Reach for Yield by U.S. Public Pension Funds

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Introduction

- We study risk-taking / reach-for-yield (RFY) by U.S. state and local pension funds (PPFs).
  - Risk-taking is related to low interest rates, underfunding, and sponsors' fiscal condition.
  - In 2016, low yields and underfunding accounted for 1/4 of total risk.
  - If transferred to sponsor states, the 5% VaR losses -- corresponding to a severe stress event — would have boosted state and local debt by about 20% in 2016.
- Related Literature: Andonov et al (2017), Boubaker et al (2018), Mohan and Zhang (2014), Pennacchi and Rastad (2011), Lucas and Zeldes (2009), Novy-Marx and Rauh (2011 and 2014), Rauh (2017)
- Contributions:
  1. Theoretical model to interpret risk-taking channels.
  2. New econometric approach for inferring funds' risk.
  3. Quantify fiscal consequences of risk-taking behavior.

Roadmap

1. Background on US PPFs
2. Model
3. Empirics: Measuring PPFs' portfolio risk
4. Empirics: Measuring underfunding
5. Empirics: Risk vs. funding ratios, Treasury yields, state finances
6. Implications

1. Background: U.S. State and Local Public Pension Funds

- PPFs = almost $4 trillion in assets.
- Most PPFs are underfunded (Funding Ratio = $\frac{PV\ (Assets)}{PV(Liabilities)} < 1$)
- Liabilities are low risk:
  - Earned benefits are considered nearly risk-free because state constitutions and court precedents give public pension beneficiaries' claims very high seniority.
- U.S. public accounting (GASB) rules undervalue PPF liabilities because discount rates are based on funds' expected asset returns.

2. Two-date model of pension fund portfolio choice

- PPF sponsor (state) acting on behalf of a representative citizen (RC)
- 2 Dates, 0 and t.
- Date 0:
  - Pension fund assets A_0 invested in risk-free and risky assets.
- Date t:
  - Assets $A_t = A_0[(1-\omega)\, e^{r_f t} + \omega e^{(r_f+\lambda-.5\,\sigma^2)t+\sigma w(t)}\,]$
  - RC income Y_t, pension liability L_t, public debt payment D_t.
  - Pension taxes: $T_t = \mathrm{Max}(\mathrm{L_t} - \mathrm{A_t}, 0)$, Consumption: $C_t = Y_t - D_t - T_t$.
- Date 0 optimization:

$$Max_\omega \quad \mathrm{E}_0\, U_t[C_t]$$

Two-Date Model Contd.

$$= \max_{\omega} E_0\, U_t[Y_t \times \left(1 - \frac{D_t}{Y_t} - \frac{L_t}{Y_t}\, Max\left(1 - \frac{A_0}{\frac{L_t}{e^{r_f t}}}\left[(1-\omega) + \omega\, e^{(\lambda - .5\sigma^2)t + \sigma\sqrt{t}\epsilon}\right], 0\right)\right)]$$

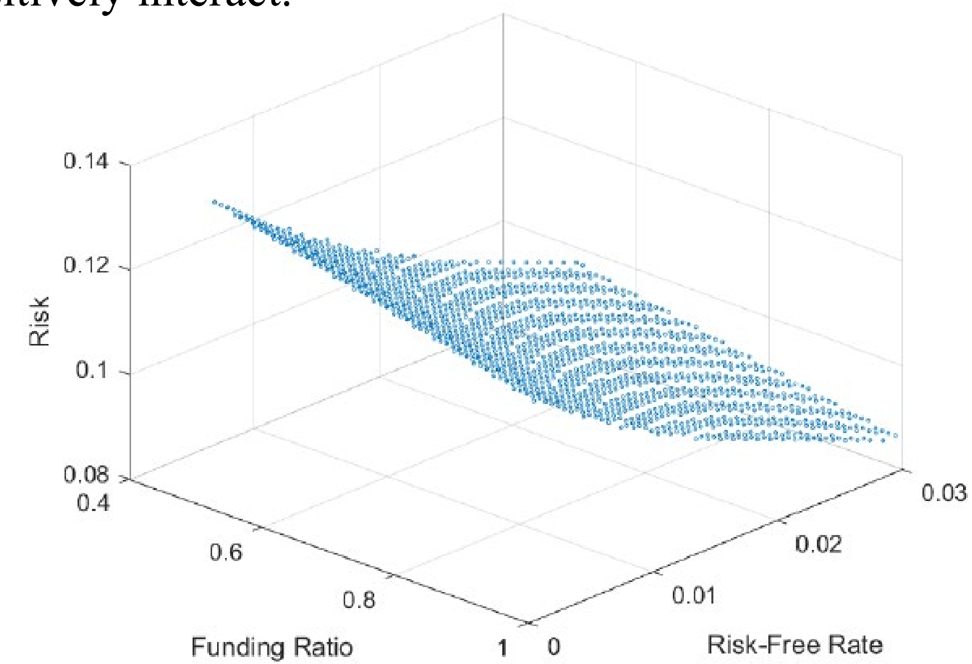
$$= \max_{\omega} E_0\, U_t[Y_t \times (1 - SDI_t - PDI_t \times \max(1 - FR_0(r_f, A_0, L_t)[(1-\omega) + \omega\, e^{(\lambda - .5\sigma^2)t + \sigma\sqrt{t}\epsilon}], 0))]$$

Risk-taking (ω) depends on:

- The Funding Ratio $FR_0(r_f, A_0, L_t)$ --- the reach for yield channel.
- The risk premium $\lambda(r_f)$ ------------- the risk premium channel.
- State debt to income SDI_t ---- the state finances channel and whether the state can default.

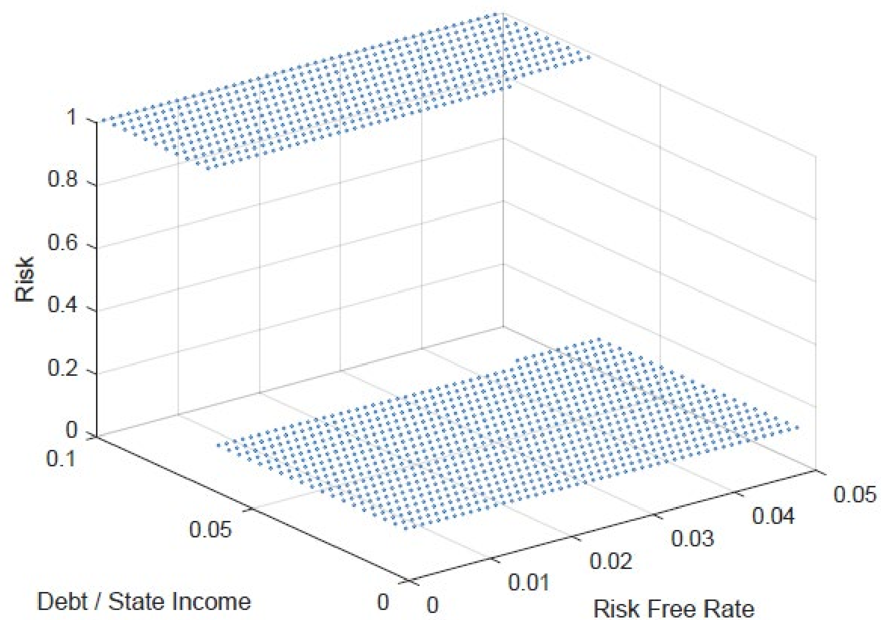
2. Model of risky portfolio choice (an example)

- With risk-free state debt (no default):
  - Risk increases in underfunding.
  - Risk increases as rates decline
  - Effects positively interact.



2. Model of risky portfolio choice (example contd)

- With risky state debt (possibility of default):
  - o PPF Risk-taking jumps for high levels of State Debt-to-Income.
  - o When SDI is high enough, risk-taking jumps as risk-free rates decline.



3. Measuring PPFs' risk-1

- **Data is Limited:**
  - PPF's annual asset returns and portfolio weights in 6 asset categories from 2001 to 2016 for 170 PPFs.

- **Other papers measure funds' risk in a restrictive fashion.**
  - *Example 1:* Share of risky assets in portfolio, or portfolio asset beta.
  - *Example 2*: Value at Risk (VaR) assuming funds' category returns are driven by a particular index.

3. Measuring PPFs' risk: **Our Paper**

- Each PPF $i's$ category return = a category index plus a fund-specific tracking error.

$$r_{c,i,t} = r_{c,t} + \epsilon_{c,i,t} \qquad (1)$$

- Each category index is a linear combination of returns of traded indices.

$$r_{c,t} = \sum_j r_{j,t}\theta_{c,j} \qquad (2)$$

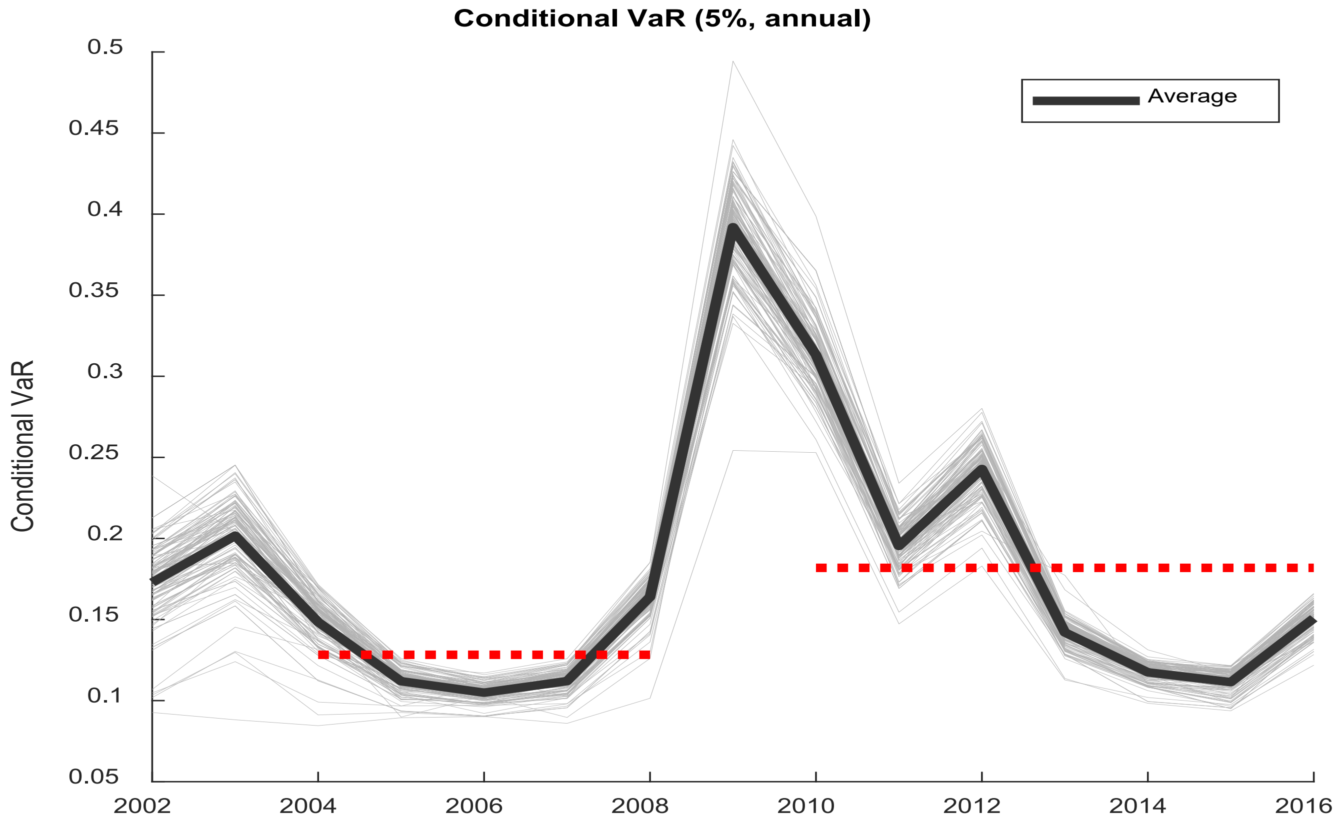
- We estimate the category indices ($\theta's$) that best explain funds returns given their portfolio weights.

$$r_{i,t} = \sum_c w_{i,c,t}(r_{c,t} + \epsilon_{c,i,t}) = \sum_{c=1}^{C}\sum_{j=1}^{J} w_{i,c,t}\, r_{j,t}\theta_{c,j} + u_{i,t}, \qquad (3)$$

- Equation (3) is estimated with the OLS post-lasso estimator.

- VaR estimated from var-cov matrices of category return indices, $\Sigma_{c,t}$ using annual daily data, funds' residual risks, σ_u^2, and funds' portfolio weights.

$$VaR_{i,t}(5\%) = 1.65\sqrt{w'_{i,t}\Sigma_t w_{i,t} + \sigma_u^2}$$



- VaR changes through time due to changes in portfolio weights and economic conditions, i.e. the variance-covariance matrix of assets returns.

4. Measuring PPFs' underfunding: revaluing liabilities

- Liabilities are under-valued because discount rates are based on assets expected returns:

"Finance theory is unambiguous that the discount rate used to value future pension obligations should reflect the riskiness of the liabilities. In actual practice, state and local plans generally set their discount rates based on the characteristics of the assets held in the pension trust rather than the characteristics of the pension liabilities." Jeffrey Brown and David W. Wilcox (2009).

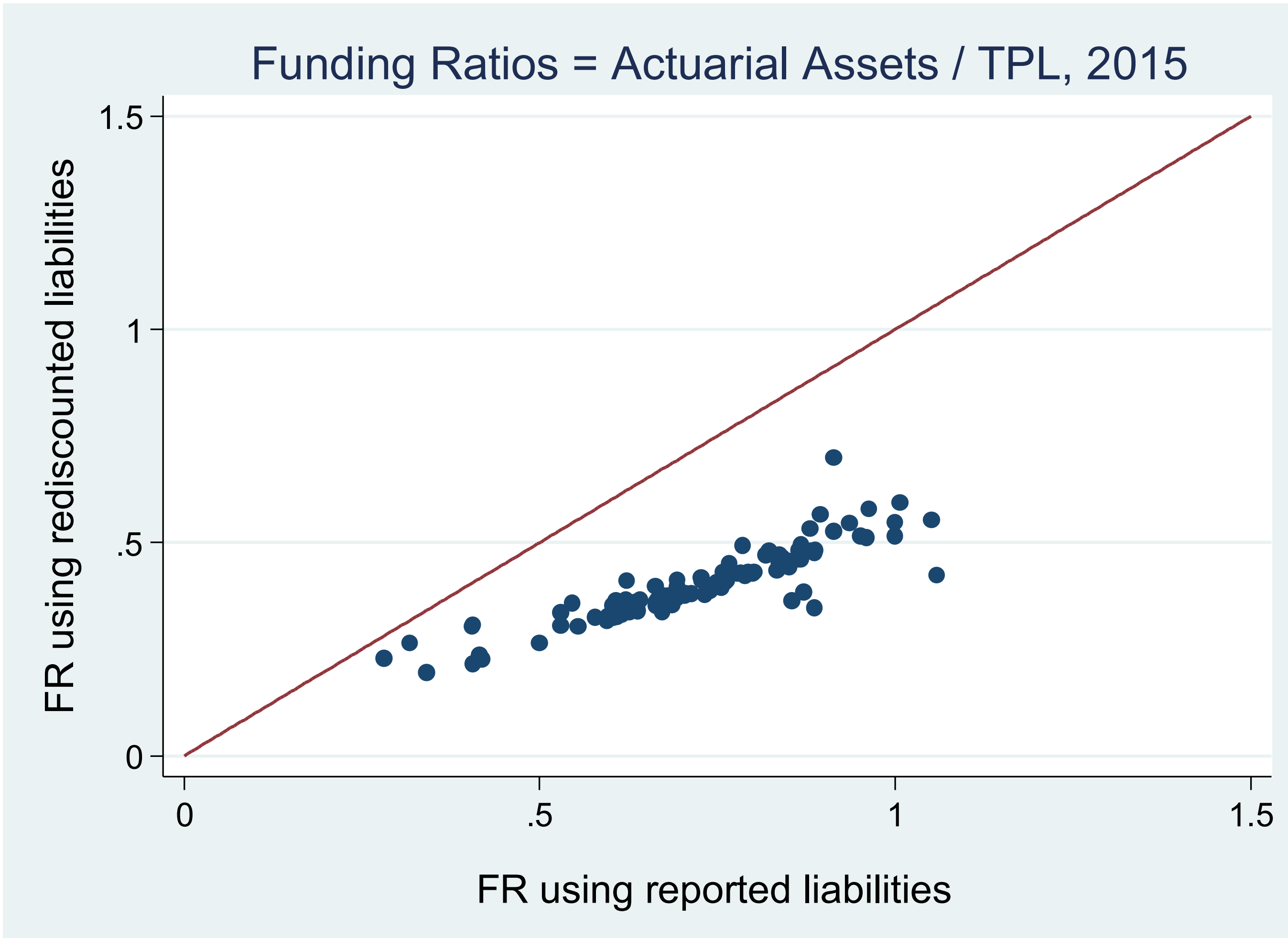
- To re-value total pension liabilities (TPL), we use the approach in Rauh (2017):

1. We infer liability duration and convexity from new regulatory data (GASB 67).

2. We re-value the liabilities by Taylor-approximating their value if the discount rate changed from its reported value r to the appropriate (duration matched) risk-free rate r':

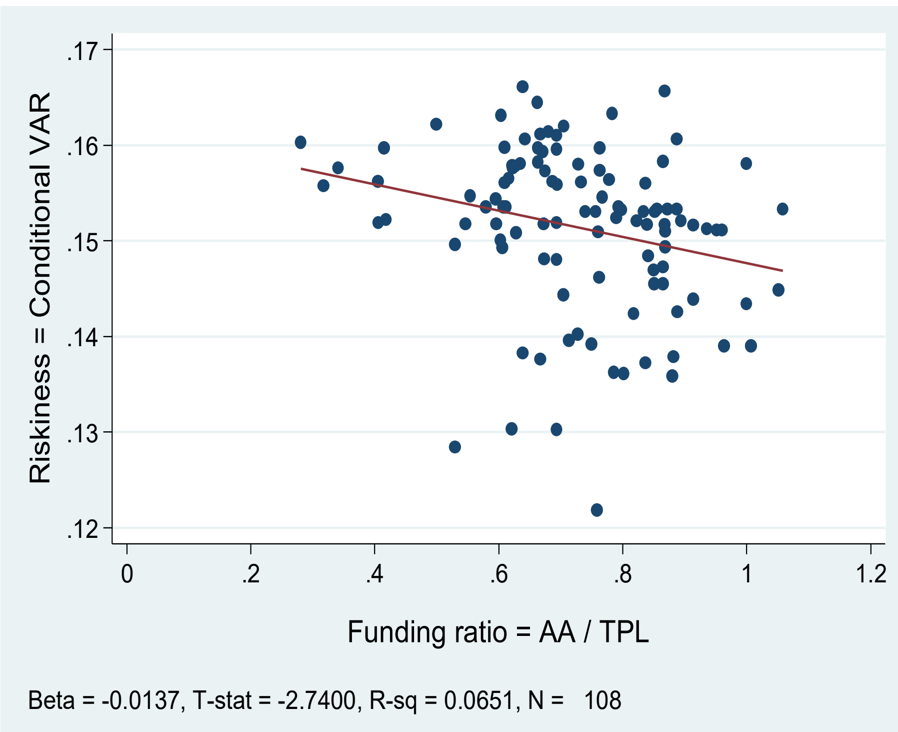
$$TPL_{r'} = TPL_r - TPL_r * Dur * (r' - r) + 0.5 * TPL_r * Convexity * (r' - r)^2$$

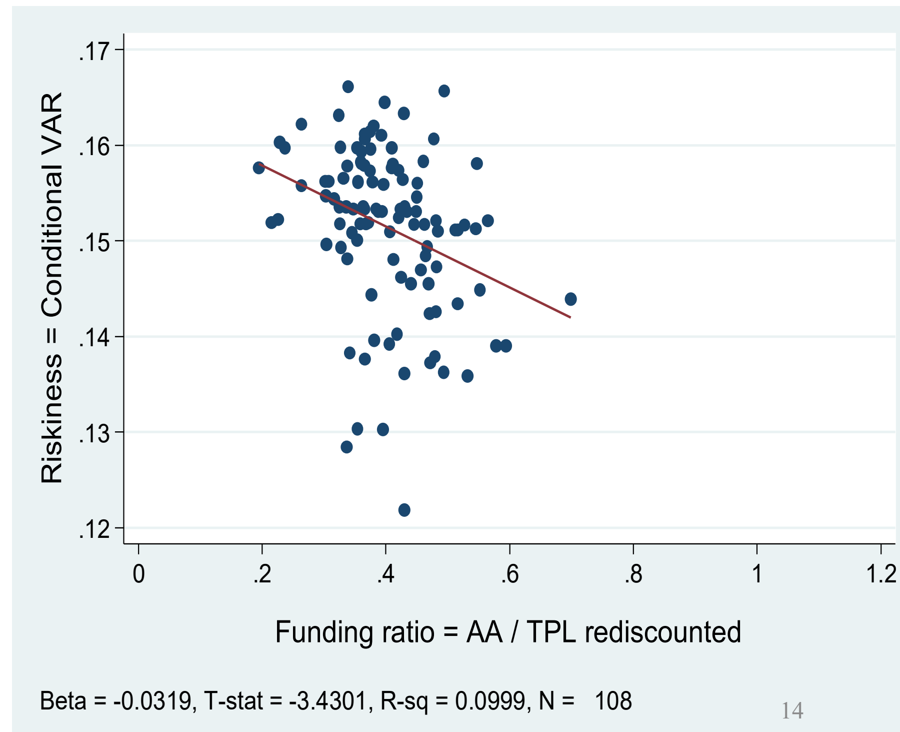
4. Rediscounting lowers funding ratios.



5. Findings: risk vs. underfunding, cross-section

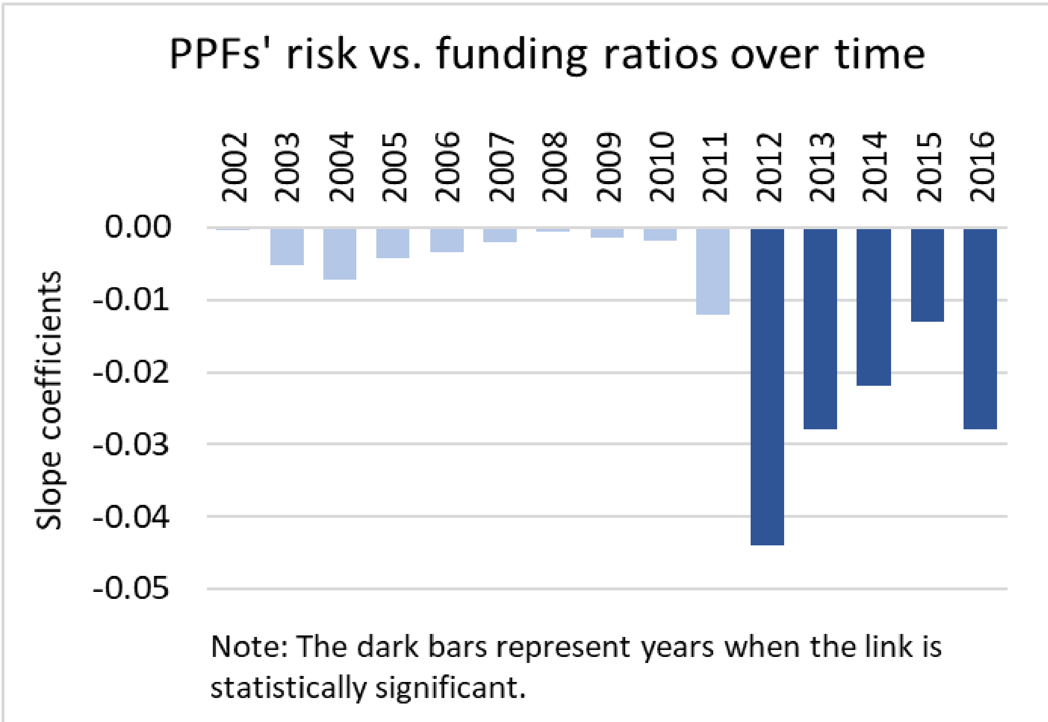
- Risk (conditional VaR) vs. lagged funding ratio, 2016.
  - Left chart: reported funding ratios are upward biased, measured with error.
  - Right chart: rediscounting increases the slope and statistical significance.





5. Findings: risk vs. funding ratio (cross-sections for 2002-2016)

- The negative link between risk and funding ratios is strong in recent years, a period with low returns on safe assets.



5. Findings: risk vs. funding ratios (panel regressions)

- Use two approaches to get funding rations for the full sample period (2001-2016):
  1. Use the 2015 value of FR_i as a proxy for past funding ratios.
  2. Use the duration and convexity available for 2014-2016 only—adjusted for demographics—to rediscount past actuarial liabilities, compute $FR_{i,t}$

- While imperfect, both approaches provide a way to use the panel data, produce similar results.

- In panel regressions:
  - Demean funding ratios by the cross-sectional mean for each year to identify their effect separately from risk-free rates.
  - Exclude years that follow financial market downturns (2002, 2003, 2009) to mitigate reverse causation.

5. Findings: risk vs. funding ratios, Treasury yields (panel)

- $Risk_{i,t} = \alpha + \beta * FR_{i,t-1} + \gamma * Yield_t + \delta * FR_{i,t-1} * Yield_t + \varepsilon_{i,t}$

VARIABLES	(1) RISK	(2) RISK	(3) RISK	(4) RISK
FR	-0.045***	-0.014***	-0.054***	-0.0052***
	(0.0034)	(0.00096)	(0.0019)	(0.00034)
TRY 5yr	-0.021**		-0.021**	
	(0.0077)		(0.0075)	
FR * TRY 5yr	0.0078***		0.013***	
	(0.00078)		(0.0012)	
Dummy post-GFC		0.054*		0.053*
		(0.030)		(0.029)
FR * Dummy post-GFC		-0.020***		-0.034***
		(0.0027)		(0.0011)
Constant	0.21***	0.13***	0.21***	0.13***
	(0.034)	(0.011)	(0.033)	(0.011)
FR	FR fixed	FR fixed	FR time var	FR time var
Fixed effects	No	No	No	No
Observations	1,296	1,296	1,289	1,289
R-squared	0.208	0.183	0.210	0.184

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- More risk associated with underfunding ($\beta < 0$).
- More risk associated with lower yields ($\gamma < 0$), especially for the more underfunded funds ($\delta > 0$).
- Results consistent with RFY in model example.

5. Findings: risk vs. state debt, funding ratios, Treasury yields (panel)

- $Risk_{i,t} = \alpha + \beta * FR_{i,t-1} + \gamma * Yield_t + \delta * State_{i,t} + \eta * Yield_t * State_{i,t} + \varepsilon_{i,t}$

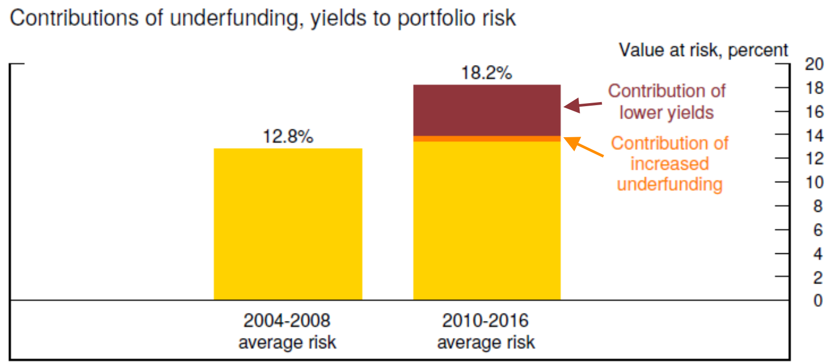
VARIABLES	(1) RISK	(2) RISK	(3) RISK	(4) RISK
FR	-0.026***	-0.023***	-0.019***	-0.016***
	(0.0025)	(0.0028)	(0.00030)	(0.00062)
TRY 5yr	-0.021**	-0.021**	-0.021**	-0.021**
	(0.0077)	(0.0077)	(0.0077)	(0.0075)
State DTI	0.024***		0.046***	
	(0.00046)		(0.0023)	
TRY 5yr * State DTI	-0.0099***		-0.016***	
	(0.00082)		(0.0018)	
State bond rating		0.0016***		0.0021***
		(0.000062)		(0.00015)
TRY 5yr * State rating		-0.00042***		-0.00049***
		(0.000019)		(0.000028)
Constant	0.21***	0.21***	0.21***	0.21***
	(0.034)	(0.034)	(0.034)	(0.033)
FR	FR fixed	FR fixed	FR time var	FR time var
Fixed effects	No	No	No	No
Observations	1,272	1,270	1,280	1,278
R-squared	0.209	0.209	0.210	0.211

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

- More risk associated with underfunding ($\beta < 0$) and worse state finances ($\delta > 0$).
- More risk associated with lower yields ($\gamma < 0$), especially for funds from states with worse finances ($\eta < 0$).
- Results consistent with model example with risk-shifting.

6. Implications

- Lower yields, funding ratios accounted for about 1/4 of portfolio risk post-crisis.



- PPFs' RFY may result in higher losses in a downturn.
  - These losses could further strain the public finances of state and local sponsors.
  - *Losses under Stress = VaR * Actuarial Assets.*
  - Losses would have added almost 20% of the state and local debt post-crisis, vs. only 13% pre-crisis.
  - The fiscal impact of the PPFs' losses would be gradual.

Conclusions

- We document the RFY behavior of U.S. PPFs:
  - RFY is related to underfunding, low yields on safe assets, sponsors' public finances.
- We use an innovative econometric approach to measure portfolio risk:
  - Identify the mix of market indexes relevant for each asset class.
  - Use these market indexes to estimate daily returns for each asset class.
  - Compute the VaR of PPFs' portfolios.
- Underfunding and low yields accounted for about 1/4 of the PPFs' total risk-taking as of 2016.
- RFY could lead to higher losses in a downturn, which would further strain state and local finances, i.e., add almost 20% to public debt in post-crisis years, vs. 13% pre-crisis.
- Thank you!