SOCIETY OF ACTUARIES

Public Pension Finance Symposium
May 2009

Session 6: The Role & Impact of Equities in Public Plan Investing

The Intergeneration Transfer of Public Pension Promises

Robert Novy-Marx, Joshua Rauh

Moderator

Emily Kessler

Discussants

Jeremy Bulow, David Kausch

Public Pension Promises: How Big Are They and What Are They Really Worth?

Robert Novy-Marx and Joshua D. Rauh
May 2009

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Motivation

- What is the true condition of defined benefit (DB) pension plans sponsored by US states?
- Starting point: add up disclosures for latest fiscal year (FY) from 116 major state plans
  - $2.8 trillion (T) in DB liabilities
  - $1.9 trillion (T) in market value DB assets [projection for December 2008]

  →Underfunding appears to be only $0.9T
- Suspicion that situation is much worse
- Note: state muni bonds outstanding = $0.94T

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Questions About Public Liabilities

1. Are liabilities discounted at the right rate?
   - Liability is a discounted stream of payments
   - Is the discount rate based on the risk of the stream of payments?

2. What liabilities are being recognized as owed to workers?
   - One could measure how much would be owed if the plan were stopped today
   - Could also recognize the plan probably won't be stopped today, and benefits will accrue fast for older workers

Main Results: Two Measures

I. "Taxpayer obligation" measure: **$1.2T underfund**
   - ➢ Assumes default on the pension promises is possible
   - ➢ Would happen in the same state of the world as default on state general obligation (GO) bonds

II. "Funding adequacy" measure: **$3.1T underfund**
   - ➢ Does not credit states for having poor ratings
   - ➢ Assumes that the state is not going to default

Note: These are just Accumulated Benefit Obligations (ABOs), how much would be owed if plans frozen today

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Why Different from State Numbers?

1. Discount Rate – Important
   - ➢ Common 8% is too high relative to risk
   - ➢ ABO Liability is
     - \$2.7T under stated rates
     - \$3.1T under state-specific muni rates, implicitly allows pensions to default with muni bonds
     - \$5.1T if discounted at risk-free rate
2. Liability Measure – Smaller effect
   - ➢ Entry Age Normal (EAN) used to state most of the state plan liabilities is broader than ABO
   - ➢ 2/3rds of liability from retired / separated workers

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Liability Measures

- Collected information from CAFRs and Center for Retirement Research (2006)
- For 67% of the state liabilities it is called “Entry Age Normal” (EAN)
- For 19% of the state liabilities it is
  - ➢Entry Age Frozen
  - ➢Aggregate Actuarial Cost
- For 14% it is Projected Unit Credit (PUC)
- Want to translate these into the Accumulated Benefit Obligation (ABO)

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Accounting Liabilities by Age for Workers Hired at Age 20

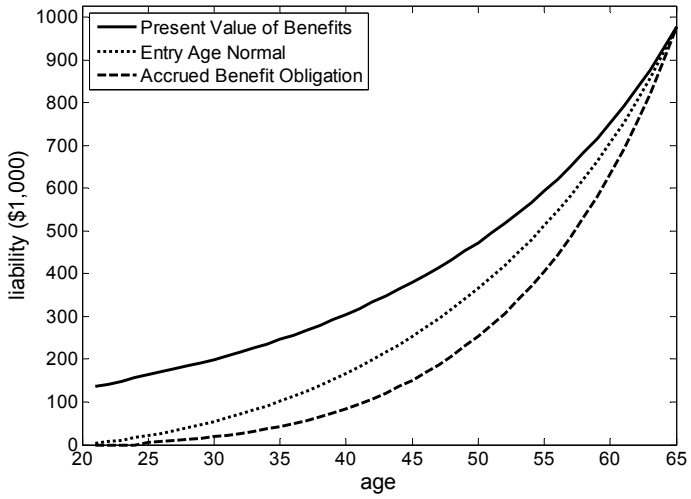

Figure 1

Converting Among Liability Methods

- Begin with 3 characteristics of each of the 116 plans:
  1. plan's stated liability from the CAFR (L_{stated})
  2. discount rate the state reports that it used (r_{stated})
  3. actuarial method the state reported that it used (EAN or PUC)
- Convert these characteristics into a modeled stream of payments $C_{j,t}$ for state j at time t, such that

$$\sum_{t=1}^{T} \frac{C_{j,t}}{\left(1+r_{stated}\right)^{t}} = L_{stated}$$

Actuarial Assumptions Required

- From plans of 10 states with largest liabilities
  - ➢salary growth by age
  - ➢separation probabilities by age
  - ➢service distribution of job leavers / retirees
  - ➢distribution of plan participants by age and years of service (the “age-service” matrix)
  - ➢average wages of employees in each cell of the age-service matrix

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Actuarial Assumptions: Member Counts and Average Salaries

Member Counts (Millions of People)

	Active	Annuitants	Separated & Vested	Total
All	12.11	5.81	2.17	20.09
PUC	1.58	0.79	0.37	2.75
Non-PUC	10.52	5.02	1.80	17.34

Average Salaries

	Active
All	$ 39,829
Projected Unit Credit	$ 43,480
Entry Age Normal and Related Methods	$ 39,279

Source: Center for Retirement Research (2006) and authors’ calculations.

Appendix Table IV.A and Appendix Table IV.E

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Technical Assumptions

- Benefit formulas, COLAs and inflation assumptions are state-specific (taken from CAFRs)
- Assume age when you can begin receiving full benefits: 65
  - ➢allow younger retirees to receive benefits prior to turning 65 in actuarially fair way
- mortality assumptions by age: RP2000 combined mortality table used by many states
- **Note: we are interested in dL/dr, which is relatively insensitive to these additional assumptions**

Additional Simplifying Assumptions

- Annuitants retired at 65
- Distribution of ages made consistent with mortality rates in steady state
  - ➢*e.g.,* mortality tables suggest that conditional on living to 65 there is ~50% probability of living to 82
  - ➢so we assume that there are twice as many annuitants of age 65 as there are of age 82
- benefit salary of annuitants: adjust the wages of currently employed workers with the same level of service for inflation and cost of living

Payment Stream (Total)

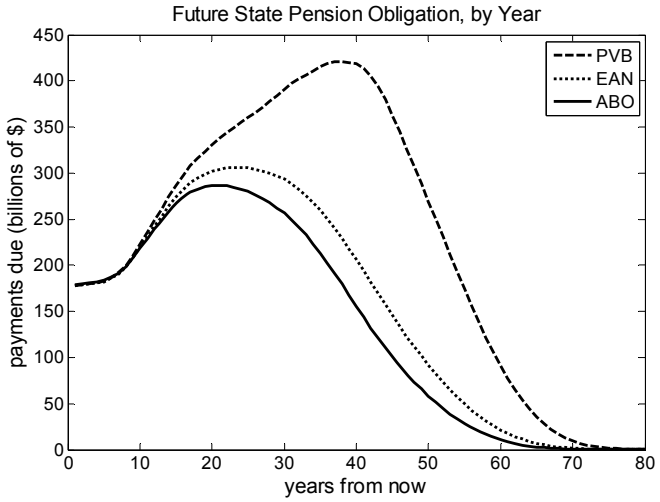

Figure 2 (Top)

Payment Stream (Breakdown)

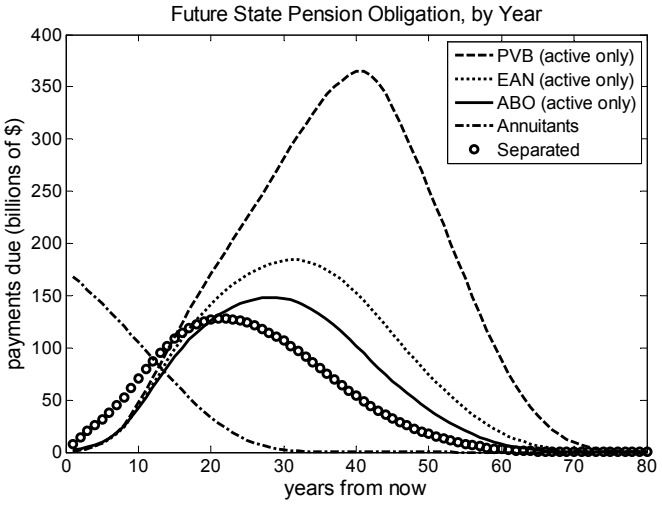

Figure 2 (Bottom)

Check of the Model

- Use weighted averages of state technical assumptions
  - ➢Weighted average benefit factor: 2.03%
  - ➢COLA: 2.86%
  - ➢Inflation: 3.40%
- Discount total payments at the mean stated rate
  - ➢weighted average is 7.94%
- To check the model, we do *not* calibrate to stated liabilities at the state level
- We get AAL of $2.72T (vs. $2.84T total of CAFR reported liabilities)

Liabilities: Various Actuarial Methods

In trillions of U.S. dollars at state-chosen discount rates

	Liability
Total (Active + Annuitants + Separated)	
As Stated, Unharmonized	$2.84
Accumulated Benefit Obligation (ABO)	$2.74
Entry Age Normal (EAN)	$2.87
Projected Value of Benefits (PVB)	$3.19
Active Participants Only	
Accumulated Benefit Obligation (ABO)	$0.70
Entry Age Normal (EAN)	$0.82
Projected Value of Benefits (PVB)	$1.15
Annuitants Only	$1.20
Separated Not Yet Receiving Benefits Only	$0.84

Table III

Liabilities: Various Actuarial Methods

In trillions of U.S. dollars at state-chosen discount rates

	Liability
Total (Active + Annuitants + Separated)	
As Stated, Unharmonized	$2.84
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Table III

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Separated Not Yet Receiving Benefits Only	$0.84

Table III

Discount Rate: Key Features

- Risk
  - financial streams of payment should be discounted at a rate that reflects their risk (Modigliani and Miller (1958)
  - in particular their covariance with pricing factors (Treynor (1961), Sharpe (1964), Lintner (1965))
- Term
  - Term structure discount each payment at $1/(1+r_t)^t$

Illustration of State Accounting

- All that GASB and ASOP require for "full funding" is
  - ➢E[Assets(2024)] = E[Liabilities(2024)
    = $3T*(1.08)^{15} = $9.5T
- "Modest Proposal": Need only $0.75B of assets today
  - ➢invest in a 10-times levered S&P fund ("10 beta")
  - ➢suppose market risk premium (r_m-r_f) = 6.5%
  - ➢annual expected return is 88% = $e^{10*\ln(1+6.5\%)}$
  - ➢$0.75B * $(1.88)^{15}$ = $9.5T
- Frees up $1.94T – $1B = $1.94T
  - pay off all state bonds ($0.94T)
  - Distribute $1T back to taxpayers: ~$3,500 for every man, woman & child in the US

Starting Point: Riskless Rate

- If state pension promises were truly riskless, one would want to use a risk-free rate
- Treasury rate with the same duration as the liabilities
  - ➢useful but imperfect benchmark for a risk-free rate
  - ➢long-term Treasury bonds may contain a risk premium over short-term bonds
- 10-year Treasury strip rate as of January 30, 2009 was 2.9% and the 15-year was 4.1%

What Risks Should Be Priced?

- Default risk
  - ➢Could states default on these obligations?
  - ➢State constitutions often build in protections for government pensions (Brown and Wilcox (2009))
  - ➢Pension priority may be higher than that of GO debt
- Salary risk
  - ➢Not relevant for ABO
  - ➢Does affect other measures

Are Risks Relevant?

- Consider the concept of “Funding Adequacy”
  - States with higher probabilities of default should not be given lighter funding requirements
  - So we argue for a risk-free rate here for the ABO
- Consider the concept of “Taxpayer Liability”
  - For taxpayers, the default option is valuable
  - Imagine state wanted to defease its entire pension obligation
  - Could pay off beneficiaries with portfolio of bonds that default in same states of the world as pensions

Municipal Bond Rates and Default

- Suppose (generously) that government pension liabilities have same priority as other government debt
- One hint as to the appropriate discount rate comes from state-specific GO ratings by S&P
- Yields on state's municipal GO debt closely related to credit ratings
- However: to defease the pension liability, state would not have to deliver tax-free bonds
- Benefits are not tax deductible like muni coupons

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Zero Coupon Yield Curves (Jan-09)

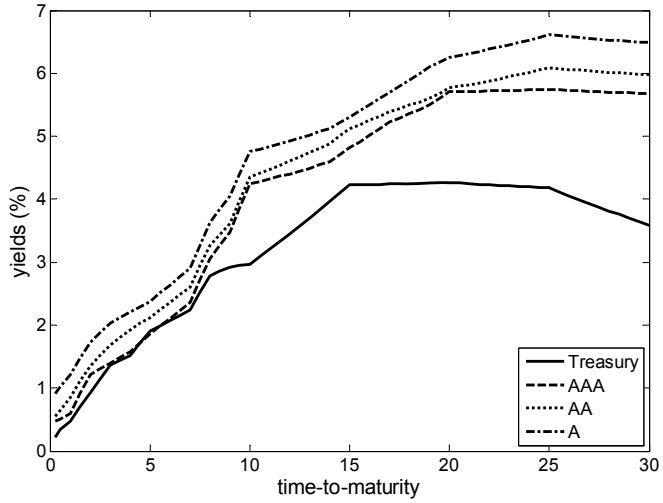

Figure 3

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Taxable Muni Yields

- Define $r_{muni(j)}$ as the yield on actual (tax-free) municipal bonds with credit rating j
- The taxable muni yield is $r_{muni(j)} / (1- \tau_B)$
- τ_B is tax rate for the marginal investor, we use 25%
- Poterba and Verdugo (2008) document that over 1991-2008 the average implied tax rate was 26.3%, considerably lower 1997-2008
  - ➢based on spread of Treasuries over munis
  - ➢complicated by the fact that this calculation assumes the market believed munis no more likely to default than Treasuries

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Aggregate State Public Pension Liabilities by Taxpayer Obligation Measure

Taxpayer Obligation Measure

Risk Assumption: Equal Priority to General Obligation (GO) Bonds

Discount rate: $\frac{r_{muni(j)}}{1-\tau_B}$, the state-specific municipal bond rate excluding the tax preference

	Amount
Annuitants	$1.44 trillion
Separated Not Yet Receiving Benefits	$0.95 trillion
Actives (Accumulated Benefit Obligation)	$0.75 trillion
Minimum Total Liabilities	$3.15
Total Assets (December 2008)	$1.94
Unfunded Liabilities	$1.21

Table IV

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Aggregate State Public Pension Liabilities by Funding Adequacy Measure

Funding Adequacy Measure

Risk Assumption: Risk-free

Discount rate: r_f, the Treasury rate

	Amount
Annuitants	$1.67 trillion
Separated Not Yet Receiving Benefits	$1.71 trillion
Actives (Accumulated Benefit Obligation)	$1.68 trillion
Maximum Total Liabilities	$5.06
Total Assets (December 2008)	$1.94
Unfunded Liabilities	$3.12

Table IV

State Public Pension Liabilities Under Various Rates and Measures

figures in trillions in U.S. dollars	r_f	$\frac{r_{muni(j)}}{1-\tau_B}$
Total (Active + Annuitants + Separated)		
Accumulated Benefit Obligation (ABO)	$5.06	$3.15
Entry Age Normal (EAN)	$5.50	$3.27
Projected Value of Benefits (PVB)	$6.90	$3.60
Active Participants		
Accumulated Benefit Obligation (ABO)	$1.68	$0.75
Entry Age Normal (EAN)	$2.11	$0.88
Projected Value of Benefits (PVB)	$3.52	$1.20
Annuitants	$1.67	$1.44
Separated Not Yet Receiving Benefits	$1.71	$0.95

Table V

Salary Risk for Broader Measures

- What if the evolution of pension liabilities is correlated with the market (pricing factor) over long horizons?
  - ➢irrelevant for retired and separated workers
  - ➢irrelevant for active worker ABO
- However, it is relevant from the perspective of the EAN and other PBO measures, for active workers
- Correlation negligible on short horizon, but could be longer on very long horizons if we had the data (Benzoni et al (2006), Lucas and Zeldes (2006))

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Wage-Market Correlations

- The loading of liabilities on the market is

$$\beta_L = \sigma_L / \sigma_M^2 = \rho_{L,M}\sigma_L\sigma_M / \sigma_M^2$$

- σ_L is the standard deviation of liabilities
- σ_M is the standard deviation of the market portfolio
- $\sigma_{L,M}$ is the covariance between *L* and *M*
- $\rho_{L,M}$ is the correlation coefficient between *L* and *M*
- If we assume σ_L = 5%, σ_M = 0.16, ρ = 0.25, then
  β_L = (0.05*0.25 / 0.16) = 0.078
  β_L * 6.5% risk premium = 51bp

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Conclusions and Ongoing Research

- Discount rate is generally a more serious distortion in state financial reports than accrual methodology
- Summary of ABO funding
  - ➢ $0.9T (-31.9% of liabilities) at state-chosen discount rates
  - ➢ $1.2T (-38.5% of liabilities) at taxable muni rate
    - allows states to default in same way as they can default on muni debt
  - ➢ $3.1T (-61.7% of liabilities) at risk-free rate
- PBO funding substantially worse

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Additional Slides

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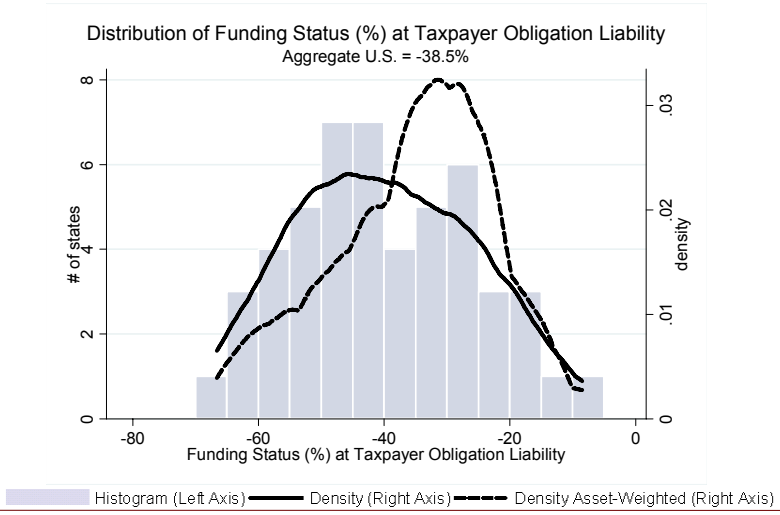
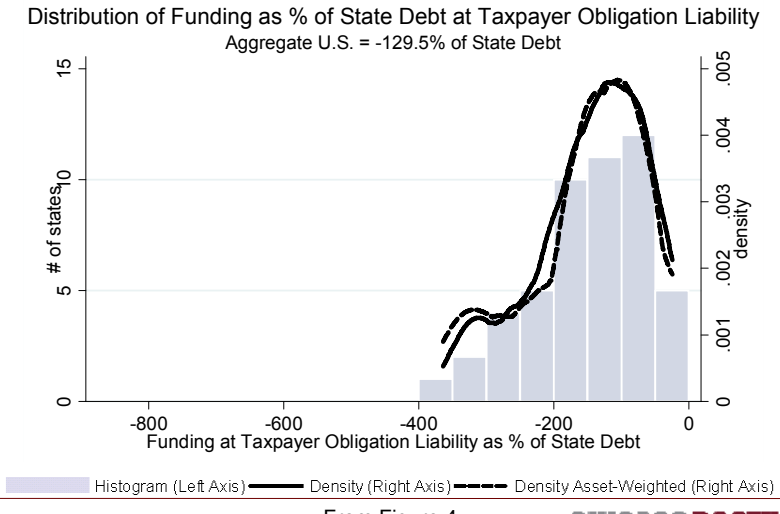
Funding Status Distribution (%) at Taxpayer Obligation Liability



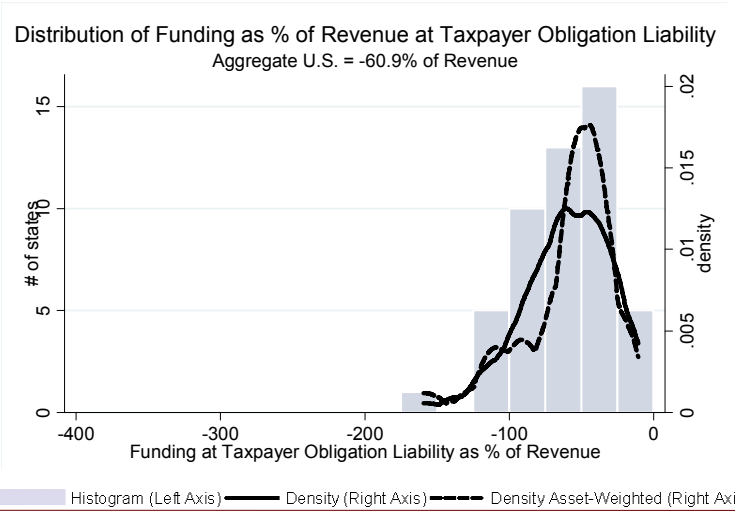
From Figure 4

Funding Distribution as % of Debt at Taxpayer Obligation Liability



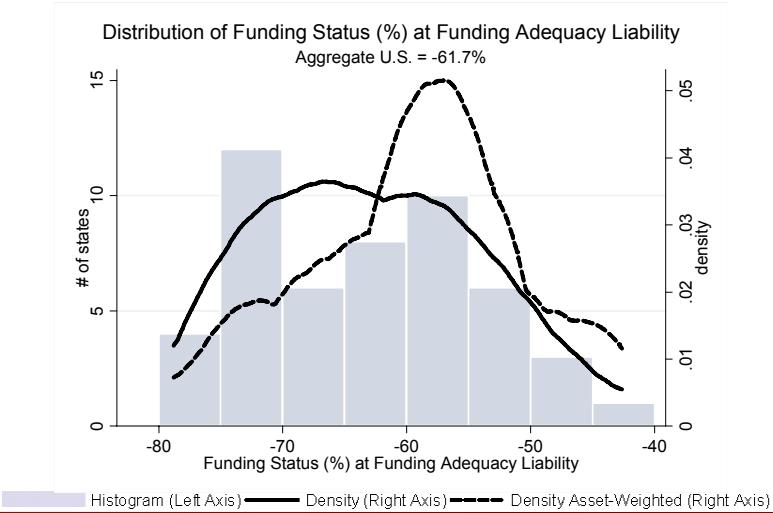
From Figure 4

Funding Distribution as % of Revenue at Taxpayer Obligation Liability



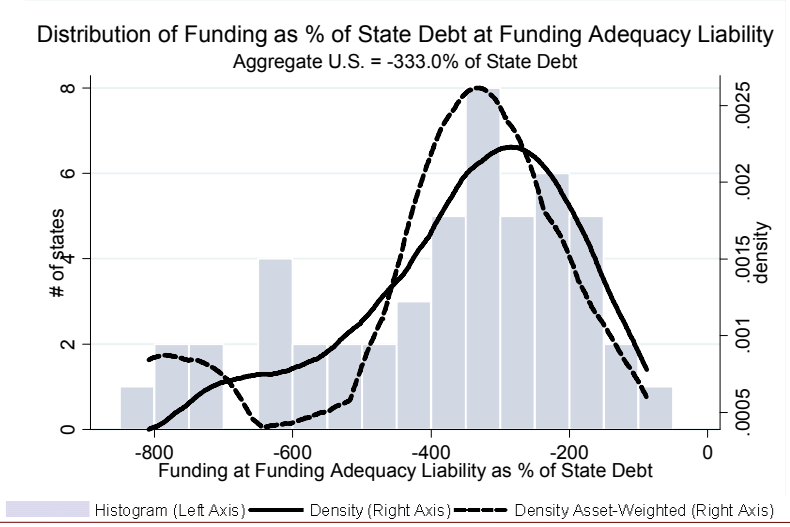
From Figure 4

Funding Status Distribution (%) at Funding Adequacy Liability



From Figure 5

Funding Distribution as % of State Debt at Funding Adequacy Liability



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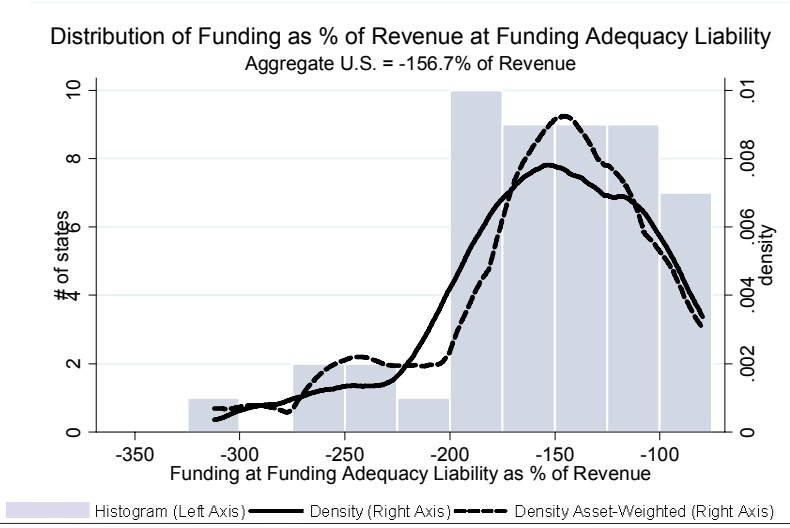

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