopped issuing plain vanilla bonds. Thus, the insignificance of our results may reflect sample selection rather than an indication of the true economic insignificance of pension underfunding.

V. Conclusion

In this paper, we investigate whether the bond market considers the states' unfunded pension obligations as a risk factor. We find no evidence that these obligations are priced in as a threat to states' creditworthiness and propose two possible explanations. First, pension liabilities may indeed not be a risk factor for bondholders. Historically, investor confidence in municipal debt has been well placed. States do maintain the authority to generate additional revenue by raising taxes, however political unpopular. States would also face penalty rates for future borrowing in the wake of default.

Investors might also be speculating that the states facing financial distress will be more likely to uphold their obligations to bondholders than to pensioners. Rhode Island's elevation of bondholders' seniority above those of pensioners in 2011 is recent evidence of this possibility. And, while states face high hurdles in reducing future pension benefits for current employees, these actions can be upheld if they are deemed reasonable and necessary for the public interest.

Another possible explanation for these results stems from the portfolio of available investment options. Investors might conclude that it is also possible that while the *risk-adjusted* returns offered by municipal bonds may be negative, these returns might still exceed the returns on other investments in the low-interest rate environment. In other words, in an environment of depressed yields, municipal bonds are the least bad investment.

Investor reaction to financial stress can be an important catalyst for restoring fiscal balance. Unchecked, increases in state and local government financial obligations would be expected to erode investor confidence in creditworthiness, leading to higher borrowing costs. Many of our nation's state and local governments will ultimately need to address resolve the growing gaps in the levels of public pension underfunding. Interestingly, this analysis suggests that the municipal bond market has not yet emerged as a source of market discipline incenting state and local governments to resolve these gaps by enacting meaningful public pension reform.

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Table 1- Sample Breakdown by State

This Table shows 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	X	X	18	24
Alaska				X		12
Arizona						
Arkansas	X	X	X	X	64	17
California	X	X	X	X	87	82
Colorado						
Connecticut	X	X	X	X	260	144
Delaware	X	X	X	X	87	89
Florida	X	X	X	X	88	39
Georgia	X	X	X	X	208	105
Hawaii	X	X		X	22	98
Idaho						
Illinois					5	
Indiana						
Iowa			X		8	
Kansas						
Kentucky						
Louisiana		X		X		39
Maine	X	X	X	X	84	38
Maryland	X	X		X	86	108
Massachusetts	X	X	X	X	143	166
Michigan	X	X			27	18
Minnesota	X	X	X	X	108	115
Mississippi	X	X	X	X	45	26
Missouri	X	X	X		35	33
Montana	X	X	X	X	29	16
Nebraska						
Nevada	X	X	X	X	80	50
New Hampshire	X	X	X	X	38	56
New Jersey	X	X	X		42	29
New Mexico	X	X	X	X	19	20
New York	X	X	X	X	92	62
North Carolina	X	X	X	X	102	56
North Dakota						
Ohio	X	X	X	X	388	331
Oklahoma						12
Oregon	X	X	X	X	151	188
Pennsylvania	X	X	X	X	124	83
Rhode Island		X	X	X	8	41
South Carolina	X	X	X	X	193	50
South Dakota						
Tennessee	X	X	X	X	44	40
Texas	X	X	X	X	165	224
Utah	X	X	X	X	17	59
Vermont	X	X	X	X	146	67
Virginia	X	X	X	X	165	69
Washington	X	X	X	X	28	91
West Virginia				X		
Wisconsin				X		11
Wyoming						

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

This Table shows the squared-errors of fitted prices of coupon-bearing state bonds.

Panel A. Primary Market Data

	Pre-Crisis				Post-Crisis			
	N	Mean	Median	99th Percentile	N	Mean	Median	99th Percentile
maturity<12 mo	986	0.562	0.121	5.737	302	0.802	0.256	8.892
12 mo<maturity<24 mo	2,603	2.500	0.325	25.254	1,200	1.348	0.390	11.916
24 mo<maturity<60 mo	23,486	5.148	0.985	82.354	9,528	3.248	1.085	26.939
60 mo<maturity<120 mo	65,954	6.709	2.072	68.503	21,676	7.087	2.516	61.163
120 mo<maturity<180 mo	5,453	9.404	3.885	74.621	1,758	13.813	4.168	116.344
180 mo<maturity<240 mo	1,081	49.388	26.862	261.141	39	10.616	3.059	111.288
maturity>240 mo	73	97.204	61.566	903.605				

Panel B. Secondary Market Data

	Pre-Crisis				Post-Crisis			
	N	Mean	Median	99th Percentile	N	Mean	Median	99th Percentile
maturity<12 mo	1,479	10.987	0.484	25.906	432	6.882	5.170	40.786
12 mo<maturity<24 mo	3,143	6.787	0.915	61.307	1,815	6.329	3.799	30.193
24 mo<maturity<60 mo	30,418	17.724	1.076	202.287	16,128	2.391	1.015	16.976
60 mo<maturity<120 mo	95,676	18.569	1.442	315.788	37,106	4.016	1.453	32.224
120 mo<maturity<180 mo	9,017	4.181	1.388	39.412	3,006	5.651	2.255	43.792
180 mo<maturity<240 mo	1,877	9.406	3.548	78.152	33	22.099	2.114	407.645
maturity>240 mo	97	46.987	12.188	473.151				

Table 3- Summary Statistics

Panel A – Pre-Crisis (2002-2008)

	Mean	Median	Std Dev	Minimum	Maximum
Pension	0.0306	0.0274	0.0258	0.0000	0.1062
Maturity (Months) †	21	11	29	1	299
Real GSP($Billion) †	332	245	321	22	1,763
Unemployment	0.0521	0.0500	0.0113	0.0280	0.0880
BBBSpread	0.0190	0.0152	0.0065	0.0114	0.0335
Issue ($Million) †	44	7	185	<1	1,350
Rated	0.1709				
Budget		2			
Year		2006			
Liquidity †	0.6257	0.5748	0.2914	0.1410	1.7230
PayDay (Days) †	69	63	29	16	179
Population (Millions) †	7.703	5.759	6.966	0.107	36.226
Median Income ($) †	44,013	43,037	10,062	23,218	66,873
Debt	0.0305	0.0231	0.0192	0.0000	0.0837

Panel B – Post-Crisis (2008-2011)

	Mean	Median	Std Dev	Minimum	Maximum
Pension	0.0474	0.0436	0.0333	0.0000	0.1243
Maturity (Months) †	22	12	23	1	130
Real GSP($Billion) †	356	255	372	22	1,756
Unemployment	0.0804	0.0810	0.0226	0.0340	0.1370
BBBSpread	0.0348	0.0261	0.0163	0.0197	0.0640
Issue ($Million) †	32	7	128	<1	1,225
Rated	0.3020				
Budget		2			
Year		2009			
Liquidity †	0.5198	0.5171	0.1642	0.1562	0.9742
PayDay (Days) †	67	64	29	26	240
Population (Millions) †	8.285	5.699	8.205	0.620	36.962
Median Income ($) †	53,040	50,272	8,382	35,632	70,005
Debt	0.0402	0.0350	0.0228	0.0059	0.0969

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

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

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	1.00	1.07
2	1.16	0.99
3	1.06	0.93
Highest	1.02	1.21

Table 5- Simple Spread Analysis – Primary Markets

This Table shows the estimates for the parameters in equation (6). The estimation technique involves state random effects and errors clustered by state within year-groups. Pseudo-R^2 is one minus the ratio of the sum of the squared model residuals divided by the sum of squared deviations from the sample mean. Standard Errors are in parenthesis.

	Linear Approach				Non-Linear Approach			
	Pre- Crisis Period		Post-Crisis Period		Pre- Crisis Period		Post-Crisis Period	
Pension	1.061		4.747	***	-3.031	*	-6.903	***
	(0.666)		(0.787)		(1.583)		(2.034)	
Pension*Pension					53.506	***	72.279	***
					(18.262)		(11.960)	
LogMat	0.247	***	0.584	***	0.247	***	0.586	***
	(0.006)		(0.016)		(0.006)		(0.016)	
LogGSP	-0.036		-1.823	***	-0.039		-1.091	**
	(0.036)		(0.485)		(0.033)		(0.436)	
Unemployment	-0.074	***	-0.071	***	-0.061	***	-0.018	
	(0.012)		(0.017)		(0.012)		(0.017)	
BBBSpread	0.863	***	0.727	***	0.878	***	0.798	***
	(0.034)		(0.076)		(0.034)		(0.075)	
LogIssue	-0.011	***	-0.007		-0.012	***	-0.004	
	(0.003)		(0.007)		(0.003)		(0.007)	
Rated	0.040	***	-0.105	***	0.040	***	-0.111	***
	(0.010)		(0.029)		(0.010)		(0.028)	
Budget 4	-0.003		0.137	**	0.004		0.103	*
	(0.027)		(0.062)		(0.027)		(0.061)	
Budget 3	0.001		0.035		0.004		0.073	
	(0.025)		(0.049)		(0.025)		(0.049)	
Budget 2	0.005		-0.010		0.014		0.011	
	(0.017)		(0.037)		(0.017)		(0.037)	
Year2008	0.098	*			0.105	**		
	(0.051)				(0.051)			
Year2007	0.504	***			0.524	***		
	(0.051)				(0.050)			
Year2006	0.369	***			0.384	***		
	(0.050)				(0.050)			
Year2005	0.486	***			0.502	***		
	(0.052)				(0.052)			
Year2004	0.146	***			0.143	***		
	(0.041)				(0.041)			
Year2011			-0.446	***			-0.449	***
			(0.062)				(0.061)	
Year2010			-0.713	***			-0.709	***
			(0.051)				(0.050)	
Year2009			-0.809	***			-0.801	***
			(0.030)				(0.030)	
Liquid	0.015		-0.185	***	0.015		-0.184	***
	(0.015)		(0.050)		(0.015)		(0.049)	
PayDay	0.098	***	0.207	***	0.092	***	0.287	***
	(0.028)		(0.050)		(0.027)		(0.050)	
LogPop	0.077	***	2.031	***	0.080	***	1.192	***
	(0.022)		(0.505)		(0.022)		(0.453)	
LogInc	0.365	***	1.577	**	0.341	***	1.264	**
	(0.072)		(0.621)		(0.071)		(0.523)	
Debt	-4.012	***	9.001	***	-3.553	***	8.878	***
	(0.996)		(3.479)		(0.931)		(2.943)	
Pseudo-R^2	59		70		59		70	

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

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

Panel A – 12-month

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	0.118	0.123
2	0.107	0.132
3	0.121	0.100
Highest	0.141	0.092

Panel B – 24-month

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	0.097	0.058
2	0.088	0.067
3	0.101	0.057
Highest	0.121	0.060

Panel C – 36-month

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	0.106	0.059
2	0.097	0.061
3	0.106	0.061
Highest	0.122	0.067

Panel D – 48-month

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	0.115	0.067
2	0.104	0.088
3	0.123	0.077
Highest	0.131	0.090

Panel E – 60-month

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	0.127	0.093
2	0.111	0.110
3	0.142	0.101
Highest	0.135	0.102

Panel F – 120-month

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	0.154	0.174
2	0.152	0.178
3	0.167	0.181
Highest	0.155	0.167

Panel G – 240-month

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	0.161	0.196
2	0.161	0.203
3	0.174	0.201
Highest	0.161	0.190

Panel H – 360-month

	Median Spread (Percent)	
Underfunding Level	**Pre-Crisis**	**Post-Crisis**
Lowest	0.194	0.233
2	0.198	0.249
3	0.206	0.234
Highest	0.195	0.236

Table 7- Zero-Coupon Spread Analysis – Primary Markets

This Table shows the estimates for the parameters in equation (7). The estimation technique involves state random effects and errors clustered by state within year-groups. Pseudo-R^2 is one minus the ratio of the sum of the squared model residuals divided by the sum of squared deviations from the sample mean. Standard Errors are in parenthesis.

Panel A. Pre-Crisis Period

	12-mo		24-mo		36-mo		48-mo		60-mo		72-mo		96-mo		120-mo		180-mo		240-mo		360-mo	
Pension	0.726		2.436		3.080		0.729		0.280		0.314		0.526		0.857		1.231	*	1.345	*	1.369	*
	(3.108)		(2.579)		(2.246)		(1.404)		(1.055)		(0.820)		(0.669)		(0.643)		(0.693)		(0.744)		(0.692)	
BBBSpread	-3.235	**	-1.927	**	-0.783		0.156		0.318		0.279		0.157		0.063		-0.022		-0.035		-0.612	
	(1.252)		(0.865)		(0.719)		(0.562)		(0.462)		(0.393)		(0.344)		(0.343)		(0.377)		(0.391)		(0.377)	
LogGSP	0.029		-0.124		-0.194		-0.081		-0.043		-0.026		0.019		0.051		0.081	**	0.089	**	0.091	**
	(0.201)		(0.195)		(0.360)		(0.093)		(0.063)		(0.047)		(0.035)		(0.033)		(0.036)		(0.039)		(0.037)	
Unemployment	-0.044		-0.110		-0.110		-0.064		-0.032		-0.015		-0.010		-0.024		-0.025		-0.023		-0.025	
	(0.098)		(0.082)		(0.069)		(0.046)		(0.035)		(0.027)		(0.022)		(0.021)		(0.023)		(0.025)		(0.023)	
Budget 4	-0.124		-0.123		-0.174		-0.109		-0.066		-0.002		0.046		0.062		0.094	**	0.099	**	0.093	**
	(0.180)		(0.150)		(0.125)		(0.084)		(0.063)		(0.050)		(0.041)		(0.039)		(0.043)		(0.046)		(0.043)	
Budget 3	0.024		-0.104		-0.090		-0.100		-0.072		-0.042		0.001		0.025		0.051		0.058		0.060	
	(0.161)		(0.135)		(0.115)		(0.076)		(0.057)		(0.045)		(0.037)		(0.036)		(0.039)		(0.042)		(0.038)	
Budget 2	-0.017		-0.236		-0.243	**	-0.124		-0.075		-0.028		0.011		0.035		0.058		0.065		0.058	
	(0.170)		(0.143)		(0.122)		(0.079)		(0.059)		(0.046)		(0.038)		(0.037)		(0.040)		(0.043)		(0.040)	
Year2008	0.532		0.767		0.698		0.569	**	0.465	**	0.355	**	0.265	**	0.226	**	0.214	**	0.257	***	0.369	***
	(0.578)		(0.594)		(0.453)		(0.262)		(0.183)		(0.140)		(0.105)		(0.094)		(0.094)		(0.097)		(0.093)	
Year2007	-2.007	*	-0.978		-0.269		0.297		0.304		0.161		-0.022		-0.130		-0.219		-0.215		-0.588	**
	(1.015)		(0.830)		(0.667)		(0.454)		(0.355)		(0.293)		(0.247)		(0.242)		(0.261)		(0.270)		(0.260)	
Year2006	-2.113	**	-1.109		-0.656		0.158		0.188		0.071		-0.077		-0.156		-0.224		-0.221		-0.585	**
	(1.027)		(0.837)		(0.737)		(0.461)		(0.361)		(0.298)		(0.252)		(0.246)		(0.267)		(0.276)		(0.266)	
Year2005	-2.870	**	-1.924	**	-0.902		-0.045		0.138		0.090		0.005		-0.051		-0.099		-0.087		-0.550	
	(1.219)		(0.953)		(0.771)		(0.551)		(0.437)		(0.364)		(0.312)		(0.307)		(0.335)		(0.347)		(0.334)	
Year2004	-2.002	***	-1.306	*	-0.721		-0.317		-0.223		-0.154		-0.204		-0.293	*	-0.346	**	-0.351	**	-0.524	***
	(0.734)		(0.669)		(0.493)		(0.335)		(0.260)		(0.196)		(0.159)		(0.157)		(0.164)		(0.169)		(0.160)	
Liquidity	-0.076		-0.133		-0.104		-0.094		-0.068		-0.038		-0.029		-0.030		-0.022		-0.018		-0.012	
	(0.163)		(0.135)		(0.115)		(0.075)		(0.057)		(0.045)		(0.038)		(0.036)		(0.039)		(0.042)		(0.039)	
PayDay	-0.187		-0.075		0.044		-0.034		-0.035		-0.014		-0.025		-0.022		-0.009		-0.005		0.004	
	(0.194)		(0.152)		(0.128)		(0.085)		(0.066)		(0.053)		(0.044)		(0.043)		(0.046)		(0.050)		(0.046)	
LogPop	-0.076		0.112		0.226		0.079		0.039		0.011		-0.029		-0.049	*	-0.075	**	-0.082	**	-0.079	**
	(0.188)		(0.186)		(0.358)		(0.087)		(0.058)		(0.042)		(0.030)		(0.028)		(0.030)		(0.032)		(0.031)	
LogInc	-0.924		-0.597		-0.419		-0.307		-0.214		-0.161		-0.170		-0.259	*	-0.300	*	-0.301	*	-0.311	*
	(0.655)		(0.508)		(0.506)		(0.292)		(0.227)		(0.183)		(0.151)		(0.146)		(0.158)		(0.170)		(0.159)	
Debt	9.423	**	11.034	***	9.611	***	6.532	***	4.720	***	3.726	***	2.190	**	1.713	*	1.149		0.911		0.720	
	(4.606)		(3.553)		(3.063)		(2.037)		(1.576)		(1.285)		(1.074)		(1.031)		(1.117)		(1.203)		(1.114)	
Pseudo-R^2 (%)	16		34		22		50		50		58		52		44		37		38		43	

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

Panel B. Post-Crisis Period

	12-mo	24-mo	36-mo	48-mo	60-mo	72-mo	96-mo	120-mo	180-mo	240-mo	360-mo
Pension	-5.025 *	-3.819	-3.291	-1.016	-0.447	-1.042	-0.330	0.829	1.915	2.160	1.615
	(2.845)	(3.922)	(3.416)	(2.408)	(1.863)	(1.788)	(1.558)	(1.550)	(1.649)	(1.619)	(1.431)
BBBSpread	-0.051	1.257	1.142	0.609	0.475	0.193	0.402	0.619	1.231 **	1.669 ***	2.113 ***
	(1.843)	(1.893)	(1.949)	(1.063)	(0.775)	(0.623)	(0.544)	(0.518)	(0.539)	(0.537)	(0.512)
LogGSP	-1.846 **	-0.666	-1.288	-0.241	-0.119	-0.099	-0.098	0.030	0.164	0.209	0.195
	(0.766)	(1.010)	(0.897)	(0.616)	(0.485)	(0.489)	(0.416)	(0.404)	(0.418)	(0.402)	(0.350)
Unemployment	0.017	0.063	0.055	0.048	0.036	0.035	0.038	0.035	0.031	0.029	0.029
	(0.061)	(0.081)	(0.075)	(0.049)	(0.038)	(0.036)	(0.031)	(0.030)	(0.032)	(0.032)	(0.029)
Budget 4	-0.561 **	-0.313	-0.389 *	-0.098	-0.059	0.024	-0.081	-0.105	-0.125	-0.121	-0.109
	(0.218)	(0.276)	(0.223)	(0.162)	(0.124)	(0.115)	(0.101)	(0.100)	(0.103)	(0.100)	(0.088)
Budget 3	0.031	-0.016	-0.240	-0.181	-0.156	-0.071	-0.118	-0.154 *	-0.186 *	-0.185 **	-0.148 *
	(0.207)	(0.250)	(0.229)	(0.151)	(0.114)	(0.102)	(0.091)	(0.091)	(0.095)	(0.092)	(0.083)
Budget 2	-0.007	0.093	-0.260	-0.077	-0.063	-0.068	-0.085	-0.109	-0.138	-0.137	-0.102
	(0.232)	(0.279)	(0.257)	(0.168)	(0.126)	(0.112)	(0.099)	(0.097)	(0.099)	(0.096)	(0.087)
Year2011	0.372	0.952	0.752	0.175	0.213	0.065	0.356	0.618	1.272 **	1.680 ***	2.065 ***
	(2.115)	(2.166)	(2.237)	(1.220)	(0.892)	(0.721)	(0.628)	(0.599)	(0.625)	(0.624)	(0.592)
Year2010	-0.105	0.646	0.187	-0.044	0.009	-0.136	0.152	0.454	1.150 *	1.588 ***	1.977 ***
	(2.020)	(2.072)	(2.146)	(1.167)	(0.854)	(0.692)	(0.603)	(0.575)	(0.599)	(0.597)	(0.566)
Liquidity	-0.070	-0.043	-0.277	-0.324 **	-0.295 **	-0.192 *	-0.194 **	-0.182 *	-0.170 *	-0.163 *	-0.160 *
	(0.258)	(0.300)	(0.278)	(0.162)	(0.131)	(0.106)	(0.094)	(0.098)	(0.102)	(0.098)	(0.090)
PayDay	0.043	0.030	0.225	0.053	0.010	0.045	0.014	0.011	-0.012	-0.018	-0.011
	(0.199)	(0.240)	(0.221)	(0.145)	(0.111)	(0.103)	(0.088)	(0.084)	(0.086)	(0.083)	(0.075)
LogPop	1.806 **	0.558	1.176	0.208	0.119	0.087	0.100	-0.004	-0.112	-0.150	-0.148
	(0.772)	(1.018)	(0.902)	(0.619)	(0.488)	(0.494)	(0.419)	(0.405)	(0.418)	(0.402)	(0.349)
LogInc	0.662	0.421	0.563	0.114	0.049	-0.006	0.079	0.071	0.055	0.054	0.053
	(0.817)	(1.048)	(0.985)	(0.677)	(0.535)	(0.545)	(0.461)	(0.445)	(0.460)	(0.443)	(0.387)
Debt	10.161 **	12.741 **	9.161 **	7.836 **	5.515 **	2.060	2.023	1.798	1.038	0.564	0.400
	(4.244)	(5.786)	(4.553)	(3.638)	(2.771)	(2.876)	(2.446)	(2.377)	(2.452)	(2.349)	(2.043)
Pseudo-R^2 (%)	10	20	23	38	43	46	49	47	40	33	34

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

Table 8- Analysis of Zero-Coupon Spread Levels – Secondary Markets

This Table shows the estimates for the parameters in equation (8). The estimation technique involves state random effects and errors clustered by state within year-groups. Pseudo-R^2 is one minus the ratio of the sum of the squared model residuals divided by the sum of squared deviations from the sample mean. Standard Errors are in parenthesis.

Panel A. Pre-Crisis Period

	12-mo	24-mo	36-mo	48-mo	60-mo	72-mo	96-mo	120-mo	180-mo	240-mo	360-mo
Pension	1.399	2.926	3.120 *	2.437 *	2.604 ***	1.875 ***	-0.773	-1.256	-2.535	-3.778	-3.925
	(2.589)	(2.304)	(1.852)	(1.472)	(0.908)	(0.646)	(0.886)	(1.370)	(2.397)	(2.414)	(2.473)
BBBSpread	-1.417 *	-0.300	-0.049	0.080	-0.083	-0.395	-0.017	0.298	0.837 **	0.755 *	0.639
	(0.787)	(0.565)	(0.425)	(0.309)	(0.236)	(0.289)	(0.266)	(0.268)	(0.391)	(0.447)	(0.493)
LogGSP	0.168	0.035	-0.125	-0.140 *	-0.051	-0.020	0.039	0.081	0.154	0.110	0.113
	(0.109)	(0.108)	(0.106)	(0.080)	(0.041)	(0.025)	(0.034)	(0.060)	(0.098)	(0.080)	(0.082)
Unemployment	0.062	-0.030	-0.015	-0.013	-0.040 *	-0.044 **	-0.008	-0.028	-0.016	0.006	0.001
	(0.073)	(0.062)	(0.052)	(0.037)	(0.024)	(0.019)	(0.025)	(0.038)	(0.059)	(0.058)	(0.059)
Budget 4	-0.122	-0.294 **	-0.160	-0.091	-0.073	-0.076 **	-0.049	-0.067	-0.069	-0.044	-0.033
	(0.151)	(0.132)	(0.112)	(0.082)	(0.052)	(0.037)	(0.046)	(0.064)	(0.105)	(0.112)	(0.114)
Budget 3	0.061	-0.092	-0.094	-0.073	-0.072 *	-0.045	0.014	-0.003	0.016	-0.033	-0.030
	(0.125)	(0.110)	(0.090)	(0.067)	(0.043)	(0.033)	(0.041)	(0.056)	(0.083)	(0.089)	(0.090)
Budget 2	0.051	-0.126	-0.112	-0.075	-0.041	0.001	0.083 **	0.109 **	0.147 *	0.052	0.036
	(0.123)	(0.106)	(0.085)	(0.062)	(0.042)	(0.035)	(0.041)	(0.052)	(0.076)	(0.085)	(0.086)
Year2008	1.397 ***	1.346 ***	1.033 ***	0.691 **	0.473 ***	0.249 *	-0.189	-0.505 ***	-0.849 ***	-0.995 ***	-0.901 ***
	(0.429)	(0.347)	(0.345)	(0.267)	(0.178)	(0.134)	(0.121)	(0.174)	(0.287)	(0.292)	(0.305)
Year2007	-0.176	0.485	0.460	0.315	0.067	-0.261	-0.350 *	-0.416 *	-0.057	-0.245	-0.314
	(0.678)	(0.513)	(0.446)	(0.337)	(0.238)	(0.232)	(0.210)	(0.248)	(0.370)	(0.419)	(0.429)
Year2006	-0.779	-0.088	-0.087	-0.071	-0.177	-0.407 *	-0.310	-0.230	0.013	-0.016	-0.061
	(0.691)	(0.518)	(0.452)	(0.342)	(0.241)	(0.238)	(0.210)	(0.239)	(0.372)	(0.421)	(0.430)
Year2005	-1.211	-0.216	-0.034	0.024	-0.120	-0.417	-0.274	-0.111	0.265	-0.005	-0.068
	(0.818)	(0.604)	(0.506)	(0.379)	(0.274)	(0.287)	(0.256)	(0.278)	(0.426)	(0.497)	(0.507)
Year2004	-0.829	-0.325	-0.234	-0.189	-0.268	-0.397 **	-0.413 ***	-0.450 **	-0.154	-0.151	-0.152
	(0.533)	(0.394)	(0.373)	(0.285)	(0.198)	(0.168)	(0.147)	(0.190)	(0.292)	(0.316)	(0.327)
Liquidity	0.039	-0.094	-0.113 *	-0.067	-0.027	-0.005	0.077 **	0.160 ***	0.113	-0.051	-0.062
	(0.096)	(0.092)	(0.067)	(0.056)	(0.035)	(0.027)	(0.039)	(0.059)	(0.079)	(0.083)	(0.085)
PayDay	0.016	-0.017	-0.024	-0.014	0.022	0.055	-0.018	-0.017	0.002	0.023	0.013
	(0.124)	(0.108)	(0.089)	(0.066)	(0.043)	(0.035)	(0.046)	(0.068)	(0.105)	(0.105)	(0.108)
LogPop	-0.116	0.042	0.183 *	0.181 **	0.094 ***	0.039 **	-0.033	-0.063	-0.106	-0.073	-0.071
	(0.089)	(0.093)	(0.095)	(0.072)	(0.035)	(0.020)	(0.027)	(0.050)	(0.077)	(0.048)	(0.049)
LogInc	-0.078	-0.373	-0.179	-0.127	-0.296 *	-0.340 ***	-0.165	-0.248	0.099	0.471	0.478
	(0.503)	(0.442)	(0.376)	(0.278)	(0.174)	(0.131)	(0.170)	(0.252)	(0.424)	(0.431)	(0.441)
Debt	0.142	0.126	0.315	1.209	1.859	2.275 **	5.745 ***	9.729 ***	8.570 **	6.514 *	5.969 *
	(3.917)	(3.376)	(2.855)	(2.117)	(1.334)	(1.058)	(1.477)	(2.251)	(3.741)	(3.817)	(3.522)
Pseudo-R^2 (%)	44	52	54	55	63	26	14	20	28	24	22

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

Panel B. Post-Crisis Period

	12-mo	24-mo	36-mo	48-mo	60-mo	72-mo	96-mo	120-mo	180-mo	240-mo	360-mo
Pension	-1.697	-1.089	-0.274	0.954	1.468	1.665 *	2.117 *	2.333 *	2.206	1.950	1.640
	(1.240)	(0.800)	(0.846)	(0.894)	(0.897)	(0.926)	(1.255)	(1.361)	(1.352)	(1.316)	(1.217)
BBBSpread	1.470 ***	1.500 ***	1.397 ***	-0.020	-0.200	-0.339	-0.963 ***	-0.310	0.245	0.701	1.236 **
	(0.467)	(0.379)	(0.480)	(0.400)	(0.330)	(0.280)	(0.367)	(0.494)	(0.546)	(0.562)	(0.556)
LogGSP	-0.152	-0.278	-0.301	0.034	0.232	0.383	0.404	0.429	0.467	0.459	0.423
	(0.338)	(0.217)	(0.228)	(0.243)	(0.250)	(0.269)	(0.362)	(0.371)	(0.363)	(0.350)	(0.318)
Unemployment	0.044 *	0.026	0.019	0.012	0.000	-0.005	0.017	0.033	0.042	0.047 *	0.048 *
	(0.025)	(0.017)	(0.019)	(0.020)	(0.020)	(0.020)	(0.024)	(0.027)	(0.027)	(0.027)	(0.025)
Budget 4	-0.086	-0.123 *	-0.140 *	-0.117 *	-0.067	-0.028	-0.043	-0.044	-0.044	-0.039	-0.033
	(0.094)	(0.066)	(0.072)	(0.070)	(0.065)	(0.061)	(0.086)	(0.095)	(0.098)	(0.096)	(0.088)
Budget 3	0.004	-0.024	-0.022	-0.033	-0.025	-0.001	-0.046	-0.106	-0.123	-0.123	-0.121
	(0.082)	(0.058)	(0.067)	(0.062)	(0.056)	(0.052)	(0.074)	(0.086)	(0.090)	(0.089)	(0.083)
Budget 2	0.025	0.046	0.037	0.026	0.023	0.000	-0.001	0.045	0.067	0.077	0.079
	(0.085)	(0.061)	(0.069)	(0.064)	(0.056)	(0.051)	(0.074)	(0.089)	(0.095)	(0.095)	(0.089)
Year2011	1.198 **	1.255 ***	1.227 **	-0.218	-0.267	-0.332	-1.097 **	-0.416	0.142	0.544	0.985
	(0.541)	(0.436)	(0.549)	(0.460)	(0.382)	(0.326)	(0.428)	(0.571)	(0.629)	(0.647)	(0.639)
Year2010	1.447 ***	1.355 ***	1.079 **	-0.436	-0.521	-0.557 *	-1.198 ***	-0.498	0.137	0.580	1.038 *
	(0.521)	(0.419)	(0.529)	(0.443)	(0.369)	(0.316)	(0.413)	(0.551)	(0.606)	(0.622)	(0.614)
Liquidity	-0.230 ***	-0.219 ***	-0.128 **	-0.055	-0.007	0.030	-0.010	-0.035	-0.098	-0.125 *	-0.131 *
	(0.083)	(0.058)	(0.064)	(0.061)	(0.056)	(0.053)	(0.072)	(0.083)	(0.087)	(0.072)	(0.076)
PayDay	0.131 *	0.150 ***	0.150 ***	0.091 *	-0.009	-0.056	-0.067	-0.082	-0.123	-0.138 *	-0.131 *
	(0.077)	(0.052)	(0.057)	(0.053)	(0.058)	(0.060)	(0.074)	(0.079)	(0.079)	(0.077)	(0.070)
LogPop	0.204	0.317	0.333	0.017	-0.171	-0.311	-0.330	-0.355	-0.397	-0.396	-0.373
	(0.339)	(0.218)	(0.230)	(0.245)	(0.252)	(0.271)	(0.366)	(0.375)	(0.367)	(0.354)	(0.322)
LogInc	0.542	0.376	0.354	0.016	-0.144	-0.245	-0.203	-0.126	0.006	0.070	0.103
	(0.391)	(0.259)	(0.279)	(0.286)	(0.292)	(0.312)	(0.403)	(0.415)	(0.408)	(0.394)	(0.360)
Debt	-1.940	0.337	1.558	1.916	1.983 *	1.879	1.167	1.271	0.579	0.274	0.059
	(1.944)	(1.273)	(1.370)	(1.450)	(1.114)	(1.631)	(2.106)	(2.133)	(2.066)	(1.980)	(1.783)
Pseudo-R^2 (%)	32	30	24	39	46	53	48	38	32	29	27

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

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

This Table shows the estimates for the parameters in equation (9). The estimation technique involves state random effects and errors clustered by state within year-groups. Standard Errors are in parenthesis.

Panel A – Pre-Crisis

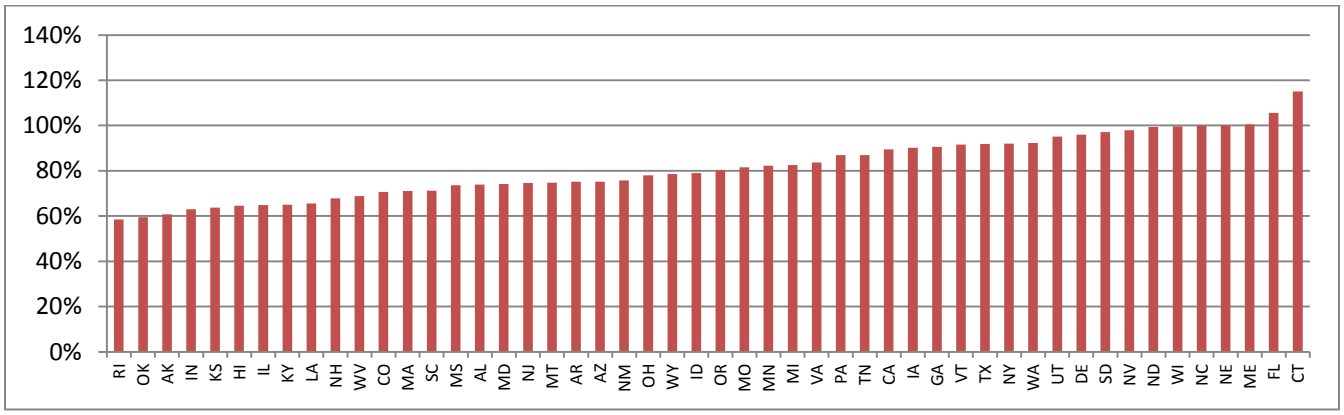
	12-mo	24-mo	36-mo	48-mo	60-mo	72-mo	96-mo	120-mo	180-mo	240-mo
ΔPension	-0.1777	-0.0472	-0.0039	0.0243	0.0351	0.0396 *	0.0081	0.0182	-0.0588	-0.1544
	(0.1338)	(0.0929)	(0.0746)	(0.0537)	(0.0347)	(0.0210)	(0.0349)	(0.0597)	(0.0716)	(0.1177)
ΔBBBSpread	0.0032	0.0045 ***	0.0033 ***	0.0023 ***	0.0015 ***	0.0009 ***	0.0007 ***	0.0006	0.0004	0.0011
	(0.0021)	(0.0014)	(0.0011)	(0.0008)	(0.0005)	(0.0003)	(0.0003)	(0.0005)	(0.0008)	(0.0012)
ΔLogGSP	0.0542 **	0.0164	0.0119	0.0077	0.0038	0.0020	0.0047	0.0153	0.0134	0.0106
	(0.0269)	(0.0197)	(0.0157)	(0.0113)	(0.0073)	(0.0044)	(0.0062)	(0.0111)	(0.0152)	(0.0200)
ΔUnemployment	0.0011	-0.0001	-0.0003	-0.0004	-0.0004	-0.0004 *	0.0001	0.0003	0.0007	0.0011
	(0.0013)	(0.0009)	(0.0007)	(0.0005)	(0.0003)	(0.0002)	(0.0002)	(0.0004)	(0.0006)	(0.0008)
ΔBudget	-0.2015	-0.1020	-0.1079	-0.0911	-0.0590	-0.0315	-0.0072	-0.0452	0.0624	0.1845
	(0.1430)	(0.1048)	(0.0840)	(0.0605)	(0.0391)	(0.0236)	(0.0334)	(0.0595)	(0.0807)	(0.1329)
ΔLiquidity	-0.0005	-0.0003	-0.0002	0.0000	0.0000	0.0000	0.0002	0.0002	0.0002	0.0001
	(0.0007)	(0.0005)	(0.0004)	(0.0003)	(0.0002)	(0.0001)	(0.0001)	(0.0002)	(0.0003)	(0.0006)
ΔPayDay	0.0010	0.0006	0.0004	0.0001	0.0000	-0.0002	0.0002	0.0003	-0.0002	-0.0010
	(0.0016)	(0.0012)	(0.0009)	(0.0007)	(0.0004)	(0.0003)	(0.0003)	(0.0005)	(0.0008)	(0.0016)
ΔLogPop	0.0006	0.0005 *	0.0003	0.0002	0.0001	0.0000	0.0000	0.0000	-0.0001	0.0000
	(0.0004)	(0.0003)	(0.0002)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)
ΔLogInc	-0.0085	-0.0079	-0.0044	-0.0018	-0.0002	0.0001	-0.0026	-0.0092	-0.0090	-0.0105
	(0.0211)	(0.0138)	(0.0111)	(0.0080)	(0.0052)	(0.0031)	(0.0046)	(0.0081)	(0.0106)	(0.0141)
ΔDebt	0.0225	0.0466	0.0530	0.0400	0.0279	0.0170	-0.0292	-0.0637	-0.0453	-0.0126
	(0.1148)	(0.0842)	(0.0674)	(0.0485)	(0.0313)	(0.0189)	(0.0311)	(0.0543)	(0.0697)	(0.0982)

Panel B – Post Crisis

	12-mo	24-mo	36-mo	48-mo	60-mo	72-mo	96-mo	120-mo	180-mo	240-mo
ΔPension	-0.0183	-0.0229	-0.0193	-0.0097	-0.0025	-0.0020	0.0018	0.0043	0.0008	-0.0016
	(0.0358)	(0.0204)	(0.0127)	(0.0080)	(0.0065)	(0.0071)	(0.0092)	(0.0115)	(0.0124)	(0.0137)
ΔBBBSpread	0.0023 **	0.0015 ***	0.0011 ***	0.0009 ***	0.0007 ***	0.0008 ***	0.0005 *	0.0005	0.0004	0.0006
	(0.0009)	(0.0006)	(0.0004)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0004)	(0.0003)	(0.0004)
ΔLogGSP	-0.0207	-0.0104	-0.0065	-0.0061	-0.0049	-0.0008	0.0005	0.0014	0.0013	0.0020
	(0.0219)	(0.0123)	(0.0077)	(0.0048)	(0.0039)	(0.0044)	(0.0057)	(0.0072)	(0.0071)	(0.0078)
ΔUnemployment	0.0003	0.0001	0.0001	0.0000	0.0000	0.0001	0.0001	0.0001	0.0000	0.0001
	(0.0005)	(0.0003)	(0.0002)	(0.0001)	(0.0001)	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
ΔBudget	-0.0781	-0.0095	0.0217	0.0188	0.0078	0.0151	-0.0034	-0.0200	-0.0563	-0.0624
	(0.1286)	(0.0686)	(0.0403)	(0.0271)	(0.0228)	(0.0231)	(0.0286)	(0.0359)	(0.0420)	(0.0483)
ΔLiquidity	0.0002	-0.0007	-0.0008 **	-0.0008 ***	-0.0005 ***	-0.0003 *	-0.0001	0.0001	0.0002	0.0002
	(0.0010)	(0.0006)	(0.0004)	(0.0002)	(0.0002)	(0.0002)	(0.0003)	(0.0003)	(0.0003)	(0.0004)
ΔPayDay	-0.0008	-0.0006	-0.0002	-0.0001	0.0002	0.0005 *	0.0008 *	0.0010 *	0.0012 **	0.0013 **
	(0.0014)	(0.0008)	(0.0006)	(0.0003)	(0.0003)	(0.0003)	(0.0004)	(0.0005)	(0.0005)	(0.0006)
ΔLogPop	-0.0177	-0.0266	-0.0186	-0.0083	0.0016	0.0083	0.0165	0.0213	0.0149	-0.0003
	(0.0598)	(0.0344)	(0.0223)	(0.0133)	(0.0108)	(0.0126)	(0.0167)	(0.0209)	(0.0200)	(0.0217)
ΔLogInc	-0.0352	-0.0401 **	-0.0350 ***	-0.0296 ***	-0.0229 ***	-0.0200 ***	-0.0137 *	-0.0094	-0.0007	0.0029
	(0.0272)	(0.0156)	(0.0098)	(0.0061)	(0.0049)	(0.0055)	(0.0072)	(0.0090)	(0.0092)	(0.0102)
ΔDebt	0.1087	0.1002	0.0457	0.0160	-0.0310	-0.0527	-0.0530	-0.0636	-0.0681	-0.0792
	(0.1653)	(0.0941)	(0.0590)	(0.0367)	(0.0299)	(0.0334)	(0.0433)	(0.0543)	(0.0554)	(0.0612)

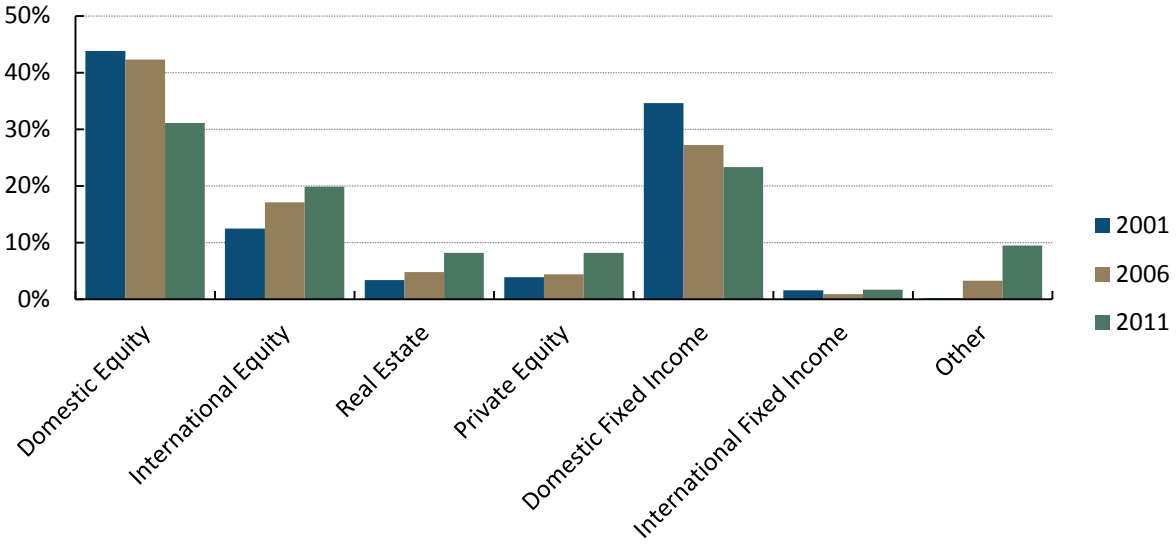
*** Significant at 1%; ** Significant at 5%; * Significant at 10%

Figure 1 - The Funding Ratios of State Public Pension Plans



Source: Center for Retirement Research

Figure 2 - Shifts in Asset Allocations



Source: Wilshire Consulting, 2012 Report on State Retirement Systems: Funding Levels and Asset Allocation, March 2, 2012