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Incentives to Work and Performance in the Public Sector

George Economides
Apostolis Philippopoulos
Petros Varthalitis

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Abstract

This paper develops a dynamic general equilibrium model with three distinct social groups, capitalists, private workers and public employees. After solving for the status quo equilibrium, which can mimic the advantages of employment in the public sector in most EU countries, the paper looks for policy reforms that can improve work incentives, and hence enhance productive efficiency, in the public sector. We focus on reforms aiming to establish parity between work conditions in the public and the private sector.

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George Economides*
Athens University of Economics and Business
School of Economic Sciences
76 Patission street
Greece – Athens 10434
gecon@aueb.gr

Apostolis Philippopoulos
Athens University of Economics and
Business / School of Economic Sciences
76 Patission street
Greece – Athens 10434
aphil@aueb.gr

Petros Varthalitis
Athens University of Economics and
Business / School of Economic Sciences
76 Patission street
Greece – Athens 10434
pvarthalitis@aueb.gr

*corresponding author

1.   Introduction

The 2008-2009 crisis and the subsequent sharp rise in sovereign debts in most countries, are forcing governments to reform their public sectors. A particularly debated reform is to establish parity between work conditions in the private and the public sector. For instance, according to the lead article in *The Economist*, January 8th 2011, "The struggle with public-sector unions should be about productivity and parity, not just spending cuts". It is thus useful to study the potential efficiency gains, but also the distributional conflicts, arising from such reforms.

It is commonly believed that employment in the public sector "differs" from employment in the private sector. Specifically, jobs in the public sector are far more secure and public employees receive a wide range of (monetary or in kind) benefits on top of their wages that are unrelated to work performance.[1] This is even if wage differentials between the private and the public sector have been reduced over time. It is natural to expect that such differences play a key role in work incentives and, hence, productive efficiency of the public sector relative to the private sector.

European Union countries provide a clear example. The standard deviation of employment in the public sector is smaller than the standard deviation of employment in the private sector (see Appendix 1) implying a higher degree of job security in the public sector. Besides, there is a lot of anecdotal evidence of extra benefits received by public employees (see e.g. Alesina, 1999, Alesina and Giavazzi, 2006, *The Economist*, January 8th 2011, while examples of "advantages of government employment" in various countries can be also found in a plethora of web links).[2] Finally, nowadays, in most EU countries, public employees enjoy on average higher wages than their counterpart workers in the private sector even after controlling for education, age, gender, etc (see e.g. de Castro et al., 2013).

In this paper, we first construct a general equilibrium model that incorporates the above facts. In particular, we construct a modified neoclassical growth model that incorporates three distinct types of agents (capitalists, private workers and public

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[1] These benefits come in the form of better health insurance, higher pensions, more paid leave (sick, holiday, vacation, etc), student loan repayments, overtime payments, child care subsidies, etc. Advantages of employment in the public sector may also come in the form of reduced working hours and a more relaxed work environment.

[2] Munnell et al. (2011) estimate the value of extra benefits that state-local public sector employees enjoy in the US vis-à-vis their private sector counterparts.

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employees) and two sectors (producing private and public goods). Capitalists and private workers are associated with the production of the private good, while public employees and goods purchased from the private sector are used by the government (i.e. by a state-owned enterprise) for the production of the public good. Private workers face job insecurity modeled as in the lotteries literature. When the model is solved numerically using common parameter values and European fiscal data, it can mimic rather well the advantages of employment in the public sector in the EU as discussed above.

In turn, departing from this status quo solution, we study the qualitative and quantitative implications of a number of reforms that aim to strengthen the incentive to work and, hence, improve productive efficiency (measured as an output-to-input ratio) in the public sector. As said, we focus on reforms that establish parity between work conditions in the public and the private sector. In particular, in light of the above empirical evidence, and similarly to the situation in the private sector, we introduce job insecurity in the public sector, link the public wage rate to a measure of labor productivity and change the mix between wages and transfers in favor of the former. We study both the aggregate and distributional implications of these reforms.

Our main results are as follows. Introducing job insecurity, like in the private sector, seems to improve the work incentives of public employees but the importance of this reform is negligible quantitatively. Cutting public wages (for instance, by linking the public wage rate to a measure of labor productivity) deteriorates the work incentives of public employees and this leads to a drop in public output and to trivial effects on the rest of the economy. By contrast, what seems to really help the aggregate economy is a policy reform that equalizes the ratio of non-labor transfers to the wage rate in the two sectors and, at the same time, uses the efficiency savings - being enjoyed by the switch to a more efficient economy with a bigger tax base - to cut income taxes. The importance of the ratio of non-labor transfers to the wage rate for work incentives should not come as a surprise: Fang and Rogerson (2011) have already shown the importance of this ratio for hours of work.

Therefore, in our experiments, the main policy task should be to equalize the ratios of non-labor transfers to the wage rate across the public and the private sector. But, as it usually happens with reforms, this does not come as a free lunch: although it is good for the aggregate economy (per capita private and public output, per capita

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welfare and public sector efficiency, they all rise), as well as for other social groups (the net income and welfare of capitalists and private workers rise), public employees are badly hurt relative to the status quo. Their work incentives are improved, but their net income and consumption level are damaged. These distributional consequences can possibly provide an explanation why public sector unions are negative to such reforms. As *The Economist*, January 8th 2011 says, "the immediate battle will be over benefits, not pay, … and the real issue is parity".

Then, a natural question to ask is whether we can find a mix of reforms that, although they generate the above social benefits, they are more feasible politically in the sense that they protect the income of public employees.[3] We show that this can be partially achieved by combining the above mentioned key reform (namely, the equalization of the ratios of non-labor transfers to the wage rate in the two sectors) with an income support policy that keeps the wage rate in the public sector above a minimum value. For instance, setting the wage rate in the public sector equal to the wage rate in the private sector, in combination with the above mentioned key reform, allows a rise in the net income and consumption levels of capitalists and private workers without hurting a lot the net income and consumption of public employees, which remain close to their status quo levels. Public employees get worse off in terms of utility, partially because of the lower consumption they enjoy relative to the status quo, but, mainly, because they have to work harder than in the status quo. On the negative side, this new mix of reforms comes at the cost of relatively smaller gains in aggregate productive efficiency, whereas public sector productive efficiency remains close to the status quo level.

The bottom line is that, although there are social options, at the end of the day, there is a value judgment to be made. It is hard to find Pareto efficient reforms. In other words, we cannot find a way of improving everything without making something else worse. As it happens in most cases, there is a tradeoff between efficiency and distribution. But, on the positive side, we can find policy mixes that mitigate the distributional costs. The problem, as Wren-Lewis (2010) points out, is that policy mixes are not well understood by the public and any mix of policies becomes an unproductive battle between the political Right and the political Left.

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[3] This is consistent with the suggestion of Diamond and Saez (2011) in the sense that reforms are implementable only if they are socially acceptable and not too complex.

The rest of the paper is as follows. Section 2 describes the economic environment. Section 3 solves for the status quo economy. Reforms are studied in section 4. Section 5 closes the paper. An Appendix includes technical details.

2. Informal description of the model

Our vehicle of analysis is a modified neoclassical growth model of a closed economy. The model comprises three social classes, called capitalists, private workers and public employees (for similar models, see e.g. Ardagna, 2007, and Economides et al., 2013 and 2014). Time is discrete and infinite. The model is deterministic for simplicity.

2.1 Population shares and households' roles

The population size at time t is N_t. Among N_t, there is a pool of identical capitalists or entrepreneurs $k = 1,2,...,N_t^k$, a pool of identical private workers $w = 1,2,...,N_t^w$ and a pool of identical public employees or bureaucrats $b = 1,2,...,N_t^b$, where $N_t^k + N_t^w + N_t^b = N_t$ at each t. Capitalists own the private firms, hold capital and government bonds and also receive labor income for their managerial services. Private workers work in the private sector facing a non-zero probability of losing their jobs. Public employees work in the public sector with probability one. For simplicity, only capitalists save in the form of capital or bonds. There are also $f = 1,2,...,N_t^f$ identical private firms owned by the capitalists. The number of capitalists equals the number of private firms or each firm is run by a capitalist. For simplicity, the fractions of the three agents in total population are exogenously set and remain constant over time. We also rule out occupational choice and mobility across groups.[4]

2.2 Production of private and public goods

Private goods are produced by private firms. These firms choose capital, supplied by capitalists, and labour services, supplied by both capitalists and private workers. They also make use of public infrastructure. Public goods are produced by the government.

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To do so, the government purchases part of the private good produced and hires public employees.[5] Public goods and services provide utility-enhancing services to households and productivity-enhancing services to private firms. In order to finance its various types of public spending, the government levies distorting taxes and issues bonds.

2.3   How private and public workers differ and how we model job insecurity

Public and private employees can differ in wages, non-labor benefits received and job security. Regarding the degree of job security, in the status quo economy, we assume that only private workers face job insecurity. Then, in the reformed economy, one possible reform will be to allow for job insecurity in the public sector too.

To model job insecurity, we will use the employment lotteries model of Hansen (1985) and Rogerson (1988) and also used by e.g. Hansen and Prescott (1995). Thus, agents face an exogenous employment lottery that determines whether or not they are employed. Although this is a rather stylized model of unemployment, it keeps the algebra simple and allows minimal deviations from both the associated market-clearing paradigm and the related literature on public employment. Details are in subsection 3.2 below.

3.   The model (status quo economy)

This section formalizes the above story. As said above, in the status quo, only private workers face job insecurity.

3.1   Capitalists' problem

The lifetime utility of each capitalist $k = 1,2,...,N_t^k$ is:

$$\sum_{t=0}^{\infty} \beta^t u(c_t^k, e_t^k, \overline{Y}_t^g) \tag{1}$$

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[4] See e.g. Acemoglu (2009, chapter 23) for occupational choice in a model with capitalists and workers. See e.g. Cavalcanti and Dos Santos (2014) for a model of occupational choice with public employees.

where c_t^k and e_t^k are each k's consumption and work effort respectively, $\overline{Y}_t^g$ is per household public goods and services (i.e. $\overline{Y}_t^g \equiv \dfrac{Y_t^g}{N_t}$) and $0 < \beta < 1$ is a time preference parameter. In what follows, it is more intuitive to assume that that those employed work a fixed shift length of $h > 0$ hours so that the disutility from working a shift of length h with a degree of effort e_t is measured by $h e_t$. Thus, hours of leisure, for those currently employed, is $1 - h e_t$ where 1 is the total time endowment. For our numerical solutions below, we will use a period utility function of the additive form:

$$u(c_t^k, e_t^k; \overline{Y}_t^g) = \mu_1 \log c_t^k + \mu_2 \log(1 - h e_t^k) + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^g \qquad (2)$$

where $0 < \mu_1, \mu_2 < 1$ are standard preference parameters.

Each k enters period t with predetermined holdings of physical capital and government bonds, k_t^k and b_t^k, whose gross returns are r_t and i_t respectively. The within-period budget constraint of each k is:

$$(1 + \tau_t^c)c_t^k + k_{t+1}^k - (1 - \delta)k_t^k + b_{t+1}^k - b_t^k = (1 - \tau_t^k)(r_t k_t^k + \pi_t^k) + (1 - \tau_t^l)w_t^k e_t^k h + i_t b_t^k + \overline{G}_t^{tr,k} \qquad (3)$$

where $0 < \delta < 1$ is the capital depreciation rate, π_t^k is dividends received from private firms, w_t^k is the wage rate earned by capitalists, $\overline{G}_t^{tr,k}$ is government transfers to each k and $0 < \tau_t^k, \tau_t^l, \tau_t^c < 1$, are the tax rates on capital income, labor income and private consumption respectively.

Each k chooses $\{c_t^k, k_{t+1}^k, b_{t+1}^k, e_t^k\}_{t=0}^{\infty}$ acting competitively. The first-order conditions include the budget constraint in (3) and:

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[5] This should be contrasted to most of the literature where it is typically assumed that the government transforms units of private goods into units of public goods at a one-to-one rate.

$$\frac{\mu_2}{(1-he_t^k)} = \frac{\mu_1(1-\tau_t^l)w_t^k}{(1+\tau_t^c)c_t^k} \tag{4a}$$

$$\frac{(1+\tau_{t+1}^c)c_{t+1}^k}{(1+\tau_t^c)c_t^k} = \beta[1-\delta+(1-\tau_{t+1}^k)r_{t+1}] \tag{4b}$$

$$\frac{(1+\tau_{t+1}^c)c_{t+1}^k}{(1+\tau_t^c)c_t^k} = \beta(1+i_{t+1}) \tag{4c}$$

where (4a) is a labor supply condition, while (4b) and (4c) are standard Euler equations for capital and government bonds respectively.

3.2   *Private workers' problem*

As said above, private workers face employment uncertainty modeled as in the lotteries model of Hansen (1985), Rogerson (1988) and Hansen and Prescott (1995). In particular, following this literature, we assume that each private worker $w = 1,2,...,N_t^w$ faces an exogenous probability $0 \leq \varphi \leq 1$ of retaining his/her job and an exogenous probability $0 \leq 1-\varphi \leq 1$ of losing his/her job in each time period. Following the same literature, we also assume that the worker can insure himself/herself through optimally chosen private unemployment insurance.[6] The worker makes his/her decisions (including employment contracts) prior to the lottery draw.[7]

The lifetime utility of each private worker, $w = 1,2,...,N_t^w$, is:

$$\sum_{t=0}^{\infty} \beta^t u(c_t^w, e_t^w, \overline{Y}_t^g) \tag{5}$$

where c_t^w and e_t^w are w's consumption and work effort respectively. For our numerical solutions below, we will again use:

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[6] We could alternatively assume that there is a representative family of workers whose members can be employed with probability ϕ, or unemployed with probability $1-\phi$ (see e.g. Cole and Ohanian, 2004, for this device although in a different problem); the results would be the same. Also note that we could alternatively use private savings instead of private unemployment insurance; again, the main results would not change but the model is algebraically simpler if we assume that workers do not participate in asset markets.

$$u(c_t^w, e_t^w; \overline{Y}_t^g) = \mu_1 \log c_t^w + \mu_2 \log(1 - h e_t^w) + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^g \tag{6}$$

If the worker is employed, which happens with probability $0 < \varphi \leq 1$, the budget constraint is:

$$(1 + \tau_t^c) c_t^{w,e} + \mu_t^w \overline{y}_t^w = (1 - \tau_t^l) w_t^w e_t^w h + \overline{G}_t^{tr,w} \tag{7a}$$

while, if the worker loses his/her job, which happens with probability $0 \leq 1 - \varphi < 1$, the budget constraint is:

$$(1 + \tau_t^c) c_t^{w,u} + \mu_t^w \overline{y}_t^w = \overline{y}_t^w + \overline{G}_t^{tr,u} \tag{7b}$$

where $c_t^{w,e}$ and $c_t^{w,u}$ are consumption when the worker is employed and unemployed respectively, w_t^w is the wage rate earned by private workers when employed, $\overline{G}_t^{tr,w}$ is government transfers to each private worker when employed, $\overline{G}_t^{tr,u}$ is government transfers to each agent when unemployed, $\overline{y}_t^w$ is the worker's private unemployment insurance whose price is denoted as μ_t^w.[8]

We solve the problem working as in e.g. Rogerson (1988) and Hansen and Prescott (1995). Thus, in each period, the private worker maximizes expected utility:

$$\varphi \Big[\mu_1 \log c_t^{w,e} + \mu_2 \log(1 - h e_t^w) + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^g \Big] + (1 - \varphi) \Big[\mu_1 \log c_t^{w,u} + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^g \Big] \tag{8}$$

subject to the single expected budget constraint:

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[7] See e.g. Hassler et al. (2005) for a case in which private decisions are made after current uncertainty is realized.

[8] Thus, we also allow for government unemployment insurance via a transfer program. A difference of government insurance from private insurance is that, while private contracts are privately optimally chosen, the government forces agents to be part of its transfer program by financing its spending by compulsory and general taxation. See also Hassler et al. (2005) for the coexistence of both private and public unemployment insurance in modern societies. We are aware of course that if private insurance markets are complete, then full risk sharing is achieved via these markers so that progressive taxation or government insurance provides no additional insurance gain (see Krueger and Perri, 2011).

$$\varphi(1+\tau_t^c)c_t^{w,e} + (1-\varphi)(1+\tau_t^c)c_t^{w,u} + \mu_t^w \bar{y}_t^w = \varphi(1-\tau_t^l)w_t^w e_t^w h + \varphi\bar{G}_t^{tr,w} + (1-\varphi)\bar{y}_t^w + (1-\varphi)\bar{G}_t^{tr,u} \quad (9)$$

Each w chooses $\{c_t^{w,e}, c_t^{w,u}, e_t^w, \bar{y}_t^w\}_{t=0}^{\infty}$ acting competitively. The first-order conditions include the budget constraint in (9) and:

$$c_t^{w,e} = c_t^{w,u} \equiv c_t^w \quad (10a)$$

$$\frac{\mu_2}{(1-he_t^w)} = \frac{\mu_1(1-\tau_t^l)w_t^w}{(1+\tau_t^c)c_t^{w,e}} \quad (10b)$$

$$\mu_t^w = 1 - \varphi \quad (10c)$$

where (10a) implies that private insurance allows consumption smoothing across different employment states, (10b) is a standard labor supply condition and (10c) equates costs and benefits of private insurance.

If we combine these first-order conditions, (10b) can be rewritten as:

$$\frac{\mu_2}{(1-he_t^w)} = \frac{\mu_1(1-\tau_t^l)w_t^w}{\varphi(1-\tau_t^l)w_t^w he_t^w + \varphi\bar{G}_t^{tr,w} + (1-\varphi)\bar{G}_t^{tr,u}} \quad (11)$$

which implies that work effort decreases with $\dfrac{\bar{G}_t^{tr,w}}{(1-\tau_t^l)w_t^w}$, $\dfrac{\bar{G}_t^{tr,u}}{(1-\tau_t^l)w_t^w}$ and φ. That is, work effort, or hours of work, fall when transfers relative to net-of-tax labor income rise or when job security rises. Keep in mind that these are direct effects holding everything else constant. The overall, or general, equilibrium effects associated with changes in tax rates, etc, are studied below. All this is conceptually similar to Fang and Rogerson (2011), although these authors focus on the effects of labor tax rate on work hours and also abstain from job insecurity issues.

3.3   Public employees' problem

Public employees are modeled similarly to private employees with the exception that (in the status quo economy) they do not face job insecurity. Thus, the lifetime utility of each $b = 1,2,...,N_t^b$ is:

$$\sum_{t=0}^{\infty} \beta^t u(c_t^b, e_t^b, \overline{Y}_t^g) \tag{12}$$

where c_t^b and e_t^b are b's consumption and work effort respectively. For our numerical solutions below, we will again use:

$$u(c_t^b, e_t^b; \overline{Y}_t^g) = \mu_1 \log c_t^b + \mu_2 \log(1 - he_t^b) + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^g \tag{13}$$

subject to the budget constraint:

$$(1 + \tau_t^c) c_t^b = (1 - \tau_t^l) w_t^g e_t^b h + \overline{G}_t^{tr,b} \tag{14}$$

where w_t^g is the wage rate in the public sector and $\overline{G}_t^{tr,b}$ is government transfers to each public employee.

Each b chooses $\{c_t^{b,e}, c_t^{b,u}, e_t^b, \overline{y}_t^b\}_{t=0}^{\infty}$ acting competitively. The first-order conditions include the budget constraint in (14) and the condition for work effort:

$$\frac{\mu_2}{(1 - he_t^b)} = \frac{\mu_1(1 - \tau_t^l) w_t^g}{(1 + \tau_t^c) c_t^{b,e}} \tag{15}$$

which, using the budget constraint, can be rewritten as:

$$\frac{\mu_2}{(1 - he_t^b)} = \frac{\mu_1(1 - \tau_t^l) w_t^g}{(1 - \tau_t^l) w_t^g he_t^b + \overline{G}_t^{tr,b}} \tag{16}$$

It is useful for what follows, to compare (16) to (11). Inspection of these two equations implies that work effort in the private sector and work effort in the public sector can differ because of differences in: (i) the degree of job security, $\varphi < 1$; (ii) the wage rate $w_t^w \neq w_t^g$; (iii) the ratio of non-labor benefits to wages, $\dfrac{\overline{G}_t^{tr,w}}{w_t^w} \neq \dfrac{\overline{G}_t^{tr,b}}{w_t^g}$. One of them, or a combination of them, is enough to cause differences between work effort

in the private sector and work effort in the public sector. Recall that this is consistent with the motivation of the paper in the Introduction.

3.4 *Private firms and production of the private good*

In each period, each private firm $f = 1, 2, ..., N_t^f$ chooses capital, k_t^f, and the two types of labor services, $e_t^{f,k}$ and $e_t^{f,w}$, to maximize period-by-period profits:

$$\pi_t^f = y_t^f - r_t k_t^f - w_t^w e_t^{f,w} - w_t^k e_t^{f,k} \tag{17}$$

where, for our numerical solutions below, we will use a production function of the form:

$$y_t^f = A(k_t^f)^{\alpha_1} (A^k e_t^{f,k} + A^w e_t^{f,w})^{\alpha_2} \left(\frac{Y_t^g}{N_t^f} \right)^{1-\alpha_1-\alpha_2} \tag{18}$$

where $A, A^k, A^w > 0$ and $0 < \alpha_1, \alpha_2 < 1$ are technology parameters. The part of the production function related to the labor input is modeled as in Hornstein et al. (2005) while here we also allow the public good to provide production services as in e.g. Barro (1990). We report that none of these assumptions is important to our main results.

The firm's first-order conditions are simply:

$$r_t = \alpha_1 \frac{y_t^f}{k_t^f} \tag{19a}$$

$$w_t^w = \alpha_2 A^w \frac{y_t^f}{(A^k e_t^{f,k} + A^w e_t^{f,w})} \tag{19b}$$

$$w_t^k = \alpha_2 A^k \frac{y_t^f}{(A^k e_t^{f,k} + A^w e_t^{f,w})} \tag{19c}$$

so that profits are:

$$\pi_t^f = (1 - \alpha_1 - \alpha_2) y_t^f \tag{19d}$$

3.5 Government budget constraint and policy instruments

The period budget constraint of the government is (aggregate quantities are denoted by capital-letters):

$$G_t^g + G_t^w + G_t^{tr,k} + G_t^{tr,w} + G_t^{tr,b} + G_t^{tr,u} + (1+i_t)B_t = B_{t+1} + T_t \tag{20a}$$

where G_t^g is total public spending on goods and services purchased from the private sector, G_t^w is the total public wage bill, $G_t^{tr,k}, G_t^{tr,w}$, $G_t^{tr,b}$ and $G_t^{tr,u}$ are respectively transfers to capitalists, private workers, public employees and the unemployed, B_t is the beginning-of-period total stock of government bonds and T_t is total tax revenues. Notice that that the output shares of G_t^g, G_t^w, G_t^{tr} (where $G_t^{tr} = G_t^{tr,k} + G_t^{tr,w} + G_t^{tr,b}$ is total transfers) and $G_t^{tr,u}$ will be set as in the data (see below for details).

Total tax revenues, T_t, are:

$$T_t \equiv \tau_t^c (N_t^k c_t^k + N_t^w c_t^w + N_t^b c_t^b) + \tau_t^k N_t^k (r_t k_t^k + \pi_t^k) + \tau_t^l (N_t^k w_t^k e_t^k h + \varphi N_t^w w_t^w e_t^w h + N_t^b w_t^g e_t^b h) \tag{20b}$$

Therefore, as in e.g. Alesina et al. (2002), we include the three main types of government spending (purchases of goods and services from the private sector, public wages, and transfers to individuals). We also include the three main types of taxes (taxes on consumption, capital income and labor income).

Inspection of (20a-b) implies that, in each time period, there are eleven policy instruments $(G_t^g, G_t^w, G_t^{tr,k}, G_t^{tr,w}, G_t^{tr,b}, G_t^{tr,u}, \tau_t^c, \tau_t^k, \tau_t^l, B_{t+1}, N_t^b)$ out of which one has to adjust residually to satisfy the government budget constraint. Following most of the related literature, we will assume that, along the transition path, the adjusting instrument is the end-of-period public debt, B_{t+1}, so that the rest can be set exogenously by the government. Instead, in the steady state, we will set the debt-to-output ratio as in the data and allow the labor tax rate to be the residually determined instrument (see also e.g. Mendoza and Tesar, 2005, in a model for the European Union).

For convenience, concerning public spending instruments, we will work in terms of their GDP shares. Thus, we define $s_t^g \equiv \frac{G_t^g}{Y_t}$, $s_t^w \equiv \frac{G_t^w}{Y_t}$, $s_t^{tr,k} \equiv \frac{G_t^{tr,k}}{Y_t}$,

$s_t^{tr,w} \equiv \frac{G_t^{tr,w}}{Y_t}$, $s_t^{tr,b} \equiv \frac{G_t^{tr,b}}{Y_t}$, and $s_t^{tr,u} \equiv \frac{G_t^{tr,u}}{Y_t}$, where Y_t denotes total output (see Appendix 2 for details). Similarly, concerning the number of public employees, we will work in terms of their population share, $v_t^b \equiv \frac{N_t^b}{N_t}$. It is convenient for what follows to define also the population share of capitalists, $v_t^k \equiv \frac{N_t^k}{N_t}$. Then, the population share of workers follows residually, $v_t^w \equiv \frac{N_t^w}{N_t} = 1 - v_t^k - v_t^b$.

3.6   State-owned enterprise and the production of public goods

Following most of the related literature,[9] we assume that total public goods and services, Y_t^g, are produced using goods and services purchased from the private sector, G_t^g, and total public employment, L_t^g. In particular, following e.g. Linnemann (2009) and Economides et al. (2013, 2014), we use a Cobb-Douglas production function of the form:

$$Y_t^g = A(G_t^g)^\theta (L_t^g)^{1-\theta} \tag{21}$$

where $0 \leq \theta \leq 1$ is a technology parameter. Notice that both private and public good production face the same TFP; this is because we do not want our results to be driven by exogenous factors. The total cost of public production, $G_t^g + w_t^g L_t^g$, is financed by the government through taxes and bonds (see the government budget constraint (20a) above).

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[9] See Economides et al. (2014) for details and a review of the literature on the production function of public goods. We report that our results are robust to adding public capital, whose changes are financed by public investment spending, as a third factor into the production function of public goods. Again, see Economides et al. (2014) for the role of public capital in public good production functions.

3.7   Decentralized competitive equilibrium (DCE) of the status quo economy

Combining the above, we now solve for a DCE. This is for any feasible policy. In this DCE: (i) all types of households maximize utility acting competitively; (ii) all firms in the private sector maximize profits acting competitively; (iii) the insurance company maximizes profits acting competitively (see Appendix 3 for details); (iv) all constraints are satisfied and (v) all markets clear (see Appendix 4 for details); (vi) the amounts, expressed as shares of output, spent by the public enterprise on inputs used for the production of the public good, s_t^g and s_t^w, are set exogenously at their data average values (see below). When $\{s_t^g, s_t^w, s_t^{tr,k}, s_t^{tr,w}, s_t^{tr,b}, s_t^{tr,u}, \tau_t^c, \tau_t^k, \tau_t^l, \nu_t^b\}_{t=0}^{\infty}$ are set by the government, we end up with a dynamic system of 16 equations in 16 endogenous variables, $\{c_t^k, c_t^w, c_t^b, k_{t+1}^k, b_{t+1}^k, e_t^k, e_t^w, e_t^b, y_t^f, y_t^g, r_t, i_t, w_t^w, w_t^k, w_t^g, \pi_t^k\}_{t=0}^{\infty}$. This equilibrium system is presented in Appendix 5. It is solved numerically first for the steady state and then for its transition path when linearized around the steady state. In the steady state, the public debt to GDP ratio is set as in the data and the labour tax rate plays the role of the residually determined fiscal policy variable.

3.8   Numerical solution of the status quo economy

In this subsection, we provide a numerical solution of the above economy. We start with parameterization.

3.8.1   Parameter values and policy instruments

Since the nature of our numerical solutions is mainly illustrative, our parameterization is chosen in a simple fashion. Regarding parameters for technology and preferences, we use common values. Regarding policy variables, we use data averages of the Eurozone over 2000-2012 (the data source is Eurostat). These values are shown in Table 1. The time unit is meant to be a year. We report that our main results are robust to changes in parameter values.

Table 1 around here
Baseline parameterization

Let us briefly discuss the parameter and policy values summarized in Table 1. In the private sector production function, the Cobb-Douglas exponents of labour and

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capital are set at 0.64 and 0.33 respectively, while the exponent of public capital is set at 0.03, which is close to the public infrastructure investment as share of output in the data (0.025). The TFP parameter, A, is normalized at 1. The time preference rate, β, is set at 0.99. The weight given to public goods and services in the utility function is set at 0.1, which is within the range used in the related literature.[10] The other preference parameters related to private consumption and leisure, μ_1 and μ_2, are set at 0.3 and 0.6 respectively; these parameter values imply hours of work within usual ranges. The capital depreciation rate, δ, is set at 0.05. In the public sector production function, the share of public employment vis-à-vis the share of goods purchased from the private sector, $1-\theta$, is set at 0.569. This value is the sample average of payments to public wages as a share of total public payments to inputs used in the production of public goods, namely $0.569 = s^w / (s^w + s^g)$, where the values of s^w and s^g in the data are reported below (for similar calibration practice, see the real business cycle literature and, in related models, see e.g. Linnemann, 2009, and Economides et al., 2013). We also set $A^k = A^w \equiv 1$ so that capitalists and private workers offer the type of labor services and get the same wage rate in the private sector. As said above, our qualitative results are robust to changes in all parameter values, including the (relatively unknown) value of $1-\theta$.

Regarding policy variables, the share of public employees in total population, v^b, is set at 0.215, which is the average value in the data. The share of capitalists, defined as those self-employed, is set at 0.148 again as in the data. The data values of the output share of public spending on public wage payments, s_t^w, on goods and services purchased from the private sector, s_t^g, on total transfers, s_t^{tr}, and on unemployment benefits, $s_t^{tr,u}$, are respectively 0.132, 0.10, 0.217 and 0.011. The effective tax rates on consumption, capital income and labor income, τ_t^c, τ_t^k and τ_t^l, are respectively 0.1938, 0.2903 and 0.378 in the data, while, in the steady state, the public debt to GDP ratio is set at 0.9.

Regarding the (relatively unknown in the data) allocation of total government transfers (s_t^{tr}) among the three social groups ($s_t^{tr,k}$, $s_t^{tr,w}$ and $s_t^{tr,b}$), we adjust the share

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[10] Chari et al. (1995) use a zero value. On the other hand, Guo and Lansing (1999) use a high value, around 0.36, in a similar utility function.

of transfers going to public employees ($s_t^{tr,b}$) vis-à-vis the share of transfers going to private agents ($s_t^{tr,k}$ and $s_t^{tr,w}$) so as to hit the public wage premium observed in the recent European data. In particular, following the detailed study of de Castro et al. (2013), we target the value of 1.03 for the ratio of the public wage rate to the private wage rate. This in turn implies an almost equal allocation of transfers between public and private agents (in particular, public employees receive 50.8% of total transfers). Notice, however, that since public employees constitute only 21.5% of the working population, this means that they receive the lion's share of government transfers, as one would expect (see the Introduction). In turn, we exogenously allocate the remaining share of transfers (49.2%) going to the two private groups (namely, entrepreneurs and workers) according to their population shares as shown in Table 1. We report, however, that our main results are not sensitive to the specific value of the public wage premium used in the status quo economy.[11]

3.8.2 *Steady state solution of the status quo economy*

Given the parameter and policy values in Table 1, the steady state solution of the status quo economy is reported in Table 2 (where the key variables are shown in bold). We also report that, when linearized around the steady state, the model is saddle-path stable.

Table 2 around here
Steady state solution of the status quo economy

The solution in Table 2 is well defined and does relatively well at mimicking the GDP ratios of key macroeconomic aggregates like consumption and capital. More importantly, in this solution, private workers work harder but consume less than public employees. As a result, in terms of utility, public employees are better off than private workers, while it is the capitalists (or "the rich") that enjoy the highest utility level. We believe that all this is consistent with the common belief that, in most European countries, public employees are the winners in terms of wages, transfers and

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[11] In a previous version of the paper, we parameterized the model assuming that, in the status quo, the public wage rate was lower than the private wage rate (this is the case in the US and in a number of European countries); the qualitative effects of reforms do not depend on this. We also parameterized the model so as workers were indifferent (either in terms of steady state consumption or in terms of

job security relative to their counterparts in the private sector (see the papers in the Introduction). In the context of our model, this can be rationalized by the implicit assumption that there is a ration of government jobs. It is also worth noticing that productive efficiency in the public sector is lower than in the private sector, where productive efficiency is typically measured as an output-to-input ratio (see Appendix 6 for details).[12]

4. Policy reforms

In this section, departing from the above steady state solution of the status quo economy, we study the implications of various exogenous changes in fiscal policy. Motivated by the discussion in the Introduction, the aim is to study the effects of policy changes aiming at parity. As we saw in the theoretical model above, work effort in the public sector and work effort in the private sector can differ because of differences in the degree of job security, the wage rate earned and the amount of income that is being received as a transfer relative to the wage rate. Hence, we will study what happens when private workers and public employees are at par regarding the degree of job security, the manner the wage rate is determined and the ratio of non-labor transfers to the wage rate.

4.1   Policy reforms studied

The reforms studied are listed in Table 3. To understand the logic of our results, and following usual practice, we start by experimenting with one reform at a time and only in turn study reform mixes.

Table 3 around here
Description of policy reforms

In Reform no. 1, we add job insecurity in the public sector like in the private sector. Thus, now public employees know that can keep their job with a nonzero

probability $0 < q < 1$ only, like their counterparts do in the private sector (see subsection 4.2 below for modeling details). In particular, we set $q = \varphi = 0.9$, meaning that both private workers and public employees fear that there is a probability 10% of losing their jobs. Since we do not want the ex ante employed public employees to receive higher per capita wages simply because their number has been decreased, we also cut the exogenously set output share of public wages, s_t^w, by 10%.

Reform no. 2 postulates that the wage rate in the public sector is set in a manner similar to that in the private sector. Specifically, we assume that the wage rate in the public sector equals a measure of the marginal product of labor in this sector, $w_t^g = \frac{(1-\theta)Y_t^g}{L_t^g}$. Algebraically, this adds an extra equation to the equilibrium system. We thus also have a new extra endogenous variable and, given the nature of the extra equation, we find it natural to choose the share of public spending going to public wages, s_t^w, to play the role of the extra endogenous variable.

Reform no. 3 postulates that the ratio of non-labor transfers to the wage rate is equal in the two sectors, $\frac{\overline{G}_t^{tr,w}}{w_t^w} = \frac{\overline{G}_t^{tr,b}}{w_t^g}$. Again this adds an extra equation to the system and we now choose the share of transfers allocated to public employees, $s_t^{tr,b}$, to play the role of the new extra endogenous variable.

Reform no. 4 is a mix of reforms that simply combines reforms 1, 2 and 3 together.

Reform no. 5 is like no. 4 with the exception that now the wage rate is assumed to be proportional to the wage rate in the private sector, where the degree of proportionality will be specified below. That is, instead of assuming $w_t^g = \frac{(1-\theta)Y_t^g}{L_t^g}$ as in Reform no. 4, we postulate a link between wages in the two sectors, $w_t^g = \rho w_t^p$, where $0 < \rho \leq 1$ is the degree of proportionality. Our interest in this reform is explained below.[13]

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[13] This rule, which is in terms of wages, $w_t^g = \rho w_t^p$, is equivalent to a rule in terms of transfers, $\overline{G}_t^{tr,b} = \rho \overline{G}_t^{tr,w}$, given that we also have $\frac{\overline{G}_t^{tr,w}}{w_t^w} = \frac{\overline{G}_t^{tr,b}}{w_t^g}$.

4.2   Adding job insecurity in the public sector and the new equilibrium system

In terms of modeling, the main new ingredient is to add job insecurity in the public sector. We thus now assume that both private workers and public employees face job uncertainty and make their decisions prior to the lottery draw. In what follows, we only model what changes relative to the status quo model in the previous section.

Public sector employees, $b = 1, 2, ..., N_t^b$, are now modeled similarly to private workers. Thus, if we denote by $0 < q \leq 1$ the probability that a public employee keeps his/her job, while $0 < 1 - q \leq 1$ is the probability of losing his/her job, then with probability $0 < q \leq 1$, the budget constraint is:

$$(1 + \tau_t^c) c_t^{b,e} + \mu_t^b \bar{y}_t^b = (1 - \tau_t^l) w_t^g e_t^b h + \bar{G}_t^{tr,b} \tag{22a}$$

while, with probability $0 < 1 - q \leq 1$, the budget constraint is:

$$(1 + \tau_t^c) c_t^{b,u} + \mu_t^b \bar{y}_t^b = \bar{y}_t^b + \bar{G}_t^{tr,u} \tag{22b}$$

where, as above, $c_t^{b,e}$ and $c_t^{b,u}$ are consumption when the public employee is employed and unemployed respectively, $\bar{G}_t^{tr,b}$ is government transfers to each public sector employee when employed, $\bar{G}_t^{tr,u}$ is government transfers to each public sector employee when unemployed and $\bar{y}_t^b$ is a private unemployment insurance whose price is μ_t^b.

Thus, in each period, each public employee maximizes expected utility:

$$q[\mu_1 \log c_t^{b,e} + \mu_2 \log(1 - h e_t^b) + (1 - \mu_1 - \mu_2) \log Y_t^g] + (1 - q)[\mu_1 \log c_t^{b,u} + (1 - \mu_1 - \mu_2) \log Y_t^g] \tag{23}$$

subject to the single expected budget constraint:

$$q(1 + \tau_t^c) c_t^{b,e} + (1 - q)(1 + \tau_t^c) c_t^{b,u} + \mu_t^b \bar{y}_t^b = q(1 - \tau_t^l) w_t^g e_t^b h + q\bar{G}_t^{tr,b} + (1 - q)\bar{y}_t^b + (1 - q)\bar{G}_t^{tr,u} \tag{24}$$

Each b chooses $\{c_t^{b,e}, c_t^{b,u}, e_t^b, \bar{y}_t^b\}_{t=0}^{\infty}$ acting competitively. The first-order conditions include the budget constraint in (24) and:

$$c_t^{b,e} = c_t^{b,u} = c_t^b \tag{25a}$$

$$\frac{\mu_2}{(1-he_t^b)} = \frac{\mu_1(1-\tau_t^l)w_t^g}{(1+\tau_t^c)c_t^{b,e}} \tag{25b}$$

$$\mu_t^b = 1-q \tag{25c}$$

If we combine these first-order conditions, the labor supply condition (25b) can be rewritten as:

$$\frac{\mu_2}{(1-he_t^b)} = \frac{\mu_1(1-\tau_t^l)w_t^g}{q(1-\tau_t^l)w_t^g he_t^b + q\bar{G}_t^{tr,b} + (1-q)\bar{G}_t^{tr,u}} \tag{26}$$

which is like (11) above for the private worker and can give (16) as a special case.

The new DCE system, as well as the associated new market-clearing conditions, is presented in the Appendix (see Appendices 3 and 4).

4.3   Steady state solutions of the reformed economies

In this subsection, we provide steady state solutions under the reforms listed in Table 3. The parameterization is as in Table 1 except that now $q = \varphi = 0.9 < 1$. The solution, under each type of reform, is reported in Table 4, where in the first column - for expositional convenience - we also repeat the status quo solution of Table 2. Notice that some ratios remain unchanged across regimes; this happens because of the functional forms used in the numerical solution but it is not important to the main results.

Table 4 around here
Steady state solutions

We start with Reform no. 1, as defined in Table 3, and compare it to the status quo. On the positive side, Reform no. 1 improves work incentives (e^b rises) in the public sector and enhances private output. On the negative side, public output and per

capita welfare all fall. But all these effects are marginal in magnitude (for instance, per capita output increases by less than 0.5%) so we are inclined to claim that the introduction of job insecurity in the public sector does not appear by itself to generate substantial social benefits.

Under Reform no. 2, as defined in Table 3, work incentives in the public sector clearly deteriorate (e^b falls a lot) and this is damaging for public sector output. This happens mainly because the resulting fall in wages in the public sector further damages the work incentive of public employees. Public sector efficiency rises (although public output decreases) but this happens only because public wages have fallen substantially. On the other hand, per capita output increases but again the change is quantitatively weak (less than 1%). Thus, as with job insecurity, the attempt to link public wages to productivity in the public sector cannot by itself lead to social benefits.

Reform no. 3, as defined in Table 3, is different. Now, work incentives in the public sector clearly improve (e^b rises a lot) and, at same time, private output, public output and per capita utility all rise. In particular, private and public output increase by more than 4% and 30% respectively. The same applies to public sector efficiency which rises substantially vis-à-vis the status quo. Notice that a larger tax base allows a cut in the labour tax rate that further stimulates the aggregate economy. On the negative side, public employees get worse off; public wages and transfers allocated to public employees both fall, so their net income and consumption also fall.

Reform no. 4 (which is a combined mix of Reforms 1, 2 and 3) is like Reform no. 3 both qualitatively and quantitatively, indicating that the main results are driven by Reform no. 3.

Therefore, taking stock of results so far, the key reform is no. 3. It is thus good for the general interest to equalize the ratio of non-labor transfers to the wage rate in the two sectors, $\dfrac{\overline{G}_t^{tr,w}}{w_t^w} \neq \dfrac{\overline{G}_t^{tr,b}}{w_t^g}$, and, at the same time, to use the efficiency savings - enjoyed by the switch to a more efficient economy - to cut labor taxes. The latter creates a second round of social benefits. The problem, as it usually happens, is that this reform is not a free lunch: although per capita private and public output, public sector efficiency and per capita welfare all rise vis-à-vis the status quo, public

employees get impoverished by the fall in their net income and get worse off relative to the status quo.

It is then natural to ask: is it possible to find a mix of policy reforms that are not only socially beneficial, but also do not hurt the net income and the consumption level of public employees? Since the above reforms were accompanied by a substantial fall in public wages that impoverished public employees, we now search for a mix that combines the key reform (Reform no. 3) with a policy that keeps the wage rate in the public sector above a minimum value. For instance, in Reform no. 5, we replace the condition $w_t^g = \frac{(1-\theta)Y_t^g}{L_t^g}$ with the condition $w_t^g = w_t^p$ (Gomes, 2014, also links public wages to private wages in a reformed economy). In all other aspects, Reform no. 5 is like Reform no. 4. Then, the results reported in the last column of Table 4 imply that, in this case, the increase in the net income and consumption of capitalists and private workers is not accompanied by a big decrease in the net income and consumption of public employees as it happened under Reforms 3 and 4. Public employees may be worse off in terms of utility relative to the status quo but since - by construction - they enjoy the same wage rate as their private counterparts, $w_t^g = w_t^p$, the decrease in utility is mainly explained by the fact that they now work harder. Private output, public output as well as per capita welfare all rise relative to the status quo, although now these rises are smaller than in Reforms 3 and 4. For instance, in Reform no. 5, private output increases by about 2.7%, which is smaller than the increase by more than 6% obtained in Reform no. 4. On the negative side, since now public wages are relatively high, public sector efficiency slightly falls relative to the status quo. This is unavoidable cost of social protection. In sum, we cannot avoid the standard tradeoff between efficiency and equity. A social value judgment has to be made.

4.4   Transition results as we travel to the reformed economy

We next study what happens when we depart from the pre-reform status quo economy and travel towards a new long-run of a reformed economy.[14]

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[14] We work as follows. We first solve and compare long-run equilibria with and without reforms. We then check that, when log-linearized around its steady state solution, each model economy is saddle-path stable. This is for each type of reform and each method of public financing studied. In turn, setting, as initial conditions for the state variables, their values from the steady state solution of the

To save on space, we focus on the case in which the economy travels to the long-run equilibrium that corresponds to Reform no. 5, since the latter is a combination of all other reforms. As said above, along the transition, public debt is the residually determined public financing variable. Results for the discounted lifetime utility of the three agents, namely, capitalists, public employees and private workers, denoted as U^k, U^b and U^w respectively, as well as per capita discounted lifetime utility, denoted as U, are reported in Table 5.

Table 5 around here
Discounted lifetime utility

Inspection of Table 5 reveals that, as it was also the case when we compared steady state solutions, capitalists and private sector employees, as well as the aggregate economy, benefit from the adoption of Reform no. 5. On the other hand, this Reform again hurts those working in the public sector. The latter are now worse off relative to the pre-reform economy. In particular, the last column of Table 5 indicates that public sector employees should receive a consumption subsidy of 25% in order to be indifferent between the pre-reform and the reformed economy. On the other hand, capitalists, private sector employees and the overall economy enjoy a consumption benefit of 17%, 20% and 10% respectively from a switch to the reformed economy. Details on the calculation of these consumption equivalents, denoted as ξ in Table 5, are in Appendix 7.

5.   Conclusions, political economy issues and extensions

In this paper, we searched for policy reforms that can strengthen the incentive to work in the public sector. Using a general equilibrium setup with heterogeneous agents and a potential conflict of interests, we showed that the adoption of specific reforms - the main feature of which was the establishment of parity between employment conditions in the public sector and employment conditions in the private sector -

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status quo economy, we compute the equilibrium transition path of each reformed economy and in turn calculate the associated discounted lifetime utilities of the three types of households as well as the resulting per capita lifetime utility. These utilities are finally compared to their associated values if we had remained in the status quo economy forever. Recall that the model is deterministic so that the only source of transition dynamics is policy reforms.

improve work incentives in the public sector, as well as benefit the aggregate economy, but at the cost of making the existing public employees worse off.

This type of work can be extended in various ways. For instance, we can add imperfect competition in product markets, as well as, trade union and rent seeking behavior on the part of public employees. Another key issue is the political feasibility of reforms (see Drazen, 2000, chapter 13). Here, we just compared the status quo to various reforms by sidestepping the issue of whether reforms are feasible politically. But a natural question to ask is: If some reforms can lift the society out of the status quo trap, meaning that they can make the majority better off, why don't we observe them in practice? In a direct democracy, it would be puzzling why socially beneficial reforms are not adopted or are adopted only with delay. In our model, for instance, if capitalists and private workers have the majority vote, such reforms should be enacted as fully and as quickly as possible.

Several interpretations, and therefore model extensions, can come to mind. For instance, as Alesina (1999) points out, in most industrial countries nowadays, a bigger and bigger fraction of the population derives its main source of income from the public sector. Here, we modeled the behavior of public employees only. But there are also pensioners, unemployed people, private firms, etc, who also rely on the government. Jointly with public employees, these groups can form a majority reluctant to reforms. This means that our model could be extended to include these other groups. Another interpretation, and therefore model extension, could be that democracies are not perfect, meaning that the one-man-one-vote rule does not always apply. In representative democracy systems, minorities can use their political or money power to block socially beneficial reforms and maintain the status quo, even if the latter hurts the majority of the society (see Acemoglu, 2009, chapter 22, for why inefficient institutions emerge and persist and Rajan, 2009, for reform paralysis). Typically, this happens through the political system. In the context of our model, even if public employees are few in number, they may have enough political power to block reforms. This means that our model could be extended to account for the (mutually beneficial) interaction between interest groups and policymakers at the top of the government hierarchy, and how this interaction ensures the preservation of the status quo. We leave these extensions for future work.

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APPENDIX

Appendix 1: Turnover in the public sector

The data source is Eurostat. Data are yearly and cover a maximum time span from 1996 to 2012. The countries included in the data set are Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovenia, Slovak Republic, Spain, Sweden, UK, US and Japan. Employment in the public sector corresponds to the number of employees in public administration, defense, education, human health and social work activities. Employment in the private sector is computed as total employees minus employment in the public sector. Finally, turnover in the public sector is defined as the standard deviation of employment in the public sector relative to the standard deviation of employment in the private sector. A value of this ratio less than 1 implies that job insecurity in the public sector is lower than job insecurity in the private sector.

Country	Turnover ratio
Austria	0.509398
Belgium	1.034886
Cyprus	0.274710
Estonia	0.286157
Finland	0.415131
France	0.294902
Germany	0.545764
Greece	0.485933
Hungary	0.265679
Ireland	0.639663
Italy	0.063845
Latvia	0.125081
Lithuania	0.179500
Luxembourg	0.287126
Malta	0.535983
Netherlands	0.864326
Poland	0.188547
Portugal	0.418393
Slovenia	0.612587
Slovak Republic	0.111292
Spain	0.293899
Sweden	0.309194
UK	1.238642
Denmark	0.318628
Czech Republic	0.149596
US	1.054764
Japan	0.958346

Source: Eurostat.

Appendix 2: Public spending categories expressed as shares of output

(a) $G_t^g = s_t^g N_t^k y_t^f$ so that $\overline{G}_t^{\,g} = \dfrac{G_t^g}{N_t} = s_t^g v_t^k y_t^f$.

(b) $\quad G_t^w = s_t^w N_t^k y_t^f \quad$ so that $\quad \overline{G}_t^{\,w} = \dfrac{G_t^w}{N_t} = s_t^w v_t^k y_t^f$. In turn, since

$G_t^w = w_t^g L_t^g = w_t^g N_t^b q e_t^b h$, $\overline{G}_t^{\,w} = s_t^w v_t^k y_t^f = w_t^g v_t^b q e_t^b h$ or $w_t^g = \dfrac{s_t^w v_t^k y_t^f}{v_t^b q e_t^b h}$. Thus, the

public wage rate, w_t^g, is determined by the related "market-clearing" condition (namely, that total spending on the public wage bill, G_t^w, equals the wage rate multiplied by total effective labor in the public sector), when the public wage bill as share of GDP, s_t^w, is set as in the data.

(c) $G_t^{tr,k} = s_t^{tr,k} N_t^k y_t^f$, so that $\overline{G}_t^{\,tr,k} = \dfrac{G_t^{tr,k}}{N_t^k} = s_t^{tr,k} y_t^f$.

(d) $G_t^{tr,w} = s_t^{tr,w} N_t^k y_t^f$, so that $\overline{G}_t^{\,tr,w} \equiv \dfrac{G_t^{tr,w}}{\varphi N_t^w} = s_t^{tr,w} \dfrac{v_t^k}{\varphi v_t^w} y_t^f$.

(e) $G_t^{tr,b} = s_t^{tr,b} N_t^k y_t^f$ so that $\overline{G}_t^{\,tr,b} = \dfrac{G_t^{tr,b}}{q N_t^b} = s_t^{tr,b} \dfrac{v_t^k}{q v_t^b} y_t^f$ where $s_t^{tr,k} + s_t^{tr,w} + s_t^{tr,b} \equiv s_t^{tr}$, and

where s_t^{tr} is the share of transfers in the data.

(f) $G_t^{tr,u} = s_t^{tr,u} N_t^k y_t^f$ so that $\overline{G}_t^{\,tr,u} = \dfrac{G_t^{tr,u}}{(1-\phi)N_t^w + (1-q)N_t^b} = s_t^{tr,u} \dfrac{v_t^k}{(1-\phi)v_t^w + (1-q)v_t^b} y_t^f$.

Appendix 3: The insurance company

The insurance company maximizes period-by-period profits by choosing a supply of unemployment insurance, denoted as I. Thus, it maximizes $\mu_t^w I - (1-\varphi)I$. Since $\mu_t^w = (1-\varphi)$ from the worker's optimization problem, the insurance company is at its break-even point.

Appendix 4: Market-clearing conditions

The equations below are the market-clearing conditions in the general case in which there is job uncertainty in both the private and the public sector. The market-clearing

conditions of the status quo model, in which there is job uncertainty in the private sector only, follows as a special case if set $q_t = 1$.

The market-clearing conditions in the labor markets are:

$$N_t^f e_t^{f,k} = N_t^k e_t^{f,k} = N_t^k e_t^k h \Rightarrow e_t^{f,k} = e_t^k h$$

$$N_t^f e_t^{f,w} = N_t^k e_t^{f,w} = \varphi N_t^w e_t^w h \Rightarrow e_t^{f,w} = \varphi \frac{v_t^w}{v_t^k} e_t^w h$$

$$L_t^g = q N_t^b e_t^b h$$

The market-clearing conditions in capital, bond and dividend markets are respectively:

$$N_t^f k_t^f = N_t^k k_t^k \Rightarrow k_t^f = k_t^k$$

$$N_t^k b_t^k = B_t$$

$$N_t^f \pi_t^f = N_t^k \pi_t^k \Rightarrow \pi_t^f = \pi_t^k$$

Finally, the market-clearing condition in the goods market (this is also the economy's resource constraint) is:

$$N_t^k c_t^k + N_t^w c_t^w + N_t^b c_t^b + N_t^k (k_{t+1}^k - (1-\delta)k_t^k) + G_t^g = N_t^f y_t^f = N_t^k y_t^f$$

Appendix 5: Decentralized Competitive Equilibrium

The system below summarizes the DCE in the general case in which there is job uncertainty in both the private and the public sector. The DCE of the status quo model, in which there is job uncertainty in the private sector only, follows as a special case if set $q_t = 1$.

Capitalists:

$$\frac{\mu_2}{(1-he_t^k)} = \frac{\mu_1(1-\tau_t^l)w_t^k}{(1+\tau_t^c)c_t^k} \tag{A.4a}$$

$$(1+\tau_{t+1}^c)c_{t+1}^k = \beta(1+\tau_t^c)c_t^k[1-\delta+(1-\tau_{t+1}^k)r_{t+1}] \tag{A.4b}$$

$$(1+\tau_{t+1}^c)c_{t+1}^k = \beta(1+\tau_t^c)c_t^k(1+i_{t+1}) \tag{A.4c}$$

Private workers:

$$(1+\tau_t^c)c_t^w = \varphi_t(1-\tau_t^l)w_t^w e_t^w h + \varphi_t\bar{G}_t^{tr,w} + (1-\varphi_t)\bar{G}_t^{tr,u} \tag{A.4d}$$

$$\frac{\mu_2}{(1-he_t^w)} = \frac{\mu_1(1-\tau_t^l)w_t^w}{\varphi(1-\tau_t^l)w_t^w he_t^w + \varphi\bar{G}_t^{tr,w} + (1-\varphi)\bar{G}_t^{tr,u}} \tag{A.4e}$$

where we use $\bar{G}_t^{tr,w} = s_t^{tr,w}\dfrac{v_t^k}{\varphi_t v_t^w}y_t^f$ and $\bar{G}_t^{tr,u} = s_t^{tr,u}\dfrac{v_t^k}{(1-\varphi_t)v_t^w + (1-q_t)v_t^b}y_t^f$

Public employees:

$$(1+\tau_t^c)c_t^b = q_t(1-\tau_t^l)w_t^g e_t^b h + q_t\bar{G}_t^{tr,b} + (1-q_t)\bar{G}_t^{tr,u} \tag{A.4f}$$

$$\frac{\mu_2}{(1-he_t^b)} = \frac{\mu_1(1-\tau_t^l)w_t^g}{q(1-\tau_t^l)w_t^g he_t^b + q\bar{G}_t^{tr,b} + (1-q)\bar{G}_t^{tr,u}} \tag{A.4g}$$

where we use $\bar{G}_t^{tr,b} = s_t^{tr,b}\dfrac{v_t^k}{q_t v_t^b}y_t^f$ and $\bar{G}_t^{tr,u} = s_t^{tr,u}\dfrac{v_t^k}{(1-\varphi_t)v_t^w + (1-q_t)v_t^b}y_t^f$.

Other equations:

$$v_t^k y_t^f = A(v_t^k k_t^k)^{\alpha_1}(A^k v_t^k e_t^k h + A^w\varphi_t v_t^w e_t^w h)^{\alpha_2}\left(\bar{Y}_t^g\right)^{1-\alpha_1-\alpha_2} \tag{A.4h}$$

$$r_t = \alpha_1\frac{y_t^f}{k_t^k} \tag{A.4i}$$

$$w_t^w = \alpha_2 A^w\frac{v_t^k y_t^f}{(A^k v_t^k e_t^k h + A^w\varphi_t v_t^w e_t^w h)} \tag{A.4j}$$

$$w_t^k = \alpha_2 A^k\frac{v_t^k y_t^f}{(A^k v_t^k e_t^k h + A^w\varphi_t v_t^w e_t^w h)} \tag{A.4k}$$

$$(s_t^g + s_t^w + s_t^{tr,k} + s_t^{tr,w} + s_t^{tr,b} + s_t^{tr,u})v_t^k y_t^f + (1+i_t)b_t = b_{t+1} +$$
$$+\tau_t^c(v_t^k c_t^k + v_t^w c_t^w + v_t^b c_t^b) + \tau_t^k v_t^k(r_t k_t^k + \pi_t^k) + \tau_t^l(v_t^k w_t^k e_t^k h + \varphi_t v_t^w w_t^w e_t^w h + q_t v_t^b w_t^g e_t^b h) \tag{A.4l}$$

$$\bar{Y}_t^g \equiv y_t^g = A(s_t^g v_t^k y_t^f)^\theta(q_t v_t^b e_t^b h)^{1-\theta} \tag{A.4m}$$

$$v_t^k c_t^k + v_t^w c_t^w + v_t^b c_t^b + v_t^k(k_{t+1}^k - (1-\delta)k_t^k) + s_t^g v_t^k y_t^f = v_t^k y_t^f \tag{A.4n}$$

$$w_t^g = \frac{s_t^w v_t^k y_t^f}{v_t^b q_t e_t^b h} \tag{A.4o}$$

$$\pi_t^k = (1 - \alpha_1 - \alpha_2) y_t^f \tag{A.4p}$$

We thus have a system of 16 equations in 16 endogenous variables.

Appendix 6: Measure of productive efficiency

Public sector efficiency is defined as public output as a share of public sector expenditure that the government allocates to achieve this particular output. Thus,

$$PubSE_t \equiv \frac{Y_t^g}{G_t^g + G_t^w} = \frac{y_t^g}{s_t^g v_t^k y_t^f + s_t^w v_t^k y_t^f}$$

where Y_t^g is "imputed" from the model solution.

Similarly, we measure private sector efficiency. Thus,

$$\mathrm{Pr}\,ivSE_t \equiv \frac{y_t^f}{r_t k_t^k + w_t^p [e_t^k + \varphi_t \frac{v_t^w}{v_t^k} e_t^w]}$$

Appendix 7: Comparison of lifetime utility under reforms

Status quo economy (denoted by superscript SQ)

Expected discounted lifetime utility for the capitalist, the private worker and the public employee are defined respectively:

$$U^{k,SQ} \equiv \frac{\mu_1 \log c^{k,SQ} + \mu_2 \log(1 - he^{k,SQ}) + (1 - \mu_1 - \mu_2) \log \overline{Y}^{g,SQ}}{1 - \beta}$$

$$U^{w,SQ} \equiv \frac{\mu_1 \log c^{w,SQ} + \varphi \mu_2 \log(1 - he^{w,SQ}) + (1 - \mu_1 - \mu_2) \log \overline{Y}^{g,SQ}}{1 - \beta}$$

$$U^{b,SQ} \equiv \frac{\mu_1 \log c^{b,SQ} + \mu_2 \log(1 - he^{b,SQ}) + (1 - \mu_1 - \mu_2) \log \overline{Y}^{g,SQ}}{1 - \beta}$$

where all variables above are set at their steady state values (if there neither reforms nor shocks, there are no transition dynamics).

Reformed economy (denoted by superscript R)

Expected discounted lifetime utility for the capitalist, the private worker and the public employee are defined respectively:

$$U^{k,R} \equiv \sum_{t=0}^{\infty} \beta^t [\mu_1 \log c_t^{k,\mathrm{R}} + \mu_2 \log(1 - he_t^{k,R}) + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^{g,R}]$$

$$U^{w,R} \equiv \sum_{t=0}^{\infty} \beta^t [\mu_1 \log c_t^{w,R} + \varphi \mu_2 \log(1 - he_t^{w,R}) + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^{g,R}]$$

$$U^{b,R} \equiv \sum_{t=0}^{\infty} \beta^t [\mu_1 \log c_t^{b,R} + q \mu_2 \log(1 - he_t^{b,R}) + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^{g,R}]$$

where the time-paths of all variables above are as in their reformed economy (now there are transition dynamics driven by policy reforms).

Welfare comparison of the two economies

Starting with capitalists, we solve for a consumption subsidy, defined as ξ_k, that makes them indifferent between the two regimes. Thus,

$$\frac{\mu_1 \log\{(1 + \xi_k) c^{k,\mathrm{SQ}}\} + \mu_2 \log(1 - he^{k,\mathrm{SQ}}) + (1 - \mu_1 - \mu_2) \log \overline{Y}^{g,SQ}}{1 - \beta} =$$

$$= \sum_{t=0}^{\infty} \beta^t [\mu_1 \log c_t^{k,R} + \mu_2 \log(1 - he_t^{k,R}) + (1 - \mu_1 - \mu_2) \log \overline{Y}_t^{g,R}]$$

or approximately:

$$\xi_k \cong \frac{(1 - \beta)(U^{k,R} - U^{k,\mathrm{SQ}})}{\mu_1}$$

Similarly, we have $\xi_w \cong \dfrac{(1 - \beta)(U^{w,R} - U^{w,\mathrm{SQ}})}{\mu_1}$ and $\xi_b \cong \dfrac{(1 - \beta)(U^{b,R} - U^{b,\mathrm{SQ}})}{\mu_1}$ for the other two agents.

Table 1: Baseline parameterization

Parameters and policy instruments	Description	Value
α_1	Share of capital in private production	0.33
α_2	Share of labor in private production	0.64
$1-\theta$	Share of public employment in public production	0.569
δ	Capital depreciation rate	0.05
β	Rate of time preference	0.99
μ_1	Preference parameter on private consumption in utility	0.3
μ_2	Preference parameter on leisure in utility	0.6
s^w	Public wage payments as share of GDP (data)	0.132
s^g	Public purchases as share of GDP (data)	0.10
s^{tr}	Public transfers as share of GDP (data)	0.2170
$s^{tr,k}$	Public transfers as share of GDP to capitalists (adjusted)	0.0201
$s^{tr,w}$	Public transfers as share of GDP to private workers (adjusted)	0.0865
$s^{tr,b}$	Public transfers as share of GDP to public sector employees (adjusted)	0.1104
$s^{tr,u}$	Public transfers as share of GDP to unemployed persons (data)	0.0110
τ^c	Tax rate on consumption (data)	0.1938
τ^k	Tax rate on capital income (data)	0.2903
τ^l	Tax rate on labor (data)	0.3780
B/Y	Public debt as a share of GDP (data)	0.9
v^k	Capitalists as share of population (data)	0.1480
v^w	Workers as share of population (data)	0.6370
v^b	Public employees as share of population (data)	0.2150
$1-\varphi$	Probability of unemployment for private workers (set)	0.10
$1-q$	Probability of unemployment for public sector employees (set)	0 and 0.10
A	Long-run TFP (set)	1

Notes: Regarding fiscal policy variables, we use data averages of the Eurozone over 2000-2012 (data source: Eurostat).

Table 2: Steady state solution of the status quo economy

Variable	Status Quo
c^k	0.290
e^k	0.154
k^k	9.547
c^w	**0.237**
e^w	**0.309**
c^b	**0.287**
e^b	**0.186**
w^g / w^p	**1.03**
y	**0.363**
y^g	**0.038**
c/y	0.705
k/y	3.897
b/y	0.9
τ^l	**0.295**
s^w	0.132
$s^{tr,b}$	0.1104
u^k	-0.798
u^w	-0.957
u^b	-0.824
u	-0.905
PubSE	**0.456**
PrivSE	**1.031**
PubSE / PrivSE	**0.442**

Notes: (i) We use the baseline parameterization in Table 1. (ii) $u = v^p u^p + v^b u^b$ (the same formula is used for all per capita quantities).

Table 3: Description of policy reforms

Reform	Description
1	decrease in q and s^w (by 10%)
2	w_g = marginal product of L^g
3	$\overline{G}^{tr,b} / w_g = \overline{G}^{tr,w} / w_p$
4	$\overline{G}^{tr,b} / w_g = \overline{G}^{tr,w} / w_p$, w_g = marginal product of L^g , decrease in q
5	$\overline{G}^{tr,b} / w_g = \overline{G}^{tr,w} / w_p$, $w_g = \rho w_p$, decrease in q

Table 4: Steady state solutions

Variable	Status Quo	Reform 1	Reform 2	Reform 3	Reform 4	Reform 5
c^k	0.290	0.294	0.316	0.333	0.360	0.310
e^k	0.154	0.156	0.171	0.174	0.186	0.163
k^k	9.547	9.592	9.640	9.951	10.133	9.808
c^w	**0.237**	**0.240**	**0.262**	**0.276**	**0.302**	**0.255**
e^w	**0.309**	**0.311**	**0.313**	**0.314**	**0.318**	**0.312**
c^b	**0.287**	**0.282**	**0.207**	**0.191**	**0.121**	**0.255**
e^b	**0.186**	**0.193**	**0.107**	**0.294**	**0.313**	**0.312**
w^g / w^p	**1.03**	**1**	**0.608**	**0.672**	**0.399**	**1**
y	**0.363**	**0.364**	**0.366**	**0.378**	**0.385**	**0.373**
y^g	**0.038**	**0.037**	**0.028**	**0.051**	**0.050**	**0.049**
c/y	0.705	0.705	0.705	0.705	0.705	0.705
k/y	3.897	3.897	3.897	3.897	3.897	3.897
b/y	0.9	0.9	0.9	0.9	0.9	0.9
τ^l	**0.295**	**0.283**	**0.204**	**0.181**	**0.099**	**0.247**
s^w	0.132	0.119	0.044	0.132	0.074	0.190
$s^{tr,b}$	0.1104	0.1104	0.1104	0.022	0.012	0.029
u^k	-0.798	-0.799	-0.815	-0.743	-0.730	-0.760
u^w	-0.957	-0.959	-0.962	-0.888	-0.867	-0.914
u^b	-0.824	-0.826	-0.898	-1.003	-1.136	-0.914
u	-0.905	-0.907	-0.926	-0.891	-0.904	-0.891
PubSE	**0.456**	**0.463**	**0.534**	**0.577**	**0.746**	**0.454**
PrivSE	**1.031**	**1.031**	**1.031**	**1.031**	**1.031**	**1.031**
PubSE / PrivSE	**0.442**	**0.449**	**0.518**	**0.560**	**0.723**	**0.440**

Notes: (i) We use the baseline parameterization in Table 1. (ii) $u = v^p u^p + v^b u^b$ (the same formula is used for all per capita quantities).

Table 5: Discounted lifetime utility

Lifetime utility	Status quo	Reform 5	ξ
U^k	-79.78	-74.81	0.17
U^w	-95.73	-89.78	0.20
U^b	-82.38	-89.78	-0.25
U	-90.50	-87.57	0.10

Notes: (i) We use the baseline parameterization in Table 1. (ii) $U = v^k U^k + v^b U^b + v^w U^w$.