Evaluating U.S. Public Pension Policy

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Introduction

- US state pensions are underfunded
  - in aggregate, a $1.5 trillion deficit [Pew, 2019]
  - mechanically, low returns + low savings
  - governance issues

- Reforms have been implemented
  - RI [2011], NJ [2011], OK [2015], MN [2018]
  - reform *levers*
    1. accounting practices
    2. plan participant compensation
  - constituents
    (i) current v retired workers
    (ii) plan members v taxpayers

Funded Ratios | Annual Required Contributions (ARC) | Target Returns

Research Question(s)

- **Question**: What is the welfare impact of pension reform on state constituents?
- Particularly:
  1. Oklahoma reform [2015] (Today)
  2. Rhode Island reform [2011]
- Policy experiments:
  1. Reforms applied to other states
  2. Discount rate reform
  3. Pension obligation bonds (POBs)

Preview of Results

- OK reform in OK:
  (1) large welfare losses in public sector
    - cost-of-living-adjustment (COLA) freeze

  (2) small welfare gains in private sector
    - reduced tax level & volatility

  (3) young cohorts fare better
    - capture long-run benefits

Model Overview

- Agent lifecycle problem
  - working and retirement periods
  - private and public sector work
  - public workers receive pension
- Joint distribution of agents
  (i) by age
  (ii) by job sector
  (iii) through time
- State fiscal authority
  - balanced budget rule and pension funding rule
  - *limited commitment* to pension funding $\rightarrow$ chronic underfundedness
- **Contribution**: comprehensive state-level welfare analysis

Agent Problem

- Workers live for ages $t = 1, 2, ..., 80$
  - mortality risk $p(t+1|t)$
- CRRA preferences over consumption c
- Discount future with β
- For each age, choose
  (i) consumption c
  (ii) savings a
  (iii) portfolio investment α

  subject to available wealth x

Agent Problem

Working, Retirement Stages

- Fixed retirement at age 45
- In working stage, receive exogenous wage $w(s, t, \epsilon, \eta)$:
  (i) job sector $s \in \{pub, priv\}$
  (ii) deterministic age trend
  (iii) idiosyncratic, transitory shock ϵ
  (iv) idiosyncratic, persistent shock η
- Wage tax $\tau(\chi, T)$:
  (i) pension funded ratio χ
  (ii) model time $T = 1, 2, \ldots$
- In retirement, workers receive sector-specific annuity b^s

Agent Problem

- Worker state: $\varsigma = \big(x, t, s, \eta, \chi, T\big)$
- Agent solves:

$$
\begin{aligned}
V(\varsigma) = \max_{c,a,\alpha} \quad & u(c) + \beta p(t+1|t)E\big[V(\varsigma')|\varsigma\big] \\
s.t. \quad & c + a = x \\
s.t. \quad & x' = \big[\alpha R' + (1-\alpha)R^f\big]a \; + \\
& \qquad\qquad \big(1-\tau(\chi', T+1)\big)w(s, t+1, \epsilon', \eta') \\
s.t. \quad & \chi' = \Gamma(\chi, R', T+1) \\
s.t. \quad & c \geq 0, \quad \alpha \in [0,1] \\
s.t. \quad & \text{exogenous processes } \{R', \eta', \epsilon'\}
\end{aligned}
$$

State Fiscal Environment

Balanced Budget Rule

- State populated by agent distribution $\Phi : s \times t \times T \rightarrow [0,1]$
  - Age cohort growth rates $\phi(t, T)$ induce demographic change

- Fiscal authority sets tax $\tau = \tau^w + \tau^p$ to balance budget:

$$\underbrace{\tau \sum_s \sum_t \Phi(s,t,T) w(s,t,0,0)}_{\text{tax base}} = \underbrace{C(\chi, T)}_{\text{pension contributions}} + \underbrace{\sum_t \Phi(pub,t,T) w(pub,t,0,0)}_{\text{public wages}}$$

for each year T, pension funded ratio χ

State Fiscal Environment

Funded Ratio

- Fixed investment portfolio α^p
- Public workers receive $\bar{b}$ in retirement
- Value of liabilities $PVL(T)$ at time T
  - method: entry age normal
  - discount rate r^p

PVL Formula

- Each year, pre-contribution funded ratio defined as

$$\chi = \frac{\text{Return on Assets} - \text{Distributions}}{PVL(T)}$$

implies unfunded liability $UFL = (1 - \chi)PVL(T)$

Funded Ratio Formula

State Fiscal Environment

Pension Funding Rule

- **Annual Required Contribution (ARC)**: contribution such that pension fully funded in long run
- ARC composed of
  (1) Normal Cost (newly accrued benefits)
  (2) Amortized Unfunded Liability
- **Limited commitment** $\theta \leq 1$ to pension funding
- Contributions set as

$$C(\chi, T) = \theta\Big[\text{Normal Cost}(T) + \text{AUFL}(\chi, T)\Big]$$

Normal Cost Formula Amortization Formula

If $\chi > \bar{\chi}$, surplus distributed to annuitants.

Equilibrium

Definition

An equilibrium is defined as a set of stochastic processes $\{R', \epsilon', \eta'\}$, and deterministic aggregates $\{\Phi(s, t, T)\}$ such that for periods $T = 1, 2, ...$

1. Agents solve their lifecycle problem
2. Fiscal authority sets τ to balance budget
3. Pension policy rules induce the law of motion

$$\chi' = \Gamma(\chi, R', T + 1)$$

Calibration

- Pension data: annual public plan financial reports
- Model parameters split into
  (1) universal
    - preferences, prices, wage process

  (2) state-specific
    - fiscal policy, demographic distribution
- Model time $T = 1, 2, ..., 45$
  - reforms affect current workers, only
- Consumption-equivalent welfare (averaged across wealth distribution)

Universal Calibration | State Calibration | CE Welfare

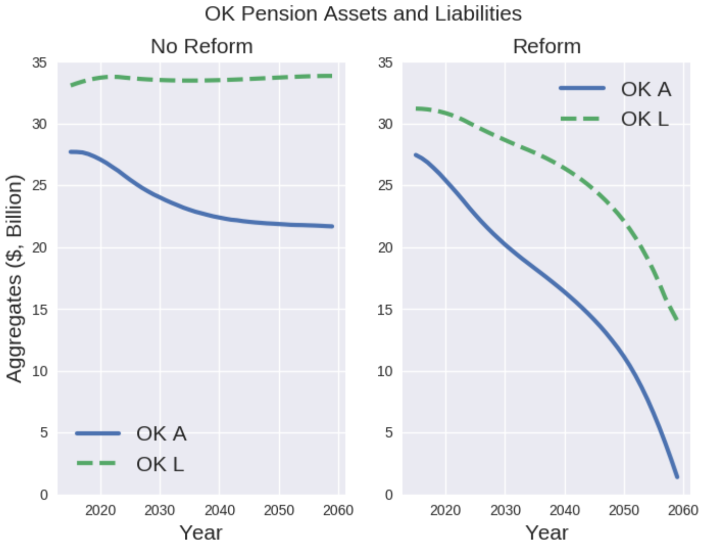
Oklahoma Reform [2015]

- Two components
  (1) Close plan to new entrants
  (2) Freeze cost-of-living-adjustments (COLAs)[1]
- Assume 1.6% annual inflation[2]
- Procedure
  - for all working cohorts at date $T = 0$
    - solve no-reform model
    - solve reform model
  - simulate both models $\rightarrow$ wealth distribution $\rightarrow$ welfare
  - compare fiscal aggregates, welfare metrics

[1] Apply COLA freezes only to future annuitants.
[2] Source: Navega Strategies

Oklahoma Reform [2015]

Pension Balance Sheet: Significant Impact on PVL

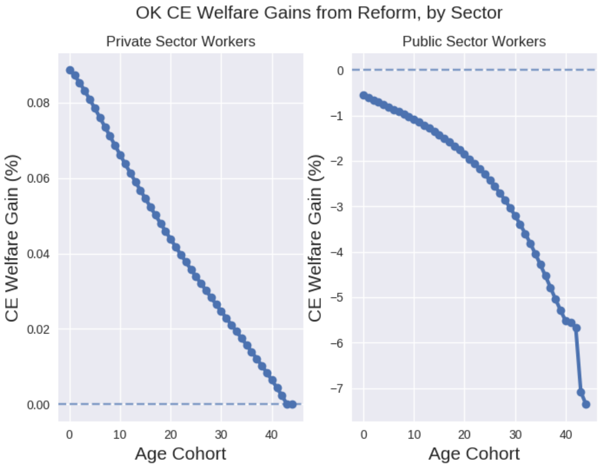


Oklahoma Reform [2015]

Tax Policy: Reduction in Level and Vol

Oklahoma Reform [2015]

Welfare Gains: Large Losses in Public Sector



	Public Sector	Private Sector	Statewide
Baseline ΔWelfare	-2.46%	0.04%	-0.27%
No COLA Freeze ΔWelfare	.01%	.01%	.01%

Next Steps

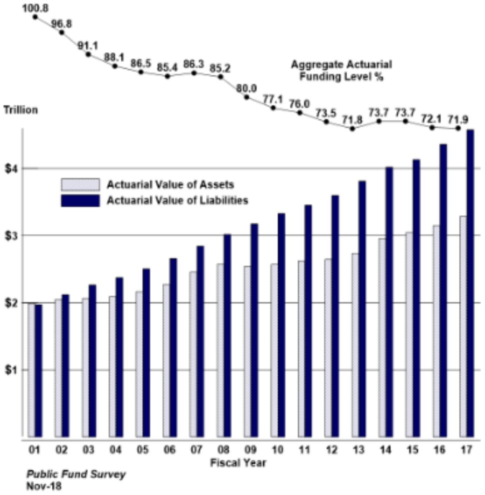
- Reform counterfactuals in other states

OK Reform

- New entrant welfare
  - model focuses on
    1. transitional features of reform
    2. welfare impact on current workers
  - consider welfare of new entrants
- Labor market *indifference*
  - model: no labor/leisure or employment decision
  - pros: tractability
  - half-step: : set wage volatility such that age 1 workers indifferent between public/private sector

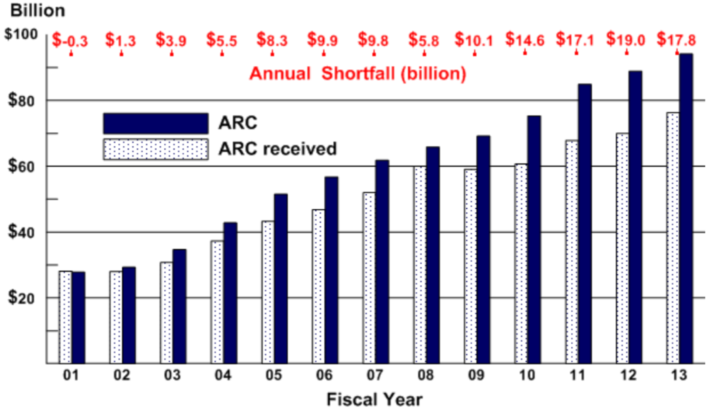
Thank You!

Aggregate Funded Ratios



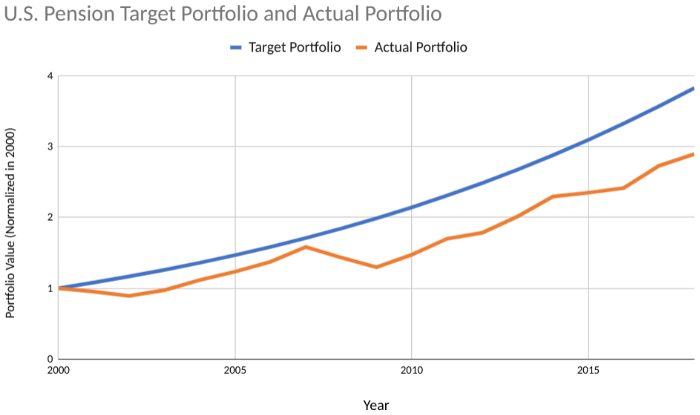
Return

Annual Required Contributions



Return

Target Returns and Investment Performance



Return

Valuing Pension Liabilities

- At time T,

$$PVL(T) = \sum_{j=0}^{\infty} \frac{c_{T+j}}{(1+r^p)^j}$$
$$= \sum_{j=0}^{\infty} \frac{1}{(1+r^p)^j} \sum_{k=45}^{80} \Phi(pub, k, T+j)\alpha(T+j, k)\bar{b}$$

with Entry Age Normal (EAN) accrual factor

$$\alpha(T+j,k) = \begin{cases} 1, & \text{if} \quad k-j \geq 45 \\ \frac{\sum_{k=1}^{k-j} w_k}{\sum_{k=1}^{45} w_k}, & \text{if} \quad k-j < 45 \end{cases}$$

Return

Funded Ratio Formula

- Given (χ, T) today,

$$\chi' = \frac{\text{Return on Assets} - \text{Distributions}}{PVL(T+1)}$$
$$= \frac{[\alpha^p R' + (1-\alpha^p)R^f]\tilde{\chi} PVL(T) - \bar{b}\sum_{k=45}^{80}\Phi(pub, k, T+1)}{PVL(T+1)}$$

where $\tilde{\chi}$ is post-contribution funded ratio

Return

$\tilde{\chi} = f(\chi, T)$ such that $\tilde{\chi} = \chi + \frac{C(\chi, T)}{PVL(T)}$ where C: pension contribution.

Normal Cost

- Define normal cost NC(T) at time T as

$$
\begin{aligned}
NC(T) &= \sum_{k=1}^{45} \Phi(pub, k, T) \sum_{m=1}^{35} \frac{p(45+m|k)}{(1+r^p)^{45-k+m}} \frac{w_k}{\sum_{l=1}^{45} w_l} \bar{b} \\
&= \underbrace{\sum_{k=1}^{45} \Phi(pub, k, T)}_{\text{aggregation}} \quad \underbrace{\tilde{\beta}(k)}_{\text{discount factor}} \quad \underbrace{\tilde{b}(k)}_{\text{accrued benefit}}
\end{aligned}
$$

Return

Amortized Unfunded Liability

- The unfunded liability (UFL) is the difference between liabilities and assets:

$$UFL = (1 - \chi)PVL$$

given pension liabiities PVL

- Given amortization period $\bar{T}$, the amortized UFL is

$$AUFL = UFL \frac{r^p}{1 - (1 + r^p)^{-\bar{T}}}$$

Return

Universal Calibration

Table 1: Universal Parameters

Parameter	Label	Value	Source/Target
β	Discount Factor	0.96	Standard
γ	Risk Aversion	10	CGM [2005]
r_f	Risk-free Rate	.02	Navega
μ_r	Equity Premium	.04	Navega
σ_r	Equity Vol	.157	Navega
$\{f(t)\}$	age wage trend	—	CGM [2005], PSID
σ^ϵ	Transitory Vol	.074	CGM [2005], PSID
σ^ν	Persistent Vol	.011	CGM [2005], PSID
$\{p(t+1\|t)\}$	Mortality Risk	—	NCHS
$\lambda(pub)$	Sector Wage Gap	.91	BEA

State-Specific Calibration

Table 2: State-Specific Parameters

Parameter	Label	Source/Target
$\bar{b}$	Pension Benefit	State Reports
$\{b^s\}$	Social Security	SSA
r^p	Stat Discount Factor	State Reports
χ^0	Initial Funded RAtio	State Reports
θ	Contribution Commitment	NASRA
α^p	Pension Portfolio	State Reports
$\mathbf{\Phi}$	Agent Distribution	UVA Weldon Cooper, NASRA, BEA
M	Total Population	2019 PVL
$\bar{T}$	Amortization Window	State Reports

Return

Consumption-Equivalent Welfare

- Given utility V^*, CE $\bar{c}^*$ defined as

$$V^* = \sum_{t=1}^{80} \beta^t \left(\prod_{j=1}^{t} p(j+1|j) \right) \frac{\bar{c}^{*(1-\gamma)}}{1-\gamma}$$

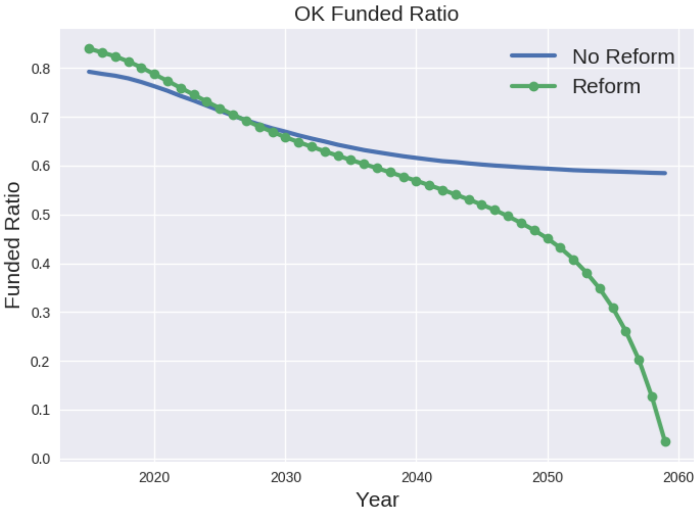
- V^* a function of endogenous agent wealth x
- For each sector s,
  1. simulate baseline w/o demographic change
  2. for each age, collect cross-section of CE values $\bar{c}_s^*(t,x)$
  3. compute average age-specific CE value

$$\bar{c}_s^*(t) = \int \bar{c}_s^*(t,x) dF(x|s,t)$$

Return

Oklahoma Reform

Funded Ratios



Oklahoma Reform

Normal Cost and Ufunded Liability

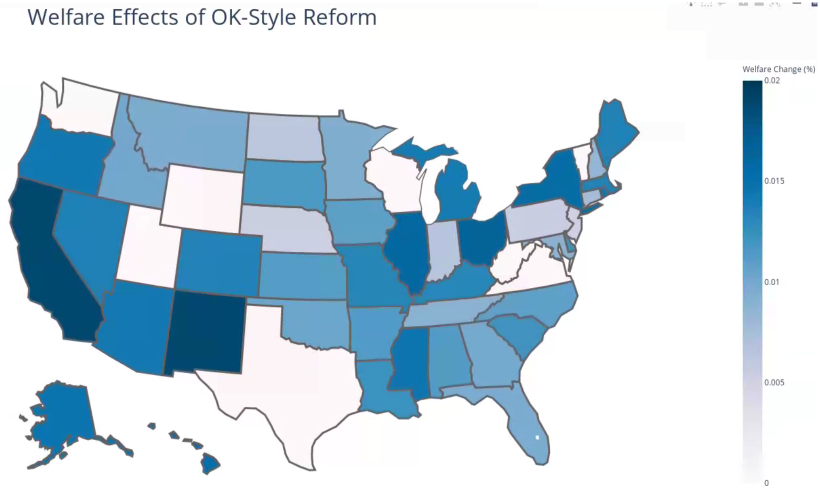
Oklahoma Reform [2015]

Applied to Other States

- Consider OK reform w/o COLA freeze
- For each state of interest,
  1. re-calibrate model
  2. re-run reform experiment

Oklahoma Reform [2015]

Applied to Other States



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