Shrouded Costs of Government: Political Economy of State and Local Public Pensions Data

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Shrouded Costs of Government: The Political Economy of State and Local Public Pensions*

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Abstract

Why do public-sector workers receive so much of their compensation in the form of pensions and other benefits? This paper presents a political economy model in which politicians compete for taxpayers' and government employees' votes by promising compensation packages, but some voters cannot evaluate every aspect of promised compensation. If pension packages are "shrouded," so that public-sector workers better understand their value than ordinary taxpayers, then compensation will be highly back-loaded. In equilibrium, the welfare of public-sector workers could be improved, holding total public-sector costs constant, if they received higher wages and lower pensions. Centralizing pension determination has two offsetting effects on generosity: more state-level media attention helps taxpayers better understand pension costs, and that reduces pension generosity; but a larger share of public-sector workers will vote within the jurisdiction, which increases pension generosity. A short discussion of pensions in two decentralized states (California and Pennsylvania) and two centralized states (Massachusetts and Ohio) suggests that centralization appears to have modestly reduced pensions, but, as the model suggests, this is unlikely to be universal.

Keywords: Public pensions, State and local government, Imperfect information, Elections, Public-sector unions
JEL codes: D72, D82, H75, H77

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1 Introduction

Credit card companies and hotels have long charged "shrouded" fees that were difficult for most consumers to assess at the first point of purchase (Gabaix and Laibson 2006). States and localities commit to pension obligations that are similarly difficult for voters to assess. Novy-Marx and Rauh (2010) argue that states and localities have underestimated the shortfall in pension funding by trillions of dollars because of aggressive assumptions about returns on pension investments, and the continuing debate over their conclusions reinforces the point that pension promises are hard to evaluate (Mitchell and McCarthy 1999). How does the difficulty of evaluating the costs of future obligations impact the level of public wages and benefits, and what institutions lead to better outcomes for taxpayers and public-sector workers?

After discussing the remarkable heterogeneity of local pension arrangements across the United States in Section 2, in Section 3 we present a political economy model in the spirit of Glaeser, Ponzetto and Shapiro (2005) and Ponzetto (2011). Politicians compete for votes by making binding promises about public-sector wages and pensions.[1] These promises ensure that public-sector workers prefer their jobs to the private sector. Housing prices equilibrate to make citizens indifferent about locations.

Policy promises are heard by only a portion of the electorate. We generally assume that pension promises are understood less well than promises about wages and that public-sector workers are more aware of these promises, especially pension promises, than ordinary voters. Public-sector worker certainly have far stronger incentives to understand the value of their own retirement packages. Our information structure follows if taxpayers and public-sector workers both have access to public information sources (the "news"), but public-sector workers also have access to an added information source (the "union"), and all sources have a proportionally lower chance of appropriately reporting pension promises relative to wage promises.

Unlike Gabaix and Laibson (2006), we assume only limited information, not limited rationality, so the ignorant correctly infer what the politicians will do. Still, as in Glaeser, Ponzetto and Shapiro (2005), their ignorance impacts the political equilibrium because politicians cannot change the voting behavior of the ignorant by changing their promises. Our core political results would not change if uninformed voters naively underestimated future pension costs, as long as the marginal home buyer correctly anticipated the cost of pension obligations. Indeed, less rationality could easily strengthen our results.

As politicians are inherently identical in the model, a variant of the standard median voter result holds, and both politicians choose identical promises.[2] The pensions and wages offered by politicians reflect two first-order conditions that offset the benefits that workers get against the cost imposed on taxpayers. The costs and benefits for the two groups are multiplied by the size of the group in the informed voting population. Some public-sector workers live outside the community, and this lowers their political clout, but public-sector

[1] It is possible to craft a similar model with retrospective voting, as long as voters do not fully understand the long-term ramifications of pension promises.

[2] A slight perturbation of the model, following our earlier work, would give one of the politicians privileged communications with public sector unions and that would lead to policy divergence between the candidates, where the politician with extra access promised more generous pensions.

workers are better informed and this effect increases their importance in the politicians' calculus.

As in many imperfect information models, assumptions about off-the-equilibrium path beliefs play a significant role. Since politicians have two choices (wages and pension), one important question is what voters assume about a hidden choice if the politician deviates on the other observed choice. One assumption is that voters believe that the politician has optimally chosen the hidden choice given the observed deviation. Another assumption is that the politician has stuck to the expected hidden choice, which might be sensible if the off-the-equilibrium path choice was a true random error. We assume a belief structure that nests both of these assumptions, although some of our results depend on a more particular belief structure, or on assuming no pre-funding.

If relatively more union voters understand pension promises, then this information asymmetry pushes the equilibrium towards greater pension obligations. When public-sector workers have a greater advantage over taxpayers in understanding pensions than wages, public-sector consumption is higher post-retirement and public-sector workers would borrow against their future pensions if they could. We don't allow such borrowing, because in reality public pensions are not alienable and typically cannot be taken in bankruptcy. If borrowing against pensions was easy, then public workers would receive no wages and receive all of their compensation in the form of pension promises.

The informational advantages of public-sector workers cause them to earn rents or quasi-rents, and the political equilibrium leads to a situation in which voters and public-sector workers could both benefit from a different age-earnings profile for public-sector workers. If public-sector workers earned higher wages while young in exchange for lower pension benefits, their welfare could improve at no cost to the taxpayer. Fitzpatrick (2012) finds that Illinois teachers choose not to forgo cash today in exchange for future pensions that have a substantially higher net present value (evaluated at market interest rates).

If pension promises are not fully funded by current taxes, then they decrease future housing prices, but if housing supply growth is positive the drop in the home values for current owners does not fully capture the cost of pension promises. Some of the costs of future pensions will be paid for by the owners of houses that have not yet been built, which means that less fully funded pensions cost current taxpayers less. We assume that vacant land doesn't have votes attached to it. Then city growth induces more generous and more back-loaded public-sector compensation, as voters support an increase in pensions with no change in public-sector wages.

A pre-funding requirement for pensions has the opposite effect. It will lead to lower pensions, but have no impact on overall public-sector wages, which causes public-sector worker welfare to decline and housing prices to increase. This impact is stronger if housing growth is positive, but it exists even when there is no ongoing construction. Public-sector workers themselves, being liquidity constrained, moderate their pension demands if they have to contribute to pre-funding during their working life.

The spatial equilibrium structure of the model means that we can separately analyze the impact of higher reservation utility, which reflects the general level of prosperity in the country as a whole, and higher private incomes in the area, which will be offset by higher housing prices. Higher incomes lead to higher public-sector wages, because they cause the cost of housing to increase, and that in turn increases the marginal benefit to public-sector workers of receiving higher wages, while leaving the marginal cost to taxpayers untouched, since their real incomes are determined by the reservation utility. We assume that workers move when they retire, so higher incomes have no impact on the cost of living when old, and therefore no impact on pensions. An increase in the cost of living in the retirement community does, however, increase pension benefits.

Increases in the reservation utility, on the other hand, cause benefits to rise and have an ambiguous impact on wages. The ambiguous effect reflects two opposite effects. A higher reservation utility means that taxpayers have a lower marginal utility of income, reducing the cost of pensions to them; but it also reduces housing prices, causing the marginal benefit of wages to public-sector workers to fall as well.

As the share of public-sector workers that live in the community rises, the amount paid to public-sector workers in both wages and pensions also increase, because the political power of the public-sector workers has risen. Liquidity-constrained public-sector employees most strongly desire higher wages, although they find higher pensions politically easier to obtain. Hence, when government employees are a larger share of the local electorate they leverage their numerical clout particularly into higher wages: the back-loading of public-sector compensation falls as the fraction of government employees living in the community rises.

As the informational advantage of public-sector workers about wages falls, public-sector wages fall. As a consequence, pensions also fall if there is a positive degree of pre-funding, because lower public-sector wages (caused by better taxpayer knowledge about wages) increase the marginal utility cost to the public workers of paying for their own pensions by decreasing their consumption while young. As the informational advantage of public-sector workers about benefits falls, benefits certainly decline, but wages may stay constant. Lower public-sector pensions do not affect government employees' marginal utility of consumption when young, because the tax benefit of lower pension pre-funding are completely offset by higher housing costs. An indirect effect, therefore, can result only from voters' beliefs off the equilibrum path. In any case, the direct effect is always dominant, so information about one policy dimension has the greatest impact on that dimension itself. Therefore, the back-loading of public-sector compensation increases with information asymmetry about pensions, but decreases with information asymmetry about wages.

In Section 4, we use these results to discuss the impact of allocating control over public pensions to the state or to lower levels of government. We assume that there are two offsetting effects of allocating control to a higher level of government. First, there are state media sources that will supplement the knowledge about pensions and wages at the local level. Our information structure implies that this greater knowledge will increase the knowledge of taxpayers about both wages and pensions, but it will have a greater impact on knowledge of pensions because that knowledge started at a lower level. We also assume that the share of public-sector workers who vote in the relevant election increases, since public-sector workers are quite likely to live in the state where they work, but they are far less likely to live in the community where they work.

The overall impact on wages and pensions depends on which effect dominates. If the impact of public-sector workers voting is more powerful, then state control will lead to more generous wages and pension benefits. If the impact of reduced information asymmetries between voters and workers is stronger, then state pensions and wages will be less generous.

If the local news sources provide at least a modest amount of information, then moving to the state level will lead to a flattening of the consumption profile for state workers, because of the reduced asymmetry between wage and pension knowledge. This flattening means that if the move to state control held housing values constant, public-sector workers would be unambiguously better off.

If the information effect dominates the public sector voter effect, then this can provide one justification for why pension arrangements for local workers are often determined at the state level. An alternative justification for this arrangement is that if localities are uncontrolled they will face a moral hazard problem that will lead them to accumulate pension obligations that will be eventually paid for by the state. While this second explanation appears highly relevant when discussing later centralization efforts, such as that of Ohio in the late 1960s, it seems far less relevant in understanding the early 20th century centralizations, such as teachers in California and Massachusetts, which occurred long before any obvious threat of insolvency. Moreover, it is far from clear that most states would actually feel obliged to take on local pension obligations.

In Section 5, we turn to four real world examples of states with different pension arrangements, both to understand why different systems evolve and to examine the impact of those systems. We compare two pairs of states: Massachusetts and California, and Ohio and Pennsylvania. Both pairs include a state with a central, state-level control over local pensions (Massachusetts and Ohio) and a state with abundant local heterogeneity in county and municipal pensions (California and Pennsylvania).

Massachusetts had a modest number of local pensions prior to World War II, but in 1945 the state passed a law which controlled the terms of local pension arrangements. The state has regularly reacted to perceived funding shortfalls by requiring higher levels of employee contributions. California's local pension plans are regulated at the state level, but counties and localities have discretion over the generosity of the plan, within limits, whether the plan is independent (like many of the county plans) or part of the broader CalPERS system. Both California and Massachusetts have generous pension arrangements, but California's local plans are typically more generous, primarily because the Massachusetts plans require significantly higher levels of member contribution.

Ohio's local plans were centralized in 1967, in response to an early under-funding problem, which appears to represent more of a response to the moral hazard problem. The program also provides large pensions, but it has a ten percent member contribution rate, which is slightly above Massachusetts. Pennsylvania has great heterogeneity in plan generosity. We consider Luzerne County, which is only slightly more generous than Ohio, and Pittsburgh, which is considerably more generous. Again, the main gap in generosity reflects differences in member contributions.

It is difficult to draw too much inference from four case studies, but in these cases central control seems to have led to lower pensions. To us this suggests the power of shrouding, because a primary difference between state and local control is that more media attention tends to be paid to pensions at the state level than purely local pension arrangements. We do not, however, believe that this is a universal phenomenon.

We now turn to some basic facts about local pension arrangements across the United States and then present our model.

2 State and Local Public Pensions

In this section, we survey the heterogeneity in local and pension plan arrangements across the United States. Our focus is on municipal pension plans, but we discuss state plans as well, because we believe they shed light on what would happen in towns and municipalities if their pensions were determined at the state level. This discussion provides the institutional basis for the model that follows in the next section.

America's fifty states have fifty different arrangements concerning state and municipal pensions. There are, however, common features across the country. Table 1 briefly summarizes the state and local plans for all fifty states. Almost all of states have state-level pension programs covering the direct employees of the state. In most cases, there is also an umbrella organization that some or all municipalities join. CalPERS, the California Public Employees Retirement System, may be the most famous example of such a super-system, as the nation's largest public pension fund, with over $200 billion dollars of assets under management. Many of these programs also deal with healthcare costs, but we will not focus on the abundantly studied issues around healthcare costs in this paper.

Teachers, who typically represent a large share of municipal employment, often have their own statewide systems that are distinct from, if often quite similar to, the more general state program. Often the teacher systems are at once a part of and independent from the state system. The California State Teacher Retirement System, CalSTRS, has $150 billion under management, making it another financial behemoth. But unlike the CalPERS plan for localities, participation in CalSTRS is obligatory for every school district and every school teacher, and every teacher faces exactly the same defined benefit program. That program is financed primarily with employer and employee contributions, currently at 8.25 and 8 percent of compensation respectively. The state also makes contributions.

By contrast, participation in CalPERS, as in many state-level municipal programs, is voluntary, and the municipalities that do participate have the option to contract tailored programs with CalPERS. As a result, some California plans are considerably more generous than others. The California system lies somewhat in the middle of American states in the degree of autonomy its grants to localities.

The most centralized state systems, such as South Dakota and Utah, enroll all municipal employees in a statewide system, managed down to every detail at the state level. These states have not eliminated local negotiation over wages, or other working conditions, but the pension payments are fixed at the state level. Both localities and workers must contribute a proportion of their wages, and retired workers receive payments that are determined by a formula based on past compensation and other factors, including years of service and age of retirement. Even within these statewide systems, however, there are sector-specific pension differences for different groups such as teachers, policemen and firefighters.

In these states, there is no distinction between the state system and the municipal system, but in most of America, the local systems—even if managed at the state level—have their own characteristics. For example, Minnesota has a statewide Public Employees Retirement Association for employees of local government, but this is distinct from the Minnesota State Retirement System, which manages retirement for the state's own workers. The Minnesota system sets terms, mandates payments and manages the system's investments.

The next level of centralization occurs in states, like Massachusetts, that have a state system which is officially voluntary, but does in fact manage all, or almost all (Boston is excluded), of the local systems. Somewhat bizarrely, even though Massachusetts sets the terms of pensions and mandates employer and employee contributions to investment funds, over 50 localities continue to maintain control over the investments related to their public pensions.

Massachusetts is at one end of a spectrum of "voluntary" statewide programs, some of which are virtually universal while some have far more sporadic membership. Each state followed a different path towards their system, and provided different incentives or rules for joining the statewide system (when it exists). In the majority of these systems, terms are set centrally, but in a number of important systems, even those municipalities that join the central system have discretion over the generosity of plan.

Within CalPERS, local governments can choose whether to have systems that accrue pensions at 1.5% or 2% or even 3% rate; that percentage is multiplied by years of service to determine the pension as a share of final compensation (subject to a maximum). Texas, Oklahoma and Tennessee also allow discretion in the nature of the plan. Localities face a menu, and then subject to the political process and bargaining with employees, choose their preferred option.

Those localities that participate in statewide systems also face clear funding requirements set at the state level. Historically, some systems once operated as pay-as-you-go systems, requiring only that localities pay for the current year's retired employees. Funding shortfalls, especially in the 1980s, caused many states to switch to somewhat more conservative systems, often moving gradually towards "full funding." Of course, full funding is often calculated using extremely high expected rates of return that still leave the possibility of substantial cash shortfalls.

Completely local pension systems would seem to be the extreme of decentralization, but even in that case, the state government can still exercise a fair amount of control over local pensions. Cities have no independent constitutional rights; they are always creatures of state government. For example, every one of California's county pension system is a matter of state law, even though the pensions have different terms that were determined by collective bargaining at the state level. State law also governs the pensions of Boston and New York. Yet in most cases, even thought the state does exercise ultimate legislative power, the legislature will often defer to the city's wishes.

Another dramatic difference across states comes from their participation in Social Security. When Social Security was originally established, constitutional issues deterred any attempt to involve lower levels of government. The Federal government did not appear to have the power to compel states and municipalities to contribute to any sort of pension system for their employees, and as a result they were completely excluded from Social Security. In the 1950s, Congress made it possible for states to enter voluntarily into Social Security, and the majority of states have taken that option. Still, Table 1 notes those states that have remained outside of the Social Security system, including Massachusetts.

Using funding ratios from Novy-Marx and Rauh (2009), which provide only a combined estimate for states and localities, we did not see a clear linkage between the level of funding and the degree of local control, perhaps because the bulk of the funding concerns state employees. We believe that further investigation of this topic is a pressing area for future research.

Table 2 compares the average yearly earnings of employees in the state in 2011 and the average benefits paid to retired state employees in 2010. The wages are calculated across all employees in the state using the 2010 Census. The benefits are calculated using the Census report on state and local pension funds that reports benefits paid and beneficiaries. These numbers do little to control for pension retiree characteristics, or even whether the state participates in Social Security, so they can only be seen as very coarse numbers. We have also calculated the ratio of retirement earnings of state workers to current workers' earnings in the next column.

In Figure 1, we show the correlation of benefits per beneficiary and state wages. There is a strong positive correlation but the relationship is far from perfect. If these numbers are in any way correct, they suggest that some states are more generous than others, even holding state income levels constant. One of the goals of our model is to provide a framework that can help explain those differences.

3 A Political Economy Model of Public Pensions

In this section, we present our core model of the political economy of public-sector pensions. In the next section, we specifically focus on the issues that relate to central and local control of pension promises. There are several key assumptions in the model. Perhaps the most critical assumption is that pension promises are "shrouded." While this model is in the spirit of Gabaix and Laibson (2006), applying their logic to the public sector, we are not assuming any irrationality. Our voters do expect to pay workers' pensions, but not every voter is aware of the pensions promised by individual politicians. They are ignorant, but not irrational.

Some voters are also unaware of wage promises, but we assume that understanding the magnitude of pension obligations is somewhat more difficult than understanding current compensation. The logic of the model, therefore, should extend to any complex form of compensation including health-related benefits. We also assume that public-sector workers know more about pensions and wages than ordinary voters. Technically, we assume that workers and taxpayers both have access to the same news-related sources of information, but public-sector workers also have access to an added source of information: the "union." In reality, workers should know more about their compensation packages because they have far stronger incentives to understand these packages than voters.

Another key assumption is that public-sector workers cannot freely borrow against future pensions. This assumption ensures that pensions are not a perfect substitute for wages from the workers' perspective. In the case of other forms of shrouded compensation, there could be other reasons why workers would prefer cash to the benefit. Workers might, for example, just not value health benefits at their cost.

We also impose several less critical assumptions. A pre-funding requirement may be imposed exogenously on government pensions. All public-sector workers vote in state elections, but only a fraction vote in local elections, because they may choose to live outside of the locality. State workers earn rents (or potentially quasi-rents) and as such there must be a rationing device, which we assume is a lottery that occurs before the start of the model. An agent may win a public-sector position in a locality that differs from his preferred place of residence, and thus choose to commute from the one to the other. For ease of reference, all parameters in the model are listed in Table 1.

3.1 Economic Environment

In its basic structure, the model follows an overlapping generations setup. Agents live for two periods.

We focus on a representative city with an exogenously determined housing stock that grows at a constant rate $\delta \geq 0$. We assume that this reflects a fixed regulatory growth limit on new construction. This assumption could also be justified by assuming that there is a cost of construction that is increasing with the amount of construction, but in an endogenous construction model, the rate of growth would be a function of pension promises. By assuming exogenous growth, we break that link. The number of city residents equals the number of homes, so population grows at the same rate δ as the housing stock.

The city government employs an exogenous fraction $q < 1/2$ of city population. Public employees are selected by a public-sector lottery, and all winners choose to work for the local government. In principle, there is a participation constraint that requires local governments to provide sufficient compensation to make that decision optimal, but that constraint does not bind in equilibrium because public employees have enough political clout to obtain an attractive compensation package.

Private-sector workers employed in the city earn a fixed location-specific income Y when they are young; they must save to consume during their retirement. We assume that Y is large enough for the city to exist in equilibrium despite the cost of supporting its local government. Public-sector workers earn wages w_t while young and are paid a pension benefit B_{t+1} when they are older. Private- and public-sector workers pay for the cost of public-sector wages with lump sum taxes. Since houses are homogeneous, we can also think of these taxes as property taxes. Proportional taxes on housing value will have an equivalent impact on initial housing prices as lump-sum taxes since both imply the same tax burden.

Taxpayers and current public-sector workers also pay for the unfunded portion of pensions paid to last period's workers, who are now retired, and the funded portion of pensions that will be paid to current workers during the next period. Specifically, we assume that a fixed proportion $\phi \in [0, 1]$ of pension obligations must be pre-funded, where $\phi = 0$ represents the baseline case of a pure pay-as-you-go system. Funds that are set aside to pay future pensions earn the market rate of return r and are given to retired public-sector workers during the next period. Taxes in period t thus equal

$$T_t = q\left(\frac{1-\phi}{1+\delta}B_t + w_t + \frac{\phi}{1+r}B_{t+1}\right). \tag{1}$$

People live in the city when they are young and retire elsewhere when they are old. The cost of housing during retirement is an exogenous amount R. At the start of each period t, the retiring old workers sell their homes to young workers at the current price H_t. The newly-built houses are sold by developers to the young. Each buyer can take out a mortgage for the full amount H_t. He will repay the principal in the following period, but must pay interest $H_t r/(1+r)$ while living in the house.

Therefore, public-sector workers in period t have disposable income

$$C^P_{W,t} = w_t - T_t - \frac{r}{1+r} H_t, \tag{2}$$

and when retired in the following period $t+1$ they have disposable income

$$C^P_{R,t+1} = B_{t+1} + H_{t+1} - H_t - R. \tag{3}$$

These disposable incomes also coincide with public-sector employees' consumption level when their borrowing constraint binds, as it always does in equilibrium.

Private-sector workers, which we will also refer to as taxpayers even if public-sector workers pay identical taxes, have a disposable income net of lifetime housing costs

$$A^T_t = Y - T_t - H_t + \frac{H_{t+1} - R}{1+r}. \tag{4}$$

They optimally choose their savings given current taxes T_t and rational expectations of future policy, which enable perfect foresight of future house prices H_{t+1}.

All agents derive utility from consumption according to the intertemporally separable logarithmic specification:

$$U_t = \log C^i_{W,t} + \beta \log C^i_{R,t}, \tag{5}$$

with a discount factor $\beta \in (0, 1]$. The optimal consumption path is then

$$C^i_{R,t+1} = \beta (1+r) C^i_{W,t}. \tag{6}$$

Hence, public-sector workers face a binding borrowing constraint whenever

$$C^P_{R,t+1} > \beta (1+r) C^P_{W,t}. \tag{7}$$

The lifetime consumption utility of a public-sector employee from generation t is then

$$\begin{aligned} U^P_t &= \log C^P_{W,t} + \beta \log C^P_{R,t+1} \\ &= \log \left[(1-q) w_t - q \left(\frac{1-\phi}{1+\delta} B_t + \frac{\phi}{1+r} B_{t+1} \right) - \frac{r}{1+r} H_t \right] \\ &\qquad + \beta \log \left(B_{t+1} + H_{t+1} - H_t - R \right). \end{aligned} \tag{8}$$

Private-sector employees optimally choose

$$C^T_{W,t} = \frac{A^T_t}{1+\beta} \text{ and } C^T_{R,t+1} = \frac{\beta (1+r)}{1+\beta} A^T_t, \tag{9}$$

Up to an irrelevant additive constant, the lifetime consumption utility of a private-sector employee from generation t is

$$\begin{aligned} U^T_t &= (1+\beta) \log A^T_t \\ &= (1+\beta) \log \left[Y - q \left(\frac{1-\phi}{1+\delta} B_t + w_t + \frac{\phi}{1+r} B_{t+1} \right) - H_t + \frac{H_{t+1} - R}{1+r} \right], \end{aligned} \tag{10}$$

3.2 Spatial Equilibrium

The spatial structure of our economy consists of three levels. We consider cities within a state and we assume that the state itself is small relative to the aggregate size of the nation. The size of each cohort is substantially larger than the sum of the housing stock in all cities in the state, and grows at a rate of no less than δ. A young worker can choose between living in the state or moving out of it. Living in the rest of the country provides a constant reservation utility $\bar{U}$, independent of current conditions within the state.

Since individuals choose their location when young, they must be indifferent between living in that location and locating someplace else. This critical spatial indifference condition implies that housing prices H_t in the representative city must be such that the anticipated utility of living in the city for those who have lost the public employment lottery equals the reservation utility of moving out of state. For the sake of notation, define the equivalent reservation income

$$\bar{A} \equiv (1+\beta)\left[\beta(1+r)\right]^{-\frac{\beta}{1+\beta}} e^{\frac{\bar{U}}{1+\beta}}. \tag{11}$$

Spatial indifference then requires that in equilibrium

$$Y - T_t - H_t + \frac{H_{t+1} - R}{1+r} = \bar{A}, \tag{12}$$

so the equilibrium consumption levels of private-sector employees are constant

$$C^T_{W,t} = \frac{\bar{A}}{1+\beta} \equiv \bar{C}_W \text{ and } C^T_{R,t+1} = \frac{\beta(1+r)}{1+\beta}\bar{A} \equiv \bar{C}_R. \tag{13}$$

This indifference condition means that changes in pensions, or institutional conditions that impact public-sector compensation, do not impact the welfare of these citizens, but they will impact housing prices in the city, which adjust to compensate residents for expected future tax payments. Indeed, we will follow the Henry George theorem (Arnott and Stiglitz, 1979) and treat the value of land at the beginning of time as one measure of welfare. However, the equivalence between housing prices and welfare in this setting only holds if we assume that the rents earned by public-sector workers have been dissipated through some early competition for public-sector jobs, which we do not model.

3.3 The Politicians' Problem

The model contains one key optimization problem: the political choice of public-sector compensation policies w_t and B_{t+1}. We model policy-making as the outcome of an electoral process with binding platform commitments but imperfectly and heterogeneously informed voters, following Ponzetto (2011).

The election is contested by two parties, labelled L and R, whose only goal is to win office and which accordingly choose their policy proposals to maximize the probability of obtaining a majority of the votes cast. The electorate consists of a continuum of voters, whose total mass can be normalized to unity each period. Following the probabilistic-voting approach (Lindbeck and Weibull 1987), voters' preferences for the competing parties comprise two independent elements. Each voter derives utility $U^i_t(w_t, B_{t+1})$ from the policy vector (w_t, B_{t+1})

enacted by the winner of the election.[3] Moreover, the two parties have fixed characteristics, such as ideology or the personal qualities of party leaders, that cannot be credibly altered with the choice of an electoral platform; and the voters have individual tastes, respectively ξ_L^i and ξ_R^i, for these characteristics.

In the standard probabilistic-voting model, parties choose binding policy platforms and all voters perfectly observe them. We relax the assumption of perfect information, and instead consider a random process of imperfect information acquisition. Information arrives independently across agents. By the time the election is held, voter i has observed all proposals with probability $\theta_B^i \in [0,1)$. Capturing our crucial assumption that pension proposals are shrouded, the voter observes wage proposals but not pension proposals with probability $\theta_w^i - \theta_B^i > 0$. Hence, θ_w^i is the probability that a voter has observed (at least) wage proposals. With complementary probability $1-\theta_w^i$ the voter reaches the election completely uninformed, though with rational expectations. A microfounded derivation of these probabilities for taxpayers and public-sector workers is detailed below.

Given his information Ω_t^i, voter i votes forms rational beliefs $\left(\tilde{w}_t^C, \tilde{B}_{t+1}^C\right)$ about the policies that each candidate $C \in \{L, R\}$ has proposed and would enact if elected. Although each atomistic voter has probability zero of deciding the election with his ballot, we set aside the rational-voter paradox through the conventional assumption that voting is costless, so all agents turn out to vote. As a consequence, a voter's decision is summarized by his preference to support one party over the other. Voter i chooses to support party R if and only if

$$\mathbb{E}\left[U_t^i\left(\tilde{w}_t^L, \tilde{B}_{t+1}^L\right)|\Omega_t^i\right] + \xi_L^i \leq \mathbb{E}\left[U_t^i\left(\tilde{w}_t^R, \tilde{B}_{t+1}^R\right)|\Omega_t^i\right] + \xi_R^i. \tag{14}$$

An individual's relative assessment of the two candidates' non-policy characteristics can be disaggregated into a common and an idiosyncratic component: $\xi_L^i - \xi_R^i = \Psi + \psi^i$. Both Ψ and ψ^i are unobservable to politicians, and independently drawn from common-knowledge probability distributions. The common shock Ψ accounts for the aggregate uncertainty in the electoral outcome. The idiosyncratic shock ψ^i provides the intensive margin of political support, and is independent and identically distributed across agents. For the sake of clarity, we assume that ψ^i has a uniform distribution with support $\left[-\bar{\psi}, \bar{\psi}\right]$ sufficiently wide that each voter's ballot is not perfectly predictable on the basis of policy considerations only.[4].

Voters in a local election are divided into two groups: fraction q of public-sector workers, and fraction $1-q$ of taxpayers. All members of either group $j \in \{P, T\}$ have an identical utility function $U_t^j\left(w_t, B_{t+1}\right)$ and identical information-acquisition probabilities θ_B^j and θ_w^i. Since there is a continuum of agents of either type and the arrival of information is independent across agents, these probabilities coincide with the shares of voters from each group that have observed proposals respectively for both policies or for w_t alone.

As we derive in the appendix, this probabilistic-voting setup leads each candidate to

[3] To simplify notation, here we denote utility by $U_t^i\left(w_t, B_{t+1}\right)$, indexing the utility function by period instead of including explicitly among its arguments the predetermined values B_t and H_t.

[4] This assumption simplifies the analytical derivations but hardly involves a loss of generality. In a symmetric pure-strategy Nash equilibrium of the platform-proposal game the policy proposals are independent of the specific distribution of ψ_i.

maximize the political support function

$$V_t\left(w_t^C, B_{t+1}^C\right) = q\left\{\theta_B^P U_t^P\left(w_t^C, B_{t+1}^C\right) + \left(\theta_w^P - \theta_B^P\right)\mathbb{E}\left[U_t^P\left(w_t^C, \tilde{B}_{t+1}^C\right)|w_t^C\right]\right\} + (1-q)\left\{\theta_B^T U_t^T\left(w_t^C, B_{t+1}^C\right) + \left(\theta_w^T - \theta_B^T\right)\mathbb{E}\left[U_t^T\left(w_t^C, \tilde{B}_{t+1}^C\right)|w_t^C\right]\right\}. \quad (15)$$

Intuitively, a politician gains support if his policy proposals are more attractive for the voters who learn about them. The intensive margin of political support makes the relationship continuous: a candidate's probability of victory increases smoothly with his platform's appeal to informed voters.[5]

Voters' preferences are weighted by their level of information, because so is their response to policy proposals. An uninformed agent would fail to notice a deviation from the expected policy choice, and thus could not react to such a deviation when casting his vote. Politicians optimally set each policy w_t^C and B_{t+1}^C to cater disproportionately to the preferences of those voters who are disproportionately likely to observe the respective proposal, because only those voters' ballots reflect directly the policy commitments.

The unconditional beliefs $\left(\bar{w}_t^C, \bar{B}_{t+1}^C\right)$ for $\Omega_t^i = \varnothing$ are pinned down by rational expectations. In equilibrium, voters have perfect foresight and their priors are precisely correct. However, for voters who have observed wage proposals $\left(w_t^L, w_t^R\right)$ but not pension proposals $\left(B_{t+1}^L, B_{t+1}^R\right)$, rational expectations only pin down beliefs $\tilde{B}_{t+1}^C$ for the equilibrium proposal w_t. Hence, multiple Nash equilibria of could be supported by arbitrary beliefs off the equilibrium path.[6] We focus our attention on equilibria supported by off-equilibrium beliefs consistent with trembling hand equilibrium refinements. Intuitively, voters interpret unexpected platforms as mistakes that the candidates are infinitesimally likely to make.

First, in the spirit of agent-strategic perfect equilibrium, we can assume that trembles are independent across a player's choices. Then, an agent who observes an unexpected wage proposal w_t^C interprets it as a mistake that conveys no information on the choice of B_{t+1}^C. Then the beliefs $\tilde{B}_{t+1}^C|w_t^C$ coincide with the unconditional rational expectation $\tilde{B}_{t+1}^C$, regardless of the observation w_t^C.[7]

Second, as in proper equilibrium, we can assume that more disadvantageous trembles are an order of magnitude less likely than more advantageous ones. As a consequence, observing a tremble on w_t^C leads voters who have not observed the announcement B_t^C to infer that it coincides almost surely with the announcement that is optimal for candidate C conditional

[5] An analogous political support function could be derived from a retrospective voting model, following Strömberg (2004). Such a model would consider an incumbent running for re-election against an untested challenger drawn randomly from the same pool of politicians. Each voter would support the incumbent's re-election if he understands he's been provided with sufficiently high utility, with an idiosyncratic threshold that reflects taste shocks Ψ and ψ^i. We would then have to assume that voters are imperfectly aware of the impact that political choices have on incomes and housing values.

[6] An arbitrary wage proposal w_t^* could be supported in Nash equilibrium if voters who observe a deviation $w_t^C \neq w_t^*$ but do not observe B_{t+1}^C were assumed to infer with certainty an infinitely bad pension proposal—either so low that public-sector retirees can afford no consumption, or so high that taxpayers cannot.

[7] Such beliefs could be motivated more formally by the assumption that that policy proposals are made simultaneously and non-cooperatively by two distinct politicians from the same party. One announces a wage proposal and the other a pension proposal, with the shared goal of leading the party to electoral victory.

on announcing w_t^C. Formally, such beliefs are defined by

$$b_t\left(w_t^C\right) = \arg\max_{B_{t+1}^C} \left\{\theta_B^P q U_t^P\left(w_t^C, B_{t+1}^C\right) + \theta_B^T (1-q) U_t^T\left(w_t^C, B_{t+1}^C\right)\right\}. \tag{16}$$

We will admit both possibilities by allowing voters to infer independent trembles with probability $1-\lambda$, and instead conditionally optimal trembles with probability λ. The two pure cases are encompassed as the limits $\lambda = 0$ and $\lambda = 1$. Under these assumptions, the political support function can be written

$$\begin{aligned} V_t\left(w_t^C, B_{t+1}^C\right) &= \theta_B^P q U_t^P\left(w_t^C, B_{t+1}^C\right) + \theta_B^T (1-q) U_t^T\left(w_t^C, B_{t+1}^C\right) \\ &+ (1-\lambda)\left[\left(\theta_w^P - \theta_B^P\right) q U_t^P\left(w_t^C, \bar{B}_{t+1}^C\right) + \left(\theta_w^T - \theta_B^T\right)(1-q) U_t^T\left(w_t^C, \bar{B}_{t+1}^C\right)\right] \\ &\lambda\left[\left(\theta_w^P - \theta_B^P\right) q U_t^P\left(w_t^C, b_t\left(w_t^C\right)\right) + \left(\theta_w^T - \theta_B^T\right)\lambda(1-q) U_t^T\left(w_t^C, b_t\left(w_t^C\right)\right)\right]. \end{aligned} \tag{17}$$

3.4 Dynamic Equilibrium

To solve the model, we must account for the dynamic structure of an overlapping generations economy. With anything short of full pre-funding, current pension promises B_{t+1} directly influence future taxes T_{t+1}. This connection implies an indirect impact on future house prices H_{t+1} through the spatial indifference condition, and on future wages w_{t+1} and pension promises B_{t+1} through the political optimality conditions.

Since pension promises impact future voting behavior, current political choices impact future political choices, as in Persson and Svensson (1989).[8] Our approach follows in the dynamic political economy tradition of Krusell and Rios-Rull (1999) where the median voter during each period determines policy outcomes, and like Besley and Coate (1998), the power of a special interest group creates inefficiencies. But unlike Acemoglu, Golosov and Tsyvinski (2008), our political leaders make binding promises and therefore there is no scope for institutions that would bind politicians while in office.

The timeline within each period t is the following.

1. The city inherits from the previous period binding pension promises B_t.
2. The house price H_t is determined so that taxpayers' spatial indifference condition holds. The young buy houses and move to the city. The old retire, sell their houses and leave the city.
3. Politicians simultaneously announce binding policy proposals $\left(w_t^C, B_{t+1}^C\right)$. Each voter i is informed of wage proposals with probability θ_w^i and of pension proposals with probability θ_B^i. The election is held.
4. The winning candidate's policy proposal is implemented. Public-sector workers earn wages w_t, while taxes T_t are levied to defray these wages, the unfunded component of current pensions B_t, and the funded component of future pensions B_{t+1}. Workers choose how much to save and invest in capital markets.

[8]Battaglini and Coate (2008) present a more recent treatment of this issue.

The period then ends, and the process beings anew for period $t+1$. Period-t voters become old and sell their houses at a price H_{t+1}. The link between generations is the joint evolution of pension and house prices.

A dynamic equilibrium is characterized by a recursive structure. At the beginning of each period, house prices H_t are determined by spatial equilibrium given past policy choices and rational expectations of future policy choices w_t and B_{t+1}. Then political competition determines the equilibrium policies w_t and B_{t+1}. The political equilibrium depends on current conditions B_t and H_t. Crucially, it also depends on voters' rational expectations of how current policy choices will determine future house prices H_{t+1}.

We will disregard the possibility for politicians to develop a reputation and restrict our analysis to Markov perfect equilibria in which house prices H_t depend on past policy choices exclusively through the inherited pension burden B_t. Such an equilibrium is described by three time-invariant functions $H(B_t)$, $w(B_t)$ and $B'(B_t)$ such that for any pension obligations B_t equilibrium house prices are $H_t = H(B_t)$, public employees' wages $w_t = w(B_t)$ and public-sector pension promises $B_{t+1} = B'(B_t)$.

For any pension burden B_t and house prices H_t, the rational expectation of future house prices $H_{t+1} = H(B_{t+1})$ then implies that the utility of public-sector employees is defined by

$$U^P(w_t, B_{t+1}; B_t, H_t) = \log\left[(1-q)\,w_t - \frac{(1-\phi)\,q}{1+\delta}B_t - \frac{r}{1+r}H_t - \frac{\phi q}{1+r}B_{t+1}\right] + \beta \log\left[B_{t+1} + H(B_{t+1}) - H_t - R\right], \quad (18)$$

and likewise for taxpayers

$$U^T(w_t, B_{t+1}; B_t, H_t) = (1+\beta)\log\left[Y - \frac{(1-\phi)\,q}{1+\delta}B_t - H_t - qw_t - \frac{\phi q}{1+r}B_{t+1} + \frac{H(B_{t+1}) - R}{1+r}\right]. \quad (19)$$

As a consequence, beliefs under the inference of optimal trembles are defined by

$$b(w_t; B_t, H_t) = \arg\max_{B_{t+1}} \left\{\theta_B^P q U^P(w_t, B_{t+1}; B_t, H_t) + \theta_B^T (1-q)\, U_t^T(w_t, B_{t+1}; B_t, H_t)\right\}. \quad (20)$$

Letting $\bar{B}_{t+1}$ denote voters' unconditional expectation, the political support function is defined by

$$\begin{aligned} V\left(w_t, B_{t+1}; B_t, H_t, \bar{B}_{t+1}\right) &= \theta_B^P q U^P(w_t, B_{t+1}; B_t, H_t) + \theta_B^T (1-q)\, U^T(w_t, B_{t+1}; B_t, H_t) \\ &+ \left(\theta_w^P - \theta_B^P\right) q \left[(1-\lambda)\, U^P\left(w_t, \bar{B}_{t+1}; B_t, H_t\right) + \lambda U^P(w_t, b(w_t; B_t, H_t); B_t, H_t)\right] \\ &+ \left(\theta_w^T - \theta_B^T\right)(1-q)\left[(1-\lambda)\, U^T\left(w_t, \bar{B}_{t+1}; B_t, H_t\right) + \lambda U^T(w_t, b(w_t; B_t, H_t); B_t, H_t)\right]. \quad (21) \end{aligned}$$

Having defined these functions, we can give the formal definition of a dynamic equilibrium.

Definition 1 *A Markov perfect dynamic rational expectations equilibrium is given by three functions $H(B_t)$, $w(B_t)$, and $B'(B_t)$ such that*

1. *For any pension burden B_t, house prices $H_t = H(B_t)$ satisfy the spatial indifference condition*

$$Y - \frac{(1-\phi)\,q}{1+\delta} B_t - H(B_t) - qw(B_t) - \frac{\phi q}{1+r} B'(B_t) + \frac{H(B'(B_t)) - R}{1+r} = \bar{A}$$

given rational expectations of policies $w_t = w(B_t)$ and $B_{t+1} = B'(B_t)$, and of future house prices $H_{t+1} = H(B'(B_t))$.

2. *For any pension burden B_t and house prices $H_t = H(B_t)$, policy choices $w_t = w(B_t)$ and $B_{t+1} = B'(B_t)$ satisfy the political optimality condition*

$$(w(B_t), B'(B_t)) = \arg\max_{w_t, B_{t+1}} V(w_t, B_{t+1}; B_t, H(B_t), B'(B_t)),$$

given rational expectations of pension promises $\bar{B}_{t+1} = B'(B_t)$.

We will focus on linear stationary Markov perfect dynamic rational expectations equilibria, in which house prices dynamics are described by the function

$$H(B_t) = K - hB_t \tag{22}$$

for endogenous constants K and h. Our assumptions allow us to derive an explicit solution for the dynamic equilibrium under this linearity condition.

3.5 The Efficient Benchmark

We begin by characterizing the equilibrium in the absence of political-economy frictions. This requires, first of all, the absence of information asymmetries. Hence, we will assume that voters have perfect information: $\theta_B^P = \theta_w^P = \theta_B^T = \theta_w^T = 1$.[9] Furthermore, there must be no new construction: $\delta = 0$. Then housing markets lead voters to internalize fully the dynamic consequences of policy choices, despite the short-sighted preferences implicit in the overlapping generations framework.

To simplify the exposition, we also assume a pay-as-you-go system with no pre-funding ($\phi = 0$), although this last assumption has no qualitative impact on the following proposition (all proofs are provided in the appendix).

Proposition 1 *Suppose that voters have perfect information ($\theta_B^P = \theta_w^P = \theta_B^T = \theta_w^T = 1$), the housing stock does not grow ($\delta = 0$), and public-sector pensions are not pre-funded ($\phi = 0$). There is a unique linear Markov perfect dynamic rational expectations equilibrium.*

At any point on the equilibrium path, both public- and private-sector employees have consumption levels $\bar{C}_W$ as young workers and $\bar{C}_R$ as old retirees.

In steady state, public-sector wages equal

$$w_{ss} = Y - \frac{R}{1+r} - \bar{A} + \bar{C}_W,$$

[9] The crucial assumption is that information is homogeneous across voters and issues, $\theta_B^P = \theta_w^P = \theta_B^T = \theta_w^T = \theta$. The equilibrium is unchanged if $\theta < 1$.

public-sector pensions equal

$$B_{ss} = R + \bar{C}_R,$$

and house prices equal

$$H_{ss} = \frac{1+r}{r}\left[Y - \frac{R}{1+r} - \bar{A} - q\left(w_{ss} + B_{ss}\right)\right].$$

Equilibrium dynamics converge to the steady state with public-sector wages

$$w\left(B_t\right) = w_{ss} + \frac{q}{1-q}\frac{B_t - B_{ss}}{1+r},$$

public-sector pensions

$$B'\left(B_t\right) = \frac{B_{ss} - qB_t}{1-q},$$

and house prices

$$H\left(B_t\right) = H_{ss} + q\left(B_{ss} - B_t\right).$$

The undistorted equilibrium reflects utilitarian welfare maximization for each cohort ot city residents. The probabilistic-voting setup induces politicians to maximize voters' welfare whenever all voters are identically informed, and a fortiori when they have perfect information. Moreover, a cohort cannot increase its aggregate wealth by establishing an unfunded pension system and imposing the burden of funding it on future generations of city residents. The cost of pension liability is fully capitalized in the price of housing. If the housing stock is not growing, all future housing belong to current city residents, who are therefore induced to internalize the future costs of accumulated pension debt.

The assumption that housing prices fully capitalize future debt obligations has a long pedigree in economics. Daly (1969) suggested that Ricardian equivalence will hold at the local level because homeowners feel the cost of future tax obligations immediately through losses in property values.[10] Epple and Schipper (1981) tied this insight direct to municipal pension funding, and provided some evidence that this capitalization appears to occur in Pittsburgh.[11] McKay (2011) examines San Diego housing prices and shows that these prices fall after a public announcement of unfunded pension liabilities, relative to prices in surrounding areas. This work both demonstrates some capitalization but also shows that homeowners have at least in one instance underestimated the true extent of pension liabilities.

With perfect information and therefore full capitalization, the efficient equilibrium described by Proposition 1 equalizes period by period the consumption level of government employees and private employees. Since the latter are indifferent ex ante between locating in the city or in the out-of-state reservation location, everyone's consumption is constantly pinned down by the reservation consumption levels $\bar{C}_W$ and $\bar{C}_R$. This implies that the

[10] Banzhaf and Oates (2011) develop a useful analysis that provides conditions under which this capitalization should be imperfect even in a fully rational mode.

[11] Stadelman and Eichenberger (2012) argue that owners should be more sensitive to debt financing because of capitalization, and then show that areas in Switzerland with more tenants relative to owners are more likely to use debt rather than taxes.

consumption path of public-sector employees is optimal, just like the one of private-sector employees.

In the steady state, housing prices H_{ss} are constant. Thus retirees realize no capital gains or losses on the sale of their city house. The steady state public-sector pension B_{ss} then equals the sum of the consumption level $\bar{C}_R$ and the cost of housing in the retirement locale, R. The steady state public-sector wage w_{ss} equals the consumption level $\bar{C}_W$ plus taxes paid to defray public-sector compensation $(q\,(w_{ss} + B_{ss}))$ and the user cost of housing $H_{ss}r/\,(1+r)$. The user cost of housing itself fully reflects the productivity value of the city. Productivity is properly measured by the difference between net earning for a private-sector employee in the city $(Y - R/\,(1+r))$ and in the reservation location $(\bar{A})$, adjusted for the cost of paying an exogenous number q of local government employees.

Transition to the steady state reflects the dynamic feedback between public-sector pensions and house prices. If the city has inherited, e.g., pension obligations below the steady state level $(B_t < B_{ss})$, the direct effect is that taxes T_t are lower by the exact amount of the reduction in aggregate pension payout $(q\,(B_{ss} - B_t))$. In the absence of city growth $(\delta = 0)$, this fall in taxes is immediately and entirely capitalized in higher house prices $(H_t - H_{ss} = q\,(B_{ss} - B_t))$. While working in the city, public-sector employees pay lower taxes; on the other hand, they incur a higher housing cost. Since the user cost of housing is only a fraction $r/\,(1+r)$ of house value, it only reflects an identical fraction of the change in taxes. Hence, the equilibrium level of consumption $\bar{C}_W$ requires a lower public-sector wage $(w_t < w_{ss})$.

On the other hand, upon retiring public-sector employees must repay a larger mortgage H_t. Hence, the equilibrium level of consumption requires a higher public-sector pension $(B_{t+1} > B_{ss})$. The increase in future pensions is multiplied by a dynamic feedback loop. If pension promises increase by $B_{t+1} - B_{ss}$, expected house price appreciation declines proportionally $(H_{t+1} - H_{ss} = q\,(B_{ss} - B_{t+1}))$. Facing a lower capital gain, public-sector retirees need an even larger pension increase to preserve their consumption level $\bar{C}_R$. For any $q < 1/2$, the multiplier remains bounded, and equilibrium dynamics converge to the steady state by dampened oscillation.

The comparative statics on steady-state values follow immediately from Proposition 1.

Corollary 1 *Suppose that voters have perfect information ($\theta_B^P = \theta_w^P = \theta_B^T = \theta_w^T = 1$), the housing stock does not grow ($\delta = 0$), and public-sector pensions are not pre-funded ($\phi = 0$). In the unique linear Markov perfect dynamic rational expectations equilibrium, consumption by public-sector employees is time invariant. It is increasing in the reservation value both while working ($\partial C_W^P/\partial \bar{A} > 0$) and while retired ($\partial C_R^P/\partial \bar{A} > 0$).*

In the steady state:

- *Public-sector wages are increasing in city productivity ($\partial w_{ss}/\partial Y = 1$), and decreasing in the cost of housing in the retirement destination ($\partial w_{ss}/\partial R < 0$) and in the reservation value ($\partial w_{ss}/\partial \bar{A} < 0$).*

- *Public-sector pensions are increasing in the cost of housing in the retirement destination ($\partial B_{ss}/\partial R = 1$) and in the reservation value ($\partial B_{ss}/\partial \bar{A} > 0$).*

- *House prices are increasing in city productivity ($\partial H_{ss}/\partial Y = 1$), and decreasing in the cost of housing in the retirement destination ($\partial H_{ss}/\partial R < 0$), in the reservation value ($\partial H_{ss}/\partial \bar{A} < 0$), and in the size of local government ($\partial H_{ss}/\partial q < 0$).*

The outside option pins down the consumption levels of private-sector employees. Hence, in an efficient equilibrium, it directly determines consumption by public-sector employees as well. All other economic primitives are reflected instead in house prices. If productivity in the city is higher, housing prices must be higher so that real incomes are not ($\partial H_{ss}/\partial Y > 0$). Since we have treated the cost of retirement housing as an expenditure for city residents, but not included it separately in the outside option, its increase also makes living in the city when young less desirable, requiring a compensating fall in city house prices ($\partial H_{ss}/\partial R < 0$). If the reservation utility of living outside the city is higher, the cost of living in it must also be lower, implying lower housing prices ($\partial H_{ss}/\partial \bar{A} < 0$). Finally, a larger local government means that the city has fewer productive private-sector employees and must support more public-sector employees, so its net earning capacity falls and real estate values must decline accordingly ($\partial H_{ss}/\partial q < 0$).

The effects on public-sector compensation follow from changes in the cost of housing. Public-sector pensions must rise one to one with the cost of retirement housing ($\partial B_{ss}/\partial R = 1$). They also rise with the reservation value to allow an increase in retirement consumption net of housing costs ($\partial B_{ss}/\partial \bar{A} > 0$). Public-sector wages are the mirror image of house prices. Thus they rise with city productivity ($\partial w_{ss}/\partial Y = 1$) and fall with the cost of retirement housing ($\partial w_{ss}/\partial R < 0$). Less immediately, they fall with the reservation value ($\partial w_{ss}/\partial \bar{A} < 0$). The overall effect is negative because a rise in the reservation value induces a larger increase in the user cost of city housing than in the net consumption of young workers.

3.6 Imperfect Information

The main focus of our analysis is on distortions in public-sector compensation arising from asymmetric information. Whenever public-sector workers are more informed about their compensation than other taxpayers ($\theta_w^P > \theta_w^T$ and $\theta_B^P > \theta_B^T$), they obtain a more generous treatment than their mere numbers would warrant. Furthermore, if their informational advantage is greater for pensions than wages ($\theta_w^P/\theta_w^T < \theta_B^P/\theta_B^T$), public-sector pensions are more generous than public-sector wages. This pattern of information asymmetry emerges from a simple process of information acquisition.

Information about policy proposals is provided to all voters by local news sources. Each agent receives information about policy proposal from the news with probability $\underline{\theta}_L \in (0, 1)$. Capturing our fundamental assumption that pension obligations are "shrouded," an agent who has received such information acquires knowledge of wage proposals, but need not learn or understand pension proposals. The conditional probability of gaining knowledge of pension proposals too is $\pi \in (0, 1)$. The assumption that $\pi < 1$ reflects directly lower availability of information about pensions than wages. State employees' salaries are publicly disclosed every year, and can be easily consulted through the online edition of local newspapers.[12] No

[12]E.g., data for Massachusetts are provided by the *Boston Herald* at http://www.bostonherald.com/projects/your_tax_dollars.bg; for California by the *Sacramento Bee* at http://www.sacbee.com/statepay/.

such database exists for the accruing pensions of currently employed civil servants. Moreover, $\pi < 1$ reflects the greater difficulty of understanding the accrual of pension obligations. Thus the parameter allows us to capture with a simple formulation that a voter may be informed of a debate about the cost of public-sector pensions, but still unable to grasp the actual impact of different policy proposals.

In addition to the local news that reach all taxpayers, public-sector workers naturally have more opportunities and greater incentives to become informed of policy proposals concerning their own compensation. Ponzetto (2011) models explicitly the sharing of information about sector-specific policy among co-workers in the workplace, and agents' willingness to make costly investments to acquire sector-specific information. Here we make the simplifying assumption that public employees have access to a second source of news: public-sector unions. In addition to the probability $\underline{\theta}_L$ of being informed by the news, and independent of the arrival of such information, every public-sector worker has probability $\underline{\theta}_U \in (0,1)$ of being informed of wage proposals by the union. Once again, pensions are less visible, and the conditional probability of learning about pensions remains π regardless of the source of information.

This structure implies that the information probabilities for taxpayers are

$$\theta_w^T = \underline{\theta}_L \text{ and } \theta_B^T = \pi \underline{\theta}_L, \tag{23}$$

while those for public-sector workers are

$$\theta_w^P = \underline{\theta}_L + \underline{\theta}_U - \underline{\theta}_L \underline{\theta}_U \text{ and } \theta_B^P = \pi \left(\underline{\theta}_L + \underline{\theta}_U\right) - \pi^2 \underline{\theta}_L \underline{\theta}_U. \tag{24}$$

To summarize the distribution of information, we define two measures of symmetry

$$\rho_w = \frac{\theta_w^T}{\theta_w^P} \text{ and } \rho_B = \frac{\theta_B^T}{\theta_B^P}, \tag{25}$$

with the following properties.

Lemma 1 *For any policy proposal, public-sector workers are more likely to informed than taxpayers. Their information advantage is greater for pensions than wages (*$0 < \rho_B < \rho_w < 1$*).*

Information asymmetry declines when local news provide more information ($\partial \rho_w / \partial \underline{\theta}_L > 0$ *and* $\partial \rho_B / \partial \underline{\theta}_L > 0$*) and increases when public-sector unions provide more information (*$\partial \rho_w / \partial \underline{\theta}_U < 0$ *and* $\partial \rho_B / \partial \underline{\theta}_U < 0$*). When pensions are more shrouded, information about them is more asymmetric (*$\partial \rho_B / \partial \pi > 0$*).*

The relative asymmetry of information about pensions compared to wages is higher when pensions are more shrouded ($\partial \left(\rho_B / \rho_w\right) / \partial \pi > 0$*) and when either source provides more information (*$\partial \left(\rho_B / \rho_w\right) / \partial \underline{\theta}_L < 0$ *and* $\partial \left(\rho_B / \rho_w\right) / \partial \underline{\theta}_U < 0$*).*

Intuitively, information acquisition has positive but diminishing returns. Receiving additional news from the union makes public-sector working better informed across the board; the effect is naturally stronger, the more information the union conveys ($\partial \rho_p / \partial \underline{\theta}_U < 0$). Moreover, the additional information is more valuable when local news are poorly informative ($\partial \rho_p / \partial \underline{\theta}_L > 0$).

Diminishing returns also imply that public employees' informational advantage is always stronger for pension proposals, which are more difficult to get to know and which taxpayers are more likely to ignore ($\rho_B < \rho_w$). Furthermore, its strength is increasing in the degree of shrouding of public-sector pensions (low π). The degree of shrouding affects information asymmetry over pensions but not over wages, so it naturally increases relative asymmetry ($\partial \left(\rho_B/\rho_w\right)/\partial\pi > 0$).

Finally, the lemma establish that any increase in informativeness, whether of the news or of the union, makes the two issues more asymmetric ($\partial \left(\rho_B/\rho_w\right)/\partial\underline{\theta}_L < 0$ and $\partial \left(\rho_B/\rho_w\right)/\partial\underline{\theta}_U < 0$). Intuitively, taxpayers' relative information is fixed at $\theta_B^T/\theta_w^T = \pi$, so the effect of greater information plays out only through public employee's relative information θ_B^P/θ_w^P. Hence, more information has the same effect on relative asymmetry regardless of its source. Diminishing returns once more explain why its effect is an increase in relative asymmetry: the additional information has a greater effect on the less visible issue, i.e., pensions.

We introduce these information asymmetries in the setting of Proposition 1, preserving at first the simplifying assumptions that $\delta = \phi = 0$. The political equilibrium then features distortions that systematically favor public-sector employees, and more so for the shrouded policy choice—pension promises.

Proposition 2 *Suppose that the housing stock does not grow ($\delta = 0$), and public-sector pensions are not pre-funded ($\phi = 0$). There is a unique linear Markov perfect dynamic rational expectations equilibrium.*

At any point on the equilibrium path, the ratio of the consumption levels of private- and public-sector employees equals

$$\tau_W \equiv \frac{\bar{C}_W}{C_W^P} = \rho_w - \lambda \frac{\beta\left(\rho_w - \rho_B\right) q}{\beta q + (1+\beta)\,\rho_B\,(1-q)} < 1$$

for young workers and

$$\tau_R \equiv \frac{\bar{C}_R}{C_R^P} = \rho_B < \tau_W$$

for old retirees.

In steady state, public-sector wages equal

$$w_{ss} = Y - \frac{R}{1+r} - \bar{A} + \frac{\bar{C}_W}{\tau_W},$$

public-sector pensions equal

$$B_{ss} = R + \frac{\bar{C}_R}{\tau_R},$$

and house prices equal

$$H_{ss} = \frac{1+r}{r}\left[Y - \frac{R}{1+r} - \bar{A} - q\left(w_{ss} + B_{ss}\right)\right].$$

Equilibrium dynamics converge to the steady state with public-sector wages

$$w\left(B_t\right) = w_{ss} + \frac{q}{1-q}\frac{B_t - B_{ss}}{1+r},$$

public-sector pensions

$$B'(B_t) = \frac{B_{ss} - qB_t}{1-q},$$

and house prices

$$H(B_t) = H_{ss} + q(B_{ss} - B_t).$$

The differences between Proposition 2 and Proposition 1 highlight that political power derives from superior knowledge of policy choices. Since public-sector employees are more informed than taxpayers about their own compensation, the strategic optimal proposal for office-seeking politicians provides higher consumption levels for public- than private-sector employees ($\tau_R, \tau_W < 1$). These political rents from superior information explain why government employment is attractive in our model, and rationed by the public-sector lottery.

Furthermore, since information about pensions is more asymmetric than for wages because of shrouding, the political equilibrium displays a greater tilt in favor of public-sector retirees than public-sector workers ($\tau_R < \tau_W$). Thus, shrouding is at the root of back-loaded public-sector compensation, and explains why government employees are liquidity constrained while young.

Pension promises display a direct link between superior information and higher equilibrium consumption. The political optimal ratio of marginal utilities (and thus of consumption levels) for retirees coincides with the ratio of information about retirement benefits ($\tau_R = \rho_B$). The same is true for wages if off-equilibrium beliefs are based on inference of independent trembles ($\lambda = 0 \Rightarrow \tau_W = \rho_w$). Inference of conditionally optimal trembles off the equilibrium path introduces instead an indirect effect that exacerbates information asymmetry and leads to an even more favorable treatment of public employees

Political optimality always requires a fixed consumption ratio for public- and private-sector retirees ($\tau_R = \rho_B$). A mistaken policy announcement proposing, e.g., lower than equilibrium wages ($w_t^C < w_t$) would generate a windfall for taxpayers given predetermined house prices (H_t consistent with $w_t > w_t^C$). Smoothing this windfall over their entire lifetime, they would increase consumption during retirement. Hence, the conditionally optimal pension proposal would be higher than expected, to increase consumption by future public-sector retirees in the same proportion ($b\left(w_t^C\right) > B_{t+1}$).

As a consequence, inference of conditionally optimal trembles off the equilibrium path would induce partially informed voters to believe that if they have observed an unexpectedly high wage proposal it must be accompanied by an unexpected low unobserved pension proposal ($b\left(w_t^C\right)$ is linearly decreasing in w_t^C). This makes partially informed taxpayers less upset about high wages, and less likely to vote against a politician proposing them. While there is a compensating loss of support among partially informed public-sector employees, it is smaller. Government employees are liquidity constrained, so they desire higher wages even at the cost of lower pensions. Therefore, inference of conditionally optimal trembles off the equilibrium path has the net effect of making generous wages more politically attractive. Therefore, it raises equilibrium wages even though, on the equilibrium path, it has no actual countervailing effect on pensions ($\partial\tau_W/\partial\lambda < 0$ but ($\partial\tau_R/\partial\lambda = 0$).

The transition dynamics are unchanged from the efficiency benchmark in Proposition 1, aside from the differences in the respective steady-state values. Comparative statics on the latter now reflect not only underlying economic conditions but also political asymmetries.

Corollary 2 *Suppose that the housing stock does not grow ($\delta = 0$), and public-sector pensions are not pre-funded ($\phi = 0$). In the unique linear Markov perfect dynamic rational expectations equilibrium:*

- *Consumption by public-sector employees while working is time invariant. It is increasing in the reservation value ($\partial C_W^P/\partial \bar{A} > 0$), in information asymmetries concerning both wages and pensions ($\partial C_W^P/\partial \rho_w < 0$ and $\partial C_W^P/\partial \rho_B \leq 0$), in the prevalence of the inference of conditionally optimal trembles ($\partial C_W^P/\partial \lambda > 0$), and in the size of local government ($\partial C_W^P/\partial q \geq 0$).*

- *Consumption by public-sector retirees is time invariant. It is increasing in the reservation value ($\partial C_R^P/\partial \bar{A} > 0$) and in information asymmetry concerning pensions ($\partial C_R^P/\partial \rho_B < 0$).*

In the steady state:

- *Public-sector wages are increasing in city productivity ($\partial w_{ss}/\partial Y = 1$) and decreasing in the cost of housing in the retirement destination ($\partial w_{ss}/\partial R < 0$). They are increasing in information asymmetries concerning both wages and pensions ($\partial w_{ss}/\partial \rho_w < 0$ and $\partial w_{ss}/\partial \rho_B \leq 0$), in the prevalence of the inference of conditionally optimal trembles ($\partial w_{ss}/\partial \lambda > 0$), and in the size of local government ($\partial w_{ss}/\partial q \geq 0$).*

- *Public-sector pensions are increasing in the cost of housing in the retirement destination ($\partial B_{ss}/\partial R = 1$), in the reservation value ($\partial B_{ss}/\partial \bar{A} > 0$), and in information asymmetry concerning pensions ($\partial B_{ss}/\partial \rho_B < 0$).*

- *House prices are increasing in city productivity ($\partial H_{ss}/\partial Y = 1$) and decreasing in the in the cost of housing in the retirement destination ($\partial H_{ss}/\partial R < 0$), in the reservation value ($\partial H_{ss}/\partial \bar{A} < 0$), and in the size of local government ($\partial H_{ss}/\partial q < 0$),in information asymmetries concerning both wages and pensions ($\partial H_{ss}/\partial \rho_w > 0$ and $\partial H_{ss}/\partial \rho_B > 0$) and in the prevalence of the inference of conditionally optimal trembles ($\partial H_{ss}/\partial \lambda < 0$).*

The comparative statics on economic primitives are essentially unchanged from Corollary 1. The only difference is that the effect of the reservation value $\bar{A}$ on steady state pensions w_{ss} becomes ambiguous. If the political clout of public-sector employees is very high, their equilibrium consumption C_W^P might rise with the reservation value faster than house prices do. Public-sector wages would then rise with $\bar{A}$, instead of falling as they do with smaller political imbalances.

The novel results stress that political power derives from superior knowledge of policy choices. Public employees' pensions and their consumption during retirement reflect asymmetric information about pension proposals themselves ($\partial B_{ss}/\partial \rho_B < 0$ and $\partial C_W^P/\partial \rho_B < 0$). Public-sector wages and government employees' consumption during youth reflect asymmetric information concerning wage proposals ($\partial w_{ss}/\partial \rho_w < 0$ and $\partial C_W^P/\partial \rho_w < 0$), but possibly also pension proposals ($\partial w_{ss}/\partial \rho_B \leq 0$ and $\partial C_W^P/\partial \rho_B \leq 0$).

The latter effect derives entirely from the possibility of inference of conditionally optimal trembles off the equilibrium path. Higher information asymmetry about pensions implies a higher inferred reduction in pension for any observed unexpected increase in wages ($\partial^2 b/\partial w \partial \rho^B > 0$). As a consequence, proposals of high wages become less unpopular, and the steady-state wage rises. The same mechanism operates for the size of the local government q. Under inference of conditionally optimal trembles off the equilibrium path, an unexpected increase in wages triggers the expectation of a larger unobserved reduction in pension promises when there is more public-sector employment ($\partial^2 b/\partial w \partial q < 0$). Thus steady state wages rise with the number of public-sector employees ($\partial w_{ss}/\partial q \geq 0$).

The effects of political power on public-sector compensation and housing prices are always opposite. The reason is that, in equilibrium, rents (or quasi-rents) are transferred to public employees from property owners. At the stage of political competition, electoral considerations pit public-sector workers against taxpayers. The former vote for higher benefits, and the latter for lower taxes that would increase their lifetime consumption. Given rational expectations and spatial indifference, however, such an increase in consumption is inconsistent with equilibrium. The expectation of lower taxes due to lower public-sector compensation instead leads agents to bid up the price of houses in the city. Thus taxpayers are essentially running a proxy competition against public employees on behalf of developers. When the information advantage of public-sector workers is lower, the eventual outcome is a rise in real-estate values ($\partial H_{ss}/\partial \rho_w > 0$ and $\partial H_{ss}/\partial \rho_B > 0$). This result is consistent with Gyourko and Tracy's (1989) empirical finding that public-sector unions earn rents for their workers, and these rents are negatively capitalized in local land values. House prices also decline with inference of conditionally optimal trembles off the equilibrium path, which blunts taxpayers' willingness to fight against government employees over their wages.

In terms of the primitive information structure described by lemma 1, all components of public-sector compensation rise with the information-managing power of public-sector trade unions ($\partial w_{ss}/\partial \underline{\theta}_U > 0$ and $\partial B_{ss}/\partial \underline{\theta}_U > 0$) and fall with the availability of public information through news media ($\partial w_{ss}/\partial \underline{\theta}_L < 0$ and $\partial B_{ss}/\partial \underline{\theta}_L < 0$). The impact on house prices is opposite in both cases ($\partial H_{ss}/\partial \underline{\theta}_U < 0$ and $\partial H_{ss}/\partial \underline{\theta}_L > 0$).

Producer interests can capture policy-making over the issues they most care about without bargaining with politicians or offering them campaign contributions, but merely by disseminating political information to their members, as Ponzetto (2011) finds for the case of trade policy. Freeman (1986) reviews the impact of public-sector unions on wages and benefits. In our model, when politicians know that their proposals for public-sector compensation are widely broadcast among unionized public employees but relatively less visible to taxpayers, they make generous offers to avoid alienating the constituency that is disproportionately mobilized by these proposals.

Conversely, the more media coverage a policy choice receives, the more policy proposals reflect the general interests of taxpayers rather than those of knowledgeable insiders. Greater shrouding of pension promises constitutes a decrease in transparency, and as such it entails greater capture of policy-making by public-sector workers and a consequent increase in their pensions ($\partial B_{ss}/\partial \pi < 0$). The transparency of wage policy is unaffected by changes in shrouding, but the politically optimal wage rate may still fall because of inference of conditionally optimal trembles off the equilibrium path ($\partial w_{ss}/\partial \pi \leq 0$).

3.7 Inefficiency

As Corollary 2 has established, there are two key interest groups in this model,: the developer (or initial land owner) and public-sector workers. We consider two possible approaches to efficiency. The first and easier approach is to only consider the developer and public employees separately. If the public-sector workers dissipate their rents through initial competition to win the public-employment lottery, then developer profits would be the only measure of welfare. Alternatively, we can think of the result on developer profits as informing us about the institutions that the developer would choose if he had the ability to do so. Public employees' welfare informs us about the institutions that public-sector unions would choose if they were in control. Our second approach to measuring efficiency relies on comparing equilibrium outcomes to a counterfactual first best that maximizes public employees' utility subject to the constraint that developer profits are not lower than in equilibrium.

Welfare for public-sector workers equals

$$U^P = \log C_W^P + \beta \log C_R^P, \tag{26}$$

which is time invariant on the transition path as established in Proposition 2, and in fact more generally as we shall show below.

The developer earns profits from the sale of the housing stock as it gradually enters the market. If there is no ongoing construction ($\delta = 0$), his profits are entirely earned at the founding of the city: $\Pi = H_0$. It is indifferent to let the developer extract some of his initial profits through a tax that the city charter imposes on the first generation of residents. It is convenient to denote this transfer by qB_0: then developer profits are

$$\Pi = H_0 + qB_0. \tag{27}$$

The appeal of this formulation is that it nest as two special cases both the baseline in which the developer can sell real estate to all generations but cannot tax even the first one ($B_0 = 0$), and the alternative in which public-sector pensions immediately jump to the steady state ($B_0 = B$). The value of B_0 is irrelevant from the developer's point of view: the present value of his profits depends only on steady-state values.

Corollary 3 *Suppose that the housing stock does not grow ($\delta = 0$), and public-sector pensions are not pre-funded ($\phi = 0$). In the unique linear Markov perfect dynamic rational expectations equilibrium:*

- *The lifetime utility of public-sector workers is time invariant. It is increasing in the reservation value ($\partial U^P/\partial \bar{A} > 0$), in information asymmetries concerning both wages and pensions ($\partial U^P/\partial \rho_w < 0$ and $\partial U^P/\partial \rho_B < 0$), in the prevalence of the inference of conditionally optimal trembles ($\partial U^P/\partial \lambda > 0$), and in the size of local government ($\partial U^P/\partial q \geq 0$).*
- *Developer profits equal*

$$\Pi = \frac{1+r}{r}\left[Y - \bar{A} - \frac{R}{1+r} - q\left(w_{ss} + \frac{B_{ss}}{1+r}\right)\right],$$

which is increasing in city productivity ($\partial\Pi/\partial Y > 0$) and decreasing in the cost of housing in the retirement destination ($\partial\Pi/\partial R < 0$), in the reservation value ($\partial\Pi/\partial\bar{A} < 0$), in information asymmetries concerning both wages and pensions ($\partial\Pi/\partial\rho_w > 0$ and $\partial\Pi/\partial\rho_B > 0$), in the prevalence of the inference of conditionally optimal trembles ($\partial\Pi/\partial\lambda < 0$), and in the size of local government ($\partial\Pi/\partial q < 0$).

The comparative statics for the welfare of public-sector workers follow immediately from the analysis of their equilibrium compensation in Corollary 2. Government employees obtain higher equilibrium compensation whenever they are more informed about policy proposals than other taxpayers, so their lifetime utility rises monotonically with any information asymmetry ($\partial U^P/\partial\rho_w < 0$, and $\partial U^P/\partial\rho_B < 0$). Therefore, unions wish to convey as much information as possible to their members ($\partial U^P/\underline{\theta}_U > 0$), while they prefer the news to be as uninformative as possible ($\partial U^P/\underline{\theta}_L < 0$) and pensions maximally shrouded ($\partial U^P/\pi < 0$). Public-sector unions also prefer higher public employment not only because it increase the number of their (potential) members, but also because it may increase equilibrium compensation for each government employee, if agents infer conditionally optimal trembles off the equilibrium path ($\partial U^P/\partial q \geq 0$ and $\partial U^P/\partial\lambda > 0$). Finally, public sector workers share one-to-one in the reservation utility ($\partial U^P/\partial\bar{U} = 1$).

Developers internalize exactly the cost of providing steady-state wages and pensions. The comparative statics are identical to those of steady-state housing prices in Corollary 2. The only difference is that developer profits take into account the one-year lag in the accrual of pension obligations in a newly established city. The institutional preferences of the initial developer are diametrically opposite to those of the public-sector union, which is its long-run political rival. Minimal information asymmetries are optimal for the developer ($\partial\Pi/\partial\rho_w > 0$ and $\partial\Pi/\partial\rho_B > 0$), who consequently would like unions to have minimal ability to inform their members ($\partial\Pi/\partial\underline{\theta}_U < 0$). Conversely, he wishes that the taxpayers who buy his homes were as informed as possible about public-sector compensation policies ($\partial\Pi/\underline{\theta}_L > 0$), and particularly desires maximum transparency of public-sector pensions ($\partial\Pi/\pi > 0$). Finally, the developer has an obvious preference for creating a highly productive city ($\partial\Pi/\partial Y > 0$) and attracting residents with poor outside opportunities ($\partial\Pi/\partial\bar{A} < 0$) and cheap housing options during retirement ($\partial\Pi/\partial R < 0$).

Corollary 3 establishes that developer profits are linear in the cost of steady-state public-sector compensation $w_{ss} + B_{ss}/(1+r)$. Thus, our counterfactual measure of efficiency consists of comparing equilibrium outcomes with first-best outcomes that have the same cost but give public employees the optimal consumption profiles.

For given consumption rates $\tau_W = \bar{C}_W/C^P_W$ and $\tau_R = \bar{C}_R/C^P_R$, the welfare of public-sector workers is

$$U^P = \bar{U} - \log\tau_W - \beta\log\tau_R. \tag{28}$$

In the steady state described by Proposition 2, the cost of public-sector compensation is

$$w_{ss} + \frac{B_{ss}}{1+r} = Y - \bar{A} + \frac{\bar{A}}{(1+\beta)\tau_W} + \frac{\beta\bar{A}}{(1+\beta)\tau_R}. \tag{29}$$

At the same cost, a maximum utility

$$U^* = \bar{U} + (1+\beta)\left[\log\left(\frac{1}{\tau_W} + \frac{\beta}{\tau_R}\right) - \log(1+\beta)\right] \tag{30}$$

could be provided by the optimal compensation profile $\tau_W^* = \tau_R^*$. The extent to which political inefficiency is leading to welfare losses can be measured by the difference the two

$$U^* - U^P = (1+\beta)\log\left(1+\beta\frac{\tau_W}{\tau_R}\right) - \beta\log\frac{\tau_W}{\tau_R} - (1+\beta)\log(1+\beta). \tag{31}$$

Thus, a sufficient statistic for inefficiency is the tilt in government employees' lifetime consumption path

$$\Gamma \equiv \frac{\tau_W}{\tau_R} = \frac{C_R^P}{\beta(1+r)\,C_W^P}. \tag{32}$$

The welfare loss $U^* - U^P$ is a function of Γ alone (up to the exogenous preference parameter β). It is maximized at the efficient level $\Gamma = 1$, and monotonically decreasing in the back-loading of public-sector compensation ($\partial\left(U^* - U^P\right)/\partial\Gamma < 0$ for all $\Gamma > 1$). The following proposition shows our results for this second welfare criterion.

Proposition 3 *Suppose that the housing stock does not grow ($\delta = 0$), and public-sector pensions are not pre-funded ($\phi = 0$). In the unique linear Markov perfect dynamic rational expectations equilibrium public-sector employees' consumption is inefficiently back-loaded ($\Gamma > 1$).*

The degree of inefficiency is independent of the reservation utility ($\partial\Gamma/\partial\bar{A} = 0$), of the cost of housing in the retirement destination ($\partial\Gamma/\partial R = 0$) and of city productivity ($\partial\Gamma/\partial Y = 0$). It is increasing in the asymmetry of information about pensions ($\partial\Gamma/\partial\rho_B < 0$) but decreasing in the asymmetry of information about wages ($\partial\Gamma/\partial\rho_w > 0$). It is decreasing in the prevalence of the inference of conditionally optimal trembles off the equilibrium path ($\partial\Gamma/\partial\lambda < 0$), and in the size of local government ($\partial\Gamma/\partial q \leq 0$).

In terms of the primitives of the information structure in Lemma 1, inefficiency is increasing in shrouding ($\partial\Gamma/\partial\pi < 0$) and in the informativeness of either source ($\partial\Gamma/\partial\underline{\theta}_L > 0$ and $\partial\Gamma/\partial\underline{\theta}_U > 0$).

Throughout the equilibrium path, and a fortiori in the steady state, public-sector workers receive back-loaded compensation. Their borrowing constraint is binding, and their equilibrium consumption suboptimally low while working and suboptimally high while retired. Proposition 1 established that, instead, in the first best all workers smooth consumption to identical levels during the two stages of their life (for $\beta(1+r) = 1$). Thus, public employees could be made better off at no cost to the developer or to the taxpayer if their total compensation were kept constant, but their pensions reduced and their wages increased. The political equilibrium is inefficient because it prevents this optimal readjustment.

The key source of inefficiency is the shrouded nature of pension promises. As Lemma 1 has shown, their relative opacity makes it easier for the public-sector trade union to give its members an informational edge concerning pensions than current salaries. Thus, public-sector pensions are more captured by public employees' than public-sector wages. Compensation is back-loaded to shroud it and confuse taxpayers about its actual cost.

Paying public workers with generous pensions becomes, in our model, a form of inefficient redistribution relative to paying those workers with wages. While economic logic tends to predict that interest groups should bargain in a way that minimizes the deadweight losses from redistribution (Stigler 1982; Becker 1983), a number of authors have highlighted different reasons why this result might fail.[13] Acemoglu and Robinson (2001) emphasize that inefficiencies might have dynamic benefits for interest groups, such as agricultural subsidies that maintain the size of the farmers lobbies.[14] Indeed, one benefit of public sector pensions is that they keep public workers in the system for many years, creating a potent potential electoral force.[15] In our model, as in Coate and Morris (1995), inefficient redistribution occurs when it is more shrouded from voters than efficient redistribution.

Our results accord with the empirical finding that government performance improves with media scrutiny (Besley and Burgess 2002; Adserà, Boix, and Payne 2003; Ferraz and Finan 2008; Snyder and Strömberg 2010; Boffa, Piolatto, and Ponzetto 2013). Closest to our analysis, Strömberg (2004) provides evidence that public spending is skewed towards constituencies with greater political information. Ponzetto (2011) shows that a special interest group exerts particularly influence over those policies for which it enjoys a particularly sharp information advantage. This phenomenon can account for the observed inefficient protectionist bias of trade policy, since industry insiders are more informed about policy proposals affecting their industry.

By an analogous mechanism, Proposition 3 highlights that inefficiency in the structure of public-sector compensation derives not merely from asymmetric information across voters, but crucially from differential asymmetry across voters and policies. Since public-sector employees have a higher information advantage concerning pension promises than wages, their equilibrium compensation is inefficiently back-loaded. In fact, inefficiency increases with information asymmetry regarding pensions ($\partial\Gamma/\partial\rho_B < 0$), but instead decreases with information asymmetry regarding wages ($\partial\Gamma/\partial\rho_w > 0$). In the limit as shrouding disappears ($\pi = 0 \Leftrightarrow \rho_w = \rho_B$) the superior information of government employees allow them to extract rents efficiently.

Because inefficiency derives from the relative asymmetry of information about pensions compared to wages, it rises monotonically with shrouding ($\partial\Gamma/\partial\pi < 0$), but also with the informativeness of either source ($\partial\Gamma/\partial\underline{\theta}_L > 0$ and $\partial\Gamma/\partial\underline{\theta}_U > 0$). There is no guarantee that transparency, naively construed, should increase the efficiency of public-sector compensation policies. On the contrary, inefficiency rises if taxpayers receive new information, but the additional information is as skewed towards wages as their original knowledge (higher $\underline{\theta}_L$, constant π). Public employees do suffer a decline in their overall benefits, but they respond to the increased pressure by obtaining benefits that are ever more skewed towards shrouded entitlements. An increase in efficiency derives only from targeted transparency on the more opaque and distorted policy dimension (higher π).

The distinction between efficient and inefficient news coverage is precisely the point where developer profits and aggregate efficiency diverge. The developer aims at an across-the-

[13] Kovenock and Roberson (2009) examine inefficient redistribution in a standard model of political competition. Bullock (1995) presents a procedure for testing the efficient redistribution hypothesis.

[14] Drazen and Limão (2008) suggest that restricting redistribution to inefficient instruments may increase governmental bargaining power, which seems less relevant in this case.

[15] Generous pensions don't necessarily increase the number of public-sector workers, but their structure should increase government employees' tenure. If workers with a long time horizon in the public sector are more effective and interested in lobbying, then the long tenures associated with generous pensions would increase the power of public-sector unions

board reduction in public employees' compensation. Consequently he appreciates, and would promote if possible, any disclosure, whether focused on pensions or wages ($\partial \Pi / \pi > 0$ and $\partial \Pi / \underline{\theta}_L > 0$). Instead, efficiency increases when pensions fall but wages rise, and thus when the former become more visible but the latter less ($\partial \Gamma / \partial \pi < 0$ but $\partial \Gamma / \underline{\theta}_L > 0$).

Finally, two results in Proposition 3 depend on inference of conditionally optimal trembles off the equilibrium path. As Proposition 2 showed, its effect is to increase public-sector wages without having any impact on public-sector pensions on the equilibrium path. As a consequence, it decreases inefficient back-loading ($\partial \Gamma / \partial \lambda < 0$), albeit transferring rents from developers to local government employees. Since this effect grows with the size of the city payroll, the degree of inefficiency (measured on a per capita basis) is also weakly decreasing in it ($\partial \Gamma / \partial q \leq 0$).

3.8 Growth and Deficit Spending

While our main focus is on the inefficiency arising from imperfect information about policy choices, and particularly from the shrouding of pension promises, the model incorporates another source of distortions. If ongoing new construction is taking place ($\delta > 0$), some of the cost of future public-sector pensions is borne by developers rather than current homeowners. Since homeowners are also voters but developers are not, growth in the housing stock reduces political opposition to generous pensions for local government employees.

Proposition 4 *Suppose that public-sector pensions are not pre-funded ($\phi = 0$). There is a unique linear Markov perfect dynamic rational expectations equilibrium.*

The equilibrium sensitivity of house prices to pension obligations is $h(\delta, q) \in [q/(1+\delta), q]$. It is decreasing in the growth rate of the housing stock ($\partial h / \partial \delta < 0$) and increasing in the number of public employees ($\partial h / \partial q > 0$).

At any point on the equilibrium path, the ratio of the consumption levels of private- and public-sector employees equals

$$\tau_W \equiv \frac{\bar{C}_W}{C_W^P} = \rho_w - \lambda \frac{\beta (\rho_w - \rho_B) q}{\beta q + (1+\beta) \rho_B (1-q)} < 1$$

for young workers and

$$\tau_R \equiv \frac{\bar{C}_R}{C_R^P} = \rho_B \frac{(1-q) h(\delta, q)}{q [1 - h(\delta, q)]} < \tau_W$$

for old retirees.

In steady state, public-sector wages equal

$$w_{ss} = Y - \frac{R}{1+r} - \bar{A} + \frac{\bar{C}_W}{\tau_W},$$

public-sector pensions equal

$$B_{ss} = R + \frac{\bar{C}_R}{\tau_R},$$

and house prices equal

$$H_{ss} = \frac{1+r}{r} \left[Y - \frac{R}{1+r} - \bar{A} - q \left(w_{ss} + \frac{B_{ss}}{1+\delta} \right) \right].$$

Equilibrium dynamics converge to the steady state with public-sector wages

$$w(B_t) = w_{ss} + \frac{h(\delta, q)}{1 - h(\delta, q)} \frac{B_t - B_{ss}}{1 + r},$$

public-sector pensions

$$B'(B_t) = \frac{B_{ss} - B_t h(\delta, q)}{1 - h(\delta, q)},$$

and house prices

$$H(B_t) = H_{ss} + (B_{ss} - B_t) h(\delta, q).$$

The comparison between these results and those of Proposition 2, which is nested in Proposition 4 as a limit case, establishes that the effect of city growth ($\delta > 0$) is to dampen the capitalization of pension promises into house prices. Real-estate value are less responsive to the burden of pension debt when city growth is faster ($\partial h/\partial \delta < 0$) because the same burden is spread over a larger number of taxpayers and houses. The sensitivity increases with the size of the public sector ($\partial h/\partial q > 0$) because a larger share of public employees makes any individual entitlement more costly in the aggregate.

As evidenced in Proposition 1, the capitalization of pension obligations B_t into current house prices H_t is the starting point of the dynamic feedback between public-sector pensions and house prices. Since growth in the housing stock implies imperfect capitalization, it also induces lower responsiveness to the pension burden B_t of the entire compensation package of the current generation of local government employees. For the same shortfall in pension obligation relative to the steady state ($B_{ss} - B_t$), wages ($w_t - w_{ss}$) rise less and future pensions ($B_{t+1} - B_{ss}$) fall less relative to their steady-state levels if city growth is faster. Thus, convergence to the steady state is faster, the faster the city is growing.

More generally, we could imagine a two-way relationship between public-sector pensions and city growth. If construction were limited by convex construction costs in a perfectly competitive market, rather than by regulatory barriers to profitable growth, a larger pension burden would not only reduce real-estate prices but consequently reduce growth in the housing stock. Qualitatively, we expect that this feedback loop would bring the sensitivity of house prices to pension promises some but not all of the way back to its level with no construction (i.e., to $\tilde{h}$ such that $h(\delta, q) < \tilde{h} < q$). However, quantifying such a generalization would involve substantial analytical complications: a linear Markov perfect dynamic rational expectations equilibrium exists if and only if the city grows at an exogenous rate.

The steady-state impact of ongoing construction is described by the following comparative statics.

Corollary 4 *Suppose that public-sector pensions are not pre-funded ($\phi = 0$). In the unique linear Markov perfect dynamic rational expectations equilibrium all results in Corollaries 2 and 3 obtain. Moreover, equilibrium consumption by public-sector retirees, the lifetime utility of public-sector workers and steady-state public-sector pensions are all increasing in city growth ($\partial C_R^P/\partial \delta > 0$, $\partial U^P/\partial \delta > 0$ and $\partial B_{ss}/\partial \delta > 0$) and in the size of the local government ($\partial C_R^P/\partial q \geq 0$ and $\partial B_{ss}/\partial q \geq 0$ as well as $\partial U^P/\partial q \geq 0$).*

Voters are never entirely oblivious to the future cost of a pay-as-you-go pension system. They have a stake in the local real-estate market, and they understand that high pension debt will weigh down the future value of their own house. However, in a growing city they also understand that part of the burden will be borne by the developers of new housing. The electorate doesn't internalize the fall in developers' profits, and thus it is willing to accrue more generous unfunded pension liabilities, the higher the growth rate of the housing stock ($\partial C_R^P/\partial\delta > 0$ and $\partial B_{ss}/\partial\delta > 0$).

City growth mutes the effect on housing prices not only of higher pension promises for a fixed government workforce, but also of a larger city payroll at any level of pensions. Hence, ongoing construction implies that pensions becomes more generous as the share of public-sector employees in the electorate increases ($\partial C_R^P/\partial q \geq 0$ and $\partial B_{ss}/\partial q \geq 0$).

The effect on city growth on steady-state housing prices is ambiguous. On the one hand, it increases the burden of financing retirees' endogenous consumption levels. On the other, it reduces the burden of financing their exogenous housing cost R, since the same amount is shared between a greater number of housing units. An equivalent ambiguity exists, a fortiori, for the present value of developer profits.

Normalizing initial city size to one, the developer sells houses valued H_0 in the first period, and $\delta\left(1+\delta\right)^{t-1}H_t$ in every subsequent period $t \geq 1$. Conveniently parametrizing by $qB_0/\left(1+\delta\right)$ the fiscal transfer from the first generation of residents to the developer, the value of the city at its inception is

$$\Pi = \frac{1}{1+\delta}\left[H_0 + \delta\sum_{t=0}^{\infty}\left(\frac{1+\delta}{1+r}\right)^t H_t + qB_0\right]. \tag{33}$$

As in Corollary 3, in the equilibrium described by Proposition 4 this can be rewritten as a function of steady-state values only:

$$\Pi = \frac{1+r}{r-\delta}\left[Y - \bar{A} - \frac{R}{1+r} - q\left(w_{ss} + \frac{B_{ss}}{1+r}\right)\right]. \tag{34}$$

For all $\delta < r$ the city has a finite value, but the effect of the growth rate is ambiguous. It induces an increase in steady-state pensions, unambiguously increasing the burden of public-sector compensation. But it also directly produces more chances to capture the net productivity value of the city ($Y - \bar{A} - R/\left(1+r\right)$).

No such ambiguity exist for our alternative measure of efficiency, the back-loading of public-sector compensation.

Corollary 5 *Suppose that public-sector pensions are not pre-funded ($\phi = 0$). In the unique linear Markov perfect dynamic rational expectations equilibrium public-sector employees' consumption is inefficiently back-loaded ($\Gamma > 1$). The degree of inefficiency is independent of the reservation utility ($\partial\Gamma/\partial\bar{A} = 0$), of the cost of housing in the retirement destination ($\partial\Gamma/\partial R = 0$) and of city productivity ($\partial\Gamma/\partial Y = 0$). It is increasing in the asymmetry of information about pensions ($\partial\Gamma/\partial\rho_B < 0$) but decreasing in the asymmetry of information about wages ($\partial\Gamma/\partial\rho_w > 0$). Thus, it is increasing in shrouding ($\partial\Gamma/\partial\pi < 0$) and in the informativeness of either source ($\partial\Gamma/\partial\underline{\theta}_L > 0$ and $\partial\Gamma/\partial\underline{\theta}_U > 0$). It is decreasing in the prevalence of the inference of conditionally optimal trembles off the equilibrium path ($\partial\Gamma/\partial\lambda < 0$).*

Inefficiency is increasing in city growth ($\partial\Gamma/\partial\delta > 0$). It is increasing in the size of local government if there is ongoing construction and no inference of conditionally optimal trembles off the equilibrium path ($\partial\Gamma/\partial q > 0$ if $\delta > 0 = \lambda$).

Because the electorate fails to internalize the impact of current policy choices on future developer profits, voters would rather reduce public employees' wages, which they pay in their entirety, and increase public pensions, accumulating unfunded liabilities that will partially be defrayed by future taxpayers, and ultimately reflected in lower prices for new construction. As city growth speeds up, the temptation becomes sharper and inefficient pension deficits larger ($\partial\Gamma/\partial\delta > 0$).

Almost all the results from Proposition 3, and in particular the inefficiencies associated with the shrouding of pensions, are unchanged if there is ongoing construction. However, the effect of the size of the city government becomes ambiguous. Given inference of conditionally optimal trembles off the equilibrium path ($\lambda > 0$), a larger public sector tends to raise wages while having no equilibrium impact on pensions. Given positive city growth ($\delta > 0$), it tends instead to raise pensions while having no equilibrium impact on wages. The net effect is certainly to increase overall compensation. Inefficient back-loading also rises with local government employment if partially informed voters infer independent trembles off the equilibrium path ($\partial\Gamma/\partial q > 0$ if $\delta > 0 = \lambda$).

3.9 Limits to the Political Clout of Government Employees

Propositions 2 and 4 show that both information asymmetries and city growth increase the political clout of local government employees relative to taxpayers, and entail inefficient distortions to the optimal composition of public-sector compensation. We shall now consider factors that act instead to reduce the influence of public-sector employees on policy choices. One such factor, counterbalancing the deficit-inducing impact of city growth, is a requirement for pre-funding pension promises, $\phi > 0$. A more direct electoral mechanism is the possibility that some local government employees do not live, and therefore do not vote, in the city that employs them.

To consider this possibility, assume that the state is composed of N identical cities, which are all identical excepts for location-specific amenities. Individuals have idiosyncratic tastes for these amenities, such that each of the cities is preferred to all others by a fraction $1/N$ of agents. Private-sector employees can costlessly choose to work in the city whose amenities their like best. Its hedonic value is normalized to zero.

Winners of the public-sector lottery for each city, however, are selected randomly. As a consequence, only a fraction $1/N$ of winners have an idiosyncratic preference for living in the city whose government has offered them a job. For the remainder $(N-1)/N$, taking up residence in the city has a utility cost ξ_i due to taste mismatch, independently and identically distributed across worker-city pairs with cumulative distribution function $F(\xi_i)$.

As an alternative, a public-sector employee can choose to live in one city and commute to work in another, though we assume that he must live within the state. The choice of commuting between two cities involves a hedonic cost ψ. We can interpret this parameter as the opportunity cost of commute time, assuming that welfare is separable in the utility of consumption and that of leisure, and that public-sector employment contracts do not provide workers with a choice of the number hours worked.

Therefore, an agent i who has won the public-sector lottery in city c but prefers living in city d chooses to commute if and only if

$$\log\left(w_t^c - T_t^d - \frac{r}{1+r}H_t^d\right) + \beta\log\left(B_{t+1}^c + H_{t+1}^d - H_t^d - R\right) - \psi >$$
$$\log\left(w_t^c - T_t^c - \frac{r}{1+r}H_t^c\right) + \beta\log\left(B_{t+1}^c + H_{t+1}^c - H_t^c - R\right) - \xi_i. \quad (35)$$

In a symmetric equilibrium, public-sector compensation and housing prices are identical across cities. Thus a fraction

$$\gamma = \frac{1 + (1-N)\,F(\psi)}{N} \in \left[\frac{1}{N}, 1\right] \quad (36)$$

of local government employees choose to live in the city for which their work. This proportion will critically determine their political clout in the city. Hence γ can be interpreted directly as a parameter that determines the electoral power of city employees. We assume that γ is large enough and ψ small enough that all lottery winners accept their public-sector job offers.[16]

When public-sector employees live and own houses in one city but work and earn compensation in another, the definition of equilibrium is slightly different from Definition 1. Not only do local government employees constitute a smaller fraction of the electorate (γq instead of q). Some of the voters (share $(1-\gamma)\,q$ in a symmetric equilibrium) are liquidity-constrained employees of another city, whose self-interest is to minimize public-sector wages and pensions in their place of residence. Since public-sector employees' superior information derives from workplace interactions and local trade-union leaders, we assume it concerns only their own compensation. Thus, commuting government employees are no more informed than other taxpayers about policy proposals in their place of residence.

The intuition underpinning the equilibrium is unchanged, and we provide the detailed derivation in the appendix. To preserve analytical tractability, we consider from now on only inference of independent trembles off the equilibrium path ($\lambda = 0$).

Proposition 5 *Suppose that agents infer independent trembles off the equilibrium path ($\lambda = 0$). There is a unique symmetric linear Markov perfect dynamic rational expectations equilibrium.*

The equilibrium sensitivity of house prices to pension obligations is $h(\delta, \phi, q) \in [(1-\phi)\,q/(1+\delta), (1-\phi)\,q]$. It is decreasing in the growth rate of the housing stock ($\partial h/\partial\delta < 0$) and in the degree of pre-funding ($\partial h/\partial\phi < 0$), and increasing in the number of public employees ($\partial h/\partial q > 0$).

At any point on the equilibrium path, the ratio of the consumption levels of private- and public-sector employees equals

$$\tau_W \equiv \frac{\bar{C}_W}{C_W^P} = \frac{\rho_w\,(1-q)}{\gamma\,(1-q) - (1-\gamma)\,\rho_w q}$$

[16]Sufficient but not necessary conditions are $\gamma > \rho_w/(1-q+\rho_w q)$ and $\psi \approx 0$.

for young workers and

$$\tau_R \equiv \frac{\bar{C}_R}{C_R^P} = \frac{1-q}{q} \frac{\gamma \left[\rho_w \phi q^2 + (1-q)\, \rho_B (\phi q + h)\right] - (1-\gamma)\, \rho_w \rho_B q h}{\left[\gamma (1-q) - (1-\gamma)\, \rho_w q\right] \left[\gamma (1-h) - (1-\gamma)\, \rho_B h\right]} < \tau_W$$

for old retirees.

In steady state, public-sector wages equal

$$w_{ss} = Y - \frac{R}{1+r} - \bar{A} + \frac{\bar{C}_W}{\tau_W},$$

public-sector pensions equal

$$B_{ss} = R + \frac{\bar{C}_R}{\tau_R},$$

and house prices equal

$$H_{ss} = \frac{1+r}{r} \left\{ Y - \frac{R}{1+r} - \bar{A} - q \left[w_{ss} + \left(\frac{\phi}{1+r} + \frac{1-\phi}{1+\delta} \right) B_{ss} \right] \right\}.$$

Equilibrium dynamics converge to the steady state with public-sector wages

$$w\,(B_t) = w_{ss} + \frac{h\,(\delta, \phi, q)}{1 - h\,(\delta, \phi, q)} \frac{B_t - B_{ss}}{1+r},$$

public-sector pensions

$$B'\,(B_t) = \frac{B_{ss} - B_t h\,(\delta, \phi, q)}{1 - h\,(\delta, \phi, q)},$$

and house prices

$$H\,(B_t) = H_{ss} + (B_{ss} - B_t)\, h\,(\delta, \phi, q)\,.$$

Comparing Proposition 5 with Proposition 4 highlights two direct consequences of pre-funding ($\phi > 0$). First, the capitalization of pension promises into house prices is reduced ($\partial h / \partial \phi < 0$) because a lower fraction of the burden must be borne by future residents when current taxpayers are paying for it in advance instead. Thus, convergence to the steady state is faster, the faster the city is growing. In the limit case when pensions are fully funded ($\phi = 1$) there is no dynamic link between the policy choices of each generation ($h = 0$), since each prepays entirely any promises it makes to its public employees. Pensions then jump immediately to their steady state level (B_{ss}).

Second, pre-funding reduces the impact of steady-state pensions (B_{ss}) on steady-state house prices (H_{ss}) because a pre-funded system is intrinsically less costly than a pay-as-you-go system in a dynamically efficient economy. The former is financed at the market rate of return r, while the latter has an internal rate of return $\delta < r$. This effect would be reversed if the local economy had a growth rate above the interest rate. Leeds (1985) failed to find evidence of a negative impact of unfunded pension liabilities on local property values.

Further indirect effects of pre-funding arise from its impact on the political equilibrium, which is also crucially affected by the fraction of local government employees who vote in city elections.

Corollary 6 *Suppose that agents infer independent trembles off the equilibrium path ($\lambda = 0$). In the unique symmetric linear Markov perfect dynamic rational expectations equilibrium:*

- *Consumption by public-sector employees while working is time invariant. It is increasing in the reservation value ($\partial C_W^P/\partial \bar{A} > 0$), in information asymmetries concerning wages ($\partial C_W^P/\partial \rho_w < 0$), and in the share of local government employees living in the city ($\partial C_W^P/\partial \gamma > 0$). It is decreasing in the size of local government ($\partial C_W^P/\partial q \leq 0$).*

- *Consumption by public-sector retirees is time invariant. It is increasing in the reservation value ($\partial C_R^P/\partial \bar{A} > 0$), in information asymmetry concerning both wages and pensions ($\partial C_R^P/\partial \rho_w \leq 0$ and $\partial C_R^P/\partial \rho_B < 0$), in the share of local government employees living in the city ($\partial C_R^P/\partial \gamma > 0$), and in city growth ($\partial C_R^P/\partial \delta > 0$). It is decreasing in pre-funding ($\partial C_R^P/\partial \phi < 0$). It is decreasing in the size of local government if there is no housing growth ($\delta = 0 \Rightarrow \partial C_R^P/\partial q \leq 0$).*

In the steady state:

- *Public-sector wages are increasing in city productivity ($\partial w_{ss}/\partial Y = 1$) and decreasing in the cost of housing in the retirement destination ($\partial w_{ss}/\partial R < 0$). They are increasing in information asymmetries concerning wage ($\partial w_{ss}/\partial \rho_w < 0$) and in the share of local government employees living in the city ($\partial w_{ss}/\partial \gamma > 0$). They are decreasing in the size of local government ($\partial w_{ss}/\partial q \leq 0$).*

- *Public-sector pensions are increasing in the cost of housing in the retirement destination ($\partial B_{ss}/\partial R = 1$), in the reservation value ($\partial B_{ss}/\partial \bar{A} > 0$), in information asymmetry concerning both wages and pensions ($\partial B_{ss}/\partial \rho_w \leq 0$ and $\partial B_{ss}/\partial \rho_B < 0$), in the share of local government employees living in the city ($\partial B_{ss}/\partial \gamma > 0$), and in city growth ($\partial B_{ss}/\partial \delta > 0$). They are decreasing in pre-funding ($\partial B_{ss}/\partial \phi < 0$). They are decreasing in the size of local government if there is no housing growth ($\delta = 0 \Rightarrow \partial B_{ss}/\partial q \leq 0$).*

- *House prices are increasing in city productivity ($\partial H_{ss}/\partial Y = 1$) and decreasing in the in the cost of housing in the retirement destination ($\partial H_{ss}/\partial R < 0$), in the reservation value ($\partial H_{ss}/\partial \bar{A} < 0$),in information asymmetries concerning both wages and pensions ($\partial H_{ss}/\partial \rho_w > 0$ and $\partial H_{ss}/\partial \rho_B > 0$), and in the share of local government employees living in the city ($\partial H_{ss}/\partial \gamma < 0$). They are increasing in pre-funding ($\partial H_{ss}/\partial \phi > 0$).*

The greater the fraction of public-sector workers that vote in local elections the greater their clout over policy making. Their consumption in every period of their life rises with the share that resides in the city ($\partial C_W^P/\partial \gamma > 0$ and $\partial C_R^P/\partial \gamma > 0$). As a consequence, steady-state public-sector wages and pensions must also rise ($\partial w/\partial \gamma > 0$ and $\partial B/\partial \gamma > 0$). In our model, public employees' wages and pensions tend to rise together as a consequence of the political power of public-sector unions, rather than exhibiting a negative comovement, as predicted by the theory of compensating differentials (Smith 1981).

Pre-funding reduces the generosity of pension benefits, and therefore public-sector retirees' consumption, through two channels ($\partial B_{ss}/\partial \phi < 0$ and $\partial C_R^P/\partial \phi < 0$). First, it reduces the tendency towards deficit spending in a growing polity without intergenerational altruism. The more pre-funding is required, the less can taxpayers shift the cost of pension promises onto future developers. Second, government employees' own demand for generous pensions declines when more pre-funding is required. Even if there is no growth and pension burdens are fully capitalized in house prices, liquidity constrained employees would rather pay their share of the cost through lower capital gains on their house when old rather than through higher taxes when young.

The latter mechanism also explains why public-sector pensions increase with information asymmetry on both issues ($\partial B_{ss}/\partial \rho_w \leq 0$ and $\partial B_{ss}/\partial \rho_B < 0$). With any pre-funding requirement ($\phi > 0$), the two types of compensation are complementary. If public employees expect higher wages because knowledge of the relevant proposals is more asymmetric ($\partial w_{ss}/\partial \rho_w < 0$), they are more aggressive in their pension demands because they know they can afford their share of pre-funding.

As always, the ultimate political opponents of local government employees are homeowners. Thus, steady-state house prices fall as the electoral weight of public-sector voters rises ($\partial H_{ss}/\partial \gamma < 0$), and conversely they rise with pre-funding ($\phi > 0$).

A larger public sector implies lower wages if any government employees commute across city lines ($\partial w_{ss}/\partial q < 0$ and $\partial C_W^P/\partial q < 0$ if $\gamma < 1$). Then, as government employment rises, resident public-sector employees are fighting their political battles more and more against their non-resident peers rather than against private-sector employees. The former are the more formidable opponents because they are liquidity constrained and thus particularly oppose higher taxes.

The same phenomenon tends to make steady-state pensions (B_{ss}) decrease with government employment. However, Corollary 4 established an opposite tendency with city growth and no pre-funding. In the general case both forces operate, so the net result is ambiguous. However, just as Corollary 4 showed the effect of construction alone, so does Corollary 6 establish that without city growth, pre-funding and commuting unambiguously induce a negative link between the size of the local government and the generosity of its pensions ($\delta = 0 \Rightarrow \partial B_{ss}/\partial q \leq 0$).

The impact of local government size on house values (H_{ss}) is also ambiguous. As in Corollary 2, there is a direct negative effect because the city needs to support more public-sector employees. On the other hand, Corollary 6 establishes that their wages fall with their number unless they all reside and vote in the city. Pensions may also decline by a similar mechanism, although this is not assured if there is ongoing construction ($\delta > 0$). We certainly expect the direct effect to dominate, but in general the decline in compensation might be so sharp as to dominate the increase in payroll. Our next proposition establishes a simple sufficient condition for the regular case.

Corollary 7 *Suppose that agents infer independent trembles off the equilibrium path ($\lambda = 0$). In the unique symmetric linear Markov perfect dynamic rational expectations equilibrium, steady-state house prices are decreasing in the size of local government if (but not only if) there is no housing growth ($\delta = 0$) and no pre-funding ($\phi = 0$), and if moreover information about public-sector compensation is sufficiently low, and the share of local government employees living in the city is sufficiently high:*

$$\delta = \phi = 0 \wedge \rho_w < \frac{\gamma}{1-\gamma} \frac{(1-q)^2}{(2-q)\,q} \Rightarrow \frac{\partial H_{ss}}{\partial q} < 0.$$

The sufficient condition ensures that wages, though decreasing in the size of local government, have less than unit elasticity, so the total wage bill increases with the number of public-sector employees. If there is neither city growth nor pre-funding ($\delta = \phi = 0$), pensions are less elastic than wages to the size of the public sector because liquidity-constrained non-resident government employees oppose them less forcefully. Hence, a sufficient condition for a declining wage bill is sufficient a fortiori for a decline in the aggregate compensation of the local government workforce.

The sufficient condition reads as an upper bound on the political clout of non-resident public-sector employees relative to that of their resident counterparts. They must not be too numerous (sufficiently high γ) nor too informed (sufficiently low ρ_w). The threshold on the right-hand side is also decreasing in q, and diverges as the local government payroll shrinks to zero. Therefore, house prices are certainly decreasing in the size of government when it is small, though the relationship might admit a maximum for an interior value $q < 1/2$.

Moving to our measures of welfare, it is again convenient to parametrize the fiscal transfer from the first generation of residents to the developer by $(1-\phi)\, qB_0/(1+\delta)$, so the special case in which the system jumps immediately to the steady state remains nested for $B_0 = B_{ss}$.

Corollary 8 *Suppose that agents infer independent trembles off the equilibrium path ($\lambda = 0$). In the unique symmetric linear Markov perfect dynamic rational expectations equilibrium:*

- *The lifetime utility of public-sector workers is time invariant. It is increasing in the reservation value ($\partial U^P/\partial \bar{A} > 0$), in information asymmetries concerning both wages and pensions ($\partial U^P/\partial \rho_w < 0$ and $\partial U^P/\partial \rho_B < 0$), in city growth ($\partial U^P/\partial \delta > 0$), and in the share of local government employees living in the city ($\partial U^P/\partial \gamma > 0$). It is decreasing in pre-funding ($\partial U^P/\partial \phi < 0$). It is decreasing in the size of local government if there is no housing growth ($\delta = 0 \Rightarrow \partial U^P/\partial q \leq 0$).*

- *The present value of developer profits equals*

$$\Pi = \frac{1+r}{r-\delta}\left[Y - \bar{A} - \frac{R}{1+r} - q\left(w_{ss} + \frac{B_{ss}}{1+r}\right)\right].$$

  It is increasing in city productivity ($\partial \Pi/\partial Y > 0$) and in pre-funding ($\partial \Pi/\partial \phi > 0$). It is decreasing in the cost of housing in the retirement destination ($\partial \Pi/\partial R < 0$), in the reservation value ($\partial \Pi/\partial \bar{A} < 0$), in information asymmetries concerning both wages and pensions ($\partial \Pi/\partial \rho_w > 0$ and $\partial \Pi/\partial \rho_B > 0$), and in the share of local government employees living in the city ($\partial \Pi/\partial \gamma < 0$). It is decreasing in the size of local government under the sufficient condition in Corollary 7.

- *Public-sector employees' consumption is inefficiently back-loaded ($\Gamma > 1$). The degree of inefficiency is time invariant. It is independent of the reservation utility ($\partial \Gamma/\partial \bar{A} = 0$), of the cost of housing in the retirement destination ($\partial \Gamma/\partial R = 0$) and of city productivity ($\partial \Gamma/\partial Y = 0$). It is increasing in the asymmetry of information about pensions ($\partial \Gamma/\partial \rho_B < 0$) but decreasing in the asymmetry of information about wages ($\partial \Gamma/\partial \rho_w > 0$). Thus, it is increasing in shrouding ($\partial \Gamma/\partial \pi < 0$) and in the informativeness of either source ($\partial \Gamma/\partial \underline{\theta}_L > 0$ and $\partial \Gamma/\partial \underline{\theta}_U > 0$). It is increasing in city growth ($\partial \Gamma/\partial \delta > 0$), and decreasing in pre-funding ($\partial \Gamma/\partial \phi < 0$) and in the share of local government employees living in the city ($\partial \Gamma/\partial \gamma < 0$).*

- *If there is no city growth, then back-loading increases with the size of the public sector if and only if pre-funding and the share of local government employees living in the city are sufficiently low, while shrouding of pensions is sufficiently high:*

$$\text{if } \delta = 0 \text{ then } \frac{\partial \Gamma}{\partial q} > 0 \Leftrightarrow \rho_B > \frac{\gamma}{1-\gamma}\frac{\phi}{1-\phi}.$$

The comparative statics for the steady-state welfare of public-sector workers follow immediately from the analysis of their equilibrium compensation in Corollary 6. Public-sector unions would like as many of their members as possible to reside and vote in the city that employs them ($\partial U^P/\partial\gamma > 0$), so as to exert greater electoral clout. However, individual local government employees do not internalize this consequence of their location choice, since each of them is atomistically small and thus cannot affect the outcome of an election with his single ballot. Public-sector unions also favor minimal pre-funding of public-sector pensions ($\partial U^P/\partial\phi < 0$), just as they favor the fastest feasible city growth ($\partial U^P/\partial\delta > 0$), because both makes taxpayers less keen on fighting pensions promises, and therefore ensure the most generous pension provision in the ensuing political equilibrium.

At least in the absence of city growth ($\delta = 0$), unionized public-sector insiders also wish to limit the size of the local government payroll, since its expansion would entail a decrease in their compensation ($\delta = 0 \Rightarrow \partial U^P/\partial q \leq 0$). This individual preference, however, may not translate into the policy preferences of the union leadership. The public-sector union as a whole might, e.g., aim at maximizing the total wage bill of its membership, rather than the individual utility of each member.

On the other side of the political rivalry, developers prefer as many local government employees as possible to be hired outside of the city, so they cannot vote in local elections ($\partial\Pi/\partial\gamma < 0$). They want maximum pre-funding ($\partial\Pi/\partial\phi > 0$) to ensure that residents are keen proxy fighters in the political battle against public-sector workers. They presumably want to minimize the local government payroll, although this preference is not fully unambiguous, as discussed in Corollary 7.

The comparative statics on back-loading highlight the opposite welfare consequences of these two checks to the political clout of local government employees. A pre-funding requirement increases efficiency ($\partial\Gamma/\partial\phi < 0$). It blunts the temptation to accumulate unfunded pension liabilities that will be partially defrayed by future developers instead of current voters. Moreover, it reduces public-sector employees' willingness to leverage their privileged information into higher pension benefits, since it requires their own taxes to rise in line with their pension promises. Nonetheless, shrouding implies inefficient back-loading even if public-sector pensions are required to be fully pre-funded.[17]

On the other hand, a lower share of resident public-sector employees reduces efficiency ($\partial\Gamma/\partial\gamma > 0$). The political influence of local government employees declines, but it also gets increasingly concentrated on the shrouded component of their compensation. Their clout is more and more dependent on information asymmetry rather than numbers. Moreover, a larger fraction of their political opponents consists of employees of other city governments, who are themselves liquidity constrained and thus keener to fight high wages than generous pensions.

[17] Formally, if $\phi = 1$, then $\Gamma = [q + (1-q)\,\rho_B/\rho_w]^{-1} > 1$.

The impact of the size of the local government on inefficient back-loading is generally ambiguous. Corollary 5 established a tendency for inefficiency to increase as the government payroll expands ($\delta > 0 \Rightarrow \partial\Gamma/\partial q > 0$) because pensions then become a more effective way of extracting profits from future developers. Corollary 8 highlights the rival forces operating when there is no growth ($\delta = 0$).

Without pre-funding ($\phi = 0$), the driving force is opposition to higher wages by non-resident public sector employees ($\gamma < 1$). Due to their liquidity constraint, they oppose less forcefully higher pensions. Then an increase in the size of government causes an increase in back-loading ($\delta = \phi = 0 \wedge \gamma < 1 \Rightarrow \partial\Gamma/\partial q > 0$). A higher pre-funding requirement, however, conversely induces resident government employees to demand higher pension and lower wages, again due to the liquidity constraint. If there is no commuting but any pre-funding, an increase in the size of government then causes a decrease in back-loading ($\delta = 0 < \phi \leq \gamma = 1 \Rightarrow \partial\Gamma/\partial q < 0$).

In an interior case, the two forces are opposed, and either can prevail. Lower shrouding of pensions (low ρ_B) implies that redistribution happens relatively more through wages, and therefore as government size (q) and redistribution increase, inefficient back-loading declines. Instead, back-loading increases with the public-sector payroll if commuting is common (γ is low), which implies there are many non-resident government employees opposing high wages more strongly than high pensions. Back-loading is also increases in the size of government if pre-funding (ϕ) is low, leading resident government employees to strengthen their pension demands relative to their wage demands.

In the limit, we can characterize the effects of changes in local government size on the generosity of a fully-funded pension system ($\phi = 1$), irrespective of city growth (δ).

Corollary 9 *Suppose that agents infer independent trembles off the equilibrium path ($\lambda = 0$) and that public-sector pensions are fully pre-funded ($\phi = 1$). In the unique symmetric linear Markov perfect dynamic rational expectations equilibrium:*

- *Consumption by public-sector retirees, the lifetime utility of public-sector workers, and steady-state public-sector pensions are decreasing in the size of local government ($\partial C_R^P/\partial q < 0$, $\partial U^P/\partial q < 0$ and $\partial B_{ss}/\partial q < 0$).*
- *Inefficient back-loading is decreasing in the size of the public sector ($\partial\Gamma/\partial q < 0$).*
- *The present value of developer profits and steady-state house prices are decreasing in the size of local government if the share of local government employees living in the city is above a threshold $\hat{\gamma}(\rho_w, \rho_B, q)$ that decreases with the asymmetry of information about pensions ($\partial\hat{\gamma}/\partial\rho_B < 0$), and increases with the asymmetry of information about wages ($\partial\hat{\gamma}/\partial\rho_w > 0$) and with the size of local government ($\partial\hat{\gamma}/\partial q > 0$).*

When the public-sector pension system requires full pre-funding, it is no longer an avenue for implicit government debt accumulation. Then, even if the city's housing stock is growing ($\delta > 0$), the inefficient tendency towards deficit spending highlighted by Proposition 4 is eliminated. Therefore, the forces discussed in Corollary 6 operate unopposed, and regardless of the growth rate all components of public-sector compensation decline as the size of the local government expands. Consequently, the lifetime utility of government employees falls.

Moreover, as discussed in Corollary 8, pre-funding makes non-resident public-sector employees strongly opposed to generous pensions, which need to be financed by taxes during their liquidity-constrained youth. For the same reason, it makes resident employees of the local government less keen on demanding generous pensions, which indirectly reduce their own net income during their working life. As a consequence, with full pre-funding a higher number of local government employees translates into a greater reduction in pensions than wages. Not only does public-sector compensation decline, but it also becomes less back-loaded.

The final result in the corollary formalizes the ambiguity of the impact of local government size on house prices. As in Corollary 7, we normally expect a negative relationship. However, public-sector wages and pensions decline highly elastically with the number of government employees when a large share of them commute across city lines (low γ) and therefore can cast their ballots to fight their peers' compensation rather than to advocate their own. The sufficient conditions in the two corollaries differ because the binding component of compensation varies with pre-funding (ϕ). With pure pay-as-you-go ($\phi = 0$, Corollary 7), if the aggregate wage bill increases so does a fortiori the total pension burden. Conversely, with full pre-funding ($\phi = 1$, Corollary 9), an increase in aggregate pension payouts is a sufficient condition for an increase in the wage bill. Then house prices are more likely to fall when pensions are less shrouded ($\partial\hat{\gamma}/\partial\rho_B < 0$). In both cases, they are more likely to fall when asymmetric information about wages is high ($\partial\hat{\gamma}/\partial\rho_w > 0$) and when the local government payroll is increasing from a low starting point ($\partial\hat{\gamma}/\partial q > 0$).

Although we have not yet turned to the topic of centralized pension bargaining, the results in this section already allow us to understand one major way in which states regulate localities: pre-funding requirements. As we discussed in Section 2, localities that participate in state systems are subject to state rules about pre-funding. These rules may be relatively lax, because of high assumed returns, but they do represent some attempt to regulate localities' behavior. Pre-funding is also a policy choice that in many cases only came about during the 1980s.

Pre-funding has no impact on wages or the consumption of public sector workers during their working life. Pre-funding, however, reduces pension promises and the consumption of retired public-sector workers, causing a decline of their lifetime welfare. As a consequence, public-sector unions should typically favor laxer pre-funding rules, which are presumably achieved in reality by assuming higher growth rates. Union power may also explain why public-sector pensions have not followed private-sector systems in moving from defined-benefit to defined-contribution schemes (Poterba, Venti, and Wise 2007). Conversely, developer profits increase with pre-funding because of the decrease in pensions. Fiscal discipline should therefore by the developers' mantra and they should push for tighter pre-funding requirements. We think that these results do help make sense of the political divisions over pre-funding requirements.

What does pre-funding do to the overall efficiency of the system? As pre-funding increases, the ratio of public consumption when young to public consumption when old increases. This means that the gap between worker welfare, and worker welfare given the first best consumption profile has decreased. As such, pre-funding doesn't just redistribute from workers to land owners, it also increases the efficiency of the system. This is one reason why pre-funding requirements may be so universal.

In the next section we turn to a broader discussion of centralized control over public-sector pensions.

4 Decentralization and Control over Pensions

The primary purpose of the model is to enable us to consider the issues raised in section 2, which highlighted the heterogeneity in local control over pensions. In our model, we assume that there are two primary differences between local and state pension setting. First, when pensions are set at the local level, only a fraction of public sector workers vote in each election because some of them live outside the locality. When pensions are set at the state level, then all public sector workers vote in the election. Second, we assume that there is a third source of information about pensions and wages when the process occurs at the state level. Statewide news media cover statewide public-policy issues, which increases the probability that voters know about both public sector workers and public sector wages.

Specifically, we assume that, in addition to the probability of being informed by local sources, and independent of the arrival of information from those sources, every individual has probability $\underline{\theta}_S \in (0,1)$ of being informed of statewide wage-policy proposals by state-level media. As with all sources of information, pensions remain less visible, and the relative probability of information through statewide news is only $\pi\underline{\theta}_S$. This implies that with centralization the information probabilities for taxpayers become

$$\theta_w^T = 1 - (1 - \underline{\theta}_L)(1 - \underline{\theta}_S) \text{ and } \theta_B^T = 1 - (1 - \pi\underline{\theta}_L)(1 - \pi\underline{\theta}_S), \tag{37}$$

while those for public-sector workers are

$$\theta_w^P = 1 - (1 - \underline{\theta}_L)(1 - \underline{\theta}_S)(1 - \underline{\theta}_U) \text{ and } \theta_B^P = 1 - (1 - \pi\underline{\theta}_L)(1 - \pi\underline{\theta}_S)(1 - \pi\underline{\theta}_U). \tag{38}$$

As in Lemma 1, the distribution of information is summarized by the two measures of symmetry. Denote the indices under centralization by ρ_w^S and ρ_B^S, and under decentralization by ρ_w^L and ρ_B^L. The information structure then admits the following characterization.

Lemma 2 *For any policy proposal, public-sector workers are more likely to informed than taxpayers. Their information advantage is greater for pensions than wages ($0 < \rho_B^S < \rho_w^S < 1$). Information asymmetry declines when either news source provides more information ($\partial\rho_w^S/\partial\underline{\theta}_L > 0$, $\partial\rho_B^S/\partial\underline{\theta}_L > 0$, $\partial\rho_w^S/\partial\underline{\theta}_S > 0$, $\partial\rho_B^S/\partial\underline{\theta}_S > 0$) and increases when public-sector unions provide more information ($\partial\rho_w^S/\partial\underline{\theta}_U < 0$ and $\partial\rho_B^S/\partial\underline{\theta}_U < 0$). When pensions are more shrouded, information about them is more asymmetric ($\partial\rho_B^S/\partial\pi > 0$). The relative asymmetry of information about pensions compared to wages is higher when pensions are more shrouded ($\partial\left(\rho_B^S/\rho_w^S\right)/\partial\pi > 0$) and when unions provide more information ($\partial\left(\rho_B^S/\rho_w^S\right)/\partial\underline{\theta}_U < 0$). It is non-monotonic in the information provided by each news source, with a global minimum at $\hat{\theta}_L \in (0,1]$ and respectively at $\hat{\theta}_S \in (0,1]$.*

Centralization reduces information asymmetry on all issues ($\rho_w^S > \rho_w^L$ and $\rho_B^S > \rho_B^L$). It reduces the relative asymmetry of information about pensions compared to wages if and only if local news are sufficiently informative: $\rho_B^S/\rho_w^S > \rho_B^L/\rho_w^L$ if and only if $\theta_L > \bar{\theta}_L$, for a threshold $\bar{\theta}_L \in (0, \max\{\underline{\theta}_S, \underline{\theta}_U\})$.

This lemma first replicates for statewide information the same results that Lemma 1 established for local information. The only difference concerns an increase in local news coverage $\underline{\theta}_L$. Under decentralization it always makes the two issues more asymmetric ($\partial\left(\rho_B^L/\rho_w^L\right)/\partial\underline{\theta}_L < 0$). Under centralization, its effect is ambiguous because taxpayers' relative information is no longer fixed at π. When they are informed by statewide news sources, an increase in information from local news has a greater impact on the less visible issue, by the usual intuition of diminishing returns to information. Hence, the effect on relative asymmetry flips, at least for lower levels of informativeness ($\partial\left(\rho_B^S/\rho_w^S\right)/\partial\underline{\theta}_L < 0$ for $\underline{\theta}_L < \hat{\theta}_L$).

The second part of Lemma 2 provides a comparison of information asymmetries with centralized and decentralized policy-making. Diminishing returns, again, imply that the statewide news source is more relevant for taxpayers, who rely on new only, than for public-sector workers, who also receive information from the unions. Thus centralization reduces the knowledge advantage of public employees on all policy dimensions ($\rho_w^S > \rho_w^L$ and $\rho_B^S > \rho_B^L$).

The final result reflects that the relative asymmetry in information about pensions and wages can be attenuated in two ways: by making taxpayers more informed about pensions, or by making taxpayers less informed about wages. In the limit as local news disappear ($\theta_L \to 0$) decentralization induces complete capture of both policy dimensions by public employees ($\rho_w \simeq \rho_B \simeq 0$). Relative asymmetry is then minimized.

However, in the case we consider most realistic, local news are more informative ($\underline{\theta}_L > \bar{\theta}$). The empirical findings of Gentzkow (2006) and Snyder and Strömberg (2010) suggest that local newspapers are the main source of information about state and local policy, which would imply $\underline{\theta}_L > \underline{\theta}_S$. Informative local news imply that decentralized government lets public employees capture pensions but not wage-setting. Then the relative asymmetry on the two issue declines with centralization, as well as the absolute asymmetry on each.

We first turn to the impact of centralization on public-sector compensation and housing prices.

Proposition 6 *Centralization reduces public employees' wages and first period consumption if and only if the share of public employees living in the city is above a critical value* $\bar{\gamma}_w$*. This threshold is increasing in the total number of public employees (*$\partial\bar{\gamma}_w/\partial q > 0$*), in the information provided by local news (*$\partial\bar{\gamma}_w/\partial\underline{\theta}_L > 0$*) and decreasing in the information provided by statewide news and public-sector unions (*$\partial\bar{\gamma}_w/\partial\underline{\theta}_S < 0$ *and* $\partial\bar{\gamma}_w/\partial\underline{\theta}_U < 0$*).*

Centralization reduces public employees' pensions and their consumption while retired if and only if the share of public employees living in the city is above a critical value $\bar{\gamma}_B$*, decreasing in the information provided by statewide news (*$\partial\bar{\gamma}_B/\partial\underline{\theta}_S < 0$*). When local news are sufficiently informative (*$\theta_L > \bar{\theta}_L$*), a reduction in public-sector pensions is more likely than one in public-sector wages (*$\bar{\gamma}_B < \bar{\gamma}_w$*)*

The impact on public employees' wages captures clearly the opposite pull of the two political consequences of centralization. On the one hand, centralization empowers public-sector workers by enabling all of them to vote for the politicians in charge of setting their salaries. On the other hand, centralization curbs the political power that public-sector unions derive from superior information, by increasing the news coverage of policy issues that reaches all taxpayers alike. The former effect dominates in cities with a low share of public workers in the electorate, and the latter in those whose employees are more likely to also be residents ($\gamma > \bar{\gamma}_w$).

When the local public sector is larger, the importance of electoral weight is greater, as proved in Corollary 6. Then centralization is less likely to reduce public-sector wages ($\partial\bar{\gamma}_w/\partial q > 0$), because government employees have a lot to gain from a higher residence share.

Centralization is more likely to reduce public-sector wages when local news sources are weaker ($\partial\bar{\gamma}_w/\partial\underline{\theta}_L > 0$) and statewide news sources stronger ($\partial\bar{\gamma}_w/\partial\underline{\theta}_S < 0$) because it then implies a greater increase in taxpayers' knowledge and thus in their power. It is also more likely to reduce wages when the union is stronger ($\partial\bar{\gamma}_w/\partial\underline{\theta}_U < 0$) and exerts greater control over local politics.

By the same mechanism, centralization reduces pensions in cities with enough public employees in their electorate ($\gamma > \bar{\gamma}_B$), and this is more likely when centralization generates more public information ($\partial\bar{\gamma}_B/\partial\underline{\theta}_S < 0$). Indeed, in the regular case of informative local news ($\theta_L > \bar{\theta}_L$), centralization reduces public-sector wages whenever it reduces public-sector pensions, but may reduce pensions alone ($\bar{\gamma}_B < \bar{\gamma}_w$). This is intuitive because, as we saw in lemma 2, centralization then reduces information asymmetries concerning pensions more than those concerning wages.

Proposition 7 *Centralization increases house prices if and only if the share of public employees living in the city is above a critical value $\bar{\gamma}_H$, decreasing in the information provided by statewide news ($\partial\bar{\gamma}_H/\partial\underline{\theta}_S < 0$). When local news are sufficiently informative ($\theta_L > \bar{\theta}_L$), an increase in house prices is more likely than a decline in public-sector wages, but less likely than one in pensions ($\bar{\gamma}_B < \bar{\gamma}_H < \bar{\gamma}_w$).*

The effect of centralization on house prices follows the familiar pattern. The more informative statewide sources, the more likely a reduction in the political power of public-sector unions. Such a decrease, by reducing the compensation of local government employees, yields a corresponding increase in house prices. Given that house prices reflect both the cost of pensions and that of wages, it is intuitive that likelihood that centralization increases them should be intermediate between those of reducing each component of public employees' lifetime compensation.

In cities with a very high share of public-sector workers in the electorate ($\gamma > \bar{\gamma}_w$), centralization reduces their political power across the board, so that both their wages and their pensions decline and house prices conversely rise. Yet, centralization need not be an unmitigated harm for public employees. It can yield a decrease in pensions, but at the same time an increase in wages. In fact, this pattern is consistent both with a decline in aggregate compensation and a rise in house prices ($\bar{\gamma}_H < \gamma < \bar{\gamma}_w$), and with an increase in aggregate compensation and a fall in house prices, when fewer public employees are local residents ($\bar{\gamma}_B < \gamma < \bar{\gamma}_H$).

The possibility of a decline in public-sector pensions matched by an increase in public-sector wages immediately suggests efficiency benefits of centralization, in the light of Proposition 3. We now turn to the impact of centralization on the welfare of public sector workers and developer profits. As before, we consider the value of the city to its developer in time zero as one element in social welfare. Public sector workers present the second element in total social welfare.

Proposition 8 *Centralization reduces the lifetime utility of public-sector workers if and only if the share of public employees living in the city is above a critical value $\bar{\gamma}_U$, decreasing in the information provided by statewide news ($\partial\bar{\gamma}_U/\partial\underline{\theta}_S < 0$). When local news are sufficiently informative ($\theta_L > \bar{\theta}_L$), a reduction in public employees' welfare is more likely than one in public-sector wages, but less likely than one in house prices, and a fortiori than one in public-sector pensions ($\bar{\gamma}_B < \bar{\gamma}_H < \bar{\gamma}_U < \bar{\gamma}_w$).*

Centralization increases the present value of developer profits if and only if the share of public employees living in the city is above a critical value $\bar{\gamma}_\Pi$, decreasing in the information provided by statewide news ($\partial\bar{\gamma}_\Pi/\partial\underline{\theta}_S < 0$). When local news are sufficiently informative ($\theta_L > \bar{\theta}_L$), an increase in public-sector pensions is more likely than a decline in public employees' welfare, and a fortiori than one in their wages. It is less likely than an increase in steady-state house prices, and a fortiori than a decrease in public-sector pensions ($\bar{\gamma}_B < \bar{\gamma}_H < \bar{\gamma}_\Pi < \bar{\gamma}_U < \bar{\gamma}_w$).

Comparing the first part of the proposition with propositions 6 reveals that the qualitative effect of centralization on public-sector worker's welfare is the same as that on their wages. Identically, the comparison with proposition 7 shows that the effect of centralization on developer profits is qualitatively the same as its effect on steady-state house prices. Quantitatively, however, centralization can reduce public employees' pensions while instead increasing their lifetime welfare ($\bar{\gamma}_B < \gamma < \bar{\gamma}_H$), through a more than compensating increase in wages. Conversely, an increase in developer profits is a stricter condition than an increase in housing prices ($\bar{\gamma}_H < \bar{\gamma}_\Pi$). Centralization can reduce public-sector pensions enough to lift steady-state house values, and yet reduce total developer profits because of the inefficiency of pay-as-you-go pensions when the interest rate is above the growth rate.[18]

Proposition 8 attests to the distributive tension connected with the choice between centralization and decentralization. Developers (and taxpayers more generally) want centralization when they expect the reduction in information asymmetry dominates the increase in the fraction of public-sector workers voting in the district ($\gamma > \bar{\gamma}_\Pi$). Public sector workers have the opposite preference, and support centralization when they believe that their greater voting numbers should dominate their reduced information advantage ($\gamma < \bar{\gamma}_U$).

Yet the final result also highlights the scope for consensual efficiency gains. There is a non-empty interval $[\bar{\gamma}_\Pi, \bar{\gamma}_U]$ for which centralization is Pareto efficient. Public-sector pensions fall ($\gamma > \bar{\gamma}_B$), house prices rise ($\gamma > \bar{\gamma}_H$) and so do developer profits ($\gamma > \bar{\gamma}_\Pi$). But public employee' wages also rise ($\tilde{\gamma} < \bar{\gamma}_w$) and so does their lifetime utility ($\tilde{\gamma} < \bar{\gamma}_U$). The decline in pensions is more than compensated by the increase in wages, since under local policy pensions are too high relative to wages. Intuitively, public employees are willingly trading off an inefficient source of asymmetric political power, privileged information, for an efficient symmetric one, participation in the election. This creates aggregate efficiency gains that under some parameter values can be shared among all parties involved, leading to Pareto efficiency.

A starker result is obtained when we measure efficiency by the welfare loss for public-sector workers compared to the first-best compensation profile that costs the same to the city developer.

[18] With full prefunding, or in the limit as $\delta \to r$, centralization increases developer profits if and only if it increases steady-state house prices: $\bar{\gamma}_H = \bar{\gamma}_\Pi$.

Proposition 9 *When local news are sufficiently informative* ($\underline{\theta}_L > \bar{\theta}_L$)*, centralization reduces the inefficient back-loading of public-sector compensation* ($\Gamma_S < \Gamma_L$)*. The threshold is always interior* ($0 < \bar{\theta}_L < \max\{\underline{\theta}_S, \underline{\theta}_U\}$)*. It increases with the information conveyed by rival sources of information* ($\partial\bar{\theta}_L/\partial\underline{\theta}_S > 0$ *and* $\partial\bar{\theta}_L/\partial\underline{\theta}_U > 0$) *and with the shrouding of public-sector pensions* ($\partial\bar{\theta}_L/\partial\pi < 0$)*.*

This results follows directly from Lemma 2 given the equilibrium value of inefficient back-loading (Γ_S or Γ_L), which is determined by the relative asymmetry of information about pensions compared to wages. In what we consider the regular case of sufficient local information, centralization is always efficient in the sense of yielding greater consumption smoothing for public-sector employees, although its effect on their welfare and on the public-sector payroll can change sign depending on participation by public employees in local elections (γ).

Nonetheless, the proposition can also be read as a cautionary note against relying on the notion that any increase in public information is always efficient. As Proposition 3 emphasized, transparency is efficient if it reduces the shrouding of pensions, but not if it merely provides more information about wages. Proposition 9 shows that, if local media are the main source of political news ($\theta_L > \max\{\underline{\theta}_S, \underline{\theta}_U\}$), then the efficiency of centralization is guaranteed. If instead local coverage is dominated by other sources of information, centralization is efficient only if the difference between these sources is no too large, and if pensions are not too shrouded. Otherwise, the flatter public-sector compensation profile may be obtained by local taxpayers who are uninformed about all policies, rather than by the statewide electorate, whose knowledge becomes more skewed as it rises above a negligible starting point.

Centralization always tends to reduce back-loading because it implies all public employees vote in the relevant election, which shifts their power from pensions towards wages, as shown by Corollary 8. This effect, however, could be more than undone by statewide news source dispelling taxpayers' across-the-board ignorance of policy proposals when local news source are very uninformative ($\underline{\theta}_L \approx 0$).

Our model thus predicts that there are conditions under which centralization is efficient, and more restrictive conditions under which it is beneficial for both sides, private developers and public-sector unions. However, we do not know whether increased information or increased voting will be more powerful in the real world. We believe that the model has served to highlight the relevant parameters which will determine the impacts of centralization. We hope that this will inform future empirical work.

At this point, we turn to a discussion of the history of centralized control over pensions in Massachusetts, California, Ohio and Pennsylvania. We discuss the first two states at length, discussing their history and current systems. We then compare Ohio and Pennsylvania today.

5 Local Pension Funds and State Control

The complexity and endogeneity of state-level pension rules do not lend themselves to easy characterization or straightforward statistical work, so we turn to a discussion of two pairs of states, to see whether there is an obvious connection between generosity and centralization. California and Massachusetts are two wealthy progressive states; Ohio and Pennsylvania are

Midwestern neighbors. One state in each of the pairs has substantial local control, while the other is more centralized, reflecting the remarkably heterogeneous rules for local pension systems across America.

5.1 Massachusetts and California

The path of public pensions in Massachusetts begins with police, expands to firemen, state employees (in 1911), teachers (in 1913) and eventually all local public employees. In 1913, Massachusetts adopted a statewide teachers' system which required employees to make contributions to an annuity fund, ranging from three to seven percent of their income. These payments would be used at retirement to fund an annuity, and the State would match the annuity payments out of general revenues.

While teachers had become entirely subsumed into the state system in 1913, Massachusetts never forced localities to adopt local pension systems. Instead, a 1945 law mandated that a pension system proposal, with terms dictated at the state level, had to be on the ballot in every subsequent state election until every city or town accepted it, and eventually the system became widespread. The 1945 law created the core Massachusetts system where salaries continue to be negotiated at a local level, but the rules regarding pensions are set at the state level.[19]

Although the system was originally pay-as-you-go, repeated funding crises led to more pre-funding, especially after 1987. Today, despite identical pension generosity, under-funding differs widely from towns, like wealthy Wellesley and Lexington, which have funding ratios over 85 percent, to poorer areas than can have funding ratios that are closer to 40 percent. Moreover, these funding ratios reflect aggressive estimates of future returns (8.25%), which may not be realized.[20]

State control has probably restricted pensions in larger cities, which have strong local unions, but since many communities did not have pensions when the system was fully voluntary (without a ballot mandate), state intervention appears to have increased pensions in smaller places where local public workers are unlikely to live.

Like Massachusetts, California adopted pensions early. In 1895, California passed an "act to create and administer a Public School Teachers' Annuity and Retirement Fund in the several counties, and cities and counties of the state," which was expanded in 1913. As in Massachusetts, teachers' pensions required employee contributions, but these were modest in California and were supplemented with statewide inheritance and transfer taxes. The state moved towards a standard pay-as-you-go system in 1944, but after 1972 began pre-funding teachers' pensions.

For other local public employees, California began with more centralization than Massachusetts, but ended up with more local heterogeneity, perhaps because it is a far larger state. In 1937, California enacted the County Employees Retirement Act, now known as the "37 Act", which has enabled the creation of 20 distinct county retirement plans, still in place

[19] Somewhat oddly, despite central control over pension terms, many localities continue to manage their portfolios at the local level.

[20] State law mandates that they set aside funds to close the funding gap by 2040, but it would not be surprising if this gap were pushed out further if returns continue to fall below 8.25 percent, or if localities raise insufficient revenues.

today. Home rule is much stronger in California than in Massachusetts, which may partially explain its greater heterogeneity of pension plans.

In 1939, the state legislature enabled smaller jurisdictions, including counties, to join the state employees retirement system (SERS, now CalPERS) that is in place today. The system involves a number of generally applicable rules, but there is plenty of scope for negotiation with CalPERS about the generosity of the pension plan. CalPERS is best seen as the manager of local plans, which have autonomy only within a band of possible contribution rates and overall generosity. CalPERS typically requires local governments to make appropriate contributions, but CalPERS limited authority means that localities under financial pressure limit their contributions.

In California, unlike Massachusetts outside of Boston, local governments negotiate with local unions over their pension systems, and California has far more generous pensions. On average, the Massachusetts system pays $21,500 in benefits per active benefit recipient. The California system pays $36,000 per active benefit recipient. This difference seems quite large, especially since similar: median household income was higher in Massachusetts in 2010 than in California.

For a worker who retires at 65 with 40 years of service, the Massachusetts system provides a maximum payment of 80 percent of pay (averaged over the last three years of service). Cost of living adjustments are optional for the community, and in recent years, the employee will have to contribute nine percent of earnings to receive this pension.

By comparison, in the Los Angeles plan, there are contributory and non-contributory options. The non-contributory option (Plan D) will also delivery 80 percent of top pay to employees who retire after 45 years of service at the age of 65. In the contributory plan, the workers' payment is only six percent of salary if the employee begins work at age 25, and it only passes nine percent if the employee starts at 45. Moreover, the maximum payment is 100 percent of pay, which is reached after 42 years of service. This plan seems substantially more generous than the Massachusetts system, and this is true for a large number of local California plans.

California's jurisdictions may have such generous pensions because they are large enough so that workers are likely to live and vote within their particular county, but not large enough to have a dedicated media focused on delivering hard analysis of pension deals. California's local heterogeneity can also mean that poorly managed governments end up taking on particularly onerous pension obligations.[21]

5.2 Ohio and Pennsylvania

The neighboring states of Pennsylvania and Ohio are similar in many ways, but they are polar opposites in the degree of local control over pensions. Pennsylvania is the extreme of local heterogeneity and control, with over 1,400 distinct, locally administered pension plans. Ohio epitomizes centralization, with a single state-wide system that covers all local employees, outside of Cincinnati. That state-wide system was put in place in 1967 to address under-funding problems at the local level.

[21] An added difference between California and Massachusetts is that since 1955, the State Supreme Court has ruled that no part of a pension system may be eliminated for existing workers, except if any reduction in benefits is offset by a comparable advantage (Monahan 2012).

Despite the proliferation of Pennsylvania plans, the average generosity of these plans is not particularly high. The average benefit per beneficiary is under $21,000 in 2010. To get an actual appreciation of terms, we compare the Ohio system with two Pennsylvania jurisdictions: Pittsburgh and Luzerne County. The average Ohio annuity per recipient in 2010 was $22,500.[22] While this is higher than the Pennsylvania average, the numbers are not exactly comparable, because Ohio workers make significant contributions, do not receive Social Security, and because the Pennsylvania benefits number includes other benefits.

The core Ohio plan requires a ten percent member contribution, and the most traditional plan offers 2.2 percent of final salary per year of service, up to 30 years, and 2.5 percent of final salary per year of service after that point. As such, a forty year veteran of the system can expect to receive 91 percent of final salary.

Despite a 1987 reform that made the Pittsburgh system less generous, the current system requires only four percent of the worker's salary. The normal benefit after 20 years of service is 50 percent of average salary, but workers earn an increment of one percent per year of service over twenty, so a forty year veteran could earn 70 percent of peak salary. The one percent increment is capped at $100 per month, but that is not limiting except for workers earning over $120,000 per year. There is a reduction in payments equal to one-half of social security payments received after age 65.

The Luzerne County system includes a contributory component of five percent or more, and the retiree receives a pension equal to the actuarial value of that contribution plus interest. In addition, the employee receives a pension of between one and two percent per years of service, depending on the class of service. Thus a twenty year worker might expect to receive 30 percent of final salary plus the accumulated value of total pension contributions.

Overall, the Ohio plan seems to be distinctly less generous than Pittsburgh's plan, particularly for workers with less than 25 years of service, since the payment is the same as a share of earnings and the contribution rate is far higher. When comparing the Ohio and Luzerne plans, it is perhaps easiest to assume that, since Ohio public employers contribute 14 percent of salary, they are paying for 60 percent of the Ohio plan, and possibly more if the plan is under-funded. In that case, the employer-funded Ohio plan amounts to around 1.4 percent per year of service making it roughly comparable to the Luzerne county plan.

Local plans can be modest, especially when (as in Luzerne County) resources are limited. But in larger local jurisdictions, both in California and Pennsylvania, the pension plans do seem to be quite generous, certainly more so than the two comparison centralized plans that we considered. As in California, Pennsylvania's local control has also led some communities, like Scranton, to face particularly large funding shortfalls.

6 Conclusion

This paper has presented a model of the political economy of public-sector pensions. The model suggests that pensions are likely to be generous, in part, because pension promises are less easily observable than promises about more direct forms of compensation. The shrouded nature of public pensions presents one explanation for why they are typically far more generous in the public than in the private sector. The model also predicts that pensions

[22] https://www.opers.org/pubs-archive/investments/cafr/2010_CAFR_LoRes.pdf

will be more generous when public-sector workers are more likely to live in the community or when pre-funding requirements are lower.

In the model, pensions are inefficiently generous. Redistributing between public-sector workers and taxpayers could be either good or bad depending on one's perspective, but the model implies that public-sector worker welfare can be improved, holding total public sector costs fixed, if pensions are reduced and wages increased. This result is corroborated by Fitzpatrick's (2012) finding that many teachers are unwilling to buy larger pensions, even at a small fraction of their total cost.

The implications of the model go far beyond pensions to all forms of compensation that are difficult to evaluate. Healthcare promises, particularly for retirees, are doubly shrouded. They involve promises far in the future, involving in-kind benefits that are inherently difficult to evaluate. The shrouded nature of these benefits can explain why public-sector healthcare costs have been particularly high.

The model does not specifically discuss different types of public projects, but there as well, shrouding should matter. If the costs of large-scale infrastructure projects are difficult to assess, then we should not be surprised to see that the public sector has a penchant for such undertakings. Certainly, there has been a regular tendency to understate the cost of these projects and overstate the projected revenues.

The results of the model enable us to analyze the choice of centralization over pension rules. Centralization leads to more overall information and often less information asymmetry between public-sector workers and taxpayers. Centralization also ensures that public-sector workers will all vote in the election. The impact of centralization on pension generosity depends on whether the informational force dominates or whether the impact of union voting dominates. Since union workers are likely to live in big cities, we speculate that moving to centralized control over big city pensions may be particularly likely to reduce generosity.

We then used the logic of the model to discuss four states. In two of these states, Ohio and Massachusetts, local pension benefits are determined at the state level. In the other two states, California and Pennsylvania, benefits are set locally. In our examples, centralized control appeared to reduce pension generosity. If this conclusion is correct, then it suggests the power of shrouding. A primary difference between state and local control is that state-wide institutions, including the media, will be focused on the costs of state level compensation. This should have the impact of reducing shrouding and reducing the back-loading of compensation.

Transparency is a watchword in public policy today, and this paper formalizes the costs of limited transparency. Shrouding is the opposite of transparency, and in our model shrouding creates the potential for considerable social losses. The remaining question is what institutions can significantly reduce the adverse consequences of the shrouded costs of government.

A Appendix

A.1. Derivation of the Political Support Function

Given the realization of the common shock Ψ, the fraction of citizens of type j who vote for party R equals

$$s_R^j = \frac{1}{2} + \frac{1}{2\bar{\psi}} \cdot \left[\left(\begin{array}{l} \theta_B^j \left[U_t^j \left(w_t^R, B_{t+1}^R \right) - U_t^j \left(w_t^L, B_{t+1}^L \right) \right] \\ + \left(\theta_w^j - \theta_B^j \right) \left\{ \mathbb{E} \left[U_t^j \left(w_t^R, \tilde{B}_{t+1}^R \right) | w_t^R \right] - \mathbb{E} \left[U_t^j \left(w_t^L, \tilde{B}_{t+1}^L \right) | w_t^R \right] \right\} \\ + \left(1 - \theta_w^j \right) \left[\mathbb{E} U_t^j \left(\tilde{w}_t^R, \tilde{B}_{t+1}^R \right) - \mathbb{E} U_t^j \left(\tilde{w}_t^L, \tilde{B}_{t+1}^L \right) \right] \end{array} \right) - \Psi \right]. \quad \text{(A1)}$$

Thus the realization of Ψ determines the number of ballots cast for each candidate: party R receives more votes than party L if and only if

$$\Psi < q \left(\begin{array}{l} \theta_B^P \left[U_t^P \left(w_t^R, B_{t+1}^R \right) - U_t^P \left(w_t^L, B_{t+1}^L \right) \right] \\ + \left(\theta_w^P - \theta_B^P \right) \left\{ \mathbb{E} \left[U_t^P \left(w_t^R, \tilde{B}_{t+1}^R \right) | w_t^R \right] - \mathbb{E} \left[U_t^P \left(w_t^L, \tilde{B}_{t+1}^L \right) | w_t^R \right] \right\} \\ + \left(1 - \theta_w^P \right) \left[\mathbb{E} U_t^P \left(\tilde{w}_t^R, \tilde{B}_{t+1}^R \right) - \mathbb{E} U_t^P \left(\tilde{w}_t^L, \tilde{B}_{t+1}^L \right) \right] \end{array} \right)$$
$$+ (1-q) \cdot \left(\begin{array}{l} \theta_B^T \left[U_t^P \left(w_t^R, B_{t+1}^R \right) - U_t^P \left(w_t^L, B_{t+1}^L \right) \right] \\ + \left(\theta_w^T - \theta_B^T \right) \left\{ \mathbb{E} \left[U_t^P \left(w_t^R, \tilde{B}_{t+1}^R \right) | w_t^R \right] - \mathbb{E} \left[U_t^P \left(w_t^L, \tilde{B}_{t+1}^L \right) | w_t^R \right] \right\} \\ + \left(1 - \theta_w^T \right) \left[\mathbb{E} U_t^P \left(\tilde{w}_t^R, \tilde{B}_{t+1}^R \right) - \mathbb{E} U_t^P \left(\tilde{w}_t^L, \tilde{B}_{t+1}^L \right) \right] \end{array} \right). \quad \text{(A2)}$$

For any distribution of the unobservable common shock Ψ, party R seeks to maximize the right-hand side, and party L to minimize it. This leads both parties to solve the same problem:

$$\max_{w_t^C, B_{t+1}^C} \left\{ \begin{array}{l} q \left\{ \theta_B^P U_t^P \left(w_t^C, B_{t+1}^C \right) + \left(\theta_w^P - \theta_B^P \right) \mathbb{E} \left[U_t^P \left(w_t^C, \tilde{B}_{t+1}^C \right) | w_t^C \right] \right\} \\ + (1-q) \left\{ \theta_B^T U_t^T \left(w_t^C, B_{t+1}^C \right) + \left(\theta_w^T - \theta_B^T \right) \mathbb{E} \left[U_t^T \left(w_t^C, \tilde{B}_{t+1}^C \right) | w_t^C \right] \right\} \end{array} \right\}. \quad \text{(A3)}$$

A.2. Proof of Proposition 1 and Corollary 1

With perfect information ($\theta_B^P = \theta_w^P = \theta_B^T = \theta_w^T = 1$) the political support function is

$$V \left(w_t, B_{t+1}; B_t, H_t \right) = q U^P \left(w_t, B_{t+1}; B_t, H_t \right) + (1-q) U^T \left(w_t, B_{t+1}; B_t, H_t \right). \quad \text{(A4)}$$

Given expectations of linear house price dynamics $H \left(B_{t+1} \right) = K - h B_{t+1}$, its maximum is defined by the first-order conditions

$$\frac{1}{(1-q) w_t - \frac{(1-\phi) q}{1+\delta} B_t - \frac{r}{1+r} H_t - \frac{\phi q}{1+r} B_{t+1}} = \frac{1+\beta}{Y - \frac{(1-\phi) q}{1+\delta} B_t - H_t - q w_t - \frac{\phi q}{1+r} B_{t+1} + \frac{H(B_{t+1}) - R}{1+r}} \quad \text{(A5)}$$

and

$$q\left\{\frac{\beta\left(1-h\right)}{B_{t+1}+H\left(B_{t+1}\right)-H_t-R}-\frac{\phi q}{\left(1+r\right)\left[\left(1-q\right)w_t-\frac{(1-\phi)q}{1+\delta}B_t-\frac{r}{1+r}H_t-\frac{\phi q}{1+r}B_{t+1}\right]}\right\}$$
$$=\frac{\left(1+\beta\right)\left(1-q\right)\left(\phi q+h\right)}{\left(1+r\right)\left[Y-\frac{(1-\phi)q}{1+\delta}B_t-H_t-qw_t-\frac{\phi q}{1+r}B_{t+1}+\frac{H(B_{t+1})-R}{1+r}\right]} \quad \text{(A6)}$$

These can be written as constant consumption ratios

$$\tau_W\equiv\frac{C_{W,t}^T}{C_{W,t}^P}=\frac{Y-\frac{(1-\phi)q}{1+\delta}B_t-H_t-qw_t-\frac{\phi q}{1+r}B_{t+1}+\frac{H(B_{t+1})-R}{1+r}}{\left(1+\beta\right)\left[\left(1-q\right)w_t-\frac{(1-\phi)q}{1+\delta}B_t-\frac{r}{1+r}H_t-\frac{\phi q}{1+r}B_{t+1}\right]}=1 \quad \text{(A7)}$$

for young workers and

$$\tau_R\equiv\frac{C_{R,t+1}^T}{C_{R,t+1}^P}=\frac{\beta\left(1+r\right)}{1+\beta}\frac{Y-\frac{(1-\phi)q}{1+\delta}B_t-H_t-qw_t-\frac{\phi q}{1+r}B_{t+1}+\frac{H(B_{t+1})-R}{1+r}}{B_{t+1}+H\left(B_{t+1}\right)-H_t-R}$$
$$=\frac{\phi q+\left(1-q\right)h}{q\left(1-h\right)} \quad \text{(A8)}$$

for old retirees.

Therefore, a Markov perfect dynamic rational expectations equilibrium is given by three functions $H\left(B_t\right)$, $w\left(B_t\right)$, and $B'\left(B_t\right)$ that satisfy simultaneously:

1. The spatial equilibrium condition

$$Y-\frac{\left(1-\phi\right)q}{1+\delta}B_t-H\left(B_t\right)-qw\left(B_t\right)-\frac{\phi q}{1+r}B'\left(B_t\right)+\frac{H\left(B'\left(B_t\right)\right)-R}{1+r}=\bar{A}. \quad \text{(A9)}$$

2. The political optimality condition for public-sector wages

$$Y-\frac{\left(1-\phi\right)q}{1+\delta}B_t-H\left(B_t\right)-qw\left(B_t\right)-\frac{\phi q}{1+r}B'\left(B_t\right)+\frac{H\left(B'\left(B_t\right)\right)-R}{1+r}$$
$$=\left(1+\beta\right)\tau_W\left[\left(1-q\right)w\left(B_t\right)-\frac{\left(1-\phi\right)q}{1+\delta}B_t-\frac{r}{1+r}H\left(B_t\right)-\frac{\phi q}{1+r}B'\left(B_t\right)\right]. \quad \text{(A10)}$$

3. The political optimality condition for public-sector pensions

$$Y-\frac{\left(1-\phi\right)q}{1+\delta}B_t-H\left(B_t\right)-qw\left(B_t\right)-\frac{\phi q}{1+r}B'\left(B_t\right)+\frac{H\left(B'\left(B_t\right)\right)-R}{1+r}$$
$$=\frac{\left(1+\beta\right)\tau_R}{\beta\left(1+r\right)}\left[B'\left(B_t\right)+H\left(B'\left(B_t\right)\right)-H\left(B_t\right)-R\right]. \quad \text{(A11)}$$

Using the spatial equilibrium condition and linear house price dynamics $H(B_t) = K - hB_t$, the political optimality condition for public-sector pensions can be solved for pension dynamics:

$$B'(B_t) = \frac{B_{ss} - hB_t}{1-h} \text{ for } B_{ss} \equiv R + \frac{\beta(1+r)\bar{A}}{(1+\beta)\tau_R}. \tag{A12}$$

Substituting $H(B_t)$ and $B'(B_t)$ in the spatial equilibrium condition,

$$qw(B_t) = Y - \bar{A} - \frac{rK+R}{1+r} - \frac{\phi q + h}{1+r}\frac{B_{ss}}{1-h} + \left[h + \frac{(\phi q + h)h}{(1+r)(1-h)} - \frac{(1-\phi)q}{1+\delta}\right]B_t. \tag{A13}$$

Substituting them in the political optimality condition for public-sector wages,

$$(1-q)w(B_t) = \frac{\bar{A}}{(1+\beta)\tau_W} + \frac{r}{1+r}K + \frac{\phi q}{1+r}\frac{B_{ss}}{1-h} + \left[\frac{(1-\phi)q}{1+\delta} - \frac{rh}{1+r} - \frac{\phi q}{1+r}\frac{h}{1-h}\right]B_t. \tag{A14}$$

By the method of undetermined coefficients, these are jointly satisfied for all B_t if and only if

$$K = \frac{1+r}{r}\left[(1-q)Y - (1-q)\bar{A} - (1-q)\frac{R}{1+r} - \frac{q\bar{A}}{(1+\beta)\tau_W} - \frac{\phi q + (1-q)h}{(1+r)(1-h)}B_{ss}\right], \tag{A15}$$

while h is implicitly defined by

$$\frac{r}{1+r}h^2 - \left[1 + \frac{(1-\phi)q(r-\delta)}{(1+\delta)(1+r)}\right]h + \frac{(1-\phi)q}{1+\delta} = 0. \tag{A16}$$

This quadratic is convex, weakly positive at $h = 0$ and strictly negative at $h = 1$, so it has a unique root in $[0, 1)$. Moreover, it is weakly positive at $h = (1-\phi)q/(1+\delta)$ and weakly negative at $h = (1-\phi)q$, so it has a unique root

$$h \in \left[\frac{(1-\phi)q}{1+\delta}, (1-\phi)q\right]. \tag{A17}$$

Wage dynamics are

$$w(B_t) = w_{ss} + \frac{h}{1-h}\frac{B_t - B_{ss}}{1+r} \text{ for } w_{ss} \equiv Y - \frac{R}{1+r} - \bar{A} + \frac{\bar{A}}{(1+\beta)\tau_W}. \tag{A18}$$

Finally, the definitions of B_{ss}, h, K and w_{ss} allow the intuitive rewriting

$$H(B_t) = H_{ss} + h(B_{ss} - B_t) \tag{A19}$$

for

$$H_{ss} \equiv \frac{1+r}{r}\left[Y - \bar{A} - \frac{R}{1+r} - qw_{ss} - \left(\frac{\phi}{1+r} + \frac{1-\phi}{1+\delta}\right)qB_{ss}\right]. \tag{A20}$$

In particular for $\delta = 0$ and $\phi = 0$, $h = q$ and the unique linear stationary Markov perfect dynamic rational expectations equilibrium features equalized consumption levels

$$\tau_W = 1 \text{ and } \tau_R = 1; \tag{A21}$$

steady-state values

$$B_{ss} = R + \bar{C}_R = R + \frac{\beta(1+r)}{1+\beta}\bar{A}, \tag{A22}$$

$$w_{ss} = Y - \frac{R}{1+r} - \bar{A} + \bar{C}_W = Y - \frac{R}{1+r} - \frac{\beta}{1+\beta}\bar{A}, \tag{A23}$$

and

$$H_{ss} = \frac{1+r}{r}\left[Y - \frac{R}{1+r} - \bar{A} - q(w_{ss} + B_{ss})\right] = \frac{1+r}{r}\left[(1-q)Y - \frac{1+qrR}{1+r} - \frac{1+\beta+\beta qr}{1+\beta}\bar{A}\right]; \tag{A24}$$

and dynamics

$$H(B_t) = H_{ss} + q(B_{ss} - B_t), \tag{A25}$$

$$B'(B_t) = \frac{B_{ss} - qB_t}{1-q}, \tag{A26}$$

and

$$w(B_t) = w_{ss} + \frac{q}{1-q}\frac{B_t - B_{ss}}{1+r}. \tag{A27}$$

A.3. Proof of Lemma 1

Symmetry of wage information equals

$$\rho_w = \frac{\underline{\theta}_L}{\underline{\theta}_L + \underline{\theta}_U - \underline{\theta}_L\underline{\theta}_U}, \tag{A28}$$

such that

$$\frac{\partial \rho_w}{\partial \underline{\theta}_L} = \frac{\underline{\theta}_U}{(\underline{\theta}_L + \underline{\theta}_U - \underline{\theta}_L\underline{\theta}_U)^2} > 0 \tag{A29}$$

and

$$\frac{\partial \rho_w}{\partial \underline{\theta}_U} = -\frac{\underline{\theta}_L(1-\underline{\theta}_L)}{(\underline{\theta}_L + \underline{\theta}_U - \underline{\theta}_L\underline{\theta}_U)^2} < 0. \tag{A30}$$

Symmetry of pension information equals

$$\rho_B = \frac{\underline{\theta}_L}{\underline{\theta}_L + \underline{\theta}_U - \pi\underline{\theta}_L\underline{\theta}_U}, \tag{A31}$$

such that

$$\frac{\partial \rho_B}{\partial \underline{\theta}_L} = \frac{\underline{\theta}_U}{(\underline{\theta}_L + \underline{\theta}_U - \pi\underline{\theta}_L\underline{\theta}_U)^2} > 0, \tag{A32}$$

and

$$\frac{\partial \rho_B}{\partial \underline{\theta}_U} = -\frac{\underline{\theta}_L \left(1 - \pi \underline{\theta}_L\right)}{\left(\underline{\theta}_L + \underline{\theta}_U - \pi \underline{\theta}_L \underline{\theta}_U\right)^2} < 0, \tag{A33}$$

as well as

$$\frac{\partial \rho_B}{\partial \pi} = \frac{\left(\pi \underline{\theta}_L\right)^2 \underline{\theta}_U}{\left[1 - \left(1 - \pi \underline{\theta}_L\right)\left(1 - \pi \underline{\theta}_U\right)\right]^2} > 0, \tag{A34}$$

which implies $\rho_B < \rho_w$ for all $\pi < 1$.

The ratio

$$\frac{\rho_B}{\rho_w} = \frac{\underline{\theta}_L + \underline{\theta}_U - \underline{\theta}_L \underline{\theta}_U}{\underline{\theta}_L + \underline{\theta}_U - \pi \underline{\theta}_L \underline{\theta}_U} < 1 \tag{A35}$$

has derivatives

$$\frac{\partial \left(\rho_B / \rho_w\right)}{\partial \underline{\theta}_L} = \frac{-\left(1 - \pi\right) \underline{\theta}_U^2}{\left(\underline{\theta}_L + \underline{\theta}_U - \pi \underline{\theta}_L \underline{\theta}_U\right)^2} < 0, \tag{A36}$$

and

$$\frac{\partial \left(\rho_B / \rho_w\right)}{\partial \underline{\theta}_U} = \frac{-\left(1 - \pi\right) \underline{\theta}_L^2}{\left(\underline{\theta}_L + \underline{\theta}_U - \pi \underline{\theta}_L \underline{\theta}_U\right)^2} < 0, \tag{A37}$$

as well as

$$\frac{\partial \left(\rho_B / \rho_w\right)}{\partial \pi} = \frac{\underline{\theta}_L \underline{\theta}_U \left(\underline{\theta}_L + \underline{\theta}_U - \underline{\theta}_L \underline{\theta}_U\right)}{\left(\underline{\theta}_L + \underline{\theta}_U - \pi \underline{\theta}_L \underline{\theta}_U\right)^2} > 0. \tag{A38}$$

A.4. Proof of Proposition 2 and Corollaries 2 and 3

For $\phi = 0$ and given expectations of linear house price dynamics $H\left(B_{t+1}\right) = K - hB_{t+1}$, the utility functions are

$$U^P\left(w_t, B_{t+1}; B_t, H_t\right) = \log\left[\left(1 - q\right) w_t - \frac{q}{1+\delta} B_t - \frac{r}{1+r} H_t\right] + \beta \log\left[K - R - H_t + \left(1 - h\right) B_{t+1}\right] \tag{A39}$$

and

$$U^T\left(w_t, B_{t+1}; B_t, H_t\right) = \left(1 + \beta\right) \log\left[Y - \frac{q}{1+\delta} B_t - H_t - q w_t + \frac{K - R - hB_{t+1}}{1+r}\right]. \tag{A40}$$

Beliefs under the inference of optimal trembles are defined by

$$\frac{\theta_B^P q \beta \left(1 - h\right)}{K - R - H_t + \left(1 - h\right) b} = \frac{\theta_B^T \left(1 - q\right)\left(1 + \beta\right) h}{K - R + \left(1 + r\right)\left(Y - \frac{q}{1+\delta} B_t - H_t - q w_t\right) - hb}, \tag{A41}$$

whose explicit solution is

$$b\left(w_t; B_t, H_t\right) = \frac{\beta \theta_B^P q \left(1 - h\right)\left[K - R + \left(1 + r\right)\left(Y - \frac{q}{1+\delta} B_t - H_t - q w_t\right)\right] - \left(1 + \beta\right) \theta_B^T \left(1 - q\right) h \left(K - R - H_t\right)}{\left[\beta \theta_B^P q + \left(1 + \beta\right) \theta_B^T \left(1 - q\right)\right] h \left(1 - h\right)}. \tag{A42}$$

The maximum of the political support function is described by the first-order conditions for pensions

$$\frac{\theta_B^P q\beta\left(1-h\right)}{K-R-H_t+\left(1-h\right)B_{t+1}}=\frac{\theta_B^T\left(1-q\right)\left(1+\beta\right)h}{K-R+\left(1+r\right)\left(Y-\frac{q}{1+\delta}B_t-H_t-qw_t\right)-hB_{t+1}} \tag{A43}$$

and for wages

$$\begin{aligned}&\frac{\theta_w^P q\left(1-q\right)}{\left(1-q\right)w_t-\frac{q}{1+\delta}B_t-\frac{r}{1+r}H_t}-\frac{\theta_B^T\left(1+\beta\right)q\left(1-q\right)}{Y-\frac{q}{1+\delta}B_t-H_t-qw_t+\frac{K-R-hB_{t+1}}{1+r}}\\&-\frac{\left(\theta_w^T-\theta_B^T\right)\left(1-\lambda\right)\left(1+\beta\right)q\left(1-q\right)}{Y-\frac{q}{1+\delta}B_t-H_t-qw_t+\frac{K-R-h\bar{B}_{t+1}}{1+r}}-\frac{\left(\theta_w^T-\theta_B^T\right)\lambda\left(1+\beta\right)q\left(1-q\right)}{Y-\frac{q}{1+\delta}B_t-H_t-qw_t+\frac{K-R-hb(w_t;B_t,H_t)}{1+r}}\\&+\lambda\left[\begin{array}{c}\frac{\left(\theta_w^P-\theta_B^P\right)\beta(1-h)}{K-R-H_t+(1-h)b(w_t;B_t,H_t)}\\-\frac{\left(\theta_w^T-\theta_B^T\right)(1+\beta)(1-q)h}{(1+r)\left(Y-\frac{q}{1+\delta}B_t-H_t-qw_t\right)+K-R-hb(w_t;B_t,H_t)}\end{array}\right]\frac{\partial b}{\partial w}\left(w_t;B_t,H_t\right)=0.\end{aligned} \tag{A44}$$

The optimality condition for pensions implies $b\left(w_t;B_t,H_t\right)=B_{t+1}$ at the equilibrium value w_t, while in a rational expectations equilibrium, $\bar{B}_t=B_{t+1}$. The first-order condition for wages is then

$$\begin{aligned}&\frac{\theta_w^P q\left(1-q\right)}{\left(1-q\right)w_t-\frac{q}{1+\delta}B_t-\frac{r}{1+r}H_t}-\frac{\theta_w^T\left(1+\beta\right)q\left(1-q\right)}{Y-\frac{q}{1+\delta}B_t-H_t-qw_t+\frac{K-R-hB_{t+1}}{1+r}}=\\&\lambda\left[\frac{\left(\theta_w^P-\theta_B^P\right)\beta q\left(1-h\right)}{K-R-H_t+\left(1-h\right)B_{t+1}}-\frac{\left(\theta_w^T-\theta_B^T\right)\left(1+\beta\right)\left(1-q\right)h}{\left(1+r\right)\left(Y-\frac{q}{1+\delta}B_t-H_t-qw_t\right)+K-R-hB_{t+1}}\right]\\&\cdot\frac{\beta\theta_B^P q^2\left(1+r\right)}{\left[\beta\theta_B^P q+\left(1+\beta\right)\theta_B^T\left(1-q\right)\right]h}.\end{aligned} \tag{A45}$$

The two political optimality conditions can then be written as constant consumption ratios

$$\tau_R=\frac{C_{R,t+1}^T}{C_{R,t+1}^P}=\rho_B\frac{\left(1-q\right)h}{q\left(1-h\right)} \tag{A46}$$

for old retirees and

$$\tau_W=\frac{C_{W,t}^T}{C_{W,t}^P}=\rho_w-\lambda\frac{\beta\left(\rho_w-\rho_B\right)q}{\beta q+\left(1+\beta\right)\rho_B\left(1-q\right)}. \tag{A47}$$

for young workers, such that $\partial\tau_W/\partial\lambda<0$,

$$\frac{\partial\tau_W}{\partial\rho_w}=\frac{\left(1-\lambda\right)\beta q+\left(1+\beta\right)\rho_B\left(1-q\right)}{\beta q+\left(1+\beta\right)\rho_B\left(1-q\right)}>0, \tag{A48}$$

$$\frac{\partial\tau_W}{\partial\rho_B}=\lambda\frac{\beta q\left[\beta q+\rho_w\left(1+\beta\right)\left(1-q\right)\right]}{\left[\beta q+\left(1+\beta\right)\rho_B\left(1-q\right)\right]^2}\geq 0, \tag{A49}$$

and

$$\frac{\partial \tau_W}{\partial q} = -\lambda \frac{(1+\beta)\beta(\rho_w - \rho_B)\rho_B}{[\beta q + (1+\beta)\rho_B(1-q)]^2} \leq 0. \tag{A50}$$

Public-sector employees are liquidity constrained because $\tau_R < \tau_W$:

$$\tau_R = \rho_B \frac{(1-q)h}{q(1-h)} \leq \rho_B \leq \rho_B \frac{\beta q + (1+\beta)\rho_w(1-q)}{\beta q + (1+\beta)\rho_B(1-q)} < \tau_W \tag{A51}$$

for any $h \in [q/(1+\delta), q]$ and any $\lambda \in [0,1]$.

Thus, the unique linear stationary Markov perfect dynamic rational expectations is defined by three functions $H(B_t) = K - hB_t$, $w(B_t)$, and $B'(B_t)$ that satisfy simultaneously the same three equilibrium conditions as in the proof of Proposition 1 above, up to a difference in the political equilibrium values τ_R and τ_W. Since $\delta = 0$ and $\phi = 0$ imply $h = q$, the constant consumption ratio during retirement is then $\tau_R = \rho_B$.

The steady state values are

$$B_{ss} = R + \frac{\bar{C}_R}{\rho_B}, \tag{A52}$$

such that $\partial B_{ss}/\partial \rho_B < 0$,

$$w_{ss} = Y - \frac{R}{1+r} - \bar{A} + \frac{\bar{C}_W}{\tau_W} \tag{A53}$$

such that $\partial w_{ss}/\partial \tau_W < 0$ but $\partial w_{ss}/\partial \bar{A}$ becomes ambiguous, and

$$\begin{aligned} H_{ss} &= \frac{1+r}{r}\left[Y - \bar{A} - \frac{R}{1+r} - q(w_{ss} + B_{ss})\right] \\ &= \frac{1+r}{r}\left\{(1-q)Y - \frac{1+qr}{1+r}R - \bar{A} - \frac{q}{1+\beta}\left[\frac{1-\tau_W}{\tau_W} + \beta\left(\frac{1+r}{\rho_B} - 1\right)\right]\bar{A}\right\} \end{aligned} \tag{A54}$$

such that $\partial H_{ss}/\partial \tau_W > 0$ and a fortiori $\partial H_{ss}/\partial \rho_B > 0$ and $\partial H_{ss}/\partial q < 0$.

The transition dynamics are identical to those of Proposition 1, up to the difference in B_{ss}. Thus developer profits are

$$\Pi = H_0 + qB_0 = H_{ss} + qB_{ss} = \frac{1+r}{r}\left[Y - \bar{A} - \frac{R}{1+r} - q\left(w_{ss} + \frac{B_{ss}}{1+r}\right)\right]. \tag{A55}$$

A.5. Proof of Proposition 3

In the equilibrium described by Proposition 2, the extent of back-loading is

$$\Gamma = \frac{\tau_W}{\tau_R} = \frac{[(1-\lambda)\rho_w + \lambda\rho_B]\beta q + \rho_w\rho_B(1+\beta)(1-q)}{\rho_B[\beta q + (1+\beta)\rho_B(1-q)]} \tag{A56}$$

such that

$$\frac{\partial \Gamma}{\partial \rho_w} = \frac{(1-\lambda)\beta q + \rho_B(1+\beta)(1-q)}{\rho_B[\beta q + (1+\beta)\rho_B(1-q)]} > 0, \tag{A57}$$

$$\frac{\partial \Gamma}{\partial \rho_B} = -\frac{\left\{\begin{array}{c}(1-\lambda)\rho_w(\beta q)^2 + 2(1-\lambda)\rho_w\rho_B\beta(1+\beta)q(1-q) \\ +\rho_w[\rho_B(1+\beta)(1-q)]^2 + \lambda\rho_B^2\beta(1+\beta)q(1-q)\end{array}\right\}}{\{\rho_B[\beta q + (1+\beta)\rho_B(1-q)]\}^2} < 0, \tag{A58}$$

while $\partial\Gamma/\partial\lambda < 0$ and $\partial\Gamma/\partial q \leq 0$ follow from the comparative statics for τ_W, since τ_R is unaffected by these variables.

Given the information structure described by Lemma 1, $\partial\Gamma/\partial\pi < 0$. Moreover

$$\frac{\partial\Gamma}{\partial\underline{\theta}_L} = \frac{\partial\Gamma}{\partial\rho_w}\frac{\partial\rho_w}{\partial\underline{\theta}_L} + \frac{\partial\Gamma}{\partial\rho_B}\frac{\partial\rho_B}{\partial\underline{\theta}_L} \tag{A59}$$

is strictly positive if and only if

$$\frac{\partial\Gamma}{\partial\rho_w}\frac{\partial\rho_w}{\partial\underline{\theta}_L} > \left|\frac{\partial\Gamma}{\partial\rho_B}\right|\frac{\partial\rho_B}{\partial\underline{\theta}_L} \tag{A60}$$

and thus if but not only if

$$\rho_w\frac{\partial\Gamma}{\partial\rho_w} \geq \rho_B\left|\frac{\partial\Gamma}{\partial\rho_B}\right| \tag{A61}$$

since we have proved above that

$$\frac{\partial\left(\rho_B/\rho_w\right)}{\partial\underline{\theta}_L} < 0 \Leftrightarrow \frac{1}{\rho_w}\frac{\partial\rho_w}{\partial\underline{\theta}_L} > \frac{1}{\rho_B}\frac{\partial\rho_B}{\partial\underline{\theta}_L}. \tag{A62}$$

The sufficient condition is

$$\lambda\left(\rho_w - \rho_B\right)\rho_B\beta\left(1+\beta\right)q\left(1-q\right) \geq 0. \tag{A63}$$

Since this is always satisfied, $\partial\Gamma/\partial\underline{\theta}_L > 0$.

Finally,

$$\frac{\partial\Gamma}{\partial\underline{\theta}_U} = \frac{\partial\Gamma}{\partial\rho_w}\frac{\partial\rho_w}{\partial\underline{\theta}_U} + \frac{\partial\Gamma}{\partial\rho_B}\frac{\partial\rho_B}{\partial\underline{\theta}_U} \tag{A64}$$

is strictly positive if and only if

$$\frac{\partial\Gamma}{\partial\rho_w}\left|\frac{\partial\rho_w}{\partial\underline{\theta}_U}\right| < \left|\frac{\partial\Gamma}{\partial\rho_B}\right|\left|\frac{\partial\rho_B}{\partial\underline{\theta}_U}\right|. \tag{A65}$$

Plugging in the explicit solutions for these four derivatives, this condition can be written

$$\left\{\begin{array}{l}(1-\lambda)\left(\beta q\right)^2\rho_w + (2-\lambda)\beta\left(1+\beta\right)q\left(1-q\right)\rho_w\rho_B \\ +\lambda\beta\left(1+\beta\right)q\left(1-q\right)\rho_B^2 + \left[\left(1+\beta\right)\left(1-q\right)\right]^2\rho_w\rho_B^2\end{array}\right\}\left[\rho_B\left(1-\pi\underline{\theta}_L\right) - \rho_w^2\left(1-\underline{\theta}_L\right)\right]$$
$$+\lambda\beta q\rho_w\rho_B\left[\left(1+\beta\right)\left(1-q\right)\rho_B\left(1-\pi\underline{\theta}_L\right) - \beta q\rho_w\left(1-\underline{\theta}_L\right)\right] > 0. \tag{A66}$$

Note that

$$\rho_B\left(1-\pi\underline{\theta}_L\right) \geq \rho_w\left(1-\underline{\theta}_L\right) \Leftrightarrow \left(1-\pi\right)\underline{\theta}_L\left(\underline{\theta}_L + \underline{\theta}_U\right) > \left(1-\pi\right)\underline{\theta}_L\underline{\theta}_U \tag{A67}$$

always hold, with strict inequality outside of limit cases. A fortiori,

$$\rho_w \leq 1 \Rightarrow \rho_B\left(1-\pi\underline{\theta}_L\right) \geq \rho_w^2\left(1-\underline{\theta}_L\right) \tag{A68}$$

and

$$q < \frac{1}{2} \Rightarrow \left(1+\beta\right)\left(1-q\right)\rho_B\left(1-\pi\underline{\theta}_L\right) - \beta q\rho_w\left(1-\underline{\theta}_L\right). \tag{A69}$$

Thus we can conclude that $\partial\Gamma/\partial\underline{\theta}_U > 0$.

A.6. Proof of Proposition 4 and Corollaries 4 and 5

From the proof of Proposition 2, for $\phi = 0$ and given expectations of linear house price dynamics $H(B_{t+1}) = K - hB_{t+1}$ the political equilibrium is described by consumption ratios

$$\tau_R = \frac{C^T_{R,t+1}}{C^P_{R,t+1}} = \rho_B \frac{(1-q)\,h}{q\,(1-h)} \tag{A70}$$

for old retirees and

$$\tau_W = \frac{C^T_{W,t}}{C^P_{W,t}} = \rho_w - \lambda \frac{\beta\,(\rho_w - \rho_B)\,q}{\beta q + (1+\beta)\,\rho_B\,(1-q)}. \tag{A71}$$

for young workers.

Thus, the unique linear stationary Markov perfect dynamic rational expectations is defined by three functions $H(B_t) = K - hB_t$, $w(B_t)$, and $B'(B_t)$ that satisfy simultaneously the same three equilibrium conditions as in the proof of Proposition 1 above, up to a difference in the political equilibrium values τ_R and τ_W. For $\phi = 0$, the sensitivity of house prices to pension obligations is

$$h \in \left[\frac{q}{1+\delta}, q\right] \text{ such that } \frac{r}{1+r}h^2 - \left[1 + \frac{q\,(r-\delta)}{(1+\delta)\,(1+r)}\right] h + \frac{q}{1+\delta} = 0, \tag{A72}$$

with comparative statics

$$\frac{\partial h}{\partial \delta} = -\frac{q\,(1-h)}{(1+\delta)^2}\left[1 + \frac{q\,(r-\delta)}{(1+\delta)\,(1+r)} - 2\frac{r}{1+r}h\right]^{-1} < 0 \tag{A73}$$

and

$$\frac{\partial h}{\partial q} = \left(1 - \frac{r-\delta}{1+r}h\right)\frac{1}{1+\delta}\left[1 + \frac{q\,(r-\delta)}{(1+\delta)\,(1+r)} - 2\frac{r}{1+r}h\right]^{-1} > 0. \tag{A74}$$

Define

$$\tilde{\tau} \equiv \frac{(1-q)\,h}{q\,(1-h)} \Leftrightarrow h = \frac{q\tilde{\tau}}{1-q+q\tilde{\tau}}. \tag{A75}$$

Then the implicit definition of h becomes an implicit definition of

$$\tilde{\tau} \in \left[\frac{1-q}{1+\delta-q}, 1\right] \tag{A76}$$

such that

$$(1+\delta)\,q\tilde{\tau}^2 + [(1+\delta)\,(1+r) - (2+\delta+r)\,q]\,\tilde{\tau} - (1+r)\,(1-q) = 0, \tag{A77}$$

with comparative statics

$$\frac{\partial \tilde{\tau}}{\partial \delta} = -\frac{(1+r-q+q\tilde{\tau})\,\tilde{\tau}}{(1+\delta)\,(1+r) - (2+\delta+r)\,q + 2\,(1+\delta)\,q\tilde{\tau}} < 0 \tag{A78}$$

and

$$\frac{\partial\tilde{\tau}}{\partial q}=-\frac{(1-\tilde{\tau})\left[1+r-(1+\delta)\tilde{\tau}\right]}{(1+\delta)(1+r)-(2+\delta+r)q+2(1+\delta)q\tilde{\tau}}\leq 0, \tag{A79}$$

with strict inequality for all $\delta>0$. Hence $\partial\tau_R/\partial\delta<0$ and $\partial\tau_R/\partial q\leq 0$.

The extent of back-loading is

$$\Gamma=\frac{\tau_W}{\tau_R}\text{ such that }\log\Gamma=\log\tau_W-\log\tau_R=\log\frac{\tau_W}{\rho_B}-\log\frac{(1-q)h}{q(1-h)}. \tag{A80}$$

Thus, for all variables except q and δ, the comparative statics from Proposition 3 apply unchanged, since they are comparative statics on τ_W/ρ_B for the same value τ_W. Moreover

$$\frac{\partial\Gamma}{\partial\delta}>0\text{ because }\frac{\partial\tau_R}{\partial\delta}<0=\frac{\partial\tau_W}{\partial\delta}. \tag{A81}$$

The number of public employees q has an ambiguous effect

$$\frac{\partial\Gamma}{\partial q}<0\text{ if }\lambda>0=\delta\text{ and }\frac{\partial\Gamma}{\partial q}>0\text{ if }\delta>0=\lambda. \tag{A82}$$

A.7. Derivation of the Present Value of Developer Profits

In the general case with pre-funding ϕ, it is convenient to parametrize by $(1-\phi)qB_0/(1+\delta)$ the fiscal transfer from the first generation of residents to the developer. Then the present value of developer profits equals

$$\Pi=\frac{1}{1+\delta}\left[H_0+\delta\sum_{t=0}^{\infty}\left(\frac{1+\delta}{1+r}\right)^t H_t+(1-\phi)qB_0\right]. \tag{A83}$$

Plugging in the equilibrium evolution of house prices,

$$\Pi=\frac{1}{1+\delta}\cdot\left\{H_{ss}+h(B_{ss}-B_0)+\delta\sum_{t=0}^{\infty}\left(\frac{1+\delta}{1+r}\right)^t\left[H_{ss}+h(B_{ss}-B_t)\right]+(1-\phi)qB_0\right\}. \tag{A84}$$

Plugging in the equilibrium dynamics of public pensions,

$$\Pi=\frac{1}{1+\delta}\left\{\begin{array}{l}H_{ss}-h(B_0-B_{ss})\\+\delta\sum_{t=0}^{\infty}\left(\frac{1+\delta}{1+r}\right)^t\left[H_{ss}-h\left(-\frac{h}{1-h}\right)^t(B_0-B_{ss})\right]\\\hfill+(1-\phi)qB_0\end{array}\right\}, \tag{A85}$$

and solving the series

$$\Pi=\frac{r}{r-\delta}H_{ss}-\frac{\left[(1+r)-rh\right]h}{(1+r)-(r-\delta)h}(B_0-B_{ss})+\frac{(1-\phi)q}{1+\delta}B_0. \tag{A86}$$

Plugging in the definition of h,

$$\Pi = \frac{r}{r-\delta} H_{ss} + \frac{(1-\phi)\, q}{1+\delta} B_{ss}. \tag{A87}$$

Finally, plugging in the steady-state value of H_{ss},

$$\Pi = \frac{1+r}{r-\delta} \left[Y - \bar{A} - \frac{R}{1+r} - q \left(w_{ss} + \frac{B_{ss}}{1+r} \right) \right]. \tag{A88}$$

A.8. Proof of Proposition 5 and Corollaries 6, 7 and 8

We focus on a representative city, and denote with a star variables relating to other cities in the state.

Commuting employees of other city governments have consumption utility

$$\begin{aligned} U_t^C &= \log C_{W,t}^C + \beta \log C_{R,t+1}^C \\ &= \log \left[w_t^* - q w_t - q \left(\frac{1-\phi}{1+\delta} B_t + \frac{\phi}{1+r} B_{t+1} \right) - \frac{r}{1+r} H_t \right] \\ &\qquad + \beta \log \left(B_{t+1}^* + H_{t+1} - H_t - R \right), \end{aligned} \tag{A89}$$

and given the rational expectation of future house prices $H_{t+1} = H\left(B_{t+1}\right)$,

$$\begin{aligned} & U^C \left(w_t, B_{t+1}; B_t, H_t, w_t^*, B_{t+1}^* \right) \\ &\quad = \log \left[w_t^* - q w_t - q \left(\frac{1-\phi}{1+\delta} B_t + \frac{\phi}{1+r} B_{t+1} \right) - \frac{r}{1+r} H_t \right] \\ &\qquad + \beta \log \left[B_{t+1}^* + H\left(B_{t+1}\right) - H_t - R \right]. \end{aligned} \tag{A90}$$

The election is decided by an electorate that comprises γq local government employees, $(1-\gamma^*)\, q$ commuters, and $1 - q + (\gamma^* - \gamma)\, q$ private-sector employees. Let $\bar{B}_{t+1}$ denote voters' unconditional expectations. For simplicity, we do not distinguish between commuters' prior expectations $\left(\bar{w}_t^*, \bar{B}_{t+1}^*\right)$ and their observations of actual proposals $\left(w_t^*, B_{t+1}^*\right)$, since they are both exogenous to the city and they coincide in a rational expectations equilibrium. The political support function is defined by

$$\begin{aligned} & V\left(w_t, B_{t+1}; B_t, H_t, \bar{B}_{t+1}, w_t^*, B_{t+1}^* \right) \\ &\quad = \gamma q \left[\theta_B^P U^P \left(w_t, B_{t+1}; B_t, H_t \right) + \left(\theta_w^P - \theta_B^P \right) U^P \left(w_t, \bar{B}_{t+1}; B_t, H_t \right) \right] \\ &\quad + (1-\gamma^*)\, q \left[\theta_B^T U^C \left(w_t, B_{t+1}; B_t, H_t, w_t^*, B_{t+1}^* \right) + \left(\theta_w^T - \theta_B^T \right) U^C \left(w_t, \bar{B}_{t+1}; B_t, H_t, w_t^*, B_{t+1}^* \right) \right] \\ &\quad + \left[1 - q + (\gamma^* - \gamma)\, q \right] \left[\theta_B^T U^T \left(w_t, B_{t+1}; B_t, H_t \right) + \left(\theta_w^T - \theta_B^T \right) U^T \left(w_t, \bar{B}_{t+1}; B_t, H_t \right) \right]. \end{aligned} \tag{A91}$$

A symmetric Markov perfect dynamic rational expectations equilibrium is given by identical initial values B_0 for all cities and by three functions $H\left(B_t\right)$, $w\left(B_t\right)$, and $B'\left(B_t\right)$ such that:

1. For any pension burden B_t, house prices $H_t = H(B_t)$ satisfy the spatial indifference condition for private-sector employees

$$Y - \frac{(1-\phi)q}{1+\delta}B_t - H(B_t) - qw(B_t) - \frac{\phi q}{1+r}B'(B_t) + \frac{H(B'(B_t)) - R}{1+r} = \bar{A} \quad \text{(A92)}$$

given rational expectations of policies $w_t = w(B_t)$ and $B_{t+1} = B'(B_t)$, and of future house prices $H_{t+1} = H(B'(B_t))$.

2. For any pension burden B_t, the share of resident public-sector employees in every city is

$$\gamma^* = \gamma = \frac{1}{N} + \frac{1-N}{N} F\left(\begin{array}{l} \psi + U^P(w(B_t), B'(B_t); B_t, H(B_t)) \\ -U^C(w(B_t), B'(B_t); B_t, H(B_t), w(B_t), B'(B_t)) \end{array} \right), \quad \text{(A93)}$$

given constant symmetry $B_t^* = B_t$ and thus house prices $H_t^* = H_t = H(B_t)$ and rational expectations of policies $w_t = w(B_t)$ and $B_{t+1} = B'(B_t)$.

3. For any pension burden B_t and house prices $H_t = H(B_t)$, policy choices $w_t = w(B_t)$ and $B_{t+1} = B'(B_t)$ satisfy the political optimality condition

$$(w(B_t), B'(B_t)) = \arg\max_{w_t, B_{t+1}} V(w_t, B_{t+1}; B_t, H_t, B'(B_t), w(B_t), B'(B_t)), \quad \text{(A94)}$$

given rational expectations of pension promises $\bar{B}_{t+1} = B'(B_t)$ and constant symmetry $B_t^* = B_t$ and thus $w_t^* = w(B_t)$ and $B_{t+1}^* = B'(B_t)$ for all t.

Given expectations of linear house price dynamics $H(B_{t+1}) = K - hB_{t+1}$, the utility functions are

$$U^P(w_t, B_{t+1}; B_t, H_t) = \log\left[(1-q)w_t - \frac{(1-\phi)q}{1+\delta}B_t - \frac{r}{1+r}H_t - \frac{\phi q}{1+r}B_{t+1}\right] + \beta\log\left[K - R - H_t + (1-h)B_{t+1}\right], \quad \text{(A95)}$$

$$U^C\left(w_t, B_{t+1}; B_t, H_t, w_t^*, B_{t+1}^*\right) = \log\left[w_t^* - qw_t - \frac{(1-\phi)q}{1+\delta}B_t - \frac{r}{1+r}H_t - \frac{\phi q}{1+r}B_{t+1}\right] + \beta\log\left[K - R - H_t + B_{t+1}^* - hB_{t+1}\right], \quad \text{(A96)}$$

and

$$U^T(w_t, B_{t+1}; B_t, H_t) = (1+\beta)\log\left[Y + \frac{K-R}{1+r} - \frac{(1-\phi)q}{1+\delta}B_t - H_t - qw_t - \frac{\phi q + h}{1+r}B_{t+1}\right]. \quad \text{(A97)}$$

The maximum of the political support function is described by the first-order conditions for wages

$$
\begin{aligned}
&\frac{\theta_B^P \gamma (1-q)}{(1-q) w_t - \frac{(1-\phi) q}{1+\delta} B_t - \frac{r}{1+r} H_t - \frac{\phi q}{1+r} B_{t+1}} + \frac{\left(\theta_w^P - \theta_B^P\right) \gamma (1-q)}{(1-q) w_t - \frac{(1-\phi) q}{1+\delta} B_t - \frac{r}{1+r} H_t - \frac{\phi q}{1+r} \bar{B}_{t+1}} = \\
&\quad \frac{\theta_B^T (1-\gamma^*) q}{w_t^* - q w_t - \frac{(1-\phi) q}{1+\delta} B_t - \frac{r}{1+r} H_t - \frac{\phi q}{1+r} B_{t+1}} + \frac{\left(\theta_w^T - \theta_B^T\right) (1-\gamma^*) q}{w_t^* - q w_t - \frac{(1-\phi) q}{1+\delta} B_t - \frac{r}{1+r} H_t - \frac{\phi q}{1+r} \bar{B}_{t+1}} \\
&\qquad + \frac{\theta_B^T \left[1 - q + (\gamma^* - \gamma) q\right] (1+\beta)}{Y + \frac{K-R}{1+r} - \frac{(1-\phi) q}{1+\delta} B_t - H_t - q w_t - \frac{\phi q + h}{1+r} B_{t+1}} \\
&\qquad\qquad + \frac{\left(\theta_w^T - \theta_B^T\right) \left[1 - q + (\gamma^* - \gamma) q\right] (1+\beta)}{Y + \frac{K-R}{1+r} - \frac{(1-\phi) q}{1+\delta} B_t - H_t - q w_t - \frac{\phi q + h}{1+r} \bar{B}_{t+1}}
\end{aligned}
\tag{A98}
$$

and for pensions

$$
\begin{aligned}
&\theta_B^P \gamma q \left\{ \frac{\beta (1-h)}{K - R - H_t + (1-h) B_{t+1}} - \frac{\phi q}{(1+r)\left[(1-q) w_t - \frac{(1-\phi) q}{1+\delta} B_t\right] - r H_t - \phi q B_{t+1}} \right\} \\
&\qquad = \theta_B^T (1-\gamma^*) q \\
&\cdot \left\{ \frac{\beta h}{K - R - H_t + B_{t+1}^* - h B_{t+1}} + \frac{\phi q}{(1+r)\left[w_t^* - q w_t - \frac{(1-\phi) q}{1+\delta} B_t\right] - r H_t - \phi q B_{t+1}} \right\} \\
&\qquad + \frac{\theta_B^T \left[1 - q + (\gamma^* - \gamma) q\right] (1+\beta) (\phi q + h)}{(1+r)\left[Y - \frac{(1-\phi) q}{1+\delta} B_t - H_t - q w_t\right] + K - R - (\phi q + h) B_{t+1}}.
\end{aligned}
\tag{A99}
$$

Rational expectations imply $\bar{B}_{t+1} = B_{t+1}$, while symmetry implies $w_t^* = w_t$, $B_{t+1}^* = B_{t+1}$ and $\gamma^* = \gamma$. The first-order condition for wages is then

$$
\begin{aligned}
&\frac{\theta_w^P \gamma (1-q) - \theta_w^T (1-\gamma) q}{(1-q) w_t - \frac{(1-\phi) q}{1+\delta} B_t - \frac{r}{1+r} H_t - \frac{\phi q}{1+r} B_{t+1}} = \\
&\qquad \frac{\theta_w^T (1-q) (1+\beta)}{Y + \frac{K-R}{1+r} - \frac{(1-\phi) q}{1+\delta} B_t - H_t - q w_t - \frac{\phi q + h}{1+r} B_{t+1}},
\end{aligned}
\tag{A100}
$$

and for pensions

$$
\begin{aligned}
&q \left\{ \frac{\left[\theta_B^P \gamma (1-h) - \theta_B^T (1-\gamma) h\right] \beta}{K - R - H_t + (1-h) B_{t+1}} - \frac{\left[\theta_B^P \gamma + \theta_B^T (1-\gamma)\right] \phi q}{(1+r)\left[(1-q) w_t - \frac{(1-\phi) q}{1+\delta} B_t\right] - r H_t - \phi q B_{t+1}} \right\} = \\
&\qquad \frac{\theta_B^T (1-q) (1+\beta) (\phi q + h)}{(1+r)\left[Y - \frac{(1-\phi) q}{1+\delta} B_t - H_t - q w_t\right] + K - R - (\phi q + h) B_{t+1}}.
\end{aligned}
\tag{A101}
$$

provided that

$$\gamma > \max\left\{\frac{\rho_w q}{1-q+\rho_w q}, \frac{\rho_B h}{1-h+\rho_B h}\right\}. \tag{A102}$$

These two political optimality conditions can be written as constant consumption ratios

$$\tau_W = \frac{C^T_{W,t}}{C^P_{W,t}} = \frac{\rho_w (1-q)}{\gamma (1-q) - \rho_w (1-\gamma) q} \tag{A103}$$

for young workers, such that

$$\frac{\partial \tau_W}{\partial \rho_w} = \frac{\gamma (1-q)^2}{\left[\gamma (1-q) - \rho_w (1-\gamma) q\right]^2} > 0, \tag{A104}$$

$$\frac{\partial \tau_W}{\partial \gamma} = -\frac{\rho_w (1-q)(1-q+\rho_w q)}{\left[\gamma (1-q) - \rho_w (1-\gamma) q\right]^2} < 0, \tag{A105}$$

and

$$\frac{\partial \tau_W}{\partial q} = \frac{\rho_w^2 (1-\gamma)}{\left[\gamma (1-q) - \rho_w (1-\gamma) q\right]^2} \geq 0; \tag{A106}$$

and

$$\tau_R = \frac{C^T_{R,t+1}}{C^P_{R,t+1}} = \frac{\rho_B (1-q)(\phi q + h) + \left[\gamma + \rho_B (1-\gamma)\right] \phi q^2 \tau_W}{\left[\gamma (1-h) - \rho_B (1-\gamma) h\right] q} \tag{A107}$$

for old retirees, such that

$$\frac{\partial \tau_R}{\partial \rho_w} = \frac{\left[\gamma + \rho_B (1-\gamma)\right] \phi q^2}{\left[\gamma (1-h) - \rho_B (1-\gamma) h\right] q} \frac{\partial \tau_W}{\partial \rho_w} \geq 0, \tag{A108}$$

$$\frac{\partial \tau_R}{\partial \rho_B} = \frac{\gamma (1-q)(\phi q + h)(1-h) + \gamma (1-\gamma) \phi q^2 \tau_W}{\left[\gamma (1-h) - \rho_B (1-\gamma) h\right]^2 q} > 0, \tag{A109}$$

and

$$\frac{\partial \tau_R}{\partial \gamma} = -\rho_B \frac{(1-q)(\phi q + h)(1-h+\rho_B h) + \phi q^2 \tau_W}{\left[\gamma (1-h) - \rho_B (1-\gamma) h\right]^2 q} + \frac{\left[\gamma + \rho_B (1-\gamma)\right] \phi q^2}{\left[\gamma (1-h) - \rho_B (1-\gamma) h\right] q} \frac{\partial \tau_W}{\partial \gamma} < 0. \tag{A110}$$

Therefore, a symmetric linear Markov perfect dynamic rational expectations equilibrium is given by a share of resident public-sector employees in every city

$$\gamma = \frac{1 + (1-N) F(\psi)}{N}, \tag{A111}$$

which we assume satisfies the condition

$$\gamma > \max\left\{\frac{\rho_w q}{1-q+\rho_w q}, \frac{\rho_B h}{1-h+\rho_B h}\right\}; \tag{A112}$$

and by three functions $H(B_t) = K - hB_t$, $w(B_t)$, and $B'(B_t)$ that satisfy simultaneously the same three equilibrium conditions as in the proof of Proposition 1 above, up to a difference in the political equilibrium values τ_R and τ_W.

Thus, there is a unique symmetric linear Markov perfect dynamic rational expectations equilibrium, with house-price sensitivity

$$h \in \left[\frac{(1-\phi)\,q}{1+\delta}, (1-\phi)\,q\right] \tag{A113}$$

such that

$$\frac{r}{1+r}h^2 - \left[1 + \frac{(1-\phi)\,q\,(r-\delta)}{(1+\delta)\,(1+r)}\right]h + \frac{(1-\phi)\,q}{1+\delta} = 0. \tag{A114}$$

Jointly with $\rho_w \geq \rho_B$ this implies that the condition for an interior political equilibrium is

$$\gamma > \frac{\rho_w q}{1-q+\rho_w q} \geq \frac{\rho_B h}{1-h+\rho_B h}. \tag{A115}$$

Comparative statics are

$$\frac{\partial h}{\partial \delta} = -\frac{(1-\phi)\,q}{(1+\delta)^2}(1-h)\left[1 + \frac{(1-\phi)\,q\,(r-\delta)}{(1+\delta)\,(1+r)} - \frac{2r}{1+r}h\right]^{-1} < 0, \tag{A116}$$

$$\frac{\partial h}{\partial \phi} = -\frac{q}{1+\delta}\left(1 - \frac{r-\delta}{1+r}h\right)\left[1 + \frac{(1-\phi)\,q\,(r-\delta)}{(1+\delta)\,(1+r)} - \frac{2r}{1+r}h\right]^{-1} < 0, \tag{A117}$$

and

$$\frac{\partial h}{\partial q} = \frac{1-\phi}{1+\delta}\left(1 - \frac{r-\delta}{1+r}h\right)\left[1 + \frac{(1-\phi)\,q\,(r-\delta)}{(1+\delta)\,(1+r)} - \frac{2r}{1+r}h\right]^{-1} > 0. \tag{A118}$$

As a consequence,

$$\frac{\partial \tau_R}{\partial \delta} = \frac{1}{q}\frac{\rho_B\,(1-q)\,\{\gamma + [\gamma + \rho_B\,(1-\gamma)]\,(\phi q)\} + [\gamma + \rho_B\,(1-\gamma)]^2\,\phi q^2 \tau_W}{[\gamma\,(1-h) - \rho_B\,(1-\gamma)\,h]^2}\frac{\partial h}{\partial \delta} < 0. \tag{A119}$$

Moreover, writing out

$$\tau_R = \frac{1-q}{q}\frac{\frac{[\gamma+\rho_B(1-\gamma)]\rho_w \phi q^2}{\gamma(1-q)-\rho_w(1-\gamma)q} + \rho_B \phi q + \rho_B h}{\gamma\,(1-h) - \rho_B\,(1-\gamma)\,h} \tag{A120}$$

we have

$$\frac{\partial \tau_R}{\partial h} = \frac{1-q}{q}\frac{\rho_B \gamma + \frac{[\gamma+\rho_B(1-\gamma)]^2 \rho_w \phi q^2}{\gamma(1-q)-\rho_w(1-\gamma)q} + [\gamma + \rho_B\,(1-\gamma)]\,\rho_B \phi q}{[\gamma\,(1-h) - \rho_B\,(1-\gamma)\,h]^2} > 0 \tag{A121}$$

and therefore

$$\frac{\partial \tau_R}{\partial \phi} = \frac{1-q}{\gamma\,(1-h) - \rho_B\,(1-\gamma)\,h}\left\{\frac{[\gamma + \rho_B\,(1-\gamma)]\,\rho_w q}{\gamma\,(1-q) - \rho_w\,(1-\gamma)\,q} + \rho_B\right\} + \frac{\partial \tau_R}{\partial h}\frac{\partial h}{\partial \phi}. \tag{A122}$$

Hence, $\partial \tau_R / \partial \phi > 0$ if and only if

$$\left|\frac{\partial h}{\partial \phi}\right| < \frac{\gamma q \left[\rho_w q + \rho_B (1-q)\right] \left[\gamma (1-h) - (1-\gamma) \rho_B h\right]}{\left[\gamma + (1-\gamma)\rho_B\right]^2 \rho_w \phi q^2 + \rho_B \left[\gamma (1+\phi q) + (1-\gamma) \rho_B \phi q\right] \left[\gamma (1-q) - (1-\gamma) \rho_w q\right]}. \quad \text{(A123)}$$

The right-hand side is increasing in ρ_w. Thus, for $\rho_w \geq \rho_B$ the condition is most difficult to satisfy for $\rho_w = \rho_B = \rho$, when it becomes

$$\left|\frac{\partial h}{\partial \phi}\right| < \frac{q \left[\gamma (1-h) - (1-\gamma) \rho h\right]}{\gamma (1-q+\phi q) - (1-\gamma) \rho (1-\phi) q}. \quad \text{(A124)}$$

The right-hand side is increasing in ρ. Thus, for $\rho_w \geq \rho_B \geq 0$ the condition is most difficult to satisfy for $\rho = 0$, when it becomes

$$\left|\frac{\partial h}{\partial \phi}\right| < \frac{q (1-h)}{1-q+\phi q}. \quad \text{(A125)}$$

This sufficient condition can be written out

$$\frac{(1+r) - (r-\delta) h}{(1+\delta)(1+r) + (r-\delta)(1-\phi) q - 2(1+\delta) r h} < \frac{1-h}{1-(1-\phi) q}, \quad \text{(A126)}$$

namely

$$\begin{aligned} 2(1+\delta) r h^2 + \{(r-\delta)[1-(1-\phi) q] - 2(1+\delta) r - (1+\delta)(1+r) - (r-\delta)(1-\phi) q\} h \\ + (1+\delta)(1+r) + (r-\delta)(1-\phi) q - (1+r)[1-(1-\phi) q] \geq 0, \quad \text{(A127)} \end{aligned}$$

and using the definition of h to remove the term in h^2,

$$(1-\delta r) h > (1+\delta)(1-\phi) q - \delta (1+r). \quad \text{(A128)}$$

1. If $\delta r < 1$, then the sufficient condition is

$$h > \frac{(1+\delta)\Phi - \delta(1+r)}{1-\delta r}, \quad \text{(A129)}$$

which is satisfied because the quadratic that defines h, evaluated at the right-hand side of this expression, equals

$$\frac{\delta (1+r) \left[1-(1-\phi) q\right]^2}{(1-r\delta)^2} > 0. \quad \text{(A130)}$$

2. If $\delta r \geq 1$, then the sufficient condition is

$$(1+\delta)\left[1-(1-\phi) q\right] + (\delta r - 1)(1-h) \geq 0, \quad \text{(A131)}$$

which is satisfied because $h \leq (1-\phi) q < 1$.

Thus we can conclude that indeed $\partial\tau_R/\partial\phi > 0$.

Moreover, if $\delta = 0 \Rightarrow h = (1-\phi)\, q$ then the consumption ratio for retirees is

$$\tau_R = \frac{\rho_B\,(1-q) + \phi\,[\gamma + (1-\gamma)\,\rho_B]\, q\tau_W}{\gamma - [\gamma + (1-\gamma)\,\rho_B]\,(1-\phi)\, q} \tag{A132}$$

such that

$$\frac{\partial\tau_R}{\partial q} = \frac{(1-\gamma)\,\rho_B^2 + \phi\,[\gamma + (1-\gamma)\,\rho_B]\,(\gamma\tau_W - \rho_B)}{\{\gamma - [\gamma + (1-\gamma)\,\rho_B]\,(1-\phi)\, q\}^2} + \frac{\phi\,[\gamma + (1-\gamma)\,\rho_B]\, q}{\gamma - [\gamma + (1-\gamma)\,\rho_B]\,(1-\phi)\, q}\frac{\partial\tau_W}{\partial q} \geq 0 \tag{A133}$$

because

$$\gamma\tau_W - \rho_B = \frac{\gamma\,(\rho_w - \rho_B)\,(1-q) + (1-\gamma)\,\rho_w\rho_B q}{\gamma\,(1-q) - \rho_w\,(1-\gamma)\, q} > 0. \tag{A134}$$

Steady-state house prices are

$$H_{ss} = \frac{1+r}{r} \cdot \left\{(1-q)\left(Y - \frac{R}{1+r} - \bar{A}\right) - q\left[\frac{\bar{C}_W}{\tau_W} + \left(\frac{\phi}{1+r} + \frac{1-\phi}{1+\delta}\right)\left(R + \frac{\bar{C}_R}{\tau_R}\right)\right]\right\}, \tag{A135}$$

such that

$$\frac{\partial H_{ss}}{\phi} = q\frac{1+r}{r}\left[\frac{r-\delta}{(1+\delta)\,(1+r)}\left(R + \frac{\bar{C}_R}{\tau_R}\right) + \left(\frac{\phi}{1+r} + \frac{1-\phi}{1+\delta}\right)\frac{\bar{C}_R}{\tau_R^2}\frac{\partial\tau_R}{\partial\phi}\right] > 0 \tag{A136}$$

and

$$\frac{\partial H_{ss}}{\partial q} = -\frac{1+r}{r}\left[\begin{array}{c} Y - \bar{A} + \frac{(1-\phi)(r-\delta)}{(1+\delta)(1+r)}R \\ +\frac{\bar{C}_W}{\tau_W}\left(1 - \frac{q}{\tau_W}\frac{\partial\tau_W}{\partial q}\right) \\ +\left(\frac{\phi}{1+r} + \frac{1-\phi}{1+\delta}\right)\frac{\bar{C}_R}{\tau_R}\left(1 - \frac{q}{\tau_R}\frac{\partial\tau_R}{\partial q}\right) \end{array}\right], \tag{A137}$$

where

$$\frac{q}{\tau_W}\frac{\partial\tau_W}{\partial q} < 1 \Leftrightarrow \rho_w < \frac{\gamma}{1-\gamma}\frac{(1-q)^2}{(2-q)\, q}. \tag{A138}$$

Moreover, if $\delta = \phi = 0 \Rightarrow h = q$ then

$$\frac{q}{\tau_R}\frac{\partial\tau_R}{\partial q} < 1 \Leftrightarrow \rho_B < \frac{\gamma}{1-\gamma}\frac{(1-q)^2}{q\,(2-q)}. \tag{A139}$$

This implies a sufficient (but far from necessary) condition for steady-state house prices to decline in the local government employment:

$$\delta = 0 \wedge \rho_w < \frac{\gamma}{1-\gamma}\frac{(1-q)^2}{(2-q)\, q} \Rightarrow \frac{\partial H_{ss}}{\partial q} < 0. \tag{A140}$$

Back-loading is

$$\Gamma = \frac{\tau_W}{\tau_R} = \frac{\rho_w q \left[\gamma\left(1-h\right) - \rho_B\left(1-\gamma\right)h\right]}{\left[\gamma + \rho_B\left(1-\gamma\right)\right]\rho_w \phi q^2 + \left[\gamma\left(1-q\right) - \rho_w\left(1-\gamma\right)q\right]\rho_B\left(\phi q + h\right)} \tag{A141}$$

such that

$$\frac{\partial \Gamma}{\partial \rho_w} = \frac{\left[\gamma\left(1-h\right) - \rho_B\left(1-\gamma\right)h\right]\gamma\rho_B q\left(1-q\right)\left(\phi q + h\right)}{\left\{\left[\gamma + \rho_B\left(1-\gamma\right)\right]\rho_w \phi q^2 + \left[\gamma\left(1-q\right) - \rho_w\left(1-\gamma\right)q\right]\rho_B\left(\phi q + h\right)\right\}^2} > 0 \tag{A142}$$

and

$$\frac{\partial \Gamma}{\partial \rho_B} = -\frac{\rho_w q \left[\gamma\left(1-\gamma\right)\rho_w \phi q^2 + \gamma\left[\gamma\left(1-q\right) - \rho_w\left(1-\gamma\right)q\right]\left(\phi q + h\right)\left(1-h\right)\right]}{\left\{\left[\gamma + \rho_B\left(1-\gamma\right)\right]\rho_w \phi q^2 + \left[\gamma\left(1-q\right) - \rho_w\left(1-\gamma\right)q\right]\rho_B\left(\phi q + h\right)\right\}^2} < 0 \tag{A143}$$

and therefore for all $\rho_B \leq \rho_w$

$$\Gamma \geq \frac{q\left[\gamma\left(1-h\right) - \left(1-\gamma\right)\rho h\right]}{\gamma\phi q + \left[\gamma\left(1-q\right) - \left(1-\gamma\right)\rho q\right]h}. \tag{A144}$$

The right-hand side is decreasing in ρ, so for all $\rho_B \leq \rho_w \leq 1$

$$\Gamma \geq \frac{q\left(\gamma - h\right)}{\gamma\phi q + \left(\gamma - q\right)h} \geq 1 \text{ for all } h \leq \left(1-\phi\right)q. \tag{A145}$$

Moreover

$$\frac{\partial \Gamma}{\partial \gamma} = -\frac{\rho_w \rho_B q h \left\{\rho_w q - \left[\rho_w q + \rho_B\left(1-q\right)\right]\left(\phi q + h\right)\right\}}{\left\{\gamma\left[\left(1-\rho_B\right)\rho_w \phi q^2 + \left(1 - q + \rho_w q\right)\rho_B\left(\phi q + h\right)\right] - \rho_w \rho_B q h\right\}^2} \tag{A146}$$

such that $\partial\Gamma/\partial\gamma < 0$ because

$$\frac{\rho_w q}{\rho_w q + \rho_B\left(1-q\right)} > q \geq \left(\phi q + h\right) \text{ for all } \rho_B < \rho_w \text{ and } h \leq \left(1-\phi\right)q. \tag{A147}$$

If $\delta = 0 \Rightarrow h = \left(1-\phi\right)q$ then back-loading is

$$\Gamma = \frac{\rho_w\left\{\gamma - \left[\gamma + \left(1-\gamma\right)\rho_B\right]\left(1-\phi\right)q\right\}}{\gamma\rho_B - \left[\gamma + \left(1-\gamma\right)\rho_w\right]\rho_B q + \phi\rho_w\left[\gamma + \left(1-\gamma\right)\rho_B\right]q} \tag{A148}$$

such that

$$\frac{\partial \Gamma}{\partial q} = \frac{\gamma\rho_w\left(\rho_w - \rho_B\right)\left\{\left(1-\gamma\right)\rho_B - \phi\left[\gamma + \left(1-\gamma\right)\rho_B\right]\right\}}{\left\{\gamma\rho_B - \left[\gamma + \left(1-\gamma\right)\rho_w\right]\rho_B q + \phi\rho_w\left[\gamma + \left(1-\gamma\right)\rho_B\right]q\right\}^2} \tag{A149}$$

and therefore

$$\frac{\partial \Gamma}{\partial q} > 0 \Leftrightarrow \rho_B > \frac{\gamma}{1-\gamma}\frac{\phi}{1-\phi} \Leftrightarrow \phi < \frac{\left(1-\gamma\right)\rho_B}{\gamma + \left(1-\gamma\right)\rho_B} \Leftrightarrow \gamma < \frac{\rho_B\left(1-\phi\right)}{\rho_B\left(1-\phi\right) + \phi}. \tag{A150}$$

A.9. Proof of Corollary 9

If $\phi = 1 \Rightarrow h = 0$ then the consumption ratio for retirees is

$$\tau_R = \frac{(1-q)\left[\rho_B + (\rho_w - \rho_B) q\right]}{\gamma - \left[\gamma + (1-\gamma)\rho_w\right] q} \tag{A151}$$

such that

$$\frac{\partial \tau_R}{\partial q} = \frac{\gamma (\rho_w - \rho_B)(1-q)^2 + (1-\gamma)\rho_w (\rho_w - \rho_B) q^2 + (1-\gamma)\rho_w \rho_B}{\left\{\gamma - \left[\gamma + (1-\gamma)\rho_w\right] q\right\}^2} > 0. \tag{A152}$$

Back-loading is

$$\Gamma = \frac{\rho_w}{\rho_B + (\rho_w - \rho_B) q} \text{ such that} \frac{\partial \Gamma}{\partial q} = -\frac{\rho_w (\rho_w - \rho_B)}{\left[\rho_B + (\rho_w - \rho_B) q\right]^2} < 0. \tag{A153}$$

House prices are

$$\frac{\partial H_{ss}}{\partial q} = -\frac{1+r}{r}\left[Y - \bar{A} + \frac{\bar{C}_W}{\tau_W}\left(1 - \frac{q}{\tau_W}\frac{\partial \tau_W}{\partial q}\right) + \frac{\bar{C}_R}{(1+r)\tau_R}\left(1 - \frac{q}{\tau_R}\frac{\partial \tau_R}{\partial q}\right)\right], \tag{A154}$$

where

$$\frac{q}{\tau_R}\frac{\partial \tau_R}{\partial q} < 1 \Leftrightarrow \gamma > \hat{\gamma} \equiv \frac{\rho_w \left[\rho_w q + 2\rho_B (1-q)\right] q}{\rho_B (1-q)^2 + \rho_w^2 q^2 + 2\rho_w \rho_B q (1-q)}. \tag{A155}$$

This condition is also sufficient for

$$\frac{q}{\tau_W}\frac{\partial \tau_W}{\partial q} < 1 \Leftrightarrow \gamma > \frac{\rho_w (2-q) q}{(1-q)^2 + \rho_w (2-q) q} \tag{A156}$$

because $\hat{\gamma}$ is above the right-hand side for all $\rho_w \geq \rho_B$.

The derivatives of $\hat{\gamma}(\rho_w, \rho_B, q)$ are

$$\frac{\partial \hat{\gamma}}{\partial \rho_w} = \frac{\rho_B \left[2\rho_w q + 2\rho_B (1-q)\right] q (1-q)^2}{\left[\rho_B (1-q)^2 + \rho_w^2 q^2 + 2\rho_w \rho_B q (1-q)\right]^2} > 0, \tag{A157}$$

$$\frac{\partial \hat{\gamma}}{\partial \rho_B} = -\left[\frac{\rho_w q (1-q)}{\rho_B (1-q)^2 + \rho_w^2 q^2 + 2\rho_w \rho_B q (1-q)}\right]^2 < 0, \tag{A158}$$

and

$$\frac{\partial \hat{\gamma}}{\partial q} = \frac{2\rho_w \rho_B \left[\rho_w q + \rho_B (1-q)\right](1-q)}{\left[\rho_B - 2(1-\rho_w)\rho_B q + (\rho_B + \rho_w^2 - 2\rho_w \rho_B) q^2\right]} > 0. \tag{A159}$$

A.10. Proof of Lemma 2 and Proposition 9

Symmetry of wage information equals

$$\rho_w^S = \frac{1 - (1 - \underline{\theta}_L)(1 - \underline{\theta}_S)}{1 - (1 - \underline{\theta}_L)(1 - \underline{\theta}_S)(1 - \underline{\theta}_U)}, \tag{A160}$$

such that

$$\frac{\partial \rho_w^S}{\partial \underline{\theta}_L} = \frac{(1-\underline{\theta}_S)\,\underline{\theta}_U}{\left[1-(1-\underline{\theta}_L)(1-\underline{\theta}_S)(1-\underline{\theta}_U)\right]^2} > 0, \tag{A161}$$

$$\frac{\partial \rho_w^S}{\partial \underline{\theta}_U} = -\frac{(1-\underline{\theta}_L)(1-\underline{\theta}_S)\left[1-(1-\underline{\theta}_L)(1-\underline{\theta}_S)\right]}{\left[1-(1-\underline{\theta}_L)(1-\underline{\theta}_S)(1-\underline{\theta}_U)\right]^2} < 0, \tag{A162}$$

and

$$\frac{\partial \rho_w^S}{\partial \underline{\theta}_S} = \frac{(1-\underline{\theta}_L)\,\underline{\theta}_U}{\left[1-(1-\underline{\theta}_L)(1-\underline{\theta}_S)(1-\underline{\theta}_U)\right]^2} > 0 \tag{A163}$$

which implies $\rho_w^S > \rho_w^L$ for all $\underline{\theta}_S > 0$.

Symmetry of pension information equals

$$\rho_B^S = \frac{1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)}{1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)(1-\pi\underline{\theta}_U)}, \tag{A164}$$

such that

$$\frac{\partial \rho_B^S}{\partial \underline{\theta}_L} = \frac{\pi^2(1-\pi\underline{\theta}_S)\,\underline{\theta}_U}{\left[1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)(1-\pi\underline{\theta}_U)\right]^2} > 0, \tag{A165}$$

$$\frac{\partial \rho_B^S}{\partial \underline{\theta}_U} = -\frac{\pi(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)\left[1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)\right]}{\left[1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)(1-\pi\underline{\theta}_U)\right]^2} < 0, \tag{A166}$$

and

$$\frac{\partial \rho_B^S}{\partial \underline{\theta}_S} = \frac{\pi^2(1-\pi\underline{\theta}_L)\,\underline{\theta}_U}{\left[1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)(1-\pi\underline{\theta}_U)\right]^2} > 0, \tag{A167}$$

which implies $\rho_B^S > \rho_B^L$ for all $\underline{\theta}_S > 0$; as well as

$$\frac{\partial \rho_B^S}{\partial \pi} = \pi^2\underline{\theta}_U \frac{\theta_L^2(1-\pi\theta_S)^2 + \theta_L\theta_S(1-\pi^2\theta_L\theta_S) + (1-\pi\theta_L)^2\theta_S^2}{\left[1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)(1-\pi\underline{\theta}_U)\right]^2} > 0, \tag{A168}$$

which implies $\rho_B^S < \rho_w^S$ for all $\pi < 1$.

The ratio

$$\frac{\rho_B^S}{\rho_w^S} = \frac{1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)}{1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)(1-\pi\underline{\theta}_U)} \frac{1-(1-\underline{\theta}_L)(1-\underline{\theta}_S)(1-\underline{\theta}_U)}{1-(1-\underline{\theta}_L)(1-\underline{\theta}_S)} \tag{A169}$$

has derivative $\partial\left(\rho_B^S/\rho_w^S\right)/\partial\pi > 0$ because $\partial\rho_B^S/\partial\pi > 0$ while $\partial\rho_w^S/\partial\pi = 0$. Moreover

$$\begin{aligned}\frac{\partial\left(\rho_B^S/\rho_w^S\right)}{\partial\underline{\theta}_U} &= -\pi(1-\pi)\frac{1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)}{1-(1-\underline{\theta}_L)(1-\underline{\theta}_S)} \\ &\cdot \frac{\theta_L^2(1-\theta_S)^2 + \theta_L\theta_S(1-\theta_L\theta_S) + \theta_S^2(1-\theta_L)^2 + (1-\pi)\theta_L\theta_S(\theta_L+\theta_S-\theta_L\theta_S)}{\left[1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)(1-\pi\underline{\theta}_U)\right]^2} \\ &< 0. \end{aligned}\tag{A170}$$

Finally

$$\frac{\partial\left(\rho_B^S/\rho_w^S\right)}{\partial\underline{\theta}_L}=\frac{(1-\pi)\,\underline{\theta}_U}{\left[1-(1-\pi\underline{\theta}_L)(1-\pi\underline{\theta}_S)(1-\pi\underline{\theta}_U)\right]^2\left[1-(1-\underline{\theta}_L)(1-\underline{\theta}_S)\right]^2}$$
$$\cdot\left\{\underline{\theta}_S^3-\underline{\theta}_L(1-\underline{\theta}_S)(1-\pi\underline{\theta}_S)\left[2\underline{\theta}_S\underline{\theta}_U+\underline{\theta}_L(\underline{\theta}_S+\underline{\theta}_U-\underline{\theta}_S\underline{\theta}_U-\pi\underline{\theta}_S\underline{\theta}_U)\right]\right\}. \quad \text{(A171)}$$

The last line is a quadratic in $\underline{\theta}_L$ with a negative coefficient on $\underline{\theta}_L^2$ and a positive value at zero. Thus

$$\frac{\partial\left(\rho_B^S/\rho_w^S\right)}{\partial\underline{\theta}_L}>0\Leftrightarrow 0<\underline{\theta}_L<\hat{\theta}_L, \quad \text{(A172)}$$

for a threshold $\hat{\theta}_L$ that can be above one (e.g., as $\underline{\theta}_S\to 1$ and $\underline{\theta}_U\to 0$). Since the ratio ρ_B^S/ρ_w^S is symmetric in $\underline{\theta}_L$ and $\underline{\theta}_S$, the same result applies to $\underline{\theta}_S$.

Centralization reduces the relative asymmetry in information about pensions compared to wages if and only if

$$\frac{\rho_B^L}{\rho_w^L}<\frac{\rho_B^S}{\rho_w^S}\Leftrightarrow\frac{\underline{\theta}_L{}^2}{(1-\pi\underline{\theta}_L)(1-\underline{\theta}_L)}>\underline{\theta}_S\underline{\theta}_U \quad \text{(A173)}$$

and thus if and only if $\underline{\theta}_L>\bar{\theta}_L$ for a threshold

$$\bar{\theta}_L\in(0,\max\{\theta_S,\theta_U\})\ \text{ with }\frac{\partial\bar{\theta}_L}{\partial\underline{\theta}_S}>0,\ \frac{\partial\bar{\theta}_L}{\partial\underline{\theta}_U}>0,\text{ and }\frac{\partial\bar{\theta}_L}{\partial\pi}<0. \quad \text{(A174)}$$

Back-loading is

$$\Gamma_L=\frac{\tau_W^L}{\tau_R^L}=\frac{\rho_w^L q\left[\gamma(1-h)-\rho_B^L(1-\gamma)h\right]}{\left[\gamma+\rho_B^L(1-\gamma)\right]\rho_w^L\phi q^2+\left[\gamma(1-q)-\rho_w^L(1-\gamma)q\right]\rho_B^L(\phi q+h)} \quad \text{(A175)}$$

with $\partial\Gamma_L/\partial\gamma<0$ and thus

$$\Gamma_L\leq\frac{q(1-h)}{\phi q^2+(\rho_B^L/\rho_w^L)(1-q)(\phi q+h)}, \quad \text{(A176)}$$

while

$$\Gamma_S=\frac{\tau_W^S}{\tau_R^S}=\frac{q(1-h)}{\phi q^2+(\rho_B^S/\rho_w^S)(1-q)(\phi q+h)}. \quad \text{(A177)}$$

Therefore

$$\underline{\theta}_L>\bar{\theta}_L\Leftrightarrow\frac{\rho_B^L}{\rho_w^L}<\frac{\rho_B^S}{\rho_w^S}\Rightarrow\Gamma_L>\Gamma_S. \quad \text{(A178)}$$

A.11. Proof of Proposition 6

Centralization reduces public employees' wages and their consumption when working if and only if

$$\tau_W^L=\frac{\rho_w^L(1-q)}{\gamma(1-q)-(1-\gamma)\rho_w^L q}<\tau_W^S=\rho_w^S, \quad \text{(A179)}$$

namely if and only if

$$\gamma > \bar{\gamma}_w \equiv \frac{\rho_w^L \left(1 - q + \rho_w^S q\right)}{\left(1 - q + \rho_w^L q\right) \rho_w^S} \tag{A180}$$

such that

$$\frac{\partial \bar{\gamma}_w}{\partial q} = \frac{\rho_w^L \left(\rho_w^S - \rho_w^L\right)}{\rho_w^S \left(1 - q + \rho_w^L q\right)^2} > 0, \tag{A181}$$

while for any other parameter z,

$$\frac{\partial \bar{\gamma}_w}{\partial z} = \frac{1 - q}{\left[\left(1 - q + \rho_w^L q\right) \rho_w^S\right]^2} \left(\frac{\partial \rho_w^L}{\partial z} - \frac{\partial \rho_w^S}{\partial z}\right). \tag{A182}$$

Immediately,

$$\frac{\partial \rho_w^S}{\partial \underline{\theta}_S} > 0 = \frac{\partial \rho_w^L}{\partial \underline{\theta}_S} \Rightarrow \frac{\partial \bar{\gamma}_w}{\partial \underline{\theta}_S} < 0. \tag{A183}$$

Moreover

$$\frac{\partial^2 \rho_w^S}{\partial \underline{\theta}_L \partial \underline{\theta}_S} = -\frac{\left[1 + \left(1 - \underline{\theta}_L\right)\left(1 - \underline{\theta}_S\right)\left(1 - \underline{\theta}_U\right)\right] \underline{\theta}_U}{\left[1 - \left(1 - \underline{\theta}_L\right)\left(1 - \underline{\theta}_S\right)\left(1 - \underline{\theta}_U\right)\right]^3} < 0 \Rightarrow \frac{\partial \rho_w^L}{\partial \underline{\theta}_L} > \frac{\partial \rho_w^S}{\partial \underline{\theta}_L} \Rightarrow \frac{\partial \bar{\gamma}_w}{\partial \underline{\theta}_L} > 0 \tag{A184}$$

and

$$\frac{\partial^2 \rho_w^S}{\partial \underline{\theta}_S \partial \underline{\theta}_U} = \frac{\left(1 - \underline{\theta}_L\right)}{\left[1 - \left(1 - \underline{\theta}_L\right)\left(1 - \underline{\theta}_S\right)\left(1 - \underline{\theta}_U\right)\right]^2} > 0 \Rightarrow \frac{\partial \rho_w^L}{\partial \underline{\theta}_U} < \frac{\partial \rho_w^S}{\partial \underline{\theta}_U} \Rightarrow \frac{\partial \bar{\gamma}_w}{\partial \underline{\theta}_U} < 0. \tag{A185}$$

Centralization reduces public employees' pensions and their consumption while retired if and only if

$$\tau_R^L < \tau_R^S = \frac{\rho_w^S \phi q^2 + \rho_B^S (1 - q)(\phi q + h)}{q (1 - h)}. \tag{A186}$$

By Proposition 5, $\partial \tau_R^L / \partial \gamma < 0$. For $\gamma = 1$,

$$\tau_R^L = \frac{\rho_w^L \phi q^2 + (1 - q) \rho_B^L (\phi q + h)}{q (1 - h)} < \tau_R^S \tag{A187}$$

because $\rho_w^L < \rho_w^S$ and $\rho_B^L < \rho_B^S$. Conversely

$$\lim_{\gamma \to \rho_w^L q / (1 - q + \rho_w^L q)} \tau_R^L = \infty > \tau_R^S. \tag{A188}$$

Thus there exists a unique value

$$\bar{\gamma}_B \in \left(\frac{\rho_w^L q}{1 - q + \rho_w^L q}, 1\right) \text{ such that } \tau_R^L \left(\bar{\gamma}_B\right) = \tau_R^S \tag{A189}$$

and that $B_{ss}^L > B_{ss}^S$ if and only if $\gamma > \bar{\gamma}_B$. By the implicit-function theorem,

$$\frac{\partial \tau_R^S}{\partial \underline{\theta}_S} > 0 = \frac{\partial \tau_R^L}{\partial \underline{\theta}_S} \Rightarrow \frac{\partial \bar{\gamma}_B}{\partial \underline{\theta}_S} < 0. \tag{A190}$$

Moreover, if (but not only if) $\underline{\theta}_L > \bar{\theta}_L$, then $\tau_W^L < \tau_W^S \Rightarrow \tau_R^L < \tau_R^S$, which means that $\bar{\gamma}_B < \bar{\gamma}_w$.

A.12. Proof of Proposition 7

Centralization increases house prices if and only if

$$\frac{1}{\tau_W^L} + \left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\frac{\beta}{\tau_R^L} > \frac{1}{\tau_W^S} + \left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\frac{\beta}{\tau_R^S}$$
$$= \frac{1}{\rho_w^S} + \beta\left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\frac{q(1-h)}{\rho_w^S \phi q^2 + \rho_B^S (1-q)(\phi q + h)}. \quad \text{(A191)}$$

On the left-hand side, $\partial \tau_W^L / \partial \gamma < 0$ and $\partial \tau_R^L / \partial \gamma < 0$. For $\gamma = 1$,

$$\frac{1}{\tau_W^L} + \left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\frac{\beta}{\tau_R^L} =$$
$$\frac{1}{\rho_w^L} + \beta\left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\frac{q(1-h)}{\rho_w^L \phi q^2 + \rho_B^L (1-q)(\phi q + h)}$$
$$> \frac{1}{\tau_W^S} + \left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\frac{\beta}{\tau_R^S}. \quad \text{(A192)}$$

because $\rho_w^L < \rho_w^S$ and $\rho_B^L < \rho_B^S$. Conversely

$$\lim_{\gamma \to \rho_w^L q/(1-q+\rho_w^L q)} \left\{\frac{1}{\tau_W^L} + \left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\frac{\beta}{\tau_R^L}\right\} = 0$$
$$< \frac{1}{\tau_W^S} + \left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\frac{\beta}{\tau_R^S}. \quad \text{(A193)}$$

Thus there exists a unique value

$$\bar{\gamma}_H \in \left(\frac{\rho_w^L q}{1-q+\rho_w^L q}, 1\right) \quad \text{(A194)}$$

such that

$$\frac{1}{\tau_W^L(\bar{\gamma}_H)} + \beta\frac{\phi + (1-\phi)\frac{1+r}{1+\delta}}{\tau_R^L(\bar{\gamma}_H)} = \frac{1}{\tau_W^S} + \beta\frac{\phi + (1-\phi)\frac{1+r}{1+\delta}}{\tau_R^S} \quad \text{(A195)}$$

and that $H_{ss}^L < H_{ss}^S$ if and only if $\gamma > \bar{\gamma}_H$. By the implicit-function theorem,

$$\frac{\partial \tau_R^S}{\partial \underline{\theta}_S} > 0 = \frac{\partial \tau_R^L}{\partial \underline{\theta}_S} \wedge \frac{\partial \tau_W^S}{\partial \underline{\theta}_S} > 0 = \frac{\partial \tau_W^L}{\partial \underline{\theta}_S} \Rightarrow \frac{\partial \bar{\gamma}_H}{\partial \underline{\theta}_S} < 0. \quad \text{(A196)}$$

Recalling that

$$\underline{\theta}_L > \bar{\theta}_L \Leftrightarrow \frac{\rho_B^L}{\rho_w^L} < \frac{\rho_B^S}{\rho_w^S} \Rightarrow \Gamma_L > \Gamma_S, \quad \text{(A197)}$$

if (but not only if) $\underline{\theta}_L > \bar{\theta}_L$, then

$$\tau_W^L < \tau_W^S \Rightarrow$$
$$\frac{1}{\tau_W^L}\left\{1 + \beta\left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\Gamma_L\right\} > \frac{1}{\tau_W^S}\left\{1 + \beta\left[\phi + (1-\phi)\frac{1+r}{1+\delta}\right]\Gamma_S\right\}, \quad \text{(A198)}$$

which means that $\bar{\gamma}_H < \bar{\gamma}_w$; moreover

$$\left\{\frac{1}{\beta\left[\phi+(1-\phi)\frac{1+r}{1+\delta}\right]\Gamma_L}+1\right\}\frac{1}{\tau_R^L} > \left\{\frac{1}{\beta\left[\phi+(1-\phi)\frac{1+r}{1+\delta}\right]\Gamma_S}+1\right\}\frac{1}{\tau_R^S}$$
$$\Rightarrow \tau_R^L < \tau_R^S, \quad \text{(A199)}$$

which means that $\bar{\gamma}_H > \bar{\gamma}_B$.

A.13. Proof of Proposition 8

Centralization reduces public employees' lifetime welfare if and only if

$$\log\tau_W^L+\beta\log\tau_R^L < \log\tau_W^S+\beta\log\tau_R^S = \log\rho_w^S+\beta\log\left[\rho_w^S\phi q^2+\rho_B^S(1-q)(\phi q+h)\right]. \quad \text{(A200)}$$

On the left-hand side, $\partial\tau_W^L/\partial\gamma < 0$ and $\partial\tau_R^L/\partial\gamma < 0$. For $\gamma = 1$,

$$\log\tau_W^L+\beta\log\tau_R^L = \log\rho_w^L+\log\left[\rho_w^L\phi q^2+\rho_B^L(1-q)(\phi q+h)\right]^\beta < \log\tau_W^S+\beta\log\tau_R^S \quad \text{(A201)}$$

because $\rho_w^L < \rho_w^S$ and $\rho_B^L < \rho_B^S$. Conversely

$$\lim_{\gamma\to\rho_w^L q/(1-q+\rho_w^L q)}\left\{\log\tau_W^L+\beta\log\tau_R^L\right\} = \infty > \log\tau_W^S+\beta\log\tau_R^S. \quad \text{(A202)}$$

Thus there exists a unique value

$$\bar{\gamma}_U \in \left(\frac{\rho_w^L q}{1-q+\rho_w^L q}, 1\right) \text{ such that } \log\tau_W^L(\bar{\gamma}_H)+\beta\log\tau_R^L(\bar{\gamma}_H) = \log\tau_W^S+\beta\log\tau_R^S \quad \text{(A203)}$$

and that $U_L^P > U_S^P$ if and only if $\gamma > \bar{\gamma}_U$. By the implicit-function theorem,

$$\frac{\partial\tau_R^S}{\partial\underline{\theta}_S} > 0 = \frac{\partial\tau_R^L}{\partial\underline{\theta}_S} \wedge \frac{\partial\tau_W^S}{\partial\underline{\theta}_S} > 0 = \frac{\partial\tau_W^L}{\partial\underline{\theta}_S} \Rightarrow \frac{\partial\bar{\gamma}_U}{\partial\underline{\theta}_S} < 0. \quad \text{(A204)}$$

Recalling that

$$\underline{\theta}_L > \bar{\theta}_L \Leftrightarrow \frac{\rho_B^L}{\rho_w^L} < \frac{\rho_B^S}{\rho_w^S} \Rightarrow \Gamma_L > \Gamma_S, \quad \text{(A205)}$$

if (but not only if) $\underline{\theta}_L > \bar{\theta}_L$, then

$$\tau_W^L < \tau_W^S \Rightarrow (1+\beta)\log\tau_W^L-\beta\log\Gamma_L < (1+\beta)\log\tau_W^S-\beta\log\Gamma_S, \quad \text{(A206)}$$

which means that $\bar{\gamma}_U < \bar{\gamma}_w$.

Centralization increases the present value of developers' profits if and only if

$$\frac{1}{\tau_W^L}+\frac{\beta}{\tau_R^L} > \frac{1}{\tau_W^S}+\frac{\beta}{\tau_R^S} = \frac{1}{\rho_w^S}+\frac{\beta q(1-h)}{\rho_w^S\phi q^2+\rho_B^S(1-q)(\phi q+h)}. \quad \text{(A207)}$$

On the left-hand side, $\partial\tau_W^L/\partial\gamma < 0$ and $\partial\tau_R^L/\partial\gamma < 0$. For $\gamma = 1$,

$$\frac{1}{\tau_W^L}+\frac{\beta}{\tau_R^L} = \frac{1}{\rho_w^L}+\frac{\beta q(1-h)}{\rho_w^L\phi q^2+\rho_B^L(1-q)(\phi q+h)} > \frac{1}{\tau_W^S}+\frac{\beta}{\tau_R^S}. \quad \text{(A208)}$$

because $\rho_w^L < \rho_w^S$ and $\rho_B^L < \rho_B^S$. Conversely

$$\lim_{\gamma \to \rho_w^L q/(1-q+\rho_w^L q)} \left\{ \frac{1}{\tau_W^L} + \frac{\beta}{\tau_R^L} \right\} = 0 < \frac{1}{\tau_W^S} + \frac{\beta}{\tau_R^S}. \tag{A209}$$

Thus there exists a unique value

$$\bar{\gamma}_\Pi \in \left(\frac{\rho_w^L q}{1-q+\rho_w^L q}, 1 \right) \text{ such that } \frac{1}{\tau_W^L(\bar{\gamma}_\Pi)} + \frac{\beta}{\tau_R^L(\bar{\gamma}_\Pi)} = \frac{1}{\tau_W^S} + \frac{\beta}{\tau_R^S} \tag{A210}$$

and that $\Pi_L < \Pi_S$ if and only if $\gamma > \bar{\gamma}_\Pi$. By the implicit-function theorem,

$$\frac{\partial \tau_R^S}{\partial \underline{\theta}_S} > 0 = \frac{\partial \tau_R^L}{\partial \underline{\theta}_S} \wedge \frac{\partial \tau_W^S}{\partial \underline{\theta}_S} > 0 = \frac{\partial \tau_W^L}{\partial \underline{\theta}_S} \Rightarrow \frac{\partial \bar{\gamma}_\Pi}{\partial \underline{\theta}_S} < 0. \tag{A211}$$

If (but not only if) $\underline{\theta}_L > \bar{\theta}_L$, then

$$\frac{1+\beta\Gamma_L}{\tau_W^L} > \frac{1+\beta\Gamma_S}{\tau_W^S} \Rightarrow \frac{1+\left[\phi+(1-\phi)\frac{1+r}{1+\delta}\right]\beta\Gamma_L}{\tau_W^L} > \frac{1+\left[\phi+(1-\phi)\frac{1+r}{1+\delta}\right]\beta\Gamma_S}{\tau_W^S} \tag{A212}$$

because

$$\Gamma_L > \Gamma_S \Rightarrow \frac{1+\beta\Gamma_L}{1+\beta\Gamma_S} < \frac{1+\left[\phi+(1-\phi)\frac{1+r}{1+\delta}\right]\beta\Gamma_L}{1+\left[\phi+(1-\phi)\frac{1+r}{1+\delta}\right]\beta\Gamma_S} \tag{A213}$$

since

$$\frac{\partial}{\partial \Gamma} \frac{1+\left[\phi+(1-\phi)\frac{1+r}{1+\delta}\right]\beta\Gamma}{1+\beta\Gamma} = \frac{\beta(1-\phi)(r-\delta)}{(1+\delta)(1+\beta\Gamma)^2} > 0 \text{ for all } r > \delta. \tag{A214}$$

This implies that $\bar{\gamma}_\Pi > \bar{\gamma}_H$.

Moreover, if (but not only if) $\underline{\theta}_L > \bar{\theta}_L$, then

$$(1+\beta)\log\tau_W^L - \beta\log\Gamma_L < (1+\beta)\log\tau_W^S - \beta\log\Gamma_S \Rightarrow \frac{1+\beta\Gamma_L}{\tau_W^L} > \frac{1+\beta\Gamma_S}{\tau_W^S} \tag{A215}$$

because

$$\Gamma_L > \Gamma_S \Rightarrow \left(\frac{\Gamma_L}{\Gamma_S}\right)^{\frac{\beta}{1+\beta}} < \frac{1+\beta\Gamma_L}{1+\beta\Gamma_S}$$

since

$$\frac{\partial}{\partial \Gamma}\left[(1+\beta\Gamma)\Gamma^{-\frac{\beta}{1+\beta}}\right] = \frac{\beta(\Gamma-1)}{1+\beta}\Gamma^{-\frac{1}{1+\beta}} > 0 \text{ for all } \Gamma > 1. \tag{A216}$$

This implies that $\bar{\gamma}_\Pi < \bar{\gamma}_U$.

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Table 1 – ***Parameters of the Model***

Parameter	Range	Interpretation
β	$(0,1]$	Discount factor
r	$(0,\infty)$	Market interest rate
Y	$(0,\infty)$	Gross income of a private-sector worker in the city
R	$(0,\infty)$	Cost of housing in the retirement locale
$\bar{U}$	$(-\infty,\infty)$	Lifetime utility in the reservation locale
$\bar{A}$	$(0,\infty)$	$= (1+\beta)\left[\beta(1+r)\right]^{-\beta/(1+\beta)} \exp\left[\bar{U}/(1+\beta)\right]:$ Reservation income
$\bar{C}_W$	$(0,\infty)$	$= \bar{A}/(1+\beta):$ Reservation consumption for young workers
$\bar{C}_R$	$(0,\infty)$	$= \bar{A}(1+r)\beta/(1+\beta):$ Reservation consumption for old workers
q	$(0,1/2)$	Number of local government employees relative to city population
ϕ	$[0,1]$	Share of public-sector pensions promises that are pre-funded
δ	$[0,r)$	Growth rate of the city housing stock
λ	$[0,1]$	Probability that voters infer conditionally optimal trembles on pensions when observing off-equilibrium wage proposals
θ_B^P	$(0,1]$	Pr. that a public-sector employee is informed of all proposals
θ_w^P	$\left[\theta_B^P,1\right]$	Pr. that a public-sector employee is informed of wage proposals
θ_B^T	$\left(0,\theta_B^P\right]$	Pr. that a private-sector employee is informed of all proposals
θ_w^T	$\left[\theta_B^T,\theta_w^P\right]$	Pr. that a private-sector employee is informed of wage proposals
ρ_B	$(0,1]$	$= \theta_B^T/\theta_B^P$: Symmetry of information about pension proposals
ρ_w	$[\rho_B,1]$	$= \theta_w^T/\theta_w^P$: Symmetry of information about wage proposals
$\underline{\theta}_L$	$(0,1]$	Probability that a voter is informed by local news media
$\underline{\theta}_S$	$(0,1]$	Probability that a voter is informed by statewide news media
$\underline{\theta}_U$	$[0,1]$	Probability that a public-sector employee is informed by the union
π	$[0,1]$	Conditional probability that an informed agent has acquired knowledge of pension proposals
N	$\mathbb{N}$	Number of identical cities in the state
ψ	$[0,\infty)$	Hedonic cost of commuting across cities
γ	$[1/N,1]$	$= [1+(1-N)F(\psi)]/N$: Share of public-sector employees who live in the city where they work in a symmetric equilibrium

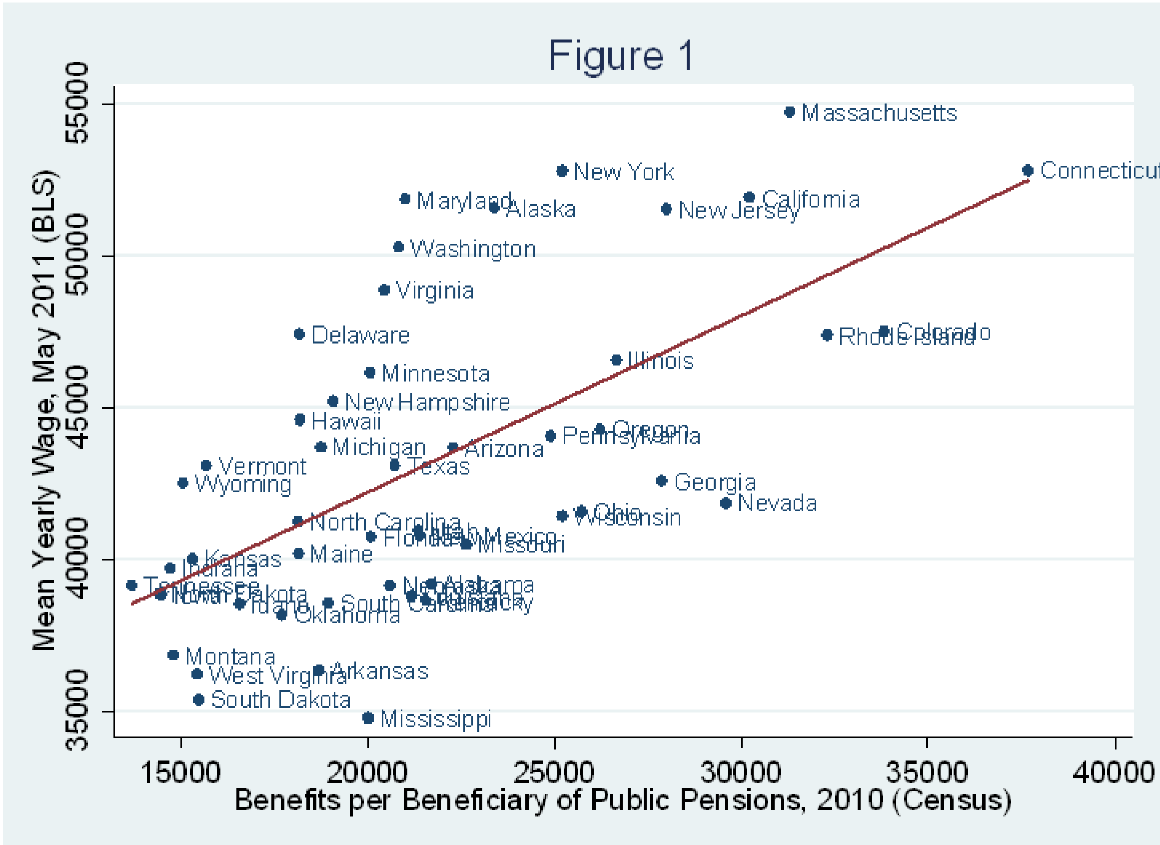
Figure 1
Mean Yearly Wage, May 2011 (BLS)
Benefits per Beneficiary of Public Pensions, 2010 (Census)
35000
40000
45000
50000
55000
15000
20000
25000
30000
35000
40000
Massachusetts
Connecticut
New York
Maryland
Alaska
New Jersey
California
Washington
Virginia
Delaware
Rhode Island
Colorado
Illinois
Minnesota
New Hampshire
Hawaii
Pennsylvania
Oregon
Michigan
Arizona
Vermont
Texas
Wyoming
Georgia
Nevada
North Carolina
Wisconsin
Ohio
Florida
New Mexico
Missouri
Kansas
Indiana
Maine
Tennessee
North Dakota
Alabama
South Carolina
Kentucky
Oklahoma
Montana
West Virginia
Arkansas
South Dakota
Mississippi