The Transitional Impact of State Pension Reform*

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Abstract

We use an overlapping generations framework to evaluate the transitional impact of state pension reform on public and private workers, and apply this analysis to all fifty U.S. states. We consider (i) closing the pension plan to new entrants, (ii) reducing benefits together with wage increases and (iii) suspending cost-of-living-adjustments (COLAs). While each reform effectively reduces long run taxes, variation in fiscal and demographic features creates significant differences in state outcomes. Closing the plan to new entrants generates the most even distribution of welfare gains across job sectors and age cohorts, while COLA suspensions prove particularly harmful to public workers.

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1 Introduction

U.S. state pension plans currently do not have sufficient funds to finance future retirement benefits. For example, 2020 Public Plans Data documents state pensions were operating with a 72% funded ratio which implies an aggregate underfunded gap greater than \$1.5 trillion. The ultimate burden of financing underfunded pension systems falls on taxpayers, as they are responsible for public employee wages and benefits. Given this, analysis related to altering state pension systems should properly account for all affected constituencies.

This paper is the first to examine the transitional welfare effects of public pension reform on both the public and private job sector at the state-level. In particular, we develop a heterogeneous overlapping generations model and evaluate pension reform for all fifty U.S. states. The cross-state variation introduces significant scope to our analysis and allows us to learn which state characteristics are most relevant for producing effective reform outcomes. Further, by focusing on transitional effects, we are able to better understand the political viability of each reform.

The model is comprised of a joint distribution of workers who solve a lifecycle problem subject to the fiscal policy of the state and other demographic trends over time. Workers vary by age, wealth and job sector, working in either the private or public sector. Public sector workers are enrolled in a state-run pension plan whereas private sector workers individually save for retirement. Each agent solves a lifecycle portfolio choice model similar to Cocco, Gomes, and Maenhout [2005] and lives through two stages (working and retirement), making decisions over consumption/savings and asset portfolios each period. Agents are exposed to three sources of risk: mortality, wage and market risk. In addition, both public and private employees are subject to a wage tax which varies with the management and health of the state-run pension plan. In terms of fiscal policy, the government operates under fixed rules which require it to finance public sector wages and pension benefits with a balanced budget. The government is also responsible for managing the pension fund which involves the investment of pension assets (portfolio management) as well as the raising of contributions (savings) for current and future benefits. Two features are key to generating the chronic pension underfundedness that is observed in the data. First, states value their pension liabilities with unrealistically high discount rates such that liabilities grow faster than investment returns. Second, states contribute an insufficient amount of funds each period to their pension asset pool.

The calibration of the quantitative model is divided into two sets: universal and state-specific parameters. State-specific parameters mostly relate to demographic features and fiscal characteristics which are obtained from state financial reports. This allows considerable tractability in parameterizing the model to a specific state and/or point in time for our analysis.

For our main policy experiment, we examine the positive and normative impact of three pension reforms for all fifty states. In the first reform (Closed Reform), we consider the impact of closing the pension plan to new entrants and increasing new entrants' wage compensation by 5%. In the second reform (Hybrid Reform), we consider the impact of a hybrid pension system which partially reduces pension benefits for current and future workers but compensates them with a 5% wage increase. Finally, we consider a cost-of-living-adjustment (COLA) freeze which reduces the real value of pension benefits for public workers by 1.5% annually and offers no additional compensation. We focus on these three reform styles as they are the most often proposed for U.S. state pensions.[1]

In terms of positive analysis, we find each reform significantly reduces pension liabilities which causes a net reduction in state taxes. When averaged across states, the Closed Reform generates a 23% reduction in pension liabilities after 45 years. For the Hybrid and COLA reforms, the reductions are 40% and 25%, respectively. The Hybrid Reform generates the largest drop in taxes: a level reduction of 1.1%, on average. While the COLA Reform creates the largest initial drop in liabilities and taxes, due to the immediate impact that COLA assumptions have on the valuation of pension liabilities, the Closed and Hybrid reforms lead to lower taxes in the long run. For each reform, state-level differences arise with respect to the timing, magnitude and direction of change in relevant fiscal aggregates. In large part, the differences are caused by variation in the size of the pension benefit and public sector, as well as demographic age trends for each state.

In terms of normative analysis, we generally find that all workers experience welfare gains

[1] See Brainard and Brown [2018].

from the Closed Reform and that those gains are the most evenly distributed across job sectors and age cohorts. In terms of age, young workers experience the largest gains due to the long run reduction in taxes which frees up additional resources for consumption. Under the Hybrid Reform, private workers experience even larger welfare gains due to the larger tax reduction, but public workers have mixed results. In particular, young public workers benefit from lower taxes and the 5% wage increase in a way that offsets losses from the reduced pension benefit. Conversely, old public workers experience significant welfare losses and are highly sensitive to benefit reductions, given their proximity to retirement. Last, we find that the COLA reform is the most contentious in the sense that private workers experience the largest welfare gain of the three reforms while public workers experience the largest welfare loss. For public workers, a freeze in COLAs effectively reduces the real value of pension benefits and this proves particularly harmful. While this type of uncompensated adjustment in retirement benefits has significant negative effects for public workers, it is a commonly employed reform used by states to quickly reduce their pension liabilities.[2]

Section 2 reviews related literature. Section 3 provides additional background with respect to U.S. state public pension plans. Section 4 details the quantitative model. Section 5 details model calibration relevant data sources. Section 6 presents results from the main policy experiments, and Section 7 concludes the paper.

2 Related Literature

We use an overlapping generations framework to evaluate reforms of a state pension system. As such, our work is related to a large literature which examines the risk-sharing benefits of public retirement systems, as well as the costs (and benefits) of transitioning to alternative retirement schemes. While public retirement systems can be used to complete markets and improve welfare (Diamond [1977], Ball and Mankiw [2007] and Shiller [1999]) they can also be a source of inefficiency arising from a host of political constraints which lead to poor management (Monahan [2015], Andonov, Hochberg, and Rauh [2018], Pennacchi and Rastad [2011] and Bradley, Pantzalis, and Yuan [2016]).

[2]Since 2009, more than half of U.S. state have proposed or implemented some form of COLA reform.

For these reasons, a significant literature has investigated the normative and positive effects of reforming pension systems. Often, the focus has been on how reform effects are distributed across generations (Cui, De Jong, and Ponds [2011], Gollier [2008], Krueger and Kubler [2002]) while others have highlighted important sources of intragenerational heterogeneity (Conesa and Krueger [1999], Fuster, Imrohoroglu, and Imrohoroglu [2003], Huggett and Ventura [1999], Imrohoroglu, Imrohoroglu, and Joines [1995], Laun, Markussen, Vigtel, and Wallenius [2019]). In addition, others have closely explored the transitional effects of reform (Nishiyama and Smetters [2007]). This is important because current generations are often the most acutely affected and this can determine the political viability of such reforms. For example, papers which evaluate transitions from a pension system to one of individual accounts often find significant welfare losses for the current generation (McKiernan [2021] and De Nardi, Imrohoroglu, and Sargent [1999]) while some others find that gains are possible (McGrattan and Prescott [2017]).

This paper is, to our knowledge, the first to examine the transitional welfare effects of public pension reform on public and private sectors workers at the U.S. state-level. This distinction is important because state pension coverage is not universal: benefits accrue to public workers while private workers are affected by taxes which fund the pension system. In addition, we use cross-state variation in fiscal and demographic characteristics to determine which factors are economically relevant in determining effective reform outcomes.

The individual lifecycle problem is most similar to frameworks used by Cocco, Gomes, and Maenhout [2005] and Campbell, Gomes, and Maenhout [2001], where agents live through a working and retirement period and make decisions related to consumption/savings as well as their financial asset portfolio. See also Chai, Horneff, Maurer, and Mitchell [2011] and Horneff, Maurer, Mitchell, and Stamos [2009]. Importantly, agents are born into one of two job sectors: the public sector where they receive an exogenous wage process and guaranteed pension benefit, or the private sector where they receive a different wage process as well as individual retirement savings accounts.

U.S. state pension plans suffer from a variety of institutional features and constraints which limit their ability to remain solvent in the long run. Monahan [2015] and Beermann [2013] describe the current chronic underfundedness as a symptom of underlying fiscal constraints and limited commitment on the part of state legislatures. While most states face balanced budget constraints, pension contributions are not an explicit component of their liabilities. Thus, lowering pension contributions is a means of relaxing fiscal pressures. This is particularly appealing as the costs of underfundedness (e.g. insolvency risk) materialize long after the current political cycle.[3] In our model, states set unrealistically high discount rates and under-contribute to their pension fund in a way that is consistent with the data. In addition, related research has explicitly focused on the constraints and incentives which determine government decisions within the context of pension plan management (see Myers [2021], Myers [2019] and Pennacchi and Rastad [2011]). For tractability we assume the state government follows a rule-based policy to balance its budget each period. This policy determines how pension contributions and taxes vary with the funded ratio of the pension over time and in a way that is consistent with empirical trends for U.S. state pension plans.

3 Background and Empirical Observations

In the aggregate, state pension plans in the United States are significantly underfunded and their condition has deteriorated over the last two decades. In this section, we document this decline and expand upon the underlying causes for chronic pension underfundedness which will, in turn, help inform modeling assumptions used in this paper. We use data from the Public Plans Database (PPD) which is provided by the Center for Retirement Research at Boston College (CRR) and the MissionSquare Research Institute and supported by the National Association of State Retirement Administrators (NASRA). This data is annual in frequency and spans the years 2000 to 2020.

A pension funded ratio is the ratio between current assets A and liabilities L of the plan. Thus, when the plan does not have enough assets to cover liabilities, the funded ratio is less than one which is a common indicator of poor pension health. Pension liabilities are present value calculations for all future benefits that the plan has guaranteed. For example, if a plan was committed to paying an infinite, deterministic stream of aggregate benefits B at a rate r, then liabilities would be $L = \frac{1+r}{r}B$. Importantly, unlike U.S. private pensions, state plans

[3] See also Fitzpatrick and Monahan [2015], Monahan [2010] and Monahan [2017].

have additional flexibility in choosing their discount rate r. Under Government Accounting Standards Board (GASB) ruling 25, pension plans choose discount rates based upon their expected investment return.[4] By choosing a high discount rate, the pension can reduce the value of its liabilities and immediately improve its funded ratio.[5]

Figure 1 plots the average public plans funded ratio, as well as the asset and liability components of the funded ratio over time. As can be seen in the top panel, even with high discount rates, the average funded ratio has declined from nearly 100% in the early 2000s to 71.5%. As of 2020, given that states have an aggregate pension liability of $5 trillion, this implies a deficit in excess of $1.5 trillion.

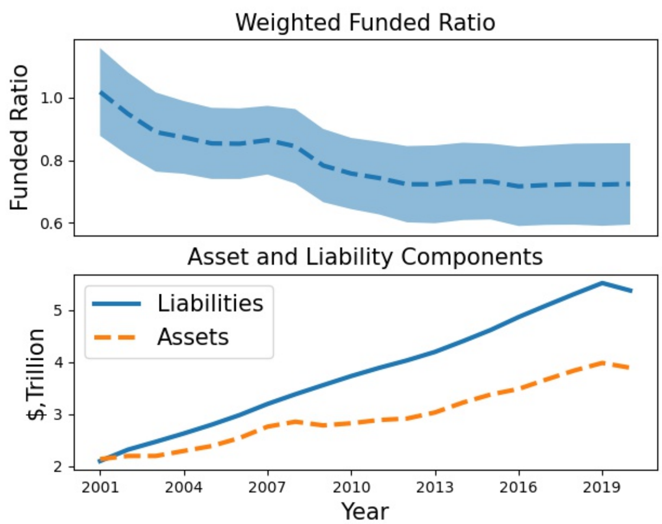

Figure 1

Notes: The top panel plots average funded ratios for each year, weighted by plan liabilities, and volatility bands are computed based upon the weighted standard deviation for each year. In the lower panel, plan liabilities and assets are simply summed for each year.

Throughout this time period, pension liabilities have continued to grow (bottom panel). A large body of research has sought to quantify the magnitude of the funding crisis and underscore the role of unsound accounting practices which mask the problem.[6] For example,

[4] According to the 2021 Milliman Corporate Pension Funding Study, the average discount rate of the top 100 U.S. corporate pensions was 3.08% in 2019, whereas the average state pension plan used a rate of 7.18%.

[5] In our example, $\frac{\partial L}{\partial r} = -\frac{B}{r^2} < 0$ for any positive discount rate r.

[6] Specifically, Government Accounting Standards Board (GASB) ruling 25 and Actuarial Standard of Practice (ASOP) item 27 allow public pension liabilities to be discounted with their expected portfolio return.

Novy-Marx and Rauh [2011a] find that by using appropriate discounting assumptions for liabilities, public pension liabilities are, conservatively, 38% higher than their reported value.[7] Also, an aging workforce is another attributing factor which has led to the growth in pension liabilities over this time period.[8]

When a pension plan is underfunded, it is commonly the result of low savings (called contributions) or low investment returns. In the aggregate, the current decline in public pension funded ratios is due to both. For the former, Figure 2 plots the average level of pension contributions relative to the Annual Required Contribution (ARC). The ARC is the level of contributions to ensure the pension is, on average, fully funded in the long run. Therefore, contributions falling below their ARC indicates insufficient saving. As can be seen in the figure, aggregate pension contributions have failed to satisfy their ARC over the whole sample period.

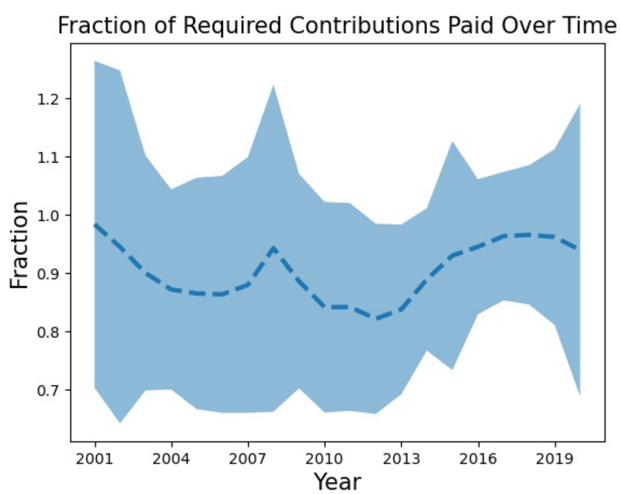

Figure 2

Notes: Average contributions as a fraction of ARC are weighted by the size of plan liabilities, and volatility bands are computed based upon the weighted standard deviation for each year.

In addition to low savings, U.S. pension plan investment returns have historically underperformed relative to their target returns. As mentioned earlier, pension target returns

[7]See also Novy-Marx and Rauh [2011b], Andonov and Rauh [2021], Brown and Wilcox [2009] and Anzia et al. [2019].

[8]See De Nardi, Imrohoroglu, and Sargent [1999] for a reference to the impact an aging workforce has on the U.S. Social Security system.

are especially important because plans discount their liabilities with the same rate. Thus, by setting a high target return, plans can automatically reduce the present value of pension liabilities and improve their funded ratio. Despite this immediate benefit, liabilities grow at the rate of their discount factor and plans risks insolvency if they cannot achieve the long run target returns. In 2020, for example, the weighted average target rate of return for public plans was 7.13% whereas the average portfolio return was 6.4%.

Figure 3 plots the hypothetical value of two portfolios, normalized to 1 in year 2000. The first portfolio's value is obtained from the target returns of U.S. state pension plans, assuming that all returns are re-invested with the principal each year. The second portfolio's value is obtained from the actual returns experienced by the plans. As illustrated, the actual portfolio significantly underperformed the target portfolio over the sample period such that it was 26.6% below its target value in 2020. This corresponds to returns underperforming by 1.6% on an annualized basis.

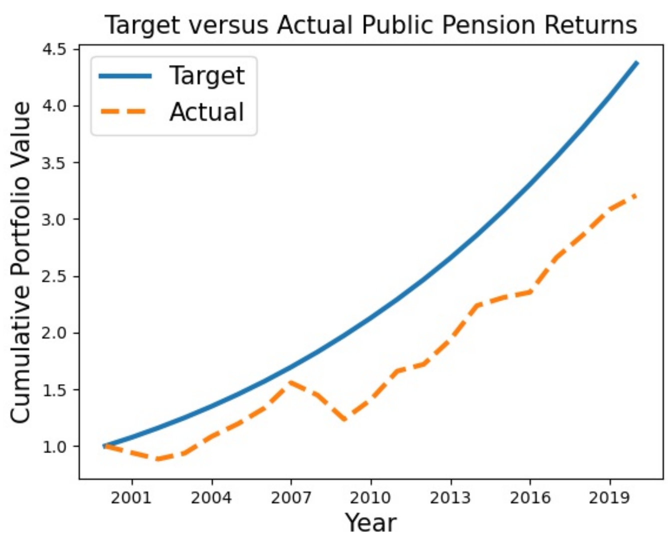

Figure 3

Notes: For each time period, an average target return and actual return are computed, weighted by the size of plan liabilities. These rates are then applied to a hypothetical portfolio, normalized to value 1 in year 2000, where annual returns are continually re-invested with the principal.

In summary, U.S. public pension plans have experienced a continual decline in funded health for the past two decades. This decline is due to low savings and low investment returns, which are linked to the discounting assumption made with respect to liabilities. Further, with an aging workforce, pension liabilities and annual benefit distributions have continued to grow. Together these features generate chronic underfundedness which places an increasing burden on current (and future) workers in both the public and private sectors. This fact has prompted many states to consider a transition to alternative retirement schemes which utilize individual retirement accounts. Our model and quantitative analysis will properly account for these institutional and fiscal features.

4 Model

We use a heterogeneous overlapping generations model with fixed prices to analyze the effects of state-level pension reform. Model agents solve a lifecycle problem with fixed working and retirement periods and differ with respect to their job sector, wealth and age. Sector of employment determines the compensation the worker receives in terms of wages and retirement benefits. We assume that all public sector workers receive a state-sponsored pension. During the lifecycle, agents are exposed to three sources of risk: wage, mortality and market risk. Both wage and mortality risk are idiosyncratic whereas market risk is an aggregate shock to investment returns. Last, there exists a state fiscal authority which follows a set of rules to fund public sector wages and contributions to the pension plan.

Lifecycle Problem. Agents in a state s are born at age $t = 1$ and can live to age $t = 80$ but are subject to mortality risk, given by conditional survival probabilities $p(t+1|t)$ for each age. Agents have CRRA preferences over consumption

$$u(c) = \frac{c^{1-\gamma}}{1-\gamma} \tag{1}$$

and discount the future at a rate $\beta \in (0, 1)$. Each period, agents solve a consumption/savings problem along with a portfolio problem. Specifically, given beginning-of-period wealth x, agents choose consumption c and savings a to satisfy the budget constraint

$$c + a = x \tag{2}$$

and choose a risky asset portfolio share $\alpha \in [0,1]$ where $R' \sim N(\mu, \sigma)$ is the risky asset gross return next period and R^f is the risk-free rate. Given the recursive structure of the problem, we use prime notation to indicate objects realized in the following period.

Agents work for the first 45 years and then enter retirement. During the working period, agents receive a wage $w(s, j, t, \epsilon, \eta)$ which is a function of their state s, job sector $j \in \{pub, priv\}$, age, and idiosyncratic wage shocks (ϵ, η) where ϵ is transitory and η is persistent. More specifically, ϵ is a mean-zero, normally distributed random variable with variances σ_ϵ^2 and η is a random walk

$$\eta' = \eta + \omega' \tag{3}$$

where ω' is a mean-zero, normally distributed random variable with variance σ_ω^2. Upon reaching retirement, agents receive a sector-specific annuity $b_{sj} = b_{sj}^{ss} + \mathbb{1}[s = pub]\bar{b}_s$ which includes a social security component, as well as a pension annuity $\bar{b}_s$ if the agent works in the public sector.[9] Last, during the working period, agents are subject to a wage tax $\tau(s, \chi, T)$ which depends upon state demographics, the pre-contribution funded ratio χ of the pension, as well as model time $T = 0, 1, 2...$ in years.[10] The law of motion on next-period agent wealth during the working period can be expressed as

$$x' = \underbrace{\left[\alpha R' + (1-\alpha)R^f\right]a}_{\text{portfolio return}} + \underbrace{\big(1 - \tau(s, \chi', T+1)\big)w(s, j, t+1, \epsilon', \eta')}_{\text{after-tax wages}} \tag{4}$$

In solving the recursive worker problem, we define an agent's point in the state space by

[9]We assume the federal government financing of social security benefits occurs outside the model environment and that model wages are net of the corresponding payroll taxes which would finance the benefits.

[10]The funded ratio χ and tax formula will be explicitly derived in the following section.

the vector $\boldsymbol{\varsigma} = \big(s, x, t, j, \eta, \chi, T\big)$. Thus, for a given individual state, the agent solves

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

where the agent faces short-selling portfolio constraints and also conditions upon the law of motion Γ for the pension funded ratio which affects the next-period wage tax. In the retirement period of the lifecycle, the state space reduces to $\boldsymbol{\varsigma}^r = \big(s, x, t, j\big)$ as the agent is no longer subject to wage risk or wage taxes. Also in retirement, the wealth law of motion reduces to

$$
x' = \big[\alpha R' + (1-\alpha) R^f\big] a + b_{sj} \tag{6}
$$

where the annuity benefit depends upon the agent's sector of employment.

State Fiscal Authority. We assume the state is populated by a continuum of agents of mass M_s who are distributed according to the joint distribution $\Phi : s \times j \times t \times T \rightarrow [0,1]$ which is a deterministic function of the state, job sector, agent age and model time.[11] Further, cohort growth rates $\phi(s,t,T)$ induce a law of motion for Φ over time. The state fiscal authority must balance the budget each period and raise taxes to fund public sector wages and the state pension plan. Specifically, for any given state s, time period T and pension funded ratio

[11]For notational ease, we normalize M_s to 1 in this section but relax the assumption when calibrating the model to particular states.

χ, the authority sets τ to balance the budget

$$(7) \qquad \tau \sum_{j=\{pub,priv\}} \sum_{t=1}^{45} \Phi(s,j,t,T) \int\int w(s,j,t,z_1,z_2)dF(z_1,z_2) = C(s,\chi,T) + \sum_{t=1}^{45} \Phi(s,pub,t,T) \int\int w(s,pub,t,z_1,z_2)dF(z_1,z_2)$$

where the left-hand side represents tax revenues which fund pension contributions $C(s,\chi,T)$ and public wages on the right-hand side.[12] Equation (7) thus implies the tax formula $\tau(s,\chi,T)$ as shown in the lifecycle problem of Equation (5).

Aggregate pension contributions are a function of the state, funded ratio and model time, and can be summarized as

$$(8) \qquad C(s,\chi,T) = \theta_s \big[NC(s,T) + AUFL(s,\chi,T)\big]$$

where $NC(s,T)$ represents normal cost expenditures and $AUFL(s,\chi,T)$ represents the cost of repaying the amortized unfunded liability of the pension. Essentially, pension contributions account for newly accrued benefits (*normal costs*) and old deficits (*amortized unfunded liability*). Importantly, the parameter θ_s represents the state's willingness to pay contributions such that a value of $\theta_s < 1$ results in insufficient contributions to properly fund the pension.

The normal cost for the pension fund is computed as

$$(9) \qquad \begin{aligned} NC(s,T) &= \sum_{k=1}^{45} \Phi(s,pub,k,T) \sum_{m=1}^{35} \frac{p(45+m|k)}{(1+r_s)^{45-k+m}} \frac{w_{sk}}{\sum_{l=1}^{45} w_{sl}} \bar{b}_s \\ &= \underbrace{\sum_{k=1}^{45} \Phi(s,pub,k,T)}_{\text{aggregation}} \quad \underbrace{\tilde{\beta}(k)}_{\text{discount factor}} \quad \underbrace{\tilde{b}_s(k)}_{\text{accrued benefit}} \end{aligned}$$

where r_s is a state-specific rate to discount the measure and $\{\omega_{sk}\}_{k=1}^{45}$ are average wages for each public sector age cohort in state s. The outer summation accounts for the size of

[12]Given that workers are subject to idiosyncratic wage risk via (ϵ,η), the cross-section of worker wages are integrated over with the joint distribution $F(z_1,z_2)$. These are assumed to be independent shocks; thus, $F(z_1,z_2) = F_1(z_1)F_2(z_2)$.

each age cohort currently working in the public sector, and thus is an aggregation term for determining the cost. For a given age cohort, the inner summation computes the present value of newly accrued pension benefits where the benefit is discounted by mortality risk and the rate r_s. The ratio $\frac{w_{sk}}{\sum_{l=1}^{45} w_{sl}}$ is an accrual factor that represents the agent being vested in the pension benefit $\bar{b}_s$ over the working period of their lifecycle.

As for the amortized unfunded liability cost term in Equation (8), some additional notation and accounting must first be introduced. Each period, the fiscal authority manages the investment portfolio of the pension, as well as contributions to the fund.[13] To calculate required contributions the state must first compute the discounted present value of pension liabilities $PVL(s,T)$ at model time T. In the baseline model, we assume the state uses the Entry Age Normal (EAN) method to value liabilities, as this is the most prominent valuation formula used by U.S. public plans. Thus, at model time T, the present value of liabilities is

$$PVL(s,T) = \sum_{j=0}^{\infty} \frac{1}{(1+r_s)^j} \sum_{k=45}^{80} \Phi(s, pub, k, T+j)\alpha(s,k,T+j)\bar{b}_s \tag{10}$$

where $\alpha(s,k,T+j)$ is the EAN accrual factor for a worker of age k at time $T+j$ in state s, written

$$\alpha(s,k,T+j) = \begin{cases} 1, & \text{if} \quad k-j \geq 45 \\ \frac{\sum_{k=1}^{k-j} w_{sk}}{\sum_{k=1}^{45} w_{sk}}, & \text{if} \quad k-j < 45 \end{cases} \tag{11}$$

As Equations 10 and 11 make clear, pension benefits accrue fractionally over the working period of a specific agent; that is, even though benefits $\bar{b}_s$ are guaranteed at retirement, they accrue slowly as a liability of the state. In addition, the state discounts pension liabilities at the rate r_s, which corresponds to their investment portfolio target return.

For ease of notation, we define the post-contribution funded ratio as $\tilde{\chi} = \tilde{\chi}(s,\chi,T)$ which is a function of the state, pre-contribution funded ratio χ and model time T. Then, the law

[13] We assume each state follows a fixed investment strategy α_s for its risky asset share.

of motion for the next period pre-contribution funded ratio is defined as

$$\begin{aligned}
\chi' =& \frac{\text{Gross Assets} - \text{Distributions}}{PVL(s, T+1)} \\
=& \frac{[\alpha_s R' + (1-\alpha_s)R^f]\tilde{\chi} PVL(s,T) - \bar{b}_s \sum_{k=45}^{80} \Phi(s, pub, k, T+1)}{PVL(s, T+1)} \\
=& \Gamma(s, \chi, R', T)
\end{aligned} \tag{12}$$

Given this, the amortized unfunded liability $AUFL(s, \chi, T)$ is computed as

$$AUFL(s, \chi, T) = (1-\chi) PVL(s,T) \frac{r_s}{1-(1+r_s)^{-\bar{T}_s}} \tag{13}$$

where $\bar{T}_s$ is the amortization window and all deficits are amortized using the pension discount factor. In summary, each period the state recognizes newly accrued benefits (Equation 9) and amortized deficits (Equation 13) as required costs which must be raised in order to fully fund the pension, in the long run. Despite this, the state only contributes a fraction θ_s which leads to chronic pension underfundedness.

Equilibrium. An equilibrium is defined as a set of stochastic processes $\{R', \epsilon', \eta'\}$, deterministic aggregates $\{\Phi(s, j, t, T)\}$ and state fiscal policy $\{\bar{b}_s, r_s, \theta_s, \alpha_s, \bar{T}_s\}$ such that for periods $T = 0, 1, 2, ...$

1. Agents solve their lifecycle problem in Equation 5
2. The fiscal authority sets τ to balance the budget in Equation 7
3. Pension policy rules induce the law of motion in Equation 12

$$\chi' = \Gamma(s, \chi, R', T)$$

For our purposes, we are interested in how pension reform affects consumer welfare as well as relevant fiscal aggregates at the state-level. This will involve solving the public and private worker lifecycle problem at time $T = 0$ under both a baseline and reform scenario for all age cohorts, and then simulating outcomes for fiscal projections.[14] Details of the analysis are provided in Section 6.

5 Calibration

In calibrating the model to a particular state environment, we identify two sets of parameters: *universal* parameters which are common across states and *state-specific* parameters which are unique to the given state of interest. Time periods are interpreted as one year.

Universal Parameters. Table 1 details the set of universal parameters. While we account for price level differences in wages and benefits across states, we employ the same functional form for the wage process. Specifically, we use the the form and estimates from Cocco, Gomes, and Maenhout [2005] which utilizes PSID data to estimate wages as a function of age as well as the error processes, using the method of Carroll and Samwick [1997].[15] Specifically, worker wages are defined as

$$w(s,j,t,\epsilon,\eta) = \lambda_{sj} e^{f(t)+\epsilon+\eta} = \lambda_{sj} e^{b_0+b_1 t+b_2 \frac{t^2}{10}+b_3 \frac{t^2}{100}+\epsilon+\eta} \tag{14}$$

with parameter values $\{b_0, b_1, b_2, b_3\} = \{-1.9317, .3194, -.0577, .0033\}$.[16] The parameter λ_{sj} controls for wage differences by state and job sector. Using data from the BEA, we set the within-state wage gap between public and private sector workers at 91% such that $\lambda_{sj=pub} = 0.91\lambda_{sj=priv}$ for each state. Conditional survival probabilities were obtained from the National Center for Health Statistics (NCHS).

[14] The numerical solution of the agent lifecycle problem was developed with the aid of program codes provided by Fehr and Kindermann [2018].

[15] Wages are defined broadly as to include total reported labor income plus unemployment compensation, social security, supplemental social security, other welfare, child support and total transfers for the head of household.

[16] Cocco, Gomes, and Maenhout [2005] wage estimates were based upon dollar estimates using 1992 as a base year. We use the CPI to update measures to 2018 dollars so as to match the nominal value of pension benefits, detailed in the State-Specific Parameters section.

Table 1: Universal Parameters

Parameter	**Label**	**Value**	**Source/Target**
β	Discount Factor	0.985	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	.0584	CGM [2005], PSID
σ^{ν}	Persistent Vol	.0169	CGM [2005], PSID
$\{p(t+1\|t)\}$	Mortality Risk	—	NCHS
$\lambda_{s,j}$	Sector/State Wage Gap	—	BEA

For investment return assumptions, we use data estimates from Navega Strategies which are also standard in the literature. Specifically, we employ a 4% real equity return premium over a 2% risk-free rate with equity return volatility set at approximately 16%.

State Parameters. State-specific parameters relate to the fiscal and demographic environment. The majority of pension-relevant data comes from the Public Plans Database which is provided by the Center for Retirement Research at Boston College (CRR) and the MissionSquare Research Institute and supported by the National Association of State Retirement Administrators (NASRA). The underlying data comes from comprehensive annual financial reports that are publicly released by individual plans.[17] We assume a constant pension benefit, which is known at the beginning of employment, whereas most pensions accrue based upon formulas which factor in a worker's wages, wage growth and years of service. Thus, in determining state pension benefits $\bar{b}_s$ we compute the average benefit, given aggregate data on benefit distributions and total number of annuitants. Further,model agents receive sector-specific social security benefits b^{ss}_{sj}. Information on state-level Social Security distributions

[17]When multiple plans exist in a state, data is aggregated up or weighted by the value of liabilities, across individual plans.

are taken from the Social Security Administration congressional report and sectoral wage gaps λ_{sj} are applied to these, as well, because Social Security is a function of past wages. In many states, public employees enrolled in a pension plan receive partial or no Social Security coverage; we also account for this using the Public Plans data.

Data such as the pension funded ratio, pension liabilities, discount rate, and the pension investment strategy are also taken from annual financial reports. We internally set the population parameter M_s such that the computed total value of pension liabilities is equal to the nominal level observed in the data.

In terms of demographic change, we use state-level measures and projections for the distribution of age cohorts, provided by the Weldon Cooper Center for Public Service at the University of Virginia. While this data pertains to total state populations, we are interested in the current workforce, as well as retirees who were previously in the workforce. To make this transformation, we employ labor force participation rates from the BEA, as well as state information about the ratio of pension annuitants to active workers. Refer to Appendix A.4 for a more detailed description. Figure 4 shows the change in the percentage of state-level retirees over the next forty years. Almost all states will experience an increase in their retired workforce which will put significant strain on state pension systems.

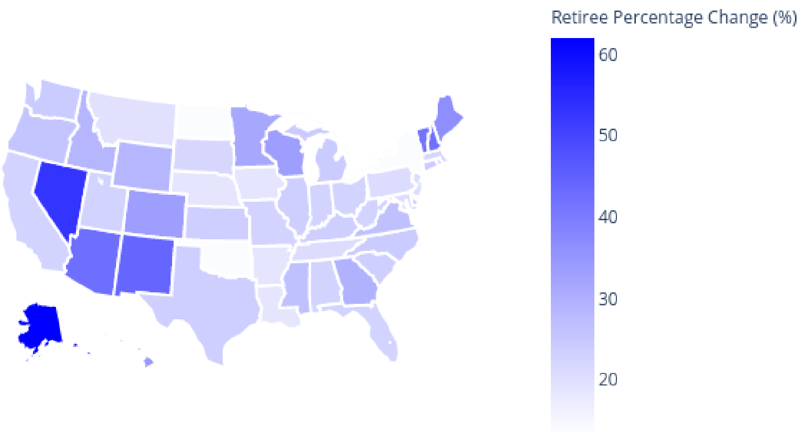

Figure 4

Notes: For each state, we measure the forecasted level change in the percentage of retirees over the next forty years. For example, our model predicts the current population of Alabama retirees to change from 23% to 45%, thus a level change of 22%.

In the baseline model, we assume all states properly adjust the nominal value of pension benefits for changes in cost of living, an assumption we relax when evaluating pension reforms in Section 6. Last, the state parameter θ_s is determined based upon the average ratio of pension contributions to their Annual Required Contributions (ARC) for each state.

Table 2 in Section A.1 of the Appendix provides each state's calibration. In terms of total liabilities, the largest public pensions plans reside in California ($1.2 Trillion), New York ($578 Billion), Texas ($354 Billion) and Illinois ($352 Billion). States with the lowest funded ratios include Kentucky (45%), Illinois (46%), Connecticutt (47%) and New Jersey (51%). Conversely, the only states or territories in our sample which are fully funded or better are South Dakota (100%) and the District of Columbia (105%).

As mentioned previously, contributions as a percentage of Annual Required Contributions (ARC) is a standard benchmark to assess whether pension plans are saving appropriately. In our sample, the states which contribute the lowest relative amounts include New Jersey (52%), Illinois (75%), North Dakota (75%) and Pennsylvania (76%) while there are 18 states which contribute the full amount or better. However, even if a state contributes their full ARC, it is not enough to guarantee a fully funded pension in the long run: the ARC calculation is based upon the discounted value of liabilities which will be unrealistically low if plans use high discount rates.

States have a fairly consistent public sector size, ranging from 7% of the workforce (Nevada) to 15% (Wyoming). The values of pension benefits ($\bar{b}_s$) and total public employee retirement benefits ($b_{sj=pub} = b^{ss}_{sj=pub} + \bar{b}_s$) in Table 2 have been normalized using state-level differences in the cost of living. States which offer the most generous pension plans include California ($36k), Colorado ($36k), Connecticut ($41k), Georgia ($39k), Illinois ($44k), Massachusetts ($38k), Nevada ($41k), and Ohio ($37k). While not listed in the table, the average social security coverage for a public sector worker with pension benefits is 78%, compared to their private sector counterpart.

Last, Table 3 in Section A.1 of the Appendix contains baseline model forecasts for each state, listing the level of fiscal aggregates at 15, 30 and 45 year horizons. For most states, pension liabilities are predicted to grow due to the accrual of new benefits, an aging workforce, and high discount rates. For example, the model predicts California pension liabilities to grow from $1.2 trillion, as measured in 2020, to $1.9 trillion in 2065. Other than the District of Columbia, all states are predicted to be under-funded in the long run with 36 states operating with funded ratios below 90%. Due to the increase in pension liabilities and shrinking tax base (i.e. relatively less workers-to-retirees), state taxes and tax volatility are forecast to increase over the next 45 years.

6 Evaluating Reforms

In this section, we estimate the state-level effects of pension reform on fiscal aggregates and consumer welfare for all fifty states, as well as the District of Columbia.[18] We consider three styles of reform as they are the most often proposed for U.S. state pensions. In the Closed Reform, the pension plan is closed to all new entrants and new entrants receive increased

[18] We use consumption-equivalent welfare as our metric. Details are provided in Section A.3.

wages in place of the old pension. In the Hybrid Reform, both current and future workers' pension benefits are reduced but those workers are compensated with increased wages. In the COLA Reform, cost-of-living-adjustments for current and future retirees are partially suspended. While each reform is not modeled after a particular state's historical experience, elements of the reforms have been proposed or implemented in a variety of states.[19]

For each reform, we first report the average impact of the reform on fiscal aggregates and welfare, by job sector and age cohort. This provides insight into the heterogeneous effect of the reform on different types and ages of workers. Then, we report state-level differences in reform outcomes and examine the important fiscal or demographic determinants. State-level output is provided in tables within the Appendix Section A.1.

6.1 Closed to New Entrants

Under the Closed Reform, the state plan is closed to all new entrants such that current workers retain full pension benefits $\bar{b}_s$ while all new hires receive a 5% wage increase but no pension. Table 4 in appendix Section A.1 provides the effect of the Closed Reform on relevant fiscal aggregates for each state.

Figure 5 below plots the average path of state liabilities over the next 45 years. Because pension liabilities accrue during an agent's working period, and the reform maintains all existing pension benefits, there is no immediate reduction in pension liabilities. Further, the effect of reducing liabilities is slow but significant in the long run: liabilities are reduced by nearly 23% after 45 years, on average. At the state-level (Section A.1 Table 4), the total reduction ranges from 12.4% to 26.1% with the majority of states experiencing reductions similar to that of the average, below.

[19] For example, similar to the Closed Reform, the Oklahoma legislature closed its defined benefit pension plan to certain new entrants in 2015 and enrolled those new workers in a defined contribution plan with 6% matching. Similar to the Hybrid Reform, the Rhode Island General Assembly established a hybrid retirement plan which reduced the pre-existing pension benefit and created a mandatory defined contribution plan. For current workers, the size of the pension reduction varied with years of work experience within the public sector. Last, for the COLA Reform, many states have engaged in partial or full suspensions of their COLAs (e.g. Rhode Island [2011], Utah [2010], New Jersey [2011], Colorado [2018], Minnesota [2018]).

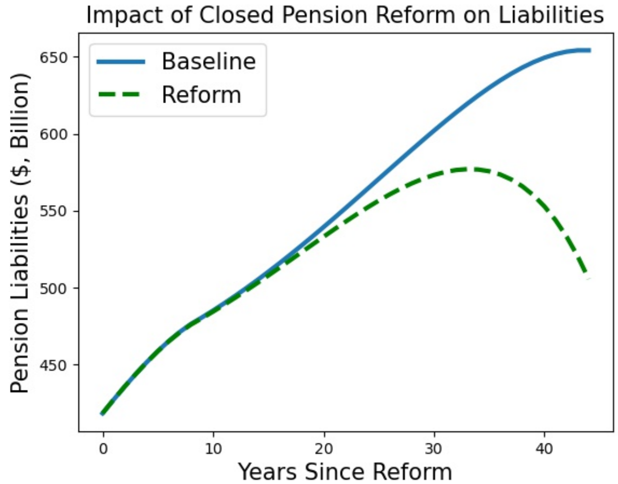

Figure 5: Weighted-Average Path of Closed Reform Public Pension Liabilities

Notes: The plots represent the weighted average pension liabilities under each scenario, where the weighting comes from the size of each state's total liabilities.

Figure 6 plots the average tax rate for both scenarios. Despite the wage increase of new entrants to the public sector, the average tax rate falls: the model predicts an average state tax reduction of 1.1%, in levels. Thus, the reduction in pension-related taxes is more than enough to offset/fund the wage increase.

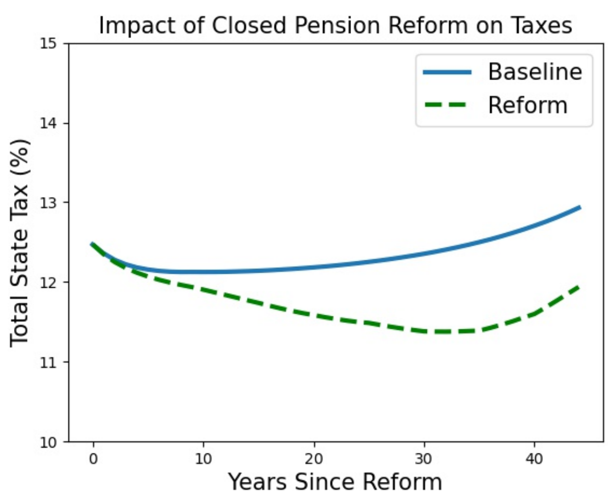

Figure 6: Weighted-Average Path of Taxes Under Closed Reform

Notes: The plots represent the weighted average wage tax under each scenario, where the weighting comes from the size of each state's total liabilities.

Figure 7 plots the welfare effects of the closed pension reform for all working age cohorts and both job sectors (public and private). Because private sector workers are not directly affected by pension benefits, all welfare effects for private workers come from the timing, level and volatility of wage taxes. In addition, since current public sector workers experience no change in their retirement benefits, their welfare effects are similar to the private sector. All working age cohorts and job sectors experience, on average, an increase in welfare with more pronounced results for young worker cohorts. Because the majority of the reform effects (in terms of lower taxes) occur in the long run, older workers experience little variation or impact in terms of their welfare. Alternatively, younger workers experience a prolonged period of lower taxes which frees up additional resources for consumption and/or savings during their working period. Private workers experience a slightly larger welfare gain, on average, due to the sectoral wage gap.

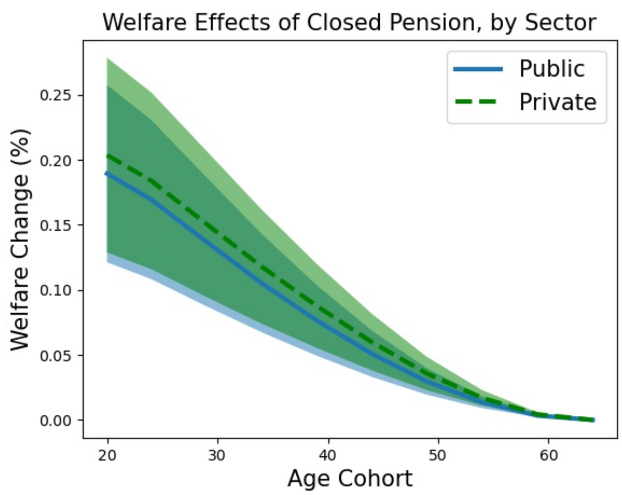

Figure 7: Weighted-Average Welfare Effects from Closed Reform, by Age and Job Sector

Notes: The plots represent the weighted average welfare effects for each age cohort under each scenario, where the weighting comes from the size of each state's total liabilities. Shaded areas represent volatility bands, computed from the cross-section variation across states.

In terms of state-level variation, Figure 8 provides a heat map for the average Closed Reform welfare effect. States which experience the largest drop in long run taxes (such as Kentucky, New York and Utah) are the same states which either have more generous initial pension benefits or are forecast to have a relatively large young workforce over the next 45 years.[20] These are the same states which experience larger welfare gains from the Closed Reform.[21] State-level variation in welfare results is also affected by the timing, reduction and volatility of post-reform taxes relative to the baseline scenario. For example, in terms of timing, while California's 45 year reduction in tax rates (10.1% drop relative to the baseline) is quite common in our sample, the state experiences a 10% relative reduction in tax rates by Year 30, which is a large outlier, and this generates large welfare gains within the state relative to others with more delayed reductions.

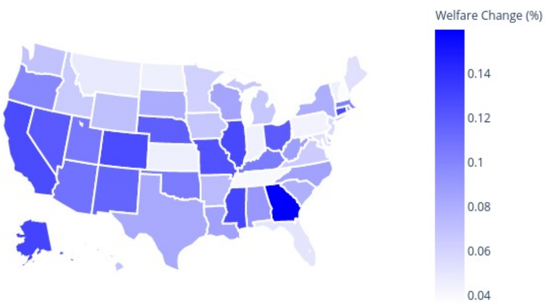

Figure 8: State-Level Welfare Effects of Closed Pension Reform

Notes: State-level welfare numbers are computed based upon the relative proportion of each age cohort and job sector.

In summary, the Closed Reform generates a slow but significant decline in long run pension liabilities which reduces taxes in a way that can properly fund a 5% wage increase for new public workers. The net effect is a reduction in taxes over the entire forecast period. Welfare results are positive for the majority of age cohorts and job sectors, and across all states, with young workers benefiting the most. In terms of state differences, states which benefit the most (in terms of tax reduction and consumer welfare) are those which have the more generous pre-existing pension systems and/or those which are forecast to have a large influx of young workers, over the next 45 years.

[20]By closing the pension to future public workers, there exists a relatively large reduction in future liabilities for states which were forecast to have many new entrants to the workforce.

[21]Refer to Table 5 in the Appendix for state-level welfare results.

6.2 Hybrid Plan with Wage Compensation

Under the Hybrid Reform, instead of closing the plan to new entrants, pension benefits for current and future workers are simply reduced and additional compensation is provided in the form of a wage increase. Specifically, current public workers aged 60 to 65 retain the original pension and receive no wage increase while younger cohorts receive anywhere from 50% to 100% benefit retention on a linear scale between the ages of 20 and 65 along with a 5% wage increase. All future entrant workers receive 50% of the original pension benefit plus the wage increase, as well. Table 6 in Section A.1 provides the effect of the Hybrid Reform on relevant fiscal aggregates for each state.

Figure 9 plots the average effect on pension liabilities. The reform has an immediate effect on pension liabilities, reducing them by roughly 3.5% on average. The Closed Reform reduces liabilities slowly and eliminates them after 80 years, whereas the Hybrid Reform generates a large immediate reduction which is relatively constant throughout the sample period of 45 years- liabilities drop by 40% relative to the Baseline scenario.[22] Further, the reform translates into a lower average tax level, relative to both the Baseline and Closed Reform scenario.

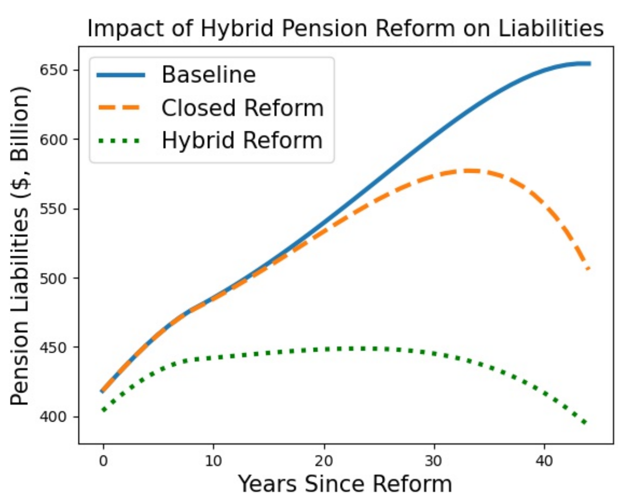

Figure 9: Weighted-Average Path of Hybrid Reform Public Pension Liabilities

Notes: The plots represent the weighted average pension liabilities under each scenario, where the weighting comes from the size of each state's total liabilities.

[22] The comparable number for the Closed Reform is 23%.

Figure 10 plots average welfare effects by age cohort and for each job sector. For private sector workers, the average state experiences a welfare gain under the reform. The effect is most pronounced for younger cohorts who are better able to capture the low tax environment over a long horizon. On the other hand, welfare results are mixed across public sector age cohorts. For young public workers, the reduction in pension benefits is more than offset by the 5% wage increase which allows them to save and compound the equity premium for the remainder of their lifecycle. In addition, public workers nearing retirement (ages 60 to 65) remain mostly indifferent as they retain their original pension benefit. Conversely, middle-aged public workers experience a welfare loss- they are too close to retirement such that the 5% wage increase is not sufficient to offset their losses from the reduced pension.

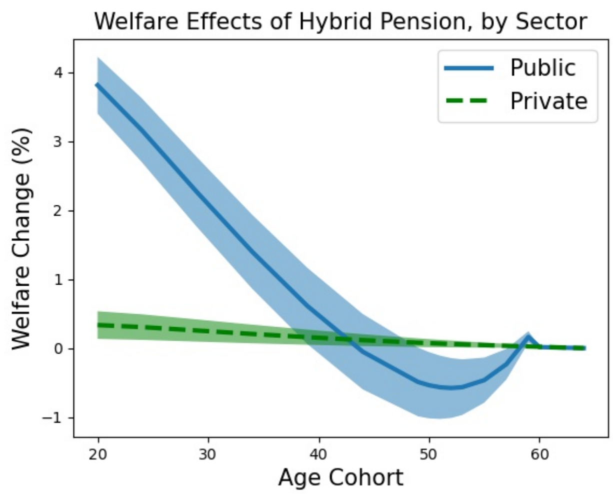

Figure 10: Weighted-Average Welfare Effects from Hybrid Reform, by Age and Job Sector

Notes: The plots represent the weighted average welfare effects for each age cohort under each scenario, where the weighting comes from the size of each state's total liabilities. Shaded areas represent volatility bands, computed from the cross-section variation across states.

Figure 11 provides a heat map for the average Hybrid Reform welfare effect.[23]. Despite the welfare losses of middle-age public workers, all states experience a welfare gain, on average. Some states experience lower welfare gains due to high taxes in the short run which are used to fund the 5% increase in public sector wages. Those states (specifically, Kansas, North Dakota and Tennessee) experience short run increases in taxes for two reasons: lower initial

[23] State-level numbers are provided in Table 7 in Section A.1

pension benefits and a large middle-aged workforce. For the former, states which offer low initial pension benefits (such as Indiana, Kansas, Tennessee and Vermont) have relatively less cost-savings to fund wage increases when they reduce the pension benefits of workers. For the latter, states which have a higher proportion of middle-aged workers must fund larger wage increases because the 5% wage hike is attached to higher salaries, on average. Despite initial increases in taxes, all states are forecast to have lower long run taxes, relative to both the Baseline and Closed Reform scenarios.

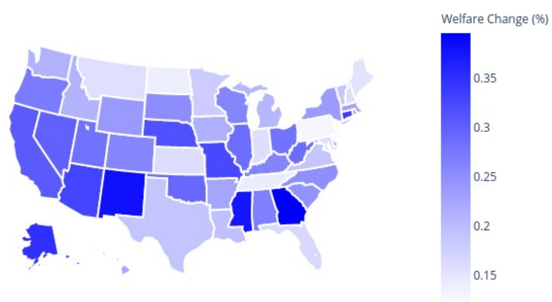

Figure 11: State-Level Welfare Effects of Hybrid Pension Reform

Notes: State-level welfare numbers are computed based upon the relative proportion of each age cohort and job sector.

On the other hand, public worker welfare is affected through both the tax channel as well as the direct change to retirement benefits. Unlike the Closed Reform, where current public workers retain their old pension benefit, the Hybrid Reform alters worker retirement benefits and leads to large movements in consumption-equivalent welfare. Of particular importance for public worker welfare is the level of external social security benefits: social security acts as a powerful substitute to state pensions and can dampen welfare losses arising from a decreased pension benefit.

Regression Table 10 in Section A.2 provides additional interpretation by regressing public sector welfare effects on relevant state characteristics. The negative relationship between original pension benefits and public welfare effects remains a robust and statistically significant feature- every $1,000 increase in pre-reform pension benefits is associated with a 3 basis point welfare loss for public employees. In our sample of states, there exists a range in pension benefits of approximately $28,000 suggesting variation in welfare effects on the order of 1.4%, holding all else constant. Social Security coverage also retains its significant positive relationship with welfare outcomes- increasing coverage by 50% is associated with a 25 basis point welfare gain. The size of the public sector, as measured by the proportion $p_{s,j=pub}$ is a significant feature explicitly related to the tax environment and not the retirement benefits of public employees. The estimates suggest that a 1% increase in the proportion of public employees is associated with a 2 basis point increase in welfare gains under the Hybrid Reform. While the magnitude is large, the sample variation is quite small- states' public sectors range from 7% to 15%.

In summary, the Hybrid Reform significantly reduces pension liabilities relative to the Closed Reform. This is associated with a larger reduction in state taxes, as well. For private workers, the vast majority of states and age cohorts experience welfare gains. In states where this is not the case, it is due to an initial increase in taxes to fund higher wage increases for public workers. While young and old public workers benefit from the hybrid pension plan, middle-aged public workers experience welfare losses. These losses are due to an insufficient wage increase to offset their pension reduction.

6.3 Suspension of Cost-of-Living-Adjustments (COLAs)

Under the COLA Reform, the real value of pensions are reduced through the partial suspension of cost-of-living-adjustments (COLAs) which are used to keep pace with changes in the price level. In practice, this type of reform is the most prevalent among U.S. state pension plans.[24] For our application, we assume that states in the Baseline scenario keep pace with cost of living changes by increasing the nominal value of pension benefits. In the reform, we allow the real value of pension benefits to decrease by 1.5% annually, starting from the date a public employee enters retirement.[25]

Figure 12 plots the impact of the COLA Reform on pension liabilities, relative to the

[24] See Brainard and Brown [2018].

[25] For example, if a pension recipient was promised $20,000 in annual benefits, the real value would fall to $17,200 after 10 years, $14,800 after 20 years and $12,700 after thirty years. Thus, small changes in state COLAs can have significant effects upon the real value of retirement benefits.

Baseline and other reform scenarios. It is clear that the COLA reform has a significant and immediate impact on liabilities, reducing them by 16.9% in the first year of reform. It is important to note that the COLA Reform has more of a level effect on plan liabilities- while pension benefits are reduced, the plan still has considerable growth in liabilities over the next 45 years. At the end of our forecast horizon, plan liabilities are, on average, 25.2% lower than the Baseline scenario.

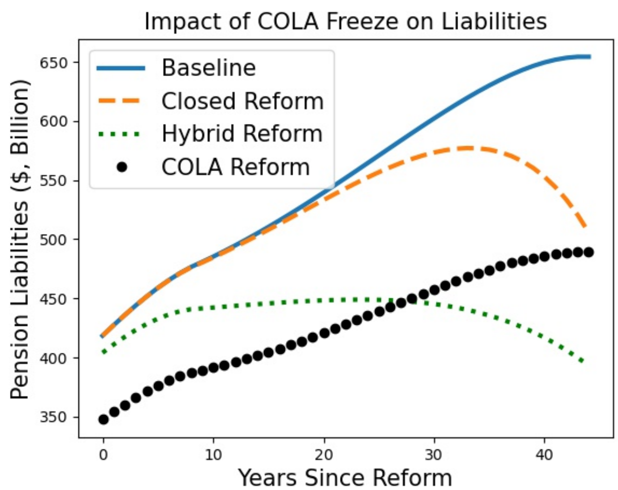

Figure 12: Weighted-Average Path of COLA Reform Public Pension Liabilities

Notes: The plots represent the weighted average pension liabilities under each scenario, where the weighting comes from the size of each state's total liabilities.

Figure 13 plots the forecasted average state tax rate for the COLA reform, relative to the Baseline and other reforms. Clearly, the large initial drop in plan liabilities is accompanied by a large drop in state taxes, more so than any other reform. However, due to the continued growth in pension liabilities, taxes trend up near the end of our forecast horizon. While they are still 0.8% lower than the Baseline scenario, it is clear that the Closed and Hybrid reforms generate lower long run taxes for the state.

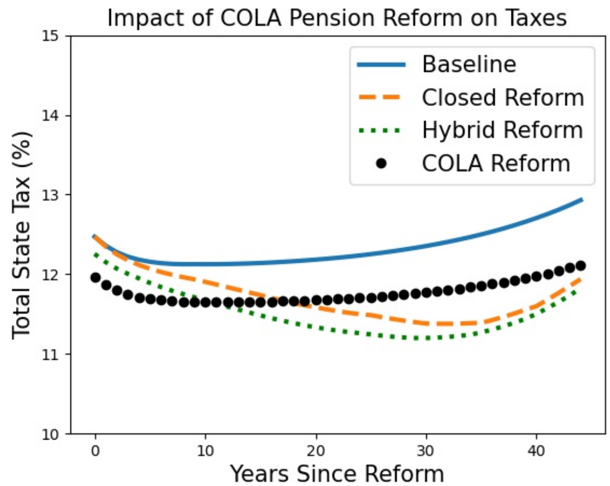

Figure 13: Weighted-Average Path of Taxes Under COLA Reform

Notes: The plots represent the weighted average wage tax under each scenario, where the weighting comes from the size of each state's total liabilities.

In Figure 14, we plot the average welfare effects by age cohort and for both job sectors. The COLA suspension imposes significant welfare losses on all public worker age cohorts and particularly those nearing retirement. Essentially, the reform reduces the discounted real value of retirement benefits with no additional compensation provided. Older workers are acutely affected along two dimensions. First, they have less time to accumulate precautionary savings and those savings lead to a significant disruption in their consumption smoothing. Second, they discount their retirement future less heavily because of their proximity to the date. Private sector workers, on the other hand, uniformly experience large welfare gains and this is driven by the near-term tax reductions, even though the long run tax rates are expected to rise. All together, the COLA reform is the most contentious in the sense that welfare gains/losses are distributed the most unevenly across job sectors.

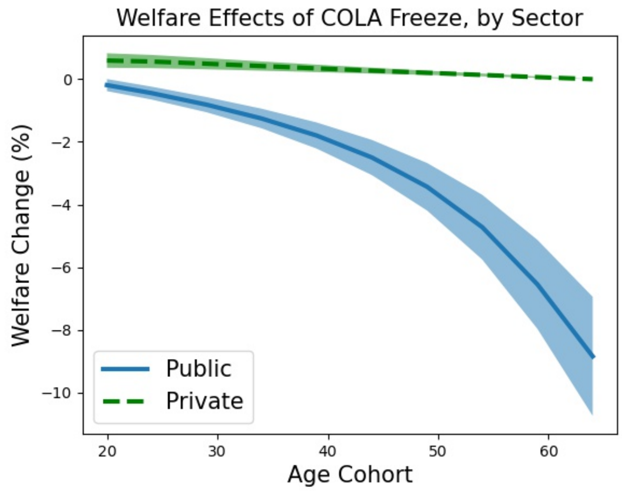

Figure 14: Weighted-Average Welfare Effects from COLA Reform, by Age and Job Sector

Notes: The plots represent the weighted average welfare effects for each age cohort under each scenario, where the weighting comes from the size of each state's total liabilities. Shaded areas represent volatility bands, computed from the cross-section variation across states.

Figure 15 provides a heat map for average welfare effects under the COLA reform. The states which experience welfare gains, or modest losses, are those with the largest initial drop in liabilities (for example, the states of Alaska, Arizona, New Hampshire, New Mexico and Nevada) due to having the most back-loaded benefit distributions in their pension systems.[26] States with back-loaded pension distributions benefit more from the COLA reform because those benefits are substantially reduced in value by the COLA suspension.[27]

[26] In the first year of reform, these states experiences a pension liability reduction of 71%, 48%, 50%, 49% and 57%, respectively.

[27] To see how this works mechanically in a stylized example, assume a stream of pension distributions $\{B_0, B_1, ...\}$ where $B_t = \gamma_t B$, such that $\sum_t \gamma_t = 1$. Then consider current pension liabilities $P = \sum_t \frac{B_t}{(1+r)^t}$ and liabilities after the COLA freeze $\hat{P} = \sum_t B_t(\frac{1-\alpha}{1+r})^t$. We are interested in how $\Delta P = P - \hat{P}$ is affected by front- or back-loaded benefits. Consider an increase in front-loaded benefits $\frac{\partial \Delta P}{\partial B_1} \equiv \frac{\partial \Delta P}{\partial \gamma_1}$ which can be expressed as

$$\frac{\partial \Delta P}{\partial \gamma_1} = B[\frac{1+r}{r+\alpha} - \frac{1+r}{r}]$$

This object is negative when COLAs do not keep pace with inflation (i.e. $\alpha > 0$). Thus, liability reductions decrease (increase) when pension benefits are front-loaded (back-loaded) in a reform with partial COLAs.

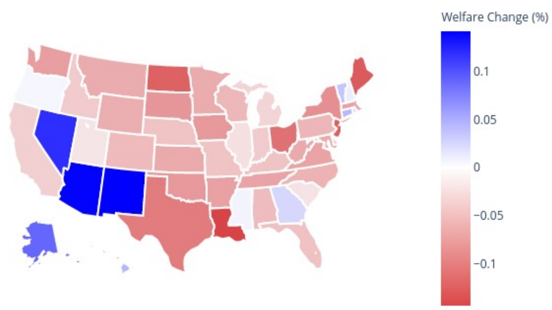

Figure 15: State-Level Welfare Effects of COLA Pension Reform

Notes: State-level welfare numbers are computed based upon the relative proportion of each age cohort and job sector.

There exists important welfare differences which arise due to a public worker's proximity to retirement. For example, regression Table 11 in Section A.2 shows that young public worker welfare does not have a significant relationship with initial pension benefits- tax effects dominate pension effects in affecting welfare. This result is further confirmed by the significant relationship that fiscal parameters (such as the funded ratio or ARC contribution fraction) have with young public worker welfare. For all public workers, low funded ratios are associated with higher welfare gains- a low funded ratio is an indication of increasing taxes such that workers would favor a reduction in pension liabilities to offset this future tax hike. Specifically, every 1% decline in the pension funded ratio is associated with a 0.45 basis point welfare gain for young workers from COLA reform, or a 0.16 basis point gain for old workers. These numbers are economically significant.[28]

In summary, we find that the COLA reform is the most effective in generating an immediate reduction in state pension liabilities which leads to a short term drop in taxes, but that these effects are transitory. In fact, both the Closed and Hybrid reforms generate lower long run taxes. Furthermore, while COLA reforms are quite common in practice, it appears that they are the most contentious for the way in which welfare gains are distributed throughout

[28]For example, the difference between a fully funded pension and one with an 80% funded ratio leads to a 3 to 9 basis point welfare effect difference, depending upon the worker's age.

the state population- public workers receive no compensation for the loss in real value of their pension benefit, while private workers benefit considerably more. Further, the negative effects of the COLA Reform are mostly borne by older public workers who are nearing retirement and have little time to adjust their consumption-savings behavior.

7 Conclusion

The failure of U.S. state public pension plans to maintain sufficient funded ratios has cast doubt on their ability to finance future retirement benefits. Because of this, many states have considered reforms which emphasize individual retirement accounts and less state management. Since the ultimate burden of funding the public pension system falls on taxpayers, proper reform analysis should account for all the relevant constituencies involved as well as important variation in state characteristics.

Our analysis shows that the Hybrid Reform is the most effective at reducing pensions liabilities and taxes in the long run, and the key state-level characteristics which affect the magnitude and direction of change are those related to the size of the initial pension system, the size of the public sector and the relative distribution of age cohorts. In terms of the normative analysis, we find that the Closed Reform uniformly improves welfare for private and public sector workers, and this result hinges on the ability of pension cost savings to fund worker wage increases. In the Hybrid Reform, young public workers experience welfare gains, implying that the 5% wage hike is enough to offset the partial reduction of benefits, while middle-age workers experience significant welfare losses. Finally, the COLA reform proves to be the most contentious in that welfare gains are almost exclusively experienced within the private sector and not in the public sector.

We would advocate for continued research which examines the transitional impact of state pension reform on working cohorts, as this is closely linked to the political viability of implementing meaningful reform. While numerically more intensive, introducing labor mobility (across sectors and states) and equilibrium wage determination is a particularly important future step for this line of research.

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A Appendix

A.1 State-Level Tables

Table 2: State-level Calibration Parameters

State	θ	r^p	PVL	χ^0	$\bar{b}$	b^{pub}	Sector	α^p
	ARC Cont	Discount	Liabilities	Funded Ratio	Pension	Total Annuity	Public Size	Portfolio
	Frac	%	$ billion	FR	$ Thousand	$ Thousand	Prop	%
AK	1.08	7.36	22	0.67	27	27	0.13	85
AL	0.96	7.69	57	0.69	25	41	0.12	66
AR	0.95	7.37	32	0.79	22	38	0.11	82
AZ	1.00	7.42	81	0.64	30	46	0.09	84
CA	0.90	7.17	1178	0.71	36	45	0.09	76
CO	0.84	7.26	81	0.61	36	36	0.10	77
CT	0.98	7.35	75	0.47	41	50	0.09	73
DC	1.00	6.50	8	1.05	25	25	0.04	67
DE	0.99	7.00	11	0.84	22	38	0.10	65
FL	0.92	7.19	200	0.81	24	40	0.08	77
GA	1.00	7.25	124	0.76	39	54	0.09	69
HI	0.95	7.00	31	0.55	23	39	0.10	81
IA	0.98	7.03	43	0.83	21	36	0.11	71
ID	0.99	7.00	18	0.91	20	36	0.11	72
IL	0.75	6.96	352	0.46	44	50	0.09	70
IN	1.00	6.75	36	0.62	17	33	0.09	70
KS	0.81	7.73	30	0.69	18	34	0.12	77
KY	0.88	6.43	72	0.45	30	38	0.10	66
LA	0.99	7.42	65	0.68	27	27	0.10	77
MA	0.92	7.22	108	0.57	38	38	0.08	77
MD	0.89	7.38	80	0.74	23	39	0.09	79
ME	1.00	6.87	17	0.83	22	22	0.10	83
MI	0.94	6.89	126	0.62	24	39	0.09	78
MN	0.81	7.50	83	0.80	25	41	0.10	76
MO	1.12	7.38	84	0.80	33	40	0.10	74
MS	1.04	7.75	46	0.60	27	43	0.13	70
MT	0.89	7.58	14	0.71	21	37	0.11	69
NC	0.99	7.00	112	0.87	22	38	0.11	61
ND	0.75	7.74	8	0.69	22	38	0.11	75
NE	1.03	7.51	17	0.82	29	45	0.11	70
NH	1.00	7.24	15	0.60	19	35	0.09	75
NJ	0.52	7.37	169	0.51	33	49	0.09	73
NM	0.88	7.25	43	0.66	28	44	0.14	68
NV	0.96	7.50	57	0.75	41	41	0.07	74
NY	0.99	6.94	578	0.86	25	41	0.10	70
OH	0.98	7.39	253	0.76	37	37	0.09	72
OK	1.07	7.37	40	0.81	23	37	0.12	66
OR	0.96	7.20	86	0.74	31	47	0.09	79
PA	0.76	7.23	169	0.56	25	41	0.08	71
RI	0.99	7.00	15	0.54	33	47	0.08	71
SC	1.00	7.24	58	0.55	22	38	0.11	78
SD	1.06	6.53	12	1.00	23	39	0.10	60
TN	1.00	7.24	55	0.97	16	32	0.09	70
TX	0.89	7.28	354	0.77	25	31	0.09	81
UT	1.00	6.95	34	0.87	26	42	0.10	77
VA	0.82	6.79	110	0.76	23	39	0.10	80
VT	1.09	7.49	7	0.64	18	34	0.10	65
WA	0.94	7.48	82	0.95	23	39	0.11	78
WI	1.00	7.03	115	0.98	26	42	0.10	64
WV	1.07	7.46	18	0.79	22	38	0.13	86
WY	0.82	7.00	10	0.73	21	37	0.15	79

Table 3: Baseline Forecast for Fiscal Aggregates

	PVL			FR			Tax			Tax Vol		
State	15y	30y	45y	15y	30y	45y	15y	30y	45y	15y	30y	45y
AK	34	51	60	95	88	74	17.1	18.5	27.2	0.9	2.1	8.1
AL	68	81	89	95	93	87	14.2	14.4	14.8	0.4	0.6	0.9
AR	38	43	47	95	93	89	13.3	13.4	13.7	0.4	0.5	0.7
AZ	105	135	153	87	84	74	12.4	13.0	15.5	0.9	1.4	3.1
CA	1439	1722	1901	97	94	89	12.3	12.4	12.8	0.4	0.6	0.8
CO	103	136	160	92	90	81	12.8	13.1	14.2	0.5	0.8	1.6
CT	90	106	114	93	93	89	13.0	13.1	13.5	0.7	0.8	1.2
DC	6	5	4	112	116	119	5.3	5.3	5.3	0.0	0.0	0.0
DE	13	16	18	95	92	86	11.8	12.0	12.4	0.4	0.5	0.9
FL	235	269	288	90	87	83	9.4	9.5	9.7	0.4	0.5	0.7
GA	158	201	229	98	95	88	12.6	12.8	13.4	0.4	0.7	1.2
HI	39	49	55	88	87	79	11.9	12.2	13.1	0.6	0.8	1.5
IA	49	56	61	97	96	92	13.2	13.2	13.4	0.3	0.4	0.6
ID	22	28	32	96	93	86	12.5	12.7	13.3	0.3	0.5	1.0
IL	428	515	571	83	86	80	12.4	12.4	13.0	0.6	0.8	1.2
IN	44	52	57	98	96	92	10.8	10.9	11.0	0.2	0.3	0.4
KS	36	43	49	89	87	81	13.1	13.2	13.6	0.3	0.4	0.7
KY	88	105	115	88	91	87	13.1	13.2	13.6	0.5	0.6	1.0
LA	76	88	96	99	97	94	12.9	13.0	13.2	0.3	0.4	0.6
MA	129	149	161	94	93	90	10.7	10.8	11.0	0.4	0.5	0.7
MD	95	112	123	96	94	90	10.5	10.6	10.7	0.3	0.3	0.5
ME	22	27	29	89	85	77	12.1	12.6	13.7	0.7	1.1	1.8
MI	152	180	197	92	91	87	11.3	11.4	11.7	0.4	0.5	0.8
MN	105	131	147	90	85	76	11.5	11.8	12.5	0.4	0.6	1.1
MO	100	118	130	99	97	93	13.1	13.3	13.7	0.5	0.7	1.0
MS	56	68	76	96	93	87	16.8	17.1	17.9	0.6	0.9	1.4
MT	15	18	20	91	91	87	12.6	12.6	12.9	0.4	0.5	0.7
NC	136	164	182	98	95	90	12.7	12.9	13.1	0.3	0.4	0.7
ND	9	10	11	93	94	91	12.7	12.8	12.8	0.2	0.3	0.3
NE	20	23	25	99	98	94	13.5	13.6	13.9	0.4	0.5	0.7
NH	20	25	27	86	83	75	10.8	11.2	12.3	0.6	0.9	1.6
NJ	201	235	256	61	59	49	11.3	11.5	12.0	0.4	0.6	0.8
NM	56	73	83	83	80	68	18.1	19.1	23.8	1.2	1.9	4.3
NV	79	109	127	89	83	69	10.8	11.8	17.5	0.9	1.6	4.9
NY	651	718	759	101	100	99	12.1	12.1	12.2	0.2	0.3	0.3
OH	301	357	393	96	94	89	12.8	13.0	13.4	0.5	0.7	1.1
OK	45	51	55	102	101	99	14.6	14.7	14.8	0.3	0.3	0.4
OR	102	126	145	95	93	86	12.3	12.5	13.1	0.5	0.7	1.2
PA	198	226	244	82	84	79	9.5	9.6	9.8	0.4	0.4	0.6
RI	18	21	23	93	93	89	10.9	11.1	11.4	0.5	0.6	0.9
SC	70	83	91	94	93	88	13.6	13.7	14.1	0.4	0.6	0.9
SD	15	17	19	99	98	94	12.8	12.9	13.1	0.3	0.4	0.6
TN	65	76	83	98	96	92	10.2	10.2	10.4	0.2	0.2	0.4
TX	438	542	611	98	94	89	11.4	11.5	11.7	0.3	0.4	0.6
UT	44	55	62	100	97	92	12.0	12.1	12.4	0.3	0.4	0.7
VA	135	165	184	92	89	83	11.7	11.9	12.2	0.3	0.5	0.8
VT	9	11	13	89	87	77	12.5	12.9	14.4	0.6	0.9	1.8
WA	99	121	138	97	94	88	12.9	13.1	13.5	0.3	0.5	0.8
WI	145	180	201	95	91	83	12.6	13.0	13.9	0.5	0.8	1.4
WV	21	25	27	95	92	87	16.3	16.5	17.0	0.6	0.8	1.3
WY	12	15	16	89	87	79	17.4	17.7	18.5	0.6	0.8	1.4

Note: This table provides baseline forecasts for each state at horizons of 10, 20 and 30 years. The Present Value of Liabilities (PVL) is stated in Billions of Dollars. The Funded Ratio (FR), Tax and Tax Volatility are presented in % units.

Table 4: % Change in Fiscal Aggregates Under Closed Pension Reform

	PVL			FR			Tax			Tax Vol		
State	15y	30y	45y	15y	30y	45y	15y	30y	45y	15y	30y	45y
AK	-0.3	-2.4	-12.4	-2.2	-6.7	-14.2	-2.9	-5.2	-3.8	7.1	10.4	-1.7
AL	-0.3	-3.9	-22.6	-3.1	-13.1	-38.2	-2.5	-5.9	-6.5	11.4	31.6	17.9
AR	-0.4	-4.4	-24.5	-2.9	-12.3	-34.8	-2.2	-5.3	-7.4	9.4	27.2	22.3
AZ	-0.3	-3.0	-16.2	-3.1	-11.9	-25.7	-3.0	-6.5	-4.1	5.5	12.3	-1.0
CA	-0.4	-4.0	-21.8	-3.0	-13.3	-38.7	-3.8	-10.0	-10.1	11.6	34.2	30.4
CO	-0.3	-3.2	-16.7	-3.5	-13.7	-34.0	-3.5	-8.3	-6.4	9.8	25.5	11.7
CT	-0.3	-3.8	-21.6	-3.1	-12.0	-37.1	-3.6	-11.0	-11.7	9.1	28.0	23.6
DC	-0.5	-7.5	-50.4	-1.6	-4.1	-20.3	-3.5	-7.8	-16.5	5.9	2.5	81.3
DE	-0.4	-4.1	-21.9	-2.5	-11.7	-33.3	-2.2	-5.5	-5.5	8.7	25.2	14.1
FL	-0.4	-4.4	-24.6	-2.5	-12.2	-38.3	-2.0	-5.0	-6.1	5.8	18.1	10.8
GA	-0.4	-3.8	-20.1	-2.9	-13.7	-35.2	-4.8	-11.9	-9.7	13.7	38.7	22.2
HI	-0.3	-3.5	-18.4	-3.2	-10.9	-26.3	-2.0	-4.7	-5.4	6.4	15.4	4.4
IA	-0.4	-4.3	-23.1	-2.7	-10.9	-30.6	-2.2	-5.2	-7.6	11.9	34.2	32.3
ID	-0.3	-3.5	-18.1	-2.6	-10.6	-25.5	-2.2	-4.6	-5.8	10.6	27.2	15.5
IL	-0.4	-4.4	-23.1	-4.5	-16.9	-46.2	-3.2	-8.2	-8.6	5.4	22.5	13.1
IN	-0.4	-4.7	-24.0	-2.7	-11.3	-30.9	-1.7	-4.6	-5.4	12.5	37.6	30.5
KS	-0.3	-3.4	-19.5	-3.7	-15.6	-42.3	-1.3	-2.6	-2.2	8.8	23.5	12.4
KY	-0.5	-5.2	-25.6	-4.1	-13.3	-34.2	-2.6	-7.0	-8.8	7.8	27.2	17.2
LA	-0.4	-4.2	-23.7	-2.5	-9.7	-30.0	-2.9	-6.8	-11.6	10.7	33.8	36.2
MA	-0.4	-4.3	-23.7	-2.9	-12.1	-38.6	-3.6	-9.9	-11.8	9.4	29.7	29.2
MD	-0.3	-3.8	-21.1	-2.7	-12.3	-38.5	-2.1	-5.6	-6.5	9.9	32.4	33.6
ME	-0.4	-3.8	-19.9	-1.7	-7.6	-23.4	-1.6	-4.1	-6.0	3.8	8.0	0.0
MI	-0.4	-4.2	-22.1	-2.6	-10.8	-33.0	-2.2	-6.2	-7.2	7.6	21.8	18.7
MN	-0.3	-3.6	-19.7	-3.1	-13.5	-38.8	-1.9	-4.0	-4.1	6.9	16.0	4.4
MO	-0.3	-4.0	-22.1	-2.3	-10.3	-29.3	-4.1	-10.1	-13.6	11.7	34.8	28.2
MS	-0.3	-3.9	-22.3	-3.1	-12.0	-32.6	-3.0	-6.8	-8.4	12.5	28.5	13.4
MT	-0.3	-3.0	-17.3	-2.8	-10.2	-31.0	-1.5	-3.0	-6.0	7.3	22.2	21.1
NC	-0.4	-4.3	-22.6	-2.8	-14.2	-37.3	-2.7	-6.5	-5.3	13.7	41.0	25.4
ND	-0.3	-3.8	-22.3	-3.6	-10.6	-37.1	-1.4	-2.6	-6.4	11.5	30.5	40.1
NE	-0.3	-3.8	-21.8	-2.8	-11.5	-32.4	-3.6	-8.3	-11.4	14.3	43.2	41.3
NH	-0.3	-3.3	-18.1	-2.2	-8.9	-26.9	-1.2	-3.2	-3.0	3.9	8.7	-1.8
NJ	-0.4	-4.3	-23.9	-6.0	-33.0	-130.5	-1.3	-3.0	-1.0	0.4	3.9	-1.7
NM	-0.3	-2.9	-15.2	-3.2	-11.0	-26.6	-1.9	-3.3	-2.6	4.4	7.8	-5.0
NV	-0.3	-2.5	-13.3	-2.8	-11.6	-24.7	-4.0	-7.9	-0.4	6.2	11.7	-3.8
NY	-0.4	-4.8	-26.1	-2.2	-9.6	-33.5	-2.9	-7.9	-11.3	13.4	47.7	69.6
OH	-0.3	-4.0	-22.1	-2.6	-11.8	-35.2	-3.7	-9.8	-11.3	9.9	30.5	23.6
OK	-0.4	-4.3	-24.6	-2.5	-10.8	-31.6	-3.2	-7.7	-10.9	16.8	59.5	66.5
OR	-0.3	-3.5	-18.0	-2.7	-10.3	-27.2	-3.1	-7.8	-9.7	9.6	24.6	16.4
PA	-0.3	-4.1	-22.6	-4.1	-15.5	-48.7	-1.4	-3.5	-4.1	4.7	16.9	11.7
RI	-0.4	-4.3	-23.0	-3.1	-10.7	-33.2	-3.1	-8.6	-10.9	8.9	25.5	21.5
SC	-0.4	-4.1	-22.3	-3.1	-11.7	-32.4	-2.2	-5.6	-6.9	9.9	27.5	19.2
SD	-0.5	-4.8	-24.2	-2.2	-8.6	-24.2	-2.6	-5.7	-10.1	12.8	35.2	30.3
TN	-0.4	-4.2	-23.2	-2.5	-12.6	-35.6	-1.7	-4.3	-4.4	12.4	39.4	32.6
TX	-0.4	-4.4	-23.4	-3.1	-14.4	-38.9	-2.9	-7.0	-7.0	12.7	37.1	26.8
UT	-0.5	-4.9	-25.4	-2.9	-11.4	-24.6	-3.7	-7.4	-11.6	15.3	36.7	21.2
VA	-0.4	-4.4	-22.2	-2.9	-12.8	-36.0	-1.9	-4.9	-5.2	7.6	22.6	15.5
VT	-0.3	-2.8	-15.6	-2.4	-8.5	-24.0	-1.3	-2.9	-2.5	5.4	11.3	-1.3
WA	-0.3	-3.3	-18.0	-2.4	-11.4	-32.2	-2.3	-5.6	-6.2	9.6	30.6	24.5
WI	-0.4	-4.0	-20.8	-2.2	-10.6	-28.4	-2.6	-5.6	-6.6	7.9	20.8	6.2
WV	-0.3	-4.0	-22.5	-2.4	-10.1	-27.3	-2.2	-5.7	-8.6	7.4	21.1	13.1
WY	-0.3	-3.2	-16.9	-2.7	-9.6	-26.2	-1.5	-2.6	-5.3	5.5	14.2	8.6

Note: All numbers correspond to % deviations from the baseline forecast numbers, presented in Table 3.

Table 5: Closed Pension Welfare by State, Sector, Age Cohort

	Public					Private					Averages		
State	20 Yr	30 Yr	40 Yr	50 Yr	60 Yr	20 Yr	30 Yr	40 Yr	50 Yr	60 Yr	Pub	Priv	State
AK	0.29	0.21	0.13	0.05	0.01	0.31	0.22	0.13	0.05	0.01	0.12	0.13	0.13
AL	0.21	0.15	0.08	0.03	0.00	0.22	0.17	0.10	0.04	0.01	0.08	0.09	0.09
AR	0.17	0.12	0.07	0.03	0.00	0.18	0.13	0.08	0.03	0.00	0.07	0.07	0.07
AZ	0.23	0.17	0.10	0.04	0.00	0.25	0.19	0.11	0.05	0.01	0.10	0.11	0.11
CA	0.27	0.19	0.10	0.04	0.00	0.29	0.22	0.12	0.05	0.01	0.11	0.13	0.13
CO	0.28	0.21	0.12	0.04	0.00	0.29	0.22	0.13	0.05	0.01	0.12	0.13	0.13
CT	0.30	0.21	0.11	0.04	0.00	0.34	0.25	0.13	0.05	0.01	0.11	0.13	0.13
DC	0.09	0.06	0.03	0.01	0.00	0.09	0.06	0.03	0.01	0.00	0.04	0.04	0.04
DE	0.16	0.12	0.06	0.03	0.00	0.17	0.13	0.07	0.03	0.00	0.06	0.07	0.07
FL	0.12	0.08	0.05	0.02	0.00	0.13	0.09	0.05	0.02	0.00	0.04	0.05	0.05
GA	0.34	0.25	0.13	0.05	0.01	0.37	0.29	0.16	0.06	0.01	0.14	0.16	0.16
HI	0.15	0.11	0.06	0.03	0.00	0.16	0.12	0.07	0.03	0.00	0.06	0.07	0.07
IA	0.15	0.11	0.06	0.03	0.00	0.16	0.12	0.07	0.03	0.00	0.06	0.07	0.07
ID	0.14	0.10	0.06	0.02	0.00	0.15	0.11	0.07	0.03	0.00	0.06	0.06	0.06
IL	0.28	0.20	0.11	0.04	0.00	0.31	0.23	0.13	0.05	0.01	0.11	0.13	0.13
IN	0.10	0.07	0.04	0.02	0.00	0.10	0.08	0.04	0.02	0.00	0.04	0.04	0.04
KS	0.09	0.07	0.04	0.02	0.00	0.10	0.08	0.05	0.02	0.00	0.04	0.04	0.04
KY	0.24	0.18	0.10	0.04	0.00	0.26	0.20	0.11	0.05	0.01	0.09	0.10	0.10
LA	0.21	0.15	0.08	0.03	0.00	0.21	0.15	0.09	0.04	0.01	0.08	0.09	0.09
MA	0.24	0.17	0.09	0.04	0.00	0.25	0.19	0.10	0.04	0.01	0.09	0.10	0.10
MD	0.12	0.09	0.05	0.02	0.00	0.13	0.10	0.05	0.02	0.00	0.05	0.05	0.05
ME	0.15	0.10	0.06	0.02	0.00	0.15	0.11	0.06	0.02	0.00	0.05	0.05	0.05
MI	0.16	0.11	0.06	0.02	0.00	0.17	0.12	0.07	0.03	0.00	0.06	0.07	0.07
MN	0.14	0.10	0.06	0.02	0.00	0.15	0.11	0.07	0.03	0.00	0.05	0.06	0.06
MO	0.29	0.21	0.11	0.04	0.00	0.31	0.23	0.13	0.05	0.01	0.11	0.12	0.12
MS	0.30	0.21	0.12	0.05	0.01	0.32	0.24	0.14	0.06	0.01	0.12	0.13	0.13
MT	0.11	0.08	0.05	0.02	0.00	0.12	0.09	0.05	0.02	0.00	0.04	0.05	0.05
NC	0.19	0.14	0.08	0.03	0.00	0.20	0.15	0.09	0.04	0.00	0.08	0.09	0.08
ND	0.10	0.07	0.04	0.02	0.00	0.10	0.07	0.05	0.02	0.00	0.04	0.04	0.04
NE	0.26	0.19	0.11	0.04	0.00	0.28	0.21	0.13	0.05	0.01	0.10	0.12	0.12
NH	0.10	0.07	0.04	0.01	0.00	0.10	0.07	0.04	0.02	0.00	0.03	0.04	0.04
NJ	0.13	0.09	0.05	0.02	0.00	0.14	0.11	0.06	0.02	0.00	0.05	0.06	0.06
NM	0.26	0.19	0.11	0.04	0.00	0.28	0.21	0.13	0.05	0.01	0.10	0.12	0.11
NV	0.25	0.19	0.11	0.04	0.00	0.27	0.21	0.12	0.05	0.01	0.11	0.12	0.12
NY	0.18	0.13	0.07	0.03	0.00	0.20	0.14	0.08	0.03	0.00	0.07	0.08	0.08
OH	0.29	0.21	0.11	0.04	0.00	0.31	0.23	0.13	0.05	0.01	0.11	0.12	0.12
OK	0.24	0.17	0.09	0.04	0.00	0.25	0.19	0.11	0.04	0.01	0.09	0.10	0.10
OR	0.22	0.16	0.09	0.03	0.00	0.24	0.18	0.10	0.04	0.00	0.09	0.10	0.10
PA	0.10	0.07	0.04	0.02	0.00	0.11	0.08	0.05	0.02	0.00	0.04	0.04	0.04
RI	0.21	0.15	0.08	0.03	0.00	0.24	0.17	0.10	0.04	0.01	0.08	0.09	0.09
SC	0.18	0.13	0.07	0.03	0.00	0.19	0.14	0.08	0.03	0.00	0.07	0.08	0.08
SD	0.19	0.13	0.08	0.03	0.00	0.20	0.15	0.09	0.04	0.00	0.07	0.08	0.08
TN	0.09	0.07	0.04	0.01	0.00	0.09	0.07	0.04	0.02	0.00	0.04	0.04	0.04
TX	0.18	0.13	0.07	0.03	0.00	0.18	0.14	0.08	0.03	0.00	0.08	0.08	0.08
UT	0.21	0.15	0.09	0.03	0.00	0.22	0.17	0.10	0.04	0.01	0.10	0.11	0.11
VA	0.14	0.10	0.06	0.02	0.00	0.15	0.11	0.07	0.03	0.00	0.06	0.06	0.06
VT	0.11	0.08	0.04	0.02	0.00	0.11	0.08	0.05	0.02	0.00	0.04	0.04	0.04
WA	0.16	0.11	0.06	0.02	0.00	0.17	0.12	0.07	0.03	0.00	0.06	0.07	0.07
WI	0.20	0.14	0.08	0.03	0.00	0.21	0.16	0.09	0.04	0.00	0.07	0.08	0.08
WV	0.22	0.16	0.09	0.03	0.00	0.24	0.17	0.10	0.04	0.00	0.08	0.09	0.09
WY	0.16	0.12	0.07	0.03	0.00	0.17	0.13	0.08	0.03	0.00	0.06	0.07	0.07

Note: All numbers correspond to % deviations in consumption-equivalent welfare (as defined in the Appendix), relative to the Baseline scenario. Sector-level and State-level averages are weighted by the relative size of age cohorts and job sectors. State-level averages are used in the Closed Reform heat map of Figure 8.

Table 6: % Change in Fiscal Aggregates Under Hybrid Pension Reform

	PVL			FR			Tax			Tax Vol		
State	15y	30y	45y	15y	30y	45y	15y	30y	45y	15y	30y	45y
AK	-9.2	-18.8	-33.9	-7.5	-12.9	-23.2	-5.3	-7.9	-9.3	13.5	0.8	-22.1
AL	-11.7	-24.9	-39.7	-10.4	-23.8	-51.0	-3.8	-7.3	-7.1	23.3	19.4	-10.6
AR	-11.9	-25.5	-40.3	-8.7	-21.3	-46.1	-3.3	-6.7	-7.7	14.3	14.5	-2.3
AZ	-10.4	-21.7	-36.1	-10.2	-20.6	-37.0	-5.0	-8.5	-7.8	6.6	-1.6	-23.2
CA	-11.7	-24.6	-39.4	-9.7	-23.1	-50.9	-6.9	-12.1	-10.8	23.0	23.5	2.2
CO	-10.8	-22.1	-36.3	-12.2	-24.4	-48.2	-5.7	-9.7	-7.6	18.9	14.4	-12.2
CT	-11.2	-24.6	-40.0	-12.7	-23.4	-49.7	-6.9	-13.4	-12.7	18.8	18.8	-5.0
DC	-14.1	-31.7	-47.2	-3.5	-6.3	-30.2	-6.0	-10.6	-16.3	5.9	-8.9	139.9
DE	-11.6	-24.7	-39.7	-8.2	-21.1	-45.1	-3.4	-6.7	-6.2	15.0	13.2	-12.3
FL	-12.1	-26.1	-41.5	-8.8	-23.7	-52.8	-3.2	-6.4	-6.7	8.1	4.5	-15.0
GA	-11.7	-23.9	-38.1	-8.6	-22.0	-44.7	-8.9	-14.2	-11.3	26.5	25.5	-5.2
HI	-10.7	-22.6	-37.1	-11.1	-20.3	-38.8	-2.7	-5.9	-6.5	8.6	3.8	-17.1
IA	-11.6	-25.2	-40.2	-8.1	-19.4	-42.6	-3.1	-6.5	-7.6	21.5	24.6	5.8
ID	-10.8	-22.3	-36.6	-7.6	-18.3	-36.4	-3.0	-5.7	-6.2	17.8	16.5	-7.2
IL	-12.0	-25.2	-39.8	-18.1	-34.3	-68.9	-5.2	-9.3	-8.0	4.7	9.7	-12.4
IN	-12.2	-25.5	-40.1	-9.2	-19.4	-41.2	-2.0	-5.3	-5.5	25.4	27.3	5.1
KS	-10.8	-23.7	-38.7	-12.6	-28.9	-60.9	-0.8	-2.7	-2.6	14.4	11.7	-14.0
KY	-12.8	-26.1	-40.5	-14.7	-25.5	-49.3	-3.8	-8.1	-8.3	9.4	15.4	-5.7
LA	-12.0	-25.7	-40.6	-8.3	-17.7	-41.4	-5.1	-9.2	-11.6	23.5	23.9	10.1
MA	-11.9	-25.8	-41.1	-11.2	-23.1	-51.6	-6.7	-12.4	-12.4	20.0	19.4	0.6
MD	-11.3	-24.4	-39.4	-9.3	-22.5	-51.6	-3.2	-6.8	-6.9	21.1	23.5	5.2
ME	-11.1	-23.6	-38.5	-6.5	-16.0	-34.5	-2.8	-6.1	-7.8	2.4	-4.8	-20.7
MI	-11.7	-24.7	-39.7	-9.9	-20.9	-45.3	-3.4	-7.6	-7.8	13.2	11.9	-6.0
MN	-11.1	-24.0	-39.1	-10.2	-25.8	-57.0	-2.7	-5.1	-5.0	10.3	3.1	-19.8
MO	-11.5	-24.9	-39.9	-7.4	-17.6	-38.4	-8.0	-13.4	-14.4	21.6	23.4	0.7
MS	-11.8	-24.9	-39.6	-10.2	-21.0	-43.6	-4.9	-8.9	-9.3	23.3	15.0	-12.9
MT	-9.8	-21.8	-36.8	-11.2	-22.2	-48.0	-1.6	-3.7	-5.6	16.3	17.8	-3.5
NC	-11.9	-24.7	-39.2	-8.0	-22.8	-47.6	-4.0	-7.5	-5.9	24.4	27.9	-3.1
ND	-11.5	-25.8	-41.5	-12.9	-24.5	-58.1	-1.3	-3.3	-5.9	23.8	28.2	13.6
NE	-11.3	-24.7	-39.8	-8.3	-20.0	-43.7	-6.3	-10.5	-11.6	28.7	34.0	11.0
NH	-10.6	-22.8	-37.9	-9.7	-19.3	-40.0	-1.4	-4.3	-5.0	4.7	-3.8	-24.3
NJ	-11.9	-25.9	-41.2	-25.3	-76.8	-206.1	-1.3	-2.8	-0.5	-7.5	-13.3	-18.3
NM	-10.0	-20.8	-35.4	-10.9	-22.2	-43.6	-3.0	-4.7	-5.2	3.1	-5.4	-26.8
NV	-9.7	-19.7	-34.3	-9.5	-20.3	-37.2	-7.3	-10.1	-6.5	9.0	-1.1	-25.8
NY	-12.2	-26.3	-41.5	-6.9	-17.7	-44.2	-5.1	-9.9	-11.2	28.1	43.1	38.9
OH	-11.6	-24.9	-39.9	-8.9	-21.3	-46.6	-7.2	-12.5	-12.2	20.0	19.1	-4.5
OK	-11.8	-25.6	-40.6	-7.4	-18.4	-42.0	-5.2	-9.4	-10.8	35.1	52.2	34.2
OR	-10.6	-22.2	-36.3	-8.7	-18.5	-37.9	-5.6	-10.1	-10.5	17.8	15.8	-5.7
PA	-11.5	-25.1	-40.3	-15.7	-34.1	-73.3	-1.5	-3.8	-3.8	4.3	5.4	-13.7
RI	-11.7	-25.3	-40.6	-11.2	-21.0	-45.5	-5.8	-11.1	-11.4	16.8	15.8	-5.6
SC	-11.7	-24.6	-39.2	-10.7	-20.7	-43.0	-3.2	-7.0	-7.5	17.8	15.2	-5.4
SD	-12.1	-25.8	-40.8	-6.4	-15.8	-35.6	-4.3	-7.6	-9.7	22.7	27.2	6.2
TN	-11.9	-25.0	-39.6	-7.6	-21.1	-45.9	-2.0	-4.9	-4.7	21.7	28.0	4.1
TX	-12.4	-25.6	-40.2	-8.9	-23.3	-50.3	-4.4	-8.2	-7.6	21.1	22.6	-0.7
UT	-12.2	-25.0	-39.0	-7.3	-18.0	-35.4	-5.8	-9.2	-11.2	24.4	23.6	3.0
VA	-12.0	-24.8	-39.3	-9.1	-22.7	-49.9	-2.6	-5.8	-5.6	12.2	10.5	-7.3
VT	-9.8	-21.3	-36.2	-9.5	-18.1	-35.8	-1.5	-3.8	-4.6	9.0	-0.1	-25.1
WA	-10.7	-22.6	-37.1	-7.9	-20.1	-43.5	-3.6	-6.9	-6.9	19.1	21.3	-1.1
WI	-11.5	-24.3	-39.2	-7.0	-18.8	-40.4	-4.5	-7.6	-7.6	12.8	7.3	-18.3
WV	-11.5	-24.4	-38.7	-7.6	-17.5	-36.7	-3.7	-7.7	-9.3	10.9	7.7	-9.6
WY	-10.1	-21.5	-36.2	-9.7	-20.1	-43.2	-1.5	-3.3	-5.2	9.5	6.2	-10.9

Note: All numbers correspond to % deviations from the baseline forecast numbers, presented in Table 3.

Table 7: Hybrid Pension Welfare by State, Sector, Age Cohort

	Public					Private					Averages		
State	20 Yr	30 Yr	40 Yr	50 Yr	60 Yr	20 Yr	30 Yr	40 Yr	50 Yr	60 Yr	Pub Avg	Priv Avg	State Avg
AK	3.64	1.91	0.19	-0.84	0.17	0.65	0.47	0.30	0.16	0.05	0.70	0.29	0.35
AL	4.10	2.54	0.85	-0.32	0.19	0.34	0.26	0.16	0.08	0.03	1.08	0.15	0.26
AR	4.12	2.65	1.03	-0.13	0.22	0.23	0.17	0.10	0.04	0.01	1.20	0.09	0.22
AZ	3.96	2.33	0.60	-0.57	0.14	0.54	0.41	0.27	0.14	0.04	1.00	0.26	0.33
CA	3.49	1.78	0.01	-1.08	0.05	0.54	0.43	0.28	0.15	0.05	0.58	0.27	0.30
CO	3.05	1.30	-0.43	-1.41	0.02	0.54	0.43	0.28	0.15	0.04	0.19	0.27	0.26
CT	3.48	1.64	-0.22	-1.33	0.01	0.72	0.58	0.38	0.21	0.07	0.30	0.34	0.34
DC	2.81	1.35	-0.06	-0.87	0.13	0.12	0.09	0.05	0.02	0.00	0.54	0.06	0.08
DE	4.07	2.61	1.01	-0.13	0.22	0.26	0.20	0.12	0.06	0.02	1.19	0.11	0.22
FL	3.82	2.39	0.82	-0.26	0.19	0.21	0.16	0.09	0.04	0.01	1.01	0.09	0.16
GA	3.75	2.00	0.15	-1.02	0.05	0.74	0.59	0.39	0.21	0.06	0.66	0.37	0.40
HI	4.05	2.57	0.96	-0.18	0.21	0.26	0.19	0.12	0.06	0.02	1.17	0.11	0.22
IA	4.10	2.66	1.06	-0.07	0.24	0.19	0.14	0.08	0.03	0.01	1.23	0.08	0.21
ID	4.12	2.71	1.14	-0.00	0.24	0.16	0.12	0.07	0.02	0.01	1.32	0.07	0.21
IL	3.10	1.27	-0.57	-1.60	-0.04	0.62	0.50	0.33	0.18	0.05	0.08	0.30	0.28
IN	4.16	2.84	1.35	0.23	0.29	0.05	0.03	0.01	-0.00	-0.00	1.44	0.01	0.16
KS	4.14	2.78	1.25	0.13	0.27	-0.00	-0.01	-0.03	-0.03	-0.01	1.41	-0.02	0.16
KY	3.68	2.02	0.29	-0.81	0.11	0.46	0.37	0.24	0.12	0.03	0.65	0.21	0.26
LA	3.26	1.64	0.03	-0.91	0.14	0.35	0.26	0.17	0.08	0.03	0.48	0.16	0.19
MA	2.85	1.10	-0.60	-1.53	-0.00	0.51	0.40	0.26	0.14	0.05	0.04	0.24	0.23
MD	3.86	2.42	0.86	-0.23	0.19	0.15	0.11	0.06	0.03	0.01	1.08	0.06	0.16
ME	3.41	1.87	0.35	-0.57	0.21	0.29	0.21	0.12	0.05	0.01	0.55	0.10	0.15
MI	3.92	2.42	0.80	-0.31	0.18	0.27	0.20	0.12	0.06	0.02	1.02	0.11	0.20
MN	3.84	2.36	0.75	-0.35	0.17	0.21	0.15	0.09	0.04	0.01	0.99	0.09	0.18
MO	3.59	1.86	0.08	-1.01	0.08	0.64	0.50	0.33	0.17	0.06	0.54	0.30	0.32
MS	4.33	2.66	0.85	-0.40	0.18	0.57	0.44	0.28	0.15	0.05	1.11	0.26	0.37
MT	4.00	2.57	1.01	-0.11	0.22	0.10	0.07	0.04	0.01	0.00	1.10	0.04	0.15
NC	4.12	2.65	1.03	-0.13	0.22	0.27	0.21	0.13	0.06	0.02	1.25	0.12	0.25
ND	3.91	2.49	0.94	-0.16	0.21	0.03	0.01	-0.01	-0.01	-0.00	1.16	-0.00	0.13
NE	4.00	2.38	0.64	-0.53	0.15	0.49	0.38	0.25	0.13	0.04	0.98	0.23	0.31
NH	4.11	2.72	1.19	0.07	0.26	0.15	0.10	0.05	0.02	0.01	1.18	0.05	0.15
NJ	3.45	1.86	0.21	-0.84	0.07	0.18	0.13	0.07	0.03	0.00	0.56	0.07	0.12
NM	4.37	2.66	0.82	-0.43	0.17	0.60	0.44	0.28	0.14	0.04	1.10	0.26	0.38
NV	2.79	1.00	-0.74	-1.69	-0.04	0.67	0.52	0.34	0.19	0.06	-0.04	0.33	0.30
NY	3.93	2.43	0.79	-0.34	0.18	0.30	0.23	0.14	0.07	0.03	1.07	0.14	0.23
OH	3.06	1.27	-0.49	-1.47	0.02	0.64	0.51	0.33	0.18	0.06	0.09	0.30	0.28
OK	4.17	2.64	0.95	-0.23	0.21	0.35	0.27	0.17	0.08	0.03	1.20	0.16	0.29
OR	3.81	2.19	0.47	-0.67	0.12	0.45	0.35	0.23	0.12	0.04	0.81	0.21	0.27
PA	3.71	2.27	0.72	-0.35	0.17	0.13	0.09	0.05	0.02	0.00	0.92	0.05	0.12
RI	3.66	2.01	0.27	-0.83	0.09	0.48	0.38	0.25	0.14	0.04	0.69	0.23	0.27
SC	4.17	2.68	1.04	-0.12	0.22	0.26	0.19	0.12	0.06	0.02	1.22	0.11	0.24
SD	4.11	2.64	1.01	-0.15	0.22	0.31	0.24	0.15	0.07	0.02	1.17	0.14	0.25
TN	4.12	2.83	1.36	0.25	0.29	0.04	0.02	-0.00	-0.01	-0.01	1.42	0.00	0.14
TX	3.52	2.00	0.42	-0.59	0.16	0.25	0.19	0.11	0.05	0.02	0.84	0.11	0.19
UT	3.94	2.43	0.79	-0.35	0.18	0.33	0.26	0.16	0.08	0.03	1.25	0.17	0.28
VA	3.95	2.49	0.91	-0.20	0.20	0.18	0.13	0.07	0.03	0.01	1.14	0.07	0.18
VT	4.23	2.83	1.27	0.13	0.27	0.15	0.10	0.05	0.02	0.01	1.26	0.05	0.18
WA	4.02	2.56	0.96	-0.18	0.21	0.20	0.15	0.08	0.03	0.01	1.18	0.08	0.21
WI	4.02	2.48	0.81	-0.34	0.18	0.38	0.30	0.19	0.09	0.03	1.02	0.17	0.26
WV	4.38	2.85	1.13	-0.10	0.23	0.37	0.28	0.16	0.07	0.02	1.17	0.14	0.29
WY	4.30	2.80	1.13	-0.06	0.24	0.15	0.09	0.05	0.01	0.00	1.26	0.05	0.24

Note: All numbers correspond to % deviations in consumption-equivalent welfare (as defined in the Appendix), relative to the Baseline scenario. Sector-level and State-level averages are weighted by the relative size of age cohorts and job sectors. State-level averages are used in the Hybrid Reform heat map of Figure 11.

Table 8: % Change in Fiscal Aggregates Under COLA Freeze

State	PVL 15y	PVL 30y	PVL 45y	FR 15y	FR 30y	FR 45y	Tax 15y	Tax 30y	Tax 45y	Tax Vol 15y	Tax Vol 30y	Tax Vol 45y
AK	-27.1	-31.0	-31.9	2.2	2.9	3.4	-4.7	-7.5	-16.8	-31.1	-35.3	-33.8
AL	-19.9	-23.3	-24.8	1.5	1.8	2.9	-3.5	-4.0	-5.0	-21.7	-27.5	-30.0
AR	-19.6	-22.9	-24.3	0.9	1.4	2.2	-3.1	-3.5	-4.1	-20.8	-26.3	-28.4
AZ	-23.2	-27.6	-29.3	2.9	2.5	3.6	-5.2	-7.1	-11.8	-24.4	-30.0	-31.4
CA	-20.9	-24.4	-25.8	1.3	1.8	2.9	-4.2	-4.7	-5.6	-23.4	-28.9	-30.7
CO	-23.3	-27.7	-29.2	2.9	2.8	4.4	-4.4	-5.4	-8.1	-26.0	-32.8	-33.6
CT	-21.0	-24.0	-25.1	2.8	2.1	2.7	-5.3	-5.9	-6.9	-23.1	-29.0	-30.3
DC	-13.6	-13.9	-14.1	-0.2	-0.2	-0.3	-3.1	-3.1	-3.1	-13.5	-14.7	-13.8
DE	-21.2	-24.5	-25.7	1.6	2.0	3.1	-3.4	-4.0	-5.2	-23.5	-28.9	-30.8
FL	-19.5	-22.4	-23.5	1.8	1.8	2.4	-3.5	-4.1	-4.8	-20.1	-24.9	-26.5
GA	-21.4	-25.4	-27.1	1.0	1.8	2.9	-4.8	-5.5	-7.2	-24.6	-30.4	-32.5
HI	-23.1	-27.0	-28.6	3.7	2.5	3.7	-3.9	-4.8	-7.2	-24.6	-30.0	-32.2
IA	-20.6	-23.8	-25.0	1.1	1.6	2.3	-3.0	-3.3	-3.8	-22.6	-28.7	-31.0
ID	-23.2	-27.5	-29.1	1.3	2.4	3.6	-3.1	-3.7	-5.3	-26.5	-33.0	-34.3
IL	-20.7	-24.1	-25.4	5.8	2.9	4.0	-4.9	-5.5	-6.9	-21.4	-27.3	-29.2
IN	-20.6	-23.9	-25.2	1.4	1.6	2.4	-2.5	-2.8	-3.3	-23.4	-28.9	-31.2
KS	-21.3	-24.9	-26.2	3.1	2.7	4.1	-2.5	-3.0	-4.0	-22.7	-28.6	-30.8
KY	-20.3	-23.6	-25.0	4.2	1.9	2.7	-4.0	-4.4	-5.4	-20.6	-27.5	-29.5
LA	-19.5	-22.8	-24.1	0.8	1.4	2.0	-3.6	-3.9	-4.4	-21.3	-27.3	-29.3
MA	-20.0	-22.9	-23.9	2.0	1.5	2.2	-4.6	-5.0	-5.7	-21.3	-26.9	-28.8
MD	-20.8	-24.3	-25.6	1.3	1.8	2.9	-3.0	-3.3	-3.9	-23.0	-28.8	-31.4
ME	-22.3	-25.9	-27.3	1.8	2.2	3.1	-4.0	-5.3	-7.7	-22.9	-28.2	-29.8
MI	-21.1	-24.5	-25.8	2.4	2.0	2.8	-3.6	-4.1	-5.0	-22.4	-28.6	-30.3
MN	-21.5	-24.9	-26.1	2.2	2.7	4.3	-3.3	-4.3	-6.1	-23.3	-28.5	-29.0
MO	-20.5	-23.8	-25.0	0.7	1.3	2.2	-4.7	-5.2	-6.1	-23.2	-28.5	-30.4
MS	-19.9	-23.4	-24.9	1.3	1.5	2.5	-3.9	-4.6	-5.9	-21.4	-27.6	-29.6
MT	-22.6	-26.8	-28.3	3.3	3.0	4.5	-3.2	-3.6	-4.5	-24.9	-33.1	-35.8
NC	-20.8	-24.4	-26.0	1.0	1.8	2.7	-3.1	-3.6	-4.4	-23.6	-30.1	-32.3
ND	-19.4	-22.5	-23.3	2.2	1.8	2.4	-2.5	-2.6	-2.9	-20.1	-26.9	-29.2
NE	-20.5	-23.8	-25.1	0.8	1.6	2.3	-3.9	-4.2	-4.9	-23.9	-29.6	-31.6
NH	-22.7	-26.3	-27.6	3.7	2.9	3.7	-3.7	-5.1	-7.9	-23.8	-28.9	-29.8
NJ	-19.7	-22.6	-23.7	14.3	10.3	14.3	-3.3	-4.0	-5.3	-18.5	-21.9	-24.1
NM	-24.3	-28.8	-30.3	6.2	4.3	5.4	-4.9	-7.1	-13.0	-25.0	-31.0	-31.7
NV	-25.1	-29.8	-31.3	3.2	3.3	4.5	-6.4	-9.7	-18.6	-27.7	-32.6	-32.6
NY	-19.4	-22.3	-23.4	0.5	1.1	1.5	-3.3	-3.5	-3.6	-21.3	-27.0	-29.1
OH	-20.4	-23.8	-25.1	1.2	1.7	2.7	-4.7	-5.3	-6.4	-22.3	-28.3	-30.3
OK	-19.5	-22.7	-24.0	0.4	1.1	1.6	-3.3	-3.5	-3.7	-22.6	-28.0	-31.1
OR	-22.9	-27.3	-29.1	1.9	2.4	3.6	-4.3	-5.0	-6.9	-25.8	-32.3	-34.3
PA	-20.4	-23.6	-24.8	6.2	3.5	4.5	-3.3	-3.7	-4.6	-20.0	-26.3	-29.0
RI	-20.6	-23.7	-24.7	2.4	1.7	2.6	-4.6	-5.1	-6.1	-22.8	-27.4	-29.4
SC	-20.6	-24.2	-25.8	1.9	1.7	2.8	-3.3	-3.8	-4.7	-22.0	-27.7	-30.3
SD	-20.9	-23.9	-24.8	0.7	1.5	2.2	-3.3	-3.7	-4.3	-23.9	-29.2	-31.6
TN	-20.2	-23.7	-25.3	0.6	1.5	2.2	-2.4	-2.7	-3.2	-22.4	-28.8	-31.1
TX	-19.9	-23.3	-24.7	0.8	1.4	2.6	-3.1	-3.5	-4.2	-21.7	-27.0	-29.4
UT	-21.0	-24.2	-25.6	0.7	1.4	2.0	-3.4	-3.9	-4.6	-23.4	-28.7	-30.2
VA	-21.3	-24.8	-26.2	2.0	2.2	3.2	-3.0	-3.5	-4.5	-23.0	-28.0	-30.1
VT	-23.6	-27.8	-29.2	3.6	3.1	4.3	-3.9	-5.2	-8.7	-26.1	-31.9	-32.1
WA	-22.2	-26.4	-28.1	1.2	2.2	3.5	-3.2	-3.7	-4.8	-25.6	-32.0	-34.1
WI	-21.6	-25.1	-26.3	1.0	2.2	3.4	-3.8	-4.8	-6.8	-24.2	-29.5	-30.2
WV	-20.4	-24.1	-25.9	0.7	1.5	2.6	-3.5	-4.1	-5.2	-21.4	-27.4	-29.9
WY	-23.8	-28.2	-29.6	3.7	3.3	5.0	-3.1	-3.9	-5.6	-25.8	-32.5	-34.3

Note: All numbers correspond to % deviations from the baseline forecast numbers, presented in Table 3.

Table 9: COLA Freeze Welfare by State, Sector, Age Cohort

	Public					Private					Averages		
State	20 Yr	30 Yr	40 Yr	50 Yr	60 Yr	20 Yr	30 Yr	40 Yr	50 Yr	60 Yr	Pub Avg	Priv Avg	State Avg
AK	0.25	-0.70	-2.05	-4.12	-8.01	1.32	0.99	0.65	0.37	0.11	-3.28	0.63	0.09
AL	-0.10	-0.69	-1.64	-3.19	-6.14	0.63	0.53	0.38	0.23	0.07	-2.79	0.33	-0.05
AR	-0.17	-0.68	-1.51	-2.89	-5.55	0.48	0.41	0.29	0.17	0.06	-2.53	0.25	-0.07
AZ	0.07	-0.64	-1.75	-3.51	-6.74	0.90	0.73	0.50	0.28	0.09	-2.86	0.46	0.14
CA	-0.34	-1.09	-2.29	-4.32	-8.19	0.62	0.52	0.37	0.22	0.07	-3.50	0.34	-0.03
CO	-0.34	-1.21	-2.56	-4.83	-9.24	0.76	0.63	0.44	0.26	0.08	-4.01	0.41	-0.05
CT	-0.13	-0.99	-2.38	-4.67	-8.91	0.93	0.79	0.56	0.34	0.11	-4.12	0.48	0.04
DC	-0.78	-1.39	-2.35	-4.02	-7.36	0.11	0.10	0.07	0.04	0.02	-3.07	0.07	-0.07
DE	-0.17	-0.69	-1.51	-2.89	-5.53	0.48	0.40	0.28	0.16	0.05	-2.57	0.25	-0.04
FL	-0.29	-0.81	-1.64	-3.04	-5.75	0.38	0.32	0.22	0.13	0.04	-2.77	0.19	-0.05
GA	-0.23	-1.00	-2.23	-4.26	-7.97	0.73	0.61	0.43	0.25	0.08	-3.45	0.39	0.02
HI	-0.03	-0.59	-1.47	-2.91	-5.63	0.65	0.54	0.37	0.22	0.07	-2.51	0.33	0.04
IA	-0.18	-0.68	-1.48	-2.82	-5.41	0.46	0.39	0.28	0.16	0.05	-2.49	0.24	-0.08
ID	-0.15	-0.64	-1.41	-2.70	-5.17	0.46	0.39	0.27	0.15	0.05	-2.27	0.24	-0.04
IL	-0.33	-1.24	-2.67	-5.07	-9.56	0.79	0.66	0.47	0.28	0.09	-4.25	0.42	-0.02
IN	-0.19	-0.59	-1.24	-2.33	-4.47	0.34	0.29	0.21	0.13	0.04	-2.04	0.18	-0.04
KS	-0.15	-0.59	-1.30	-2.48	-4.76	0.42	0.35	0.24	0.14	0.05	-2.12	0.22	-0.06
KY	-0.18	-0.90	-2.03	-3.91	-7.53	0.71	0.60	0.43	0.26	0.08	-3.46	0.37	-0.04
LA	-0.43	-1.15	-2.28	-4.17	-7.91	0.54	0.46	0.33	0.20	0.07	-3.69	0.29	-0.14
MA	-0.51	-1.35	-2.69	-4.98	-9.45	0.60	0.51	0.37	0.22	0.07	-4.40	0.32	-0.07
MD	-0.29	-0.80	-1.61	-2.99	-5.66	0.36	0.31	0.22	0.13	0.04	-2.60	0.19	-0.06
ME	-0.28	-0.97	-2.02	-3.71	-6.94	0.62	0.50	0.34	0.19	0.06	-3.65	0.27	-0.13
MI	-0.19	-0.74	-1.63	-3.12	-5.96	0.51	0.43	0.31	0.18	0.06	-2.80	0.26	-0.03
MN	-0.23	-0.79	-1.69	-3.18	-6.03	0.48	0.40	0.27	0.16	0.05	-2.78	0.24	-0.06
MO	-0.26	-1.01	-2.23	-4.27	-8.18	0.71	0.60	0.43	0.25	0.08	-3.76	0.37	-0.04
MS	0.09	-0.58	-1.64	-3.36	-6.53	0.89	0.74	0.53	0.32	0.11	-2.86	0.46	0.01
MT	-0.13	-0.64	-1.46	-2.82	-5.41	0.51	0.43	0.30	0.18	0.06	-2.59	0.25	-0.06
NC	-0.19	-0.70	-1.53	-2.91	-5.56	0.47	0.39	0.28	0.16	0.05	-2.49	0.25	-0.06
ND	-0.27	-0.76	-1.55	-2.89	-5.49	0.37	0.32	0.23	0.14	0.05	-2.54	0.20	-0.12
NE	-0.19	-0.82	-1.84	-3.53	-6.72	0.60	0.51	0.37	0.22	0.07	-3.00	0.32	-0.04
NH	-0.04	-0.53	-1.29	-2.53	-4.90	0.55	0.45	0.31	0.18	0.05	-2.40	0.26	0.01
NJ	-0.38	-1.04	-2.08	-3.85	-7.17	0.46	0.38	0.26	0.15	0.05	-3.38	0.23	-0.12
NM	0.48	-0.32	-1.52	-3.34	-6.59	1.36	1.06	0.71	0.39	0.11	-2.77	0.64	0.14
NV	-0.23	-1.22	-2.72	-5.18	-9.86	0.99	0.77	0.50	0.28	0.08	-4.22	0.48	0.12
NY	-0.30	-0.84	-1.72	-3.22	-6.11	0.41	0.35	0.25	0.15	0.05	-2.76	0.22	-0.08
OH	-0.41	-1.27	-2.64	-4.96	-9.47	0.72	0.61	0.43	0.26	0.08	-4.48	0.37	-0.11
OK	-0.17	-0.72	-1.61	-3.10	-5.96	0.53	0.46	0.33	0.20	0.07	-2.65	0.29	-0.08
OR	-0.17	-0.84	-1.91	-3.68	-6.99	0.66	0.56	0.39	0.23	0.07	-3.11	0.35	0.00
PA	-0.30	-0.83	-1.68	-3.13	-5.91	0.39	0.33	0.23	0.14	0.04	-2.85	0.20	-0.05
RI	-0.21	-0.91	-2.03	-3.90	-7.38	0.66	0.56	0.40	0.24	0.08	-3.41	0.35	0.03
SC	-0.07	-0.60	-1.46	-2.87	-5.57	0.60	0.50	0.36	0.22	0.07	-2.52	0.31	-0.02
SD	-0.20	-0.72	-1.56	-2.96	-5.65	0.46	0.39	0.28	0.16	0.05	-2.65	0.24	-0.08
TN	-0.25	-0.64	-1.25	-2.30	-4.37	0.26	0.22	0.15	0.09	0.03	-2.04	0.14	-0.07
TX	-0.42	-1.02	-1.98	-3.62	-6.85	0.39	0.33	0.24	0.14	0.05	-2.99	0.22	-0.10
UT	-0.28	-0.83	-1.73	-3.23	-6.13	0.44	0.37	0.26	0.16	0.05	-2.42	0.25	-0.02
VA	-0.24	-0.76	-1.58	-2.97	-5.65	0.42	0.35	0.25	0.14	0.05	-2.55	0.22	-0.07
VT	0.09	-0.42	-1.20	-2.46	-4.81	0.68	0.55	0.38	0.22	0.07	-2.31	0.32	0.03
WA	-0.21	-0.73	-1.56	-2.96	-5.65	0.46	0.38	0.27	0.15	0.05	-2.52	0.24	-0.07
WI	-0.16	-0.75	-1.68	-3.22	-6.13	0.57	0.47	0.32	0.18	0.05	-2.87	0.28	-0.05
WV	0.04	-0.52	-1.43	-2.89	-5.63	0.72	0.61	0.43	0.25	0.08	-2.67	0.35	-0.06
WY	0.08	-0.48	-1.37	-2.80	-5.45	0.75	0.62	0.43	0.24	0.07	-2.42	0.37	-0.06

Note: All numbers correspond to % deviations in consumption-equivalent welfare (as defined in the Appendix), relative to the Baseline scenario. Sector-level and State-level averages are weighted by the relative size of age cohorts and job sectors. State-level averages are used in the COLA Reform heat map of Figure 15.

A.2 Regression Tables

Table 10: Regression Analysis for Determinants of Hybrid Reform Public Welfare Effects

	(1) Δ Pub. Welfare	(2) Δ Pub. Welfare	(3) Δ Pub. Welfare	(4) Δ Pub. Welfare
Constant	2.860***	1.4704***	1.2185***	1.0028***
	(0.100)	(0.092)	(0.113)	(0.208)
Benefit $\bar{b}_s$	−0.0509***	−0.0357***	−0.0345***	−0.0319***
	(0.004)	(0.002)	(0.002)	(0.002)
SS Coverage		0.5215***	0.4984***	0.5268***
		(0.047)	(0.045)	(0.037)
Pub Sector $p_{s,pub}$			2.2685***	2.4597***
			(0.659)	(0.506)
FR $\chi(s, T = 0)$				0.0850
				(0.066)
ARC Cont. θ_s				0.3296***
				(0.095)
Discount r_s				−3.7594
				(2.882)
Observations	51	51	51	51
R-squared	0.770	0.953	0.963	0.974
Adj R-squared	0.766	0.951	0.960	0.971
F-stat	173.6	1043.0	793.0	484.8

Note: This table displays the results from regressing public sector welfare change on state-level characteristics. Average public welfare change is listed in percentages. *SS Coverage* is listed as a proportion between 0 and 1. All other explanatory variables are in the same units as listed in Table 2. The coefficients are displayed with robust standard errors below in parenthesis. We also denote the statistical significance of each estimate using stars (*p<0.1, **p<0.05, ***p<0.01).

Table 11: Regression Analysis for Determinants of COLA Reform Public Welfare Effects

	(1) 20 yr Δ Welfare	(2) 20 yr Δ Welfare	(3) 55 yr Δ Welfare	(4) 55 yr Δ Welfare
Constant	-1.1346^{***}	-1.2935^{***}	-2.2951^{***}	-2.1564^{***}
	(0.168)	(0.305)	(0.094)	(0.230)
Benefit $\bar{b}_s$	0.0028	0.0005	-0.1139^{***}	-0.1152^{***}
	(0.003)	(0.003)	(0.002)	(0.002)
SS Coverage	0.1328^{*}	0.1521^{**}	1.1090^{***}	1.1068^{***}
	(0.072)	(0.062)	(0.025)	(0.027)
Pub Sector $p_{s,pub}$	7.2778^{***}	6.3724^{***}	-2.0584^{***}	-2.2806^{***}
	(1.412)	(1.475)	(0.450)	(0.519)
FR $\chi(s, T = 0)$		-0.4459^{***}		-0.1587^{**}
		(0.094)		(0.070)
ARC Cont. θ_s		0.6023^{***}		0.0688
		(0.122)		(0.096)
Discount r_s		0.7754		-0.3698
		(4.40)		(3.042)
Observations	51	51	51	51
R-squared	0.584	0.711	0.996	0.997
Adj R-squared	0.558	0.671	0.996	0.996
F-stat	18.72	20.35	2893.0	1502.0

Note: This table displays the results from regressing public sector welfare change on state-level characteristics for 20- and 55-year old age cohorts. Public welfare change is listed in percentages. *SS Coverage* is listed as a proportion between 0 and 1. All other explanatory variables are in the same units as listed in Table 2. The coefficients are displayed with robust standard errors below in parenthesis. We also denote the statistical significance of each estimate using stars (*p<0.1, **p<0.05, ***p<0.01).

A.3 Welfare Analysis

We utilize consumption-equivalent welfare as our metric for normative analysis. Suppose a worker's optimal consumption policy function $\{c_t^*\}_{t=1}^{80}$ yields ex-ante expected welfare V^* via

$$V^* = E\left[\sum_{t=1}^{80} \beta^t \Big(\prod_{j=1}^{t} p_j\Big) \frac{c_t^{*1-\gamma}}{1-\gamma}\right] \tag{A3.1}$$

We define the consumption-equivalent (CE) welfare as a scalar $\bar{c}^*$ such that

$$\text{(A3.2)} \qquad \bar{c}^* = \Big[\frac{V^*(1-\gamma)}{\sum_{t=1}^{80}\beta^t\big(\prod_{j=1}^{t}p_j\big)}\Big]^{\frac{1}{1-\gamma}}$$

In our main analysis, we report cohort-specific measures of welfare at model time $T = 0$ and thus compute an average, given the cross-section of workers. Specifically, for a given age cohort and job sector, workers vary by their wealth x and persistent wage shock η. Given a joint distribution of these state variables $F(x, \eta|t, j)$, age-sector consumption-equivalent welfare is

$$\text{(A3.3)} \qquad \bar{c}(t, j) = \int\int \bar{c}^*(x, \eta|t, j)dF(x, \eta|t, j)$$

Since we do not directly observe the current distribution of workers, we construct F through simulating the baseline model and then collecting the observed cross-sections of (x, η) for each job sector, age cohort and state. Given baseline consumption-equivalent welfare $\bar{c}^{base}(t, j)$, welfare gains from reform are reported as percentage deviations

$$\text{(A3.4)} \qquad 100^*\frac{\bar{c}^{ref}(t, j) - \bar{c}^{base}(t, j)}{\bar{c}^{base}(t, j)} \quad \forall t, j$$

and for each state s where $\bar{c}^{ref}$ is consumption-equivalent welfare under the policy reform.

A.4 Computing Age Cohort Distributions

We assume age cohort distributions are invariant to job sector such that $\Phi(s, t, T) = prob(pub)\tilde{\Phi}(t, T)+ \big(1 - prob(pub)\big)\tilde{\Phi}(t, T)$. Define data cohort distributions as $G(t, T)$ for age group t and time T, as well as labor force participation rates $\gamma(t)$, the ratio of annuitants to workers ϕ and cohort growth rates $\phi(t, T)$.[29] To construct $\tilde{\Phi}$ as the model analogue to G, we apply the following procedure: for model time $T = 1$, apply labor force participation rates $\gamma(t)$ to working age cohorts such that $\tilde{\Phi}(t, 1) = \gamma(t)G(t, 1)$ for $t = 1, ..., 45$, and use the transformation $\tilde{\Phi}(t, 1) = \bar{\kappa}G(t, 1)$ for retired cohorts $t = 46, ..., 80$ where κ is recovered from the

[29]The Weldon Cooper data is organized in 5-year age bins, while our model accounts for individual ages. To account for this, we take the proportions within each age bucket and evenly apply it to individual age buckets.

model-implied ratio of annuitants to workers ϕ, given by

(A4.1) $$\phi = \frac{\bar{\kappa} \sum_{t=46}^{80} G(t,1)}{\sum_{t=1}^{45} \tilde{\Phi}(t,1)}$$

For time periods $T = 2, ...,$ apply cohort growth rates $\tilde{\Phi}(t, T+1) = \phi(t,T)\tilde{\Phi}(t,T)$ for $t = 1, ..., 80$. For each time period T, the cross-section of workers is also normalized to 1.