A reform of public sector wages*

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February 12, 2014

Abstract

I propose a reform of public sector wages consisting of: i) a review of pay of all public sector workers to align the distribution of public sector wages with the private sector and ii) stipulating up a rule to determine the yearly growth rate of public sector wages. I set up a DSGE model with labour market frictions and heterogeneous workers to structure the discussion of the reform. I show that, in a sample of 29 developed countries for the pre-crisis period of 1995-2006, countries that deviated more from the rule had a larger increase in the unemployment rate and higher volatility of unemployment relative to GDP.

JEL Classification: E24; E62; J45.
Keywords: Public sector employment; public sector wages; unemployment; fiscal rules.

*This manuscript was prepared for the workshop *Government wage bill: determinants, interactions and effects*, organized by the European Commission (DG ECFIN). I would like to thank Matthias Burgert, Matteo Salto, Gernot Müller and the participants of the workshop for comments and suggestions. .

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1 Introduction

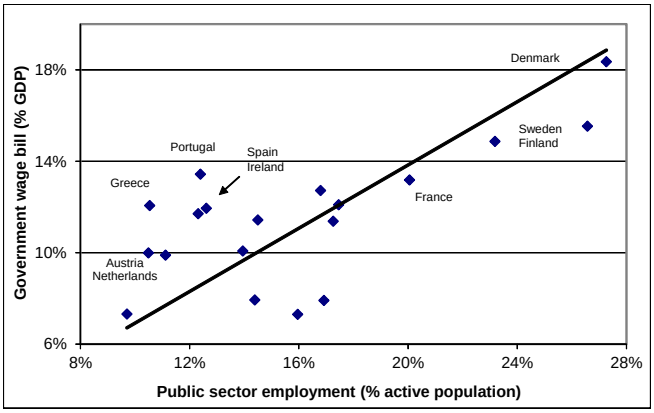
I propose a reform of public sector wages that incorporates some optimality principles on the labour market, and limits the government discretionary power to use public sector wages for political reasons. My proposal builds on two independent pillars. The first pillar consists of a review of pay of all public sector workers, having as benchmark the wages of equivalent workers in the private sector. The second pillar aims to establish a rule to guide the annual increase of public sector wages. The idea behind the rule is that the average public sector wage should target an aggregate measure, such as GDP per worker or the average private wage. This reform offers several advantages: i) it guarantees the parity between the two sectors and that this parity is maintained over the business cycle; ii) it avoids the use of the public sector wage by politicians as an electoral tool; iii) it requires low tax burden in recessions and iv) it is simple and offers more predictability in one of the most important decisions governments take every year.

Public sector wages have two characteristics distinctive from other types of government expenditures. First, they do not directly affect the total supply of government services. Second, they are both a payment to a factor of production and a transfer from society to a specific group of citizens. This makes them vulnerable to be manipulated for political reasons related to elections, rather than preferences, in the spirit of Nordhaus (1975) political cycles. For instance, Borjas (1984) finds that, in the United States, the pay increases in federal agencies are 2 to 3 percent higher on election years. Matschke (2003) also finds evidence of systematic public wage increases of about 2 to 3 percent prior to federal elections in Germany. In Portugal in 2009 - year of crisis and 3 elections - public sector workers saw their wages increase by more than 4 percent in real terms.

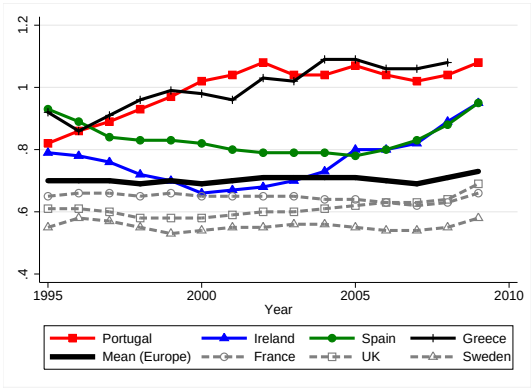
The first chart in Figure 1 shows the size of the general government employment over the active population and the government wage bill as a fraction of GDP for several countries in 2009. Four countries distinguish themselves for having a high public sector wage bill relative to the level of employment: Ireland, Portugal, Spain and Greece. Theses countries were later in the center of the Euro area crisis, because of their poor public finance and sclerotic labour markets. The second chart, shows the evolution of the ratio between these two variables. We can see that, during the decade prior to the crisis, the ratio increased dramatically in these 4 countries relative to other countries like Sweden, United Kingdom or France.

The key idea of the reform is to use private sector wages as the benchmark when deciding the pay in the public sector, across workers and over time. The first step aims to adjust the government wage bill (as in Figure 1a). It avoids excess pay, not through blind cuts for all

Figure 1: Government wage bill and employment



(a) Government wage bill and employment in 2009



(b) Ratio of gov. wage bill (%GDP) over public sector employment (% of active population)

Note: data is from OECD.

public sector workers, but targeting them to the ones who have higher gains relative to the private sector. The second step pushes for the creation of a fiscal rule to set the wage growth in the public sector, that aims to stabilize an aggregate ratio as in Figure 1b.

As a payment for a factor of production, there is no reason for identical worker to have different values of working in the private or the public sector. In a simple RBC model, as in Finn (1998), even if the productivity differ across sectors, identical workers receive the same wage in the two sectors because of arbitrage. With frictions, the labour market tolerates different wages. In a previous paper, I analysed the optimal wage policy in the context of a two sector search and matching model [Gomes (2014), building on Quadrini and Trigari (2007)]. If the government sets a high wage, it induces too many unemployed to queue for public sector jobs and raises private sector wages, thus reducing private sector job creation and increasing unemployment. Conversely, if it sets a lower wage, few unemployed want a public sector job and the government faces recruitment problems. The optimal wage premium depends mainly on the differences in the labour market frictions parameters of the two sectors. For instance, lower separation rate in the public sector induces many unemployed to search there, so the government should offer lower wages to offset it. Over the business cycle, the government wages should follow the one from the private sector to maintain the wage ratio constant. If the public sector wages are acyclical, in recessions they become more attractive relative to the wages in the private sector, inducing more unemployed to queue for public sector jobs. This further dampens job creation in the private sector and amplifies the business cycle. Deviation from the optimal policy can entail significant welfare losses.

The first part of the paper extends the model of Gomes (2014) by introducing worker heterogeneity along two dimensions: education and ability. Heterogeneity in education is relevant for two reasons: i) the government predominantly hires workers with higher education and ii) empirical studies find that the public sector wage premium is different across education categories. Katz and Krueger (1991) find that in the previous two decades in the United States, more educated individuals tend to be paid less in the public sector, while individuals with less education tend to receive a higher premium. As a consequence, they find that blue collar workers are willing to queue to obtain public sector jobs, whereas the public sector has difficulty in recruiting and retaining highly skilled workers. Christofides and Michael (2013) study the public private sector wage gap in 27 European countries and find that less educated workers have higher premium of working in the public sector, with the exception of 5 Eastern European countries. Castro, Salto, and Steiner (2013) find that, on average for the European Union, the public sector wage premium is 11 percent for the low educated, 6 percent for the medium educated and a gap of 6 percent for the high educated. Similar results were found in Giordano et al. (2011). Postel-Vinay and Turon (2007) also finds evidence in the United Kingdom of low-educated workers have higher premium in the public sector, compared to workers with tertiary education. They also find evidence of a more compressed wage distribution in the public sector.

This heterogeneity implies that one size does not fit all. Public sector wage cuts across the board can reduce distortions in the bottom of the distribution but increase it on the top. Modeling the workers by education allows us to analyse these issues and is, by itself, an important contribution to the literature. The most relevant papers that analyse the effects of public employment consider homogeneous workers, as for instance: Algan, Cahuc, and Zylberberg (2002), Finn (1998), Ardagna (2007), Quadrini and Trigari (2007) or more recently Michaillat (2014). There are two notable exceptions. Domeij and Ljungqvist (2006) document a divergence of the skill premium between the United States and Sweden and argue that it can be explained by the expansion of the public sector employment of low-skilled workers in Sweden. Bradley, Postel-Vinay, and Turon (2013) study the effects of public employment on the private wage distribution, in a setting with on-the-job search and transitions between the two sectors.

I also consider ability as a second element of heterogeneity. One common argument to avoid public sector wage cuts is that only the government will not be able to hire high-quality workers. By adding this extra dimension I am able to examine the effects of public sector wages on the average quality of public sector workers. The model also includes capital stock assuming capital-skill complementarity in the private sector, nominal rigidities and

distortionary taxes.

The objective of the model is to guide the discussion of the public sector wage reform. First, it is important to understand the consequences of a pay review of different types of public sector workers in steady-state. I examine the effects on the equilibrium unemployment rate, on the quality of the pool of public sector workers and its composition, on total government spending and welfare. While wage cuts of unskilled government employees reduce unemployment and raise welfare, wage cuts of skilled workers have little effect on unemployment and beyond a certain point reduce welfare. Second, it is important to understand the dynamics of the aggregate unemployment rate following different types of shocks, depending on the rule for public wages. I examine the response to technology, government services, cost-push and monetary policy shocks. I propose several rules and discuss their merits and caveats. The rules that aim to stabilize the aggregate ratio as in Figure 1b, reduce the volatility of unemployment by 20 to 60 percent, depending on the type of shock.

In the final part of the paper I discuss how the reform can be implemented. Using data from European Commission and OECD on 29 countries for the pre-crisis period of 1995-2007, I show that countries that deviate more from the rule had larger increases in the unemployment rate and higher volatility of unemployment relative to GDP. I then discuss some practical issues of the implementation of this reform and some potential problems.

The idea that the public sector wages should follow closely the private sector wages is simple and intuitive, but it does not seem to be acknowledged by policy makers who view the government wage as a stabilization tool. In an occasional paper from the European Central Bank (Holm-Hadulla, Kamath, Lamo, Pérez, and Schuknecht (2010)), the authors argue that the mild procyclicality of wages should be avoided by the government, as increasing wages in expansions might boost aggregate demand and amplify the business cycle. This policy could heavily distort the labour market and puts pressure on the budget during recessions. While under this rule the government would loose one instrument, for the purpose of stabilizing demand the government can use either employment, purchases of intermediate goods, investment or transfers, leaving the wage to promote efficiency in the labour market.

2 Model

The dynamic stochastic general equilibrium model extends Gomes (2014) by adding heterogeneous workers, capital accumulation, distortionary taxation,and nominal rigidities.

2.1 General setting

In the economy there are two sectors $j \in \{p, g\}$. Public sector variables are denoted by the superscript g while private sector variables are denoted by p. Time is discrete and denoted by $t = 0, 1, 2, ...$

The economy is populated by a measure one of workers. Workers differ ex-ante from one another. There are four types of workers: $i \in \{\bar{h}, \underline{h}, \bar{\mu}, \underline{\mu}\}$, with two dimensions of heterogeneity. The first dimension is education with skilled workers (with university degree) denoted by h and the unskilled denoted by μ. Within each group there are workers with higher ability, $(\bar{h}, \bar{\mu})$, and others with lower ability $(\underline{h}, \underline{\mu})$. The productivity of workers of type i is denoted by z^i, with $z^{\bar{h}} > z^{\underline{h}}$ and $z^{\bar{\mu}} > z^{\underline{\mu}}$. The mass of workers of type i is ω^i, with $\sum_i \omega^i = 1$.

For each type, a fraction of workers are unemployed (u_t^i), while the remaining fraction are working either in the public $(l_t^{g,i})$ or in the private $(l_t^{p,i})$ sectors.

$$1 = l_t^{p,i} + l_t^{g,i} + u_t^i, \quad \forall i. \tag{1}$$

Total unemployment is denoted by $u_t = \sum_i \omega^i u_t^i$. The presence of search and matching frictions in the labour market prevents some unemployed from finding jobs. The evolution of employment of type i in sector j depends on the number of new matches $m_t^{j,i}$ and on the job separations. In each period, jobs are destroyed at constant fraction $\lambda^{j,i}$, potentially different across sectors and types.

$$l_{t+1}^{j,i} = (1 - \lambda^{j,i}) l_t^{j,i} + m_t^{j,i}, \quad \forall ji. \tag{2}$$

I assume the markets are segmented and are independent across types. This assumption is worth discussing. While the length of education is easily observable by the employers from the CV, this is not necessarily the case with ability. As we have heterogeneity in ability, we have to take a stand whether this is observable ex-ante by the employers or if it is private information. If ability is not observable, low ability workers can apply to a high-ability job and there might not be an equilibrium with segmented markets. I want to abstract from all the complications arising from asymmetric information. I rely on previous papers that study the issues of asymmetric information with labour market frictions, such as Guerrieri, Shimer, and Wright (2010) or Fernández-Blanco and Gomes (2013). These papers argue that firms can design mechanisms such that workers self-select into the correct segment.[1] In

[1] In the case of Guerrieri, Shimer, and Wright (2010) this is done by contracts specifying the hours worked. Assuming that high-ability workers have lower disutility of work, firms can post a contract specifying a higher wage but more hours, which excludes the low-ability type. In this paper I follow the setting of Fernández-

section 2.4 I explain in more detail why it is not a problem to assume observable types.

A second assumption is that the unemployed can direct their search to the private or the public sector. This assumption finds support in micro-econometric evidence and was discussed in length in Gomes (2014). These two assumptions imply that the new matches are determined by the following matching functions:

$$m_t^{j,i} = m^j(u_t^{j,i}, v_t^{j,i}), \quad \forall ji. \tag{3}$$

I assume the unemployed choose the sector in which they concentrate their search; thus, $u_t^{j,i}$ represents the number of unemployed searching in sector j. Vacancies in each segment are denoted by $v_t^{j,i}$. An important part of the analysis focuses on the behaviour of those unemployed specifically searching for a public sector job, defined as: $s_t^i \equiv \frac{u_t^{g,i}}{u_t^i}$.

From the matching functions we can define $q_t^{j,i}$ as the probability of vacancies of type i in sector j being filled, and $f_t^{j,i}$ as the job-finding rate of an unemployed of type i searching in sector j:

$$q_t^{j,i} = \frac{m_t^{j,i}}{v_t^{j,i}}, \ f_t^{j,i} = \frac{m_t^{j,i}}{u_t^{j,i}}, \quad \forall ji.$$

2.2 Households

Following Merz (1995), I assume all the income of the members is pooled so the private consumption is equalized across members. This is a common assumption on the literature to maintain a representative agent framework in the presence of unemployment. Without this risk sharing assumption, risk-averse workers with different employment histories would accumulate different levels of wealth. As the wealth distribution is not relevant to our problem, I prefer to simplify and keep the representative agent which allows reasonable solutions. The household is infinitely-lived and has the following preferences:

$$E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t) + \nu(u_t)], \tag{4}$$

where

$$c_t \equiv \left(\int_0^1 c_{n,t}^{\frac{\xi-1}{\xi}} dn \right)^{\frac{\xi}{\xi-1}} \tag{5}$$

Blanco and Gomes (2013). They assume that the output of a match depends on the capital supplied by firms and that wages are bargained over between firms and workers. Firms specify a capital plan ex-ante. With capital-skill complementarity, the low-ability worked does not have the incentive to apply to the high-ability job, as it implies having too much capital and hence lower wages.

is the Dixit-Stiglitz basket of consumption goods produced by the final good retail sector. The household also derives utility from the members that are unemployed $\nu(u_t)$, which captures the value of leisure and home production. $\beta \in (0, 1)$ is the discount factor. The budget constraint in period t is given in nominal terms by:

$$p_t c_t + B_{t+1} + p_t K_{t+1} = (1+i_{t-1})B_t + (1-\delta)K_t p_t + (1-\tau_t^k) r_t K_t + \sum_j \sum_i \omega^i w_t^{j,i} l_t^{j,i} (1-\tau_t^l) + \Pi_t, \quad (6)$$

where i_{t-1} is the nominal interest rate from period $t-1$ to t and B_t are the holdings of one period bonds. The households can also save by accumulating capital stock K_t. The capital stock depreciates at a rate δ and can be rented to firms at a nominal rental rate of r_t. The second source of income is labour income. $w_t^{j,i}$ is the nominal wage rate from the members of type i working in sector j. The household pays a tax τ_t^l on its labour income and τ_t^k on the income from the capital stock. Finally, Π_t encompasses the lump sum taxes or transfers from the government and possible profits from the private sector firms. I assume there are no unemployment benefits. p_t is the aggregate price level given by

$$p_t \equiv \left(\int_0^1 (p_t^n)^{1-\xi} dn \right)^{\frac{1}{1-\xi}}. \quad (7)$$

The household chooses the sequence of $\{c_t, K_{t+1}, B_{t+1}^c\}_{t=0}^{\infty}$ to maximize the expected utility subject to the sequence of budget constraints, taking taxes and prices as given. The solution is the Euler equation and an arbitrage condition between capital and bonds:

$$u_c(c_t) = \beta(1+i_t) E_t[\frac{p_t}{p_{t+1}} u_c(c_{t+1})], \quad (8)$$

$$1 + i_t = E_t[\frac{p_{t+1}}{p_t}(1 - \delta + \tilde{r}_{t+1}(1-\tau_{t+1})], \quad (9)$$

where $\tilde{r}_t = \frac{r_t}{p_t}$ is the real rental rate of capital. The second condition compares the nominal interest rate paid by a one-period bond with the expected nominal return on a unit of investment. Notice that, in this specification, the capital tax introduces an extra burden on investment in capital relative to bonds.

2.3 Workers

The unweighted value of each member of type i to the household depends on their current state. The value of being employed in sector j is given by:

$$W_t^{j,i} = (1-\tau_t^l)\tilde{w}_t^{j,i} + E_t\beta_{t,t+1}[(1-\lambda^{j,i})W_{t+1}^{j,i} + \lambda^{j,i}U_{t+1}^{j,i}], \quad \forall ji, \tag{10}$$

where $\beta_{t,t+k} = \beta^k \frac{u_c(c_{t+k})p_t}{u_c(c_t)p_{t+k}}$ is the stochastic discount factor and $\tilde{w}_t^{j,i} = \frac{w_t^{j,i}}{p_t}$ is the real wage. The value of being employed in a specific sector depends on the current wage, as well as the continuation value of the job, which depends on the separation probability. Under the assumption of direct search, unemployed are searching for a job in either the private or the public sector, with value functions given by:

$$U_t^{j,i} = \frac{\nu_u(u_t)}{u_c(c_t)} + E_t\beta_{t,t+1}[f_t^{j,i}W_{t+1}^{j,i} + (1-f_t^{j,i})U_{t+1}^{j,i}], \quad \forall ji. \tag{11}$$

Beside the marginal utility from unemployment, the value of being unemployed and searching in a particular sector depends on the probability of finding a job and the value of working in that sector. Optimality implies that movements between the two segments guarantee no additional gain for searching in one sector *vis-à-vis* the other:

$$U_t^{p,i} = U_t^{g,i} = U_t^i, \quad \forall i. \tag{12}$$

This equality determines the share of unemployed searching in each sector. We can re-write it as

$$\frac{m_t^{p,i}E_t\beta_{t,t+1}[W_{t+1}^{p,i} - U_{t+1}^i]}{(1-s_t^i)} = \frac{m_t^{g,i}E_t\beta_{t,t+1}[W_{t+1}^{g,i} - U_{t+1}^i]}{s_t^i}, \quad \forall i, \tag{13}$$

which implicitly defines s_t^i. An increase in the value of employment in the public sector, driven by either wage increases or a decrease in the separation rate, raises s_t until no extra gain exists for searching in that sector.

2.4 Intermediate good producers

There is a large continuum of firms that produce one of four types of intermediate goods x_t^i that is sold at price $p_t^{x,i}$. Firms open vacancies in a given sub-market i. If the vacancy is filled, the firm is matched to a type-i worker and produce $f(a_t, z^i, k_t^i)$, where a_t is an aggregate productivity that follows an AR1 process and k_t^i is the capital used in the match with a worker of type i. The production technology $f(\cdot,\cdot,\cdot)$ is increasing and concave in all

its arguments with a positive cross partial derivative of capital and skill. The value of a job in real terms is given by

$$J_t^i = \max_{k_t^i}[\tilde{p}_t^{x,i} f^i(a_t, z^i, k_t^i) - \tilde{w}_t^{p,i} - \tilde{r}_t^{p,i} k_t^i + E_t \beta_{t,t+1}[(1-\lambda^{p,i}) J_{t+1}^i], \quad \forall i. \tag{14}$$

For each match, the firm chooses how much capital it wants to rent to provide to the worker. The optimal level of capital k_t^{*i} is solves the first-order condition

$$\tilde{p}_t^{x,i} f_k^i(a_t, z^i, k_t^{*i}) = \tilde{r}_t, \quad \forall i. \tag{15}$$

So we can write the value of a job as

$$J_t^i = [\tilde{p}_t^{x,i} f^i(a_t, z^i, k_t^{*i}) - \tilde{w}_t^{p,i} - \tilde{r}_t^{p,i} k_t^{*i} + E_t \beta_{t,t+1}[(1-\lambda^{p,i}) J_{t+1}^i], \quad \forall i. \tag{16}$$

The value of opening a vacancy for type i is given by:

$$V_t^i = -\kappa^{p,i} + E_t \beta_{t,t+1}[q_t^{p,i} J_{t+1}^i + (1-q_t^{p,i}) V_{t+1}^i], \quad \forall i. \tag{17}$$

where $\kappa^{p,i}$ is the cost of posting a vacancy. The number of firms is determined in equilibrium by free entry

$$V_t^i = 0, \quad \forall i. \tag{18}$$

The surplus from the match is shared by the firm and the worker as wages are bargained over. Let b denote the worker's bargaining power. The private wages are the outcome of a Nash bargaining

$$\tilde{w}_t^{p,i} = \arg\max_{\tilde{w}_t^{p,i}} (W_t^{p,i} - U^i{}_t)^b (J_t^i)^{1-b}, \quad \forall i. \tag{19}$$

The Nash bargaining solution is given by:

$$(W_t^{p,i} - U_t^i) = \frac{b(1-\tau_t^l)}{1-b\tau_t^l}(W_t^{p,i} - U_t^i + J_t^i). \tag{20}$$

In the presence of distortionary taxes the share of the surplus going to the worker is lower than its bargaining power. The reason is that for every unit that the firm gives up in favour of the worker, the pair lose a fraction τ_t to the government. So they economise on their tax payments by agreeing a lower wage.

Notice that, from equation 15, there is only one capital level that maximizes the surplus of the match and hence the wages. Given the capital-skill complementarity, the optimal

level of capital is increasing with ability. This is the key mechanism that insures that, even the ability was not observable, we could design a separating equilibrium. If firms commit to supplying a capital stock of the high type in every period, the low ability workers would not want to pretend to be high ability workers. Even if they would have higher job-finding rate, they would be paired with too much capital for the duration of the match, which would imply lower surplus and lower wages.[2]

2.5 Wholesale firms

There is a representative wholesale firm that, in a competitive market, buys the intermediate inputs, produces a final good. The objective is to choose the inputs to maximize profits given by

$$\max_{\mathbf{x}_t}[\tilde{p}_t^y F(\mathbf{x}_t) - \sum_i \tilde{p}_t^{x,i} x_t^i], \tag{21}$$

where bold denotes a vector, i.e. $\mathbf{x}_t$ denotes a vector with all four intermediate inputs. The solution is given by the first-order conditions:

$$\tilde{p}_t^y F'_{x^i} = \tilde{p}_t^{x,i}, \quad \forall i. \tag{22}$$

2.6 Retails firms

The retailers face monopolistic competition. Each firm n buys the intermediate good, $y_{n,t}$ to use in their production function. Each firm faces a sequence of downward slopping demand curves:

$$y_{n,t+s} = \left(\frac{p_{t+s}^n}{p_{t+s}}\right)^{-\xi} Y_{t+s}, s = 0, 1, ... \tag{23}$$

where Y_t is the aggregate demand of differentiated final goods. The real marginal cost is

$$\varphi_t = \tilde{p}_t^y + \varepsilon_t^c, \tag{24}$$

where ε_t^c is a cost-push shock that follows an AR1 process. I follow the Calvo(1983) price setting model. In each quarter, a share θ of firms does not reset their price. All firms re-optimizing at date t solve an identical problem given by

[2]For details see Fernández-Blanco and Gomes (2013).

$$\max_{p_t^{n,*}} E_t \left\{ \sum_{s=0}^{\infty} \theta^s \beta_{t,t+s} \left[\frac{p_t^{n,*}}{p_{t+s}} - \varphi_{t+s} \right] Y_{n,t+s|t} \right\}$$

$$s.t.$$

$$y_{n,t+s|t} = \left(\frac{p_t^{n,*}}{p_{t+s}} \right)^{-\xi} Y_{t+s}.$$

The optimal pricing decision is therefore

$$E_t \sum_{s=0}^{\infty} (\theta)^s \beta_{t,t+s} Y_{t+s} p_{t+s}^{\xi} (\frac{p_t^*}{p_{t+s}} - \frac{\xi}{\xi - 1} \varphi_{t+s}) = 0. \tag{25}$$

The law of motion for the price level is given by

$$p_t^{1-\xi} = \theta p_{t-1}^{1-\xi} + (1-\theta) p_t^{*1-\xi}. \tag{26}$$

2.7 Government

I assume the government needs to produce a minimum number of services, given by g_t which follows an AR(1) process. To produce these services the government has to hire different types of workers. I consider the public sector wages as the policy variables. I assume that the government can set the wages of the four types of workers one period in advance at the time it posts the vacancies. Given a certain level of wages, the government chooses the vacancies of each type of worker to minimize the total cost of providing the government services. The total costs encompasses the wage bill and the recruitment costs. Its problem is

$$\min_{v_t^{g,i}} \sum_i p_t \omega^i \kappa^i v_t^{g,i} + \beta_{t,t+1} [\sum_i \omega^i w_{t+1}^{g,i} l_{t+1}^{g,i}]$$

$$s.t.$$

$$g_{t+1} = g(\mathbf{l}_{t+1}^g)$$

$$l_{t+1}^{g,i} = (1 - \lambda^{j,i}) l_t^{g,i} + q_t^{g,i} v_t^{g,i}, \quad \forall i.$$

where $g(\mathbf{l}_t^g)$ is the production function of government services that uses the four types of workers, denoted by $\mathbf{l}_t^g$. Given the level of public wages and a market tightness that is taken as given, the government has to guarantee that it post enough vacancies to maintain an employment level capable of providing the government services. The first order conditions

are given by

$$\frac{\omega^i \kappa^i}{q_t^{g,i}} + \beta_{t,t+1}[\omega^i \frac{w_{t+1}^{g,i}}{p_t}] = \zeta_t g'_{i,t+1}, \quad \forall i \tag{27}$$

where ζ_t is the real multiplier of the constraint on government services and $g'_{i,t}$ is the partial derivative of the government services with respect to government employment of type i. This problem incorporates two mechanisms that are important to understand the role of public sector wages. For instance, if the wages of the skilled go down, the government would want to hire more skilled workers, but at the same time might find it harder to recruit them. To maintain a constant level of services, the government has to either spend more resources on recruiting skilled workers or substitute its workforce towards unskilled workers.

The government budget constraint in nominal terms is given by:

$$\tau_t^l(\sum_j \sum_i \omega^i l_t^{j,i} w_t^{j,i}) + \tau_t^k(r_t K_t) = \sum_i \omega^i l_t^{g,i} w_t^{g,i} + \sum_i p_t \omega^i v_t^{g,i} \kappa^{g,i} + T_t + p_t \bar{g}^{int} \tag{28}$$

Where T_t are lump-sum transfers and $\bar{g}^{int}$ are exogenous purchases of intermediate goods. The costs of recruiting are external, meaning that the cost comes out of the budget constraint. Throughout the paper I consider two cases. In the benchmark case any adjustment of the government budget is guaranteed by changes in lump-sum transfers. I also consider a case where distortionary taxes adjust to changes in spending.

2.8 Central bank

Finally, the central bank sets the nominal interest rate i_t using a Taylor rule:

$$1 + i_t = \frac{1}{\beta} + \phi(\pi_t - 1) + \varepsilon_t^m \tag{29}$$

where $\pi_t = \frac{p_t}{p_{t-1}}$ and ε_t^m a monetary policy shock that follows an AR1 process.

2.9 Market clearing

The market clearing conditions in the intermediate and final goods' markets are:

$$x_t^i = \omega l_t^{p,i} f^i(a_t, z^i, k_t^i), \quad \forall i, \tag{30}$$

$$Y_t = F(\mathbf{x}_t) = c_t + g^{\bar{i}nt} + K_{t+1} - (1-\delta)K_t + \sum_i \sum_j \omega^i v_t^{j,i} \kappa^{j,i}. \tag{31}$$

In this economy the measure of GDP as in the national accounts would be $GDP_t = F(\mathbf{x}_t) + \sum_i \omega^i l_t^{g,i} w_t^{g,i}$. The market clearing in the capital market implies that all capital is rented to the intermediate good producers:

$$K_t = \sum_i \omega^i k_t^i l^{p,i}. \tag{32}$$

As bonds are in zero-net supply, the market clearing for bonds is

$$B_t = 0 \tag{33}$$

2.10 Calibration

To solve the model, I consider the following functional forms for the matching functions, production functions and preferences.

$$m_t^{j,i} = \zeta^{j,i}(u_t^{j,i})^{\eta^j}(v_t^{j,i})^{1-\eta^j}, \forall i, j,$$

$$u(c_t) = \frac{c_t^{1-\sigma}}{1-\sigma},$$

$$\nu(u_t) = \chi u_t,$$

$$f(a_t, z^i, k^i) = a_t z^i (k^i)^\alpha \quad \forall i$$

$$F(\mathbf{x}_t) = ((x_t^{\bar{h}})^\varrho + (x_t^{\underline{h}})^\varrho)^{\frac{\Psi}{\varrho}}((x_t^{\bar{\mu}})^\varrho + (x_t^{\underline{\mu}})^\varrho)^{\frac{1-\Psi}{\varrho}}$$

$$g(\mathbf{l}_{t+1}^g) = ((\omega^{\bar{h}} z^{\bar{h}} l_{t+1}^{g,\bar{h}})^\varrho + (\omega^{\underline{h}} z^{\underline{h}} l_{t+1}^{g,\underline{h}})^\varrho)^{\frac{\Phi}{\varrho}}((\omega^{\bar{\mu}} z^{\bar{\mu}} l_{t+1}^{g,\bar{\mu}})^\varrho + (\omega^{\underline{\mu}} z^{\underline{\mu}} l_{t+1}^{g,\underline{\mu}})^\varrho)^{\frac{1-\Phi}{\varrho}}$$

I assume a CRRA utility function and linear utility of unemployment. For the matching function, the matching elasticity with respect to unemployment, η^j, can be different across sectors but not across types, while the matching efficiency, $\zeta^{j,i}$, differs across sectors and education but not by ability. For the production function of individual firms, I assume an elasticity of output with respect to the capital per worker of $\alpha \in (0, 1)$. Finally, I assume that the production function of the final output is a Cobb-Douglas in the skilled and unskilled intermediate outputs with an elasticity of Ψ. The skill input is an aggregation of the low and high ability, with the parameter ϱ determining the elasticity of substitution between types. Finally, the production function of the government is assumed to have the same elasticity of substitution between high and low ability workers as in the private sector.

The model is calibrated to match the UK economy at a quarterly frequency. I calibrate the public sector wage premium to be consistent with microeconometric estimations. The

studies cited in the introduction point to a low or even negative public sector wage premium for workers with university degree. But the is also heterogeneity within the group. Disney and Gosling (1998) find that workers with university degree, on the 75th percentile of the distribution of income, face a negative premium. On the 25th percentile, the premium is close to zero.[3] I set the public sector wages of the four types such that the public-private wage ratio in steady-state is $\frac{w^{g,\bar{h}}}{w^{p,\bar{h}}} = 0.98$, $\frac{w^{g,\underline{h}}}{w^{p,\underline{h}}} = 1$, $\frac{w^{g,\bar{\mu}}}{w^{p,\bar{\mu}}} = 1.03$ and $\frac{w^{g,\underline{\mu}}}{w^{p,\underline{\mu}}} = 1.05$. These numbers reflect two facts about the public sector wages: i) the premium is not homogeneous across groups with skilled workers having lower premium and ii) there is wage compression in the public sector, i.e. for workers with the same education there is lower wage dispersion.

To calibrate the labour market parameters I used data from the Labour Force Survey (LFS) for the period of 2000-2010. During the past 2 decades there has been a significant improvement of the education of the labour force, as documented in Gomes (2012). I take an average of the past decades that places the share of university graduates at 35 percent of the population. I consider that the high and low ability workers have the same mass, so $\omega^{\bar{h}} = \omega^{\underline{h}} = 0.175$ and $\omega^{\bar{\mu}} = \omega^{\underline{\mu}} = 0.325$.

Regarding government employment, $\bar{g}$ and Φ are calibrated such that total government employment is 36 percent for university graduates and 16 percent for workers without university degree. These numbers, also taken from the LFS, reflect the fact that government hire predominantly skilled workers. From the LFS I construct flows data to calibrate the separation rates. I assume that the separation rates are equal for workers of different abilities, but are different by education and sector. The numbers are $\lambda^{p,h} = 0.012$, $\lambda^{p,\mu} = 0.0173$, $\lambda^{g,h} = 0.004$, $\lambda^{p,\mu} = 0.006$. There are two to three times more separations in the private sector compared to the public sector. There are also more separations for unskilled workers.

The matching elasticities with respect to unemployment are set to $\eta^p = 0.4$ and $\eta^g = 0.15$, following Gomes (2014). The bargaining power of workers is set such that the Hosios Condition is satisfied $b = 0.4$. The United Kingdom has a unique source on recruitment costs by sector. Every year, the Chartered Institute of Personal Development performs a recruitment practice survey covering approximately 800 organizations from the following sectors: manufacturing and production, private sector services, public sector services and voluntary, community and not-for-profit sector (CIPD (2009)). The costs of recruiting a worker, which encompass advertising and agency costs, are around £13000 for a skilled worker in the private sector and £8000 for the public sector, corresponding to approximately

[3]See also the survey by Gregory and Borland (1999) or for the United Kingdom see Postel-Vinay and Turon (2007).

26 and 16 weeks of the median income in the United Kingdom. For a low skilled worker the costs are £3500 and £2000 for private and public sector respectively. To target these numbers the costs of posting vacancies are set to $\varsigma^{p,h} = 1.32$, $\varsigma^{g,h} = 0.88$ $\varsigma^{p,\mu} = 0.13$, $\varsigma^{g,\mu} = 0.13$.

The CIPD data also reports vacancy duration. It takes 14.5 weeks to hire a skilled worker in the private sector and 16 weeks in the public sector. For unskilled workers it take 5.5 weeks to hire in the private sector and 9.1 weeks in the public. The matching elasticities are set to match these moments: $\zeta^{g,h} = 0.70$, $\zeta^{p,h} = 0.60$, $\zeta^{g,\mu} = 0.77$ and $\zeta^{p,\mu} = 1.79$.

The parameter of the private production Ψ is set to 0.402 to target an average college premium of 50 percent. I normalize $z^{\underline{h}} = z^{\bar{\mu}} = 1$. I consider that the dispersion of ability is equal for skilled and unskilled workers. I set $z^{\bar{h}} = 1.23$ and $z^{\underline{\mu}} = 0.77$, jointly with the utility of unemployed members of $\chi = 0.547$ to target an unemployment rate of 2.9 percent for the skilled and 6.9 percent for the unskilled. These values imply that the replacement rate is in between 22 percent for the high ability skilled workers and 68 percent for the low ability unskilled workers.[4]

I assume an elasticity of substitution between the workers with different abilities of 10 ($\varrho = 0.9$), making them strong substitutes.

The rest of the parameters are consensual. β is set to 0.99. In the benchmark case I consider log-utility ($\sigma = 1$). The depreciation rate, δ is set to 0.02 and the elasticity of output with respect to capital α is set to 0.33. Regarding the nominal frictions, the elasticity of substitution between different varieties, ϵ is set to 6, implying a markup of 20 percent. The share of firms that are not allowed to reset prices, θ is $\frac{2}{3}$ while the central bank responds to inflation with $\phi = 1.5$. Finally, for the government, I set both the labour and capital tax to be equal to 0.2. The government's purchases of intermediate inputs is $\bar{g}^{int} = 0.05$. The numbers imply that total government consumption is 25 percent of GDP, with 16 percent being the government wage bill.

3 Effect of public sector wages in steady-state

I examine the effects of changing the public sector wages of unskilled workers, skilled workers and all workers. I assume that the labour and capital taxes are kept constant and all

[4]The unobserved heterogeneity implies an average within group interquartile of log wages of around 0.3. Using the British Household Panel Survey, the residuals of mincer regressions by sector and education, show an inter-quartile difference of 0.8. The calibration implies that around 35 percent of the residual dispersion is due to unobserved heterogeneity.

budgetary consequences are neutralized with lump-sum taxes.

Figure 2 shows how the steady-state variables change with the unskilled wages. As the government reduces the unskilled wages, it shifts the composition of public employment from skilled to unskilled workers. Lower public sector wages have two opposite effects: a wage bill effect and a recruitment effect. As unskilled workers become cheaper, the government wants to employ more to save on the wage will. However, offering lower wages makes the public sector less attractive for the unemployed, so fewer will search in the public sector making the recruitment more expensive. When the government reduces the unskilled wages, the first effect dominates, because there is still a queue of unskilled unemployed searching in the public sector. To maintain the same level of services, the government has to hire more workers. However, while total public sector employment increases, the total wage bill plus recruitment costs decrease.

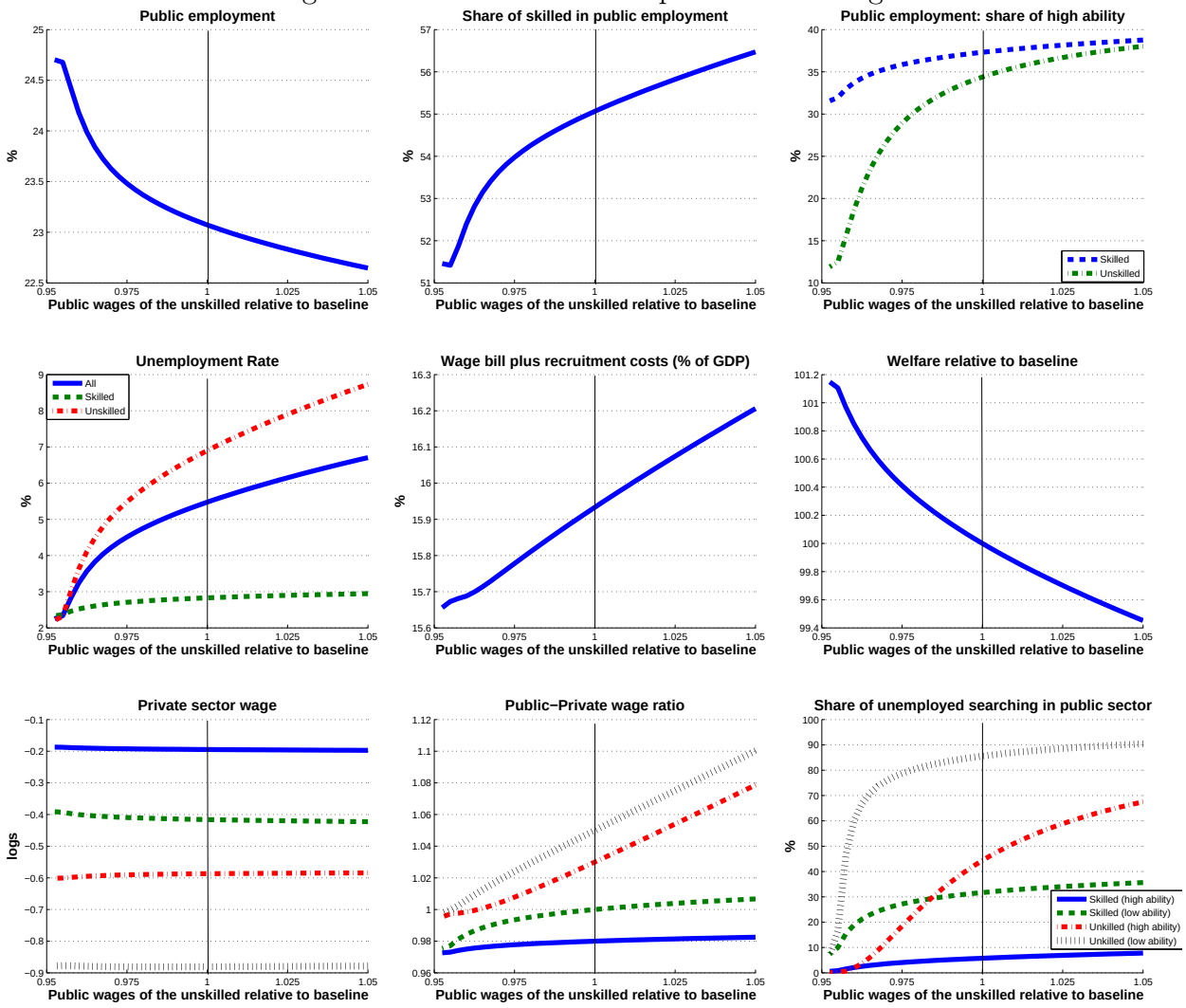
In the labour market, the consequences of lowering the wages of unskilled public sector workers are dramatic. With a 5 percent wage cut, the unemployment rate of the unskilled falls from 7 percent to under 3 percent. Two mechanisms explain this fall. The most important is that, by lowering the public wages, fewer unemployed search in the public sector. By shifting the search to the private sector, firms post more vacancies, thus reducing unemployment.

The second effect is through the spillover on private wages. By lowering the outside option of workers, it reduces the threat point in the wage bargaining and hence wages. The elasticity of private wages with respect to public wages varies and depends crucially on how slack the market is. Notice that, for the unskilled workers with lower ability, reducing wages by 5 percent, reduces the public-private wage premium by 5 percent, implying an elasticity close to zero (private sector wages do not respond). For the unskilled with high ability, a 5 percent fall in wages reduces the public-private wage premium by 3 percent, implying a fall of private sector wages by 2 percent.

The wage policy for the unskilled also impacts the market of skilled workers. Lowering public sector unskilled wages increases the number of unskilled employed in the private sector, which in turn raises the wages of the skilled and lowers their own unemployment rate. Overall, reducing wages of the unskilled raises welfare. A 5 percent wage cut raises the welfare by 1 percent of consumption equivalent variation.

Figure 3 shows how the steady-state variables change with the skilled wages. As the government reduces the wages of the skilled, it shifts the composition of public employment out of skilled workers to unskilled workers. In the case of skilled wage cuts, the recruitment

Figure 2: Effects of unskilled public sector wages



effect dominates the wage bill effect. By offering too low wages, few skilled unemployed look for public sector jobs. The government faces recruitment problems making it very costly to hire a skilled worker. We can see this in the bottom right graph. With wage cuts of more than 3 percent, the share of unemployed searching in the public sector is close to zero. To maintain government services, it has to hire more unskilled workers, with the total size of public employment increasing. This is a case where lowering wages have perverse effects, raising the total wage bill plus recruitment costs.

Cutting wages of skilled public sector workers reduces unemployment, but it does not improve welfare. In fact, a wage cut of 5 percent in skilled wages reduces welfare by 1 percent of consumption equivalent variation relative to baseline.

We can see again that the effect on private sector wages is not linear. When the public

sector wages are close to baseline, the elasticity of private wages is low. But when public sector wages are lower, the elasticity increases. Notice that a cut of skilled wages beyond 4 percent, hardly affects the public-private wage premium. In this region the elasticity of private wages with respect to public wages is close to 1.

In Appendix I show the steady-state effects of an across-the-board public sector wage change. The effects are an average of the two previous cases. With public sector wage cuts, public employment increases, with a lower share of public skilled workers and high ability workers. Unemployment rate goes down, because fewer unemployed search in the public sector. However, if the wage cuts are too high, the wage bill plus recruitment costs increase and welfare is reduced. This is due to the effect on the labour market of skilled workers. I also redo the exercises, with the adjustments in the government budget constraint being

Figure 3: Effects of skilled public sector wages

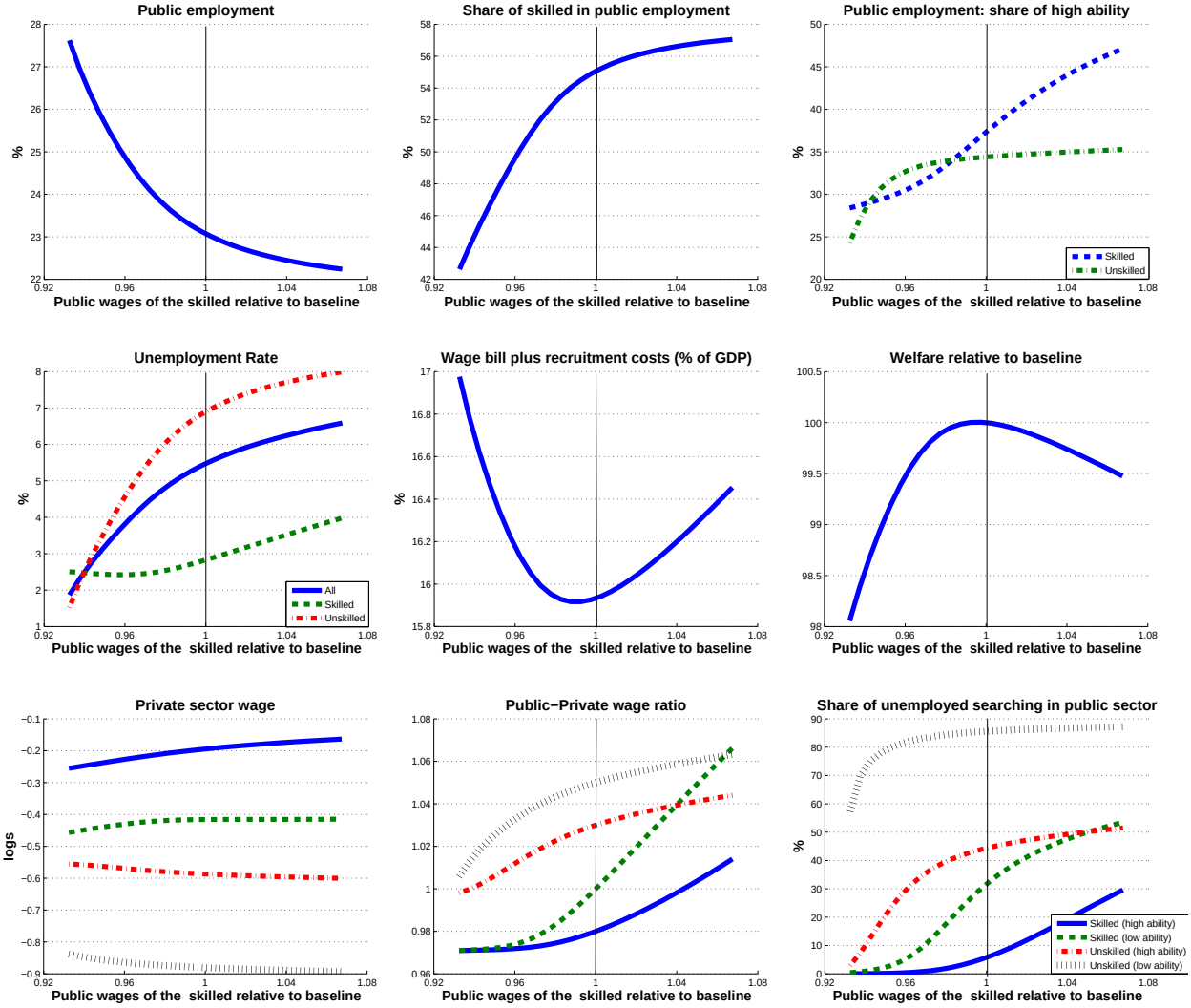


Table 1: Reform of public sector wages

Public-private wage ratio	Baseline $\bar{h}: 0.98$, $\underline{h}: 1$ $\bar{\mu}: 1.03$, $\underline{\mu}: 1.05$	Reform 1 $\bar{h}: 1$, $\underline{h}: 1$, $\bar{\mu}: 1$, $\underline{\mu}: 1$	Reform 2 $\bar{h}: 0.98$, $\underline{h}: 0.98$ $\bar{\mu}: 1$, $\underline{\mu}: 1$
Unemployment rate	0.0548	0.0411	0.0336
Skilled	0.0283	0.0301	0.0264
Unskilled	0.0690	0.0470	0.0376
Public employment	0.231	0.2244	0.2294
Private employment	0.715	0.7346	0.7370
Consumption	0.583	0.5915	0.5941
Wage bill + recruitment costs (%GDP)	0.1593	0.1577	0.1565
Welfare Gains relative to baseline	-	0.78%	0.80%

financed with income taxes ($\tau_t^l = \tau_t^k$). The qualitative results remain unchanged.

3.1 A public sector wage reform

Lets consider a review of public sector wages to have a clearer parity with the private sector across workers in steady-state. I consider two scenarios. In the first scenario, the wages of all workers are the same as in the private sector. In the second scenario the wages of the unskilled are the same, and the wages of the skilled face a gap of 2 percent. The results are shown in Table 1

We can see that both reforms lower unemployment rate significantly, from 5.5 percent to 4.1 and 3.4 percent respectively. This is linked to the fall in unskilled unemployment, whereas skilled unemployment rate stays relatively flat. The sum of the wage bill with the recruitment costs as a fraction of GDP falls and overall there are welfare gains of around 0.8 of consumption equivalent variation.

4 Business cycle policies

We now turn to the business cycle policies. The objective is to examine how the volatility of unemployment depends on the cyclicality of government wages. Existing evidence by Lane (2003) and Lamo, Pérez, and Schuknecht (2008) suggest that public sector wages are less procyclical than private sector wages. Additionally, a study by Devereux and Hart (2006) using micro data for the United Kingdom finds that for job movers in the private sector, the wages are procyclical but for the public sector they are acyclical.

I assume that the government adjusts the wages of all types of workers proportionally. I

consider first that the government sets the real wage as:

$$\log(\frac{w_{t+1}^{g,i}}{p_t}) \quad = \quad \log(\bar{w}^g) + \gamma[\log(\frac{w_t^p}{p_{t-1}}) - \log(\bar{w}^p)]. \tag{34}$$

where $w_t^p \equiv \frac{\mathbf{w}_t^p \mathbf{l}_t^p}{l_t^p}$ represents the average nominal wage in the private sector. γ measures the cyclicality of wages. If $\gamma = 0$ wages do not respond to private sector wages. If $\gamma = 1$ the public wages respond 1 to 1 with the wages in the private sector. If $\gamma < 0$, they are countercyclical.

I consider two additional procyclical rules, in which the growth rate of public sector wages for the subsequent period Ξ_{t+1} is such that an aggregate target for the average wage is met. I am going to consider two possible targets:

$$Target\ 1: \quad \Xi_{t+1} \frac{\mathbf{w}_t^g \mathbf{l}_t^g}{l_t^g} \quad = \quad \Upsilon^y \times p_t \times GDP_t \tag{35}$$

$$Target\ 2: \quad \Xi_{t+1} \frac{\mathbf{w}_t^g \mathbf{l}_t^g}{l_t^g} \quad = \quad \Upsilon^w \times \frac{\mathbf{w}_t^p \mathbf{l}_t^p}{l_t^p} \tag{36}$$

We can have two interpretations of the first rule. On the left hand side we have a measure on average nominal public sector wages and we index it to a measure of nominal GDP per capita (the labour force has a measure of 1), such that the ratio is the same as steady-state, given by Υ^y. Alternatively we could interpret the rule as the government maintaining the wage bill relative to GDP proportional to the share of public sector workers as in steady-state. In the second rule, the government maintains the same proportion of the average nominal public sector wages relative to the average nominal private sector wages as in steady-state, given by Υ^w. The spirit of the rules goes back to Figure 1b where the government determines the growth rate of wages to stabilize the ratio. In these cases they are backward looking ruler, where the government sets tomorrow's wage as a function of today's variables.

Gomes (2014) finds that, following technology shocks, an acyclical wage policy raises the volatility of unemployment significantly. In recessions, when private sector wages fall, if they are not accompanied by the public sector, unemployed turn to the public sector for jobs, which further reduces job creation in the private sector, amplifying the business cycle. I want to measure the effects of different wage policies on unemployment, but considering 4 types of shocks: technology shocks, government services shocks, cost-push shocks and monetary policy shocks, with persistence of 0.95.

Table 2 shows the volatility of unemployment, consumption and inflation relative to the acyclical public sector wage rule. We can see that procyclical wages reduce unemployment volatility between 20 to 55 percent, depending on the shock, relative to the acyclical public sector wages. On the other hand, even a mild countercyclical wage (with $\gamma = -0.3$) raises unemployment volatility by 20 to 55 percent.

The two rules that target aggregate moments capture the procyclicality of public sector wages, so they also reduce the volatility of unemployment. The rule that targets the ratio of government wage bill to the private wage bill does even better than the procyclical wage. The rule that targets the government wage bill as a fraction of GDP does not perform as well and, in the case of shocks to government services, raises the volatility of unemployment. The reason why the rule that targets the government wage bill as a fraction of GDP does worse is because changes in unemployment or capital income that do not affect private wages would generate adjustments in public sector wages.

Comparing now the volatility of other variables, we see that the procyclical wages also reduces the volatility of consumption by 1.2 percent in the case of technology shocks and 13.2 percent in the case of cost-push shocks. Inflation volatility goes up with procyclical wages, following technology and government's services shocks. However, these are the two shocks that generate the lower inflation volatility. On the other hand, in the case of cost-push shocks, a procyclical wage reduces the volatility of inflation by around 6 percent.

Table 3 shows the relative unemployment volatility under 4 alternative settings. The first setting is with a forward looking rule, in which the decisions are based on expectations about next period variables rather than today's. The second is with distortionary taxation instead of lump-sum taxes. The third is a case where the government maintains the same level and composition of employment. Finally I consider a case with an alternative interest rate rule, where the central bank also responds to changes in output.

In all four cases, the procyclical rules reduce unemployment volatility significantly following technology and cost push shocks. In three cases, following a government service shock the procyclical wage rule increases the volatility of unemployment but by no more than 7 percent.

Comparing the two rules that target the aggregate ratios, the rule that targets the ratio of public and private wage bills perform better in most cases. With a forward look rule, Rule 2 decreases the volatility of unemployment following all shocks, while Rule 1 only reduces

Table 2: Volatility of key variables relative to acylical policy

Optimal rule	Procyclical ($\theta = 1$)	Countercyclical ($\theta = -0.3$)	Target 1	Target 2
Technology shocks				
Unemployment	-55.2%	54.4%	-52.4%	-56.7%
Consumption	-1.2%	0.8%	-0.5%	-1.1%
Inflation	12.0%	1.7%	10.3%	11.4%
Government services				
Unemployment	-30.3%	19.1%	9.4%	-31.2%
Consumption	-2.0%	1.1%	1.3%	-2.0%
Inflation	6.1%	-1.0%	9.9%	4.1%
Cost-push shocks				
Unemployment	-22.7%	28.1%	-16.9%	-22.5%
Consumption	-13.2%	5.4%	-10.8%	-13.1%
Inflation	-6.6%	4.7%	-3.7%	-6.9%
Monetary policy shocks				
Unemployment	-41.0%	21.7%	-8.6%	-47.6%
Consumption	-8.3%	4.0%	-2.7%	-9.4%
Inflation	0.4%	-0.2%	0.0%	0.6%

volatility following technology and cost-push shocks. With distortionary taxation and with an alternative interest rate rule, Rule 1 reduces volatility of unemployment following all shock except government services.

5 A reform of public sector wages in practice

5.1 Setting a target

In this section I evaluate whether developed countries are implicitly following a rule. I collected data from AMECO on compensation to government employees, compensation to employees in the economy and GDP, all in nominal terms. From Eurostat I collect data on government employment, total employment, labour force, working age population and the unemployment rate. When data on government employment is absent, I complement it with data from OECD. Overall, the sample contains 29 countries for the pre-crisis period of 1995-2007.

Using the data I compute three series:

- Rule 1a: $\frac{\text{Government Wage Bill}}{\text{Nominal GDP}} / \frac{Government\ \ Employment}{Labour\ \ Force}$,
- Rule 1b: $\frac{\text{Government Wage Bill}}{\text{Nominal GDP}} / \frac{Government\ \ Employment}{Working\ \ Age\ \ Population}$,

Table 3: Volatility of unemployment relative to acylical policy, robustness

Optimal rule	Procyclical ($\theta = 1$)	Countercyclical ($\theta = -0.3$)	Target 1	Target 2
Forward looking rule				
Technology shocks	-56.8%	37.9%	-48.3%	-57.0%
Government services	1.0%	-0.5%	84.5%	-28.7%
Cost-push shocks	-21.2%	14.6%	-11.7%	-22.4%
Monetary policy shocks	-27.7%	9.1%	38.2%	-51.9%
With distortionary taxes				
Technology shocks	-57.1%	47.6%	-58.0%	-58.8%
Government services	-19.5%	12.7%	15.4%	-20.2%
Cost-push shocks	-26.5%	24.7%	-21.4%	-26.9%
Monetary policy shocks	-35.5%	17.6%	-8.9%	-42.0%
With constant public employment				
Technology shocks	-47.8%	18.0%	-50.3%	-47.8%
Government services	1.0%	-0.3%	-0.4%	1.0%
Cost-push shocks	-21.1%	6.5%	-14.0%	-21.1%
Monetary policy shocks	12.5%	-3.9%	-10.9%	12.5%
Alternative interest rate rule				
Technology shocks	-68.3%	50.8%	-54.1%	-67.5%
Government services	6.6%	9.7%	26.4%	10.3%
Cost-push shocks	-33.6%	40.5%	-21.9%	-33.0%
Monetary policy shocks	-41.4%	28.2%	-13.7%	-46.6%

- Rule 2: $\frac{\text{Government Wage Bill}}{\text{Private Sector Wage Bill}} / \frac{Government\ \ Employment}{Private\ \ Sector\ \ Employment}$.

The first two rules set the government wage bill as a fraction of GDP, normalize them by the fraction of government employment. The first case includes government employment as a fraction of the labour force and the second case as a fraction of the working-age population. In the model, there was no distinction between the two because they were the same, but in reality the two might differ because of movements in labour force participation. In Rule 2, I normalize the government wage bill as a fraction of private sector wage bill by the ratio of public to private sector employment. In essence, this is a measure of aggregate wage premium.

In Appendix, I show the behaviour of these three rules for different countries. With this data, I do two exercises. First, I compute the change of unemployment rate between 1995 and 2007 for each country and regress it on the trend of each of the rule. The coefficient is positive and significant independently of the rule considered, with R-squared varying from 0.12 to 0.29. Without claiming causality I show that, as consistent with Section 3, countries for which the public sector wage increased relatively more, are also the ones that had bigger

Table 4: Rules and macroeconomic performance

	Rule 1a	Rule 1b	Rule 2
	$Trend^{1995-2007}$	$Trend^{1995-2007}$	$Trend^{1995-2007}$
$\Delta(Unemployment\ rate)_{1995-2007}$	0.902***	0.634***	0.373*
	(2.67) [0.21]	(3.31) [0.29]	(1.94) [0.12]
	St.dev.	St.dev.	St.dev.
$\frac{St.dev.\ (Unemployment\ rate)}{St.dev.\ (Real\ GDP\ growth)}$	10.363***	6.222***	6.224***
	(3.44) [0.30]	(3.74) [0.34]	(3.54) [0.32]

Note: The first panel shows the regression of the change in unemployment rate between 1995 and 2007 on the same period trend of the respective rule. In brackets is the t-statistic and in square brackets the R-squared. Statistical significance at 1 percent (***), 5 percent (**) and 10 percent (*). The countries included in the sample are: Norway, Finland, Slovakia, Slovenia, Portugal, Malta, Hungary, Luxembourg, Lithuania, Latvia, Cyprus, Italy, France, Greece, Denmark, Czech Republic, Bulgaria, Belgium, Ireland, Spain, Netherlands, Austria, Poland, United Kingdom, Iceland, United States, Japan, Canada, Germany and Sweden.

increases in unemployment rate.

I then compute the volatility of the unemployment rate relative to the volatility of real GDP growth and regress it on the standard deviations of the target. I interpret the standard deviation as a measure of how far the government is from following the rule. We can see that the coefficient is positive and significant. As consistent with the results from Section 4, countries that deviate more from the rule also have higher volatility of unemployment relative to volatility of real GDP growth. The R-squared between 0.30-0.34.

5.2 Implementing a rule

The implementation of a reform of public sector wages requires two steps.

The first step is to review the pay schedule and progression structure of public sector workers by occupation and education. In many European countries the pay structure in the public sector is obsolete. Fore each specific occupation and level of education, the public sector wage should be set having as benchmark the private sector wages. Some adjustments might be considered. For instance, if there are substantial differences in separation rate between public and private sector workers, public sector wages can be adjusted downwards to compensate for the job security premium. The wages might also be adjusted downwards if the government offers other significant perks and benefits (i.e. medical care, pensions). On the other hand, an efficiency wage premium can be offered for sensitive types of jobs, such as the ones involving national security or jobs that are prone to attempts of corruption.

For occupations with low private sector employment (for instance judges) they should be comparable to occupations in the private sector with similar careers and education. Here there is scope for some political choices. One element that is absent from the model is the

tenure profile. In practice, we want to match the tenure profile of the public sector to the private. Also important, but more difficult, is the creation of a sensible evaluation scheme for public sector workers. Good performance should be associated with extra compensation, as a way to reward the unobservable skills and avoid the wage compression.

Once a review of pay schedule is done, the government can define one of the three target proposed above. Each year, the government should set the growth rate of public sector wages to maintain one of the these targets in line. When deciding, the government should take in account that the growth rate of public sector wages has an *automatic* component based on progression structure.

Having an aggregate target to anchor the choice of public sector wage growth gives more stability and predictability, allowing the private sector agents to incorporate it when forming expectations. While it is true that the government looses on instrument, for any desired counter-cyclical policy, it can still use employment, investment, purchases of intermediate goods or transfers, that are arguably more effective. Suppose we enter in a deep recession, and the public sector wages fall by two percent, it allows the government to increase employment by 2 percent while keeping spending constant, which can arguably have a stronger effect on aggregate demand.

While within a few years it is unlikely that changes in composition of public employment can drive the aggregate ratios, this can happen after a long period of time. To avoid it, the pay structure of the public sector workers can be re-evaluated every 10 years, to adjust targets for composition.

6 Conclusion

In this paper I propose a reform of public sector wages consisting on: i) a review of pay per occupation and education level and ii) setting up a simple rule to guide the public sector wage growth.

During the Euro Area crisis, countries facing budgetary pressures undertook severe public sector wage cuts. In most cases the cuts were larger for skilled workers. The model suggest that this might have negative consequences as the best public sector workers will be harder to retain. A review of pay per occupation is important to make the whole distribution of public sector wages closer to the distribution of private sector wages.

An implication of the reform is that the unskilled public sector workers would see their wage cut more than the skilled workers. In a period after a substantial rise in inequality, this

is a hard policy to implement. It is true that the mitigation of inequality is a valid policy objective. But the key insight is that if the government wants to lower inequality, it should use a suitable instrument. It should use the income tax, lowering it for the lowest income earners. By trying to deal with problem of inequality, only protecting an arbitrary group of workers (public sector), the government does not solve the problem and it further increases distortions in the labour market.

The most used example of a fiscal rule is the Stability Pact, that imposed a 3 percent ceiling on government deficits of European Union member states. However, the rule does not guide or inform the governments on how to achieve it. It does not have the spirit of, for instance, a Taylor Rule that explicitly gives a relation between the state of the economy and a policy variable. In contrast with a central bank, which typically only uses the interest rate as an instrument, the government controls a wide range of instruments. In particular, on the expenditure side, it decides on investment, purchases of goods and services, employment, wages and transfers. Can all of these variables be determined by a rule? If we think of investment, purchases of goods and services or employment, we face the problem that these variables involve a political choice reflecting the preferences of society for the supply of public goods. Hence, it is difficult to define a rule for them.[5] Transfers, are also somewhat politically motivated as a tool to protect the weakest members of society. On the other hand, public sector wages have very different characteristics. First, they do not directly affect the total supply of government services. Second, they are both a payment to a factor of production and a transfer from society to a specific group of citizens.

Implementing a fiscal rule that determines the public sector wage increases, such that they track more closely the behaviour of the private sector has several advantages. It maintains the parity between the two sectors. It reduces the scope of government to use wages for electoral purposes. It requires a low tax burden in recessions. It is simple and easy for economic agents to understand. It introduces some predictability in one of the most important decisions government take every year.

The implications of this rule are similar to Costain and de Blas (2012). I argue that, in recessions the public sector wages should go down to maintain the parity with the private sector which implies lower government spending. In their paper, they look at the best way to stabilize debt in response to shocks and find that the best one is by adjusting transfers and wages, rather than taxes. Although they use a different mechanism, both papers agree on what the government should do.

[5]Technically, in our models, these variables would enter in the utility function.

The idea that the public sector wages should follow closely the private wages is simple and intuitive, but it does not seem to be acknowledged by policy makers who view the government wage as a stabilization tool. In a recent occasional paper from the European Central Bank (Holm-Hadulla, Kamath, Lamo, Pérez, and Schuknecht (2010)), the authors argue that the mild procyclicality of wages should be avoided by the government, as increasing wages in expansions might boost aggregate demand and amplify the business cycle. This policy could heavily distort the labour market. While under this rule the government would loose one instrument, for the purpose of stabilizing demand the government can use either employment, purchases of intermediate goods, investment or transfers, leaving the wage to promote efficiency in the labour market.

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Appendix

Table A1: Baseline calibration

Parameter value	Description	Target
$z^{\bar{h}} = 1.231$	Market ability of type $\bar{h}$	Unemployment rate
$z^{\underline{h}} = 1$	Market ability of type $\underline{h}$	Normalization
$z^{\bar{\mu}} = 1$	Market ability of type $\bar{\mu}$	Normalization
$z^{\underline{\mu}} = 0.769$	Market ability of type $\underline{\mu}$	Normalization
$\omega_{\cdot} = \omega^{\bar{h}} = 0.175$	Weight of type h	Labour Force Survey + Normalization
$\omega^{\underline{\mu}} = \omega^{\bar{\mu}} = 0.325$	Weight of type h	Labour Force Survey + Normalization
$\alpha = 0.33$	Capital elasticity	Standard
$\beta = 0.99$	Discount factor	Annual interest rate of 4 percent
$\sigma = 1$	Elasticity of Intertemporal substitution	Log-utility
$\eta^g = 0.15$	Matching elasticity public sector	Gomes (2013)
$\eta^p = 0.40$	Matching elasticity private sector	Gomes (2013)
$\zeta^{g,h} = 0.697525$	Matching efficiency public sector, skilled	Target average time to fill a vacancy (CIPD)
$\zeta^{p,h} = 0.598713$	Matching efficiency private sector, skilled	Target average time to fill a vacancy (CIPD)
$\zeta^{g,u} = 0.774184$	Matching efficiency public sector, unskilled	Target average time to fill a vacancy (CIPD)
$\zeta^{p,u} = 1.78998$	Matching efficiency private sector, unskilled	Target average time to fill a vacancy (CIPD)
$\kappa^{g,h} = 0.881099$	Vacancy posting cost, public sector, skilled	Target cost per hire (CIPD)
$\kappa^{p,h} = 1.31752$	Vacancy posting cost, private sector, skilled	Target cost per hire (CIPD)
$\kappa^{g,u} = 0.125281$	Vacancy posting cost, public sector, unskilled	Target cost per hire (CIPD)
$\kappa^{p,u} = 0.132509$	Vacancy posting cost, private sector, unskilled	Target cost per hire (CIPD)
$\lambda^{g,h} = 0.004$	Job separation in public sector, skilled	Labour Force Survey
$\lambda^{p,h} = 0.012$	Job separation in private sector, skilled	Labour Force Survey
$\lambda^{g,\mu} = 0.006$	Job separation in public sector, unskilled	Labour Force Survey
$\lambda^{p,\mu} = 0.0173$	Job separation in private sector, unskilled	Labour Force Survey
$\delta = 0.02$	Depreciation rate	Standard
$\xi = 6$	Elasticity of substitution	Standard
$\theta = 2/3$	Calvo parameter	Standard
$\Phi = 0.795745$	Weight of h in gov. production	Target share of skilled workers in the gov.
$\bar{g} = 0.135769$	Government services	Target total government employment
$\Psi = 0.402202$	Weight of h in prod. of output	Target a skill premium of 50 percent
$\chi = 0.547142$	Unemployment disutility	Unemployment rate
$\tau^l = 0.2$	Labour tax	Standard
$\tau^k = 0.2$	Capital tax	Standard
$\varrho = 0.90$	Elasticity of substitution between workers	High substitutability

Figure A1: Effects of public sector wages

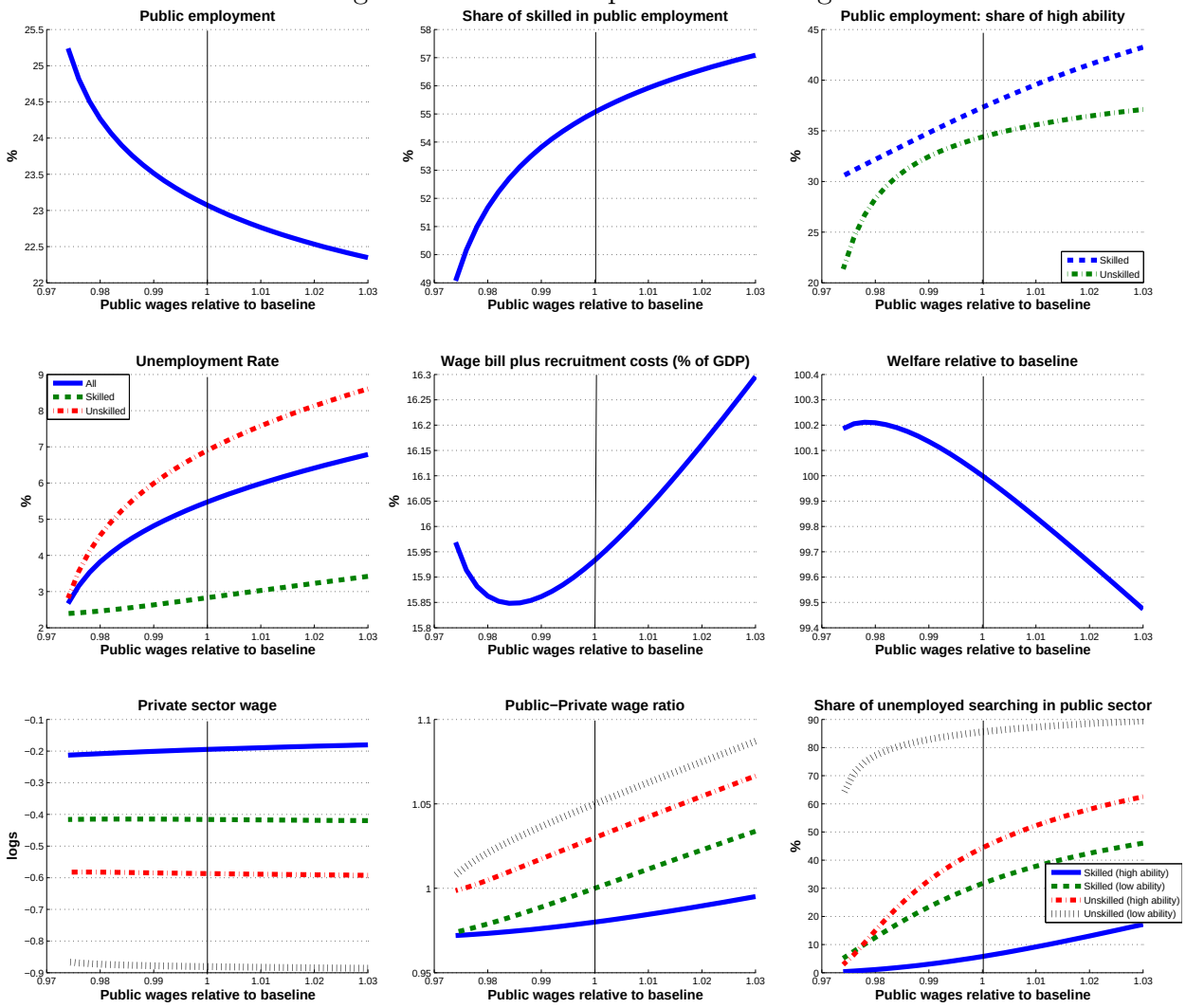
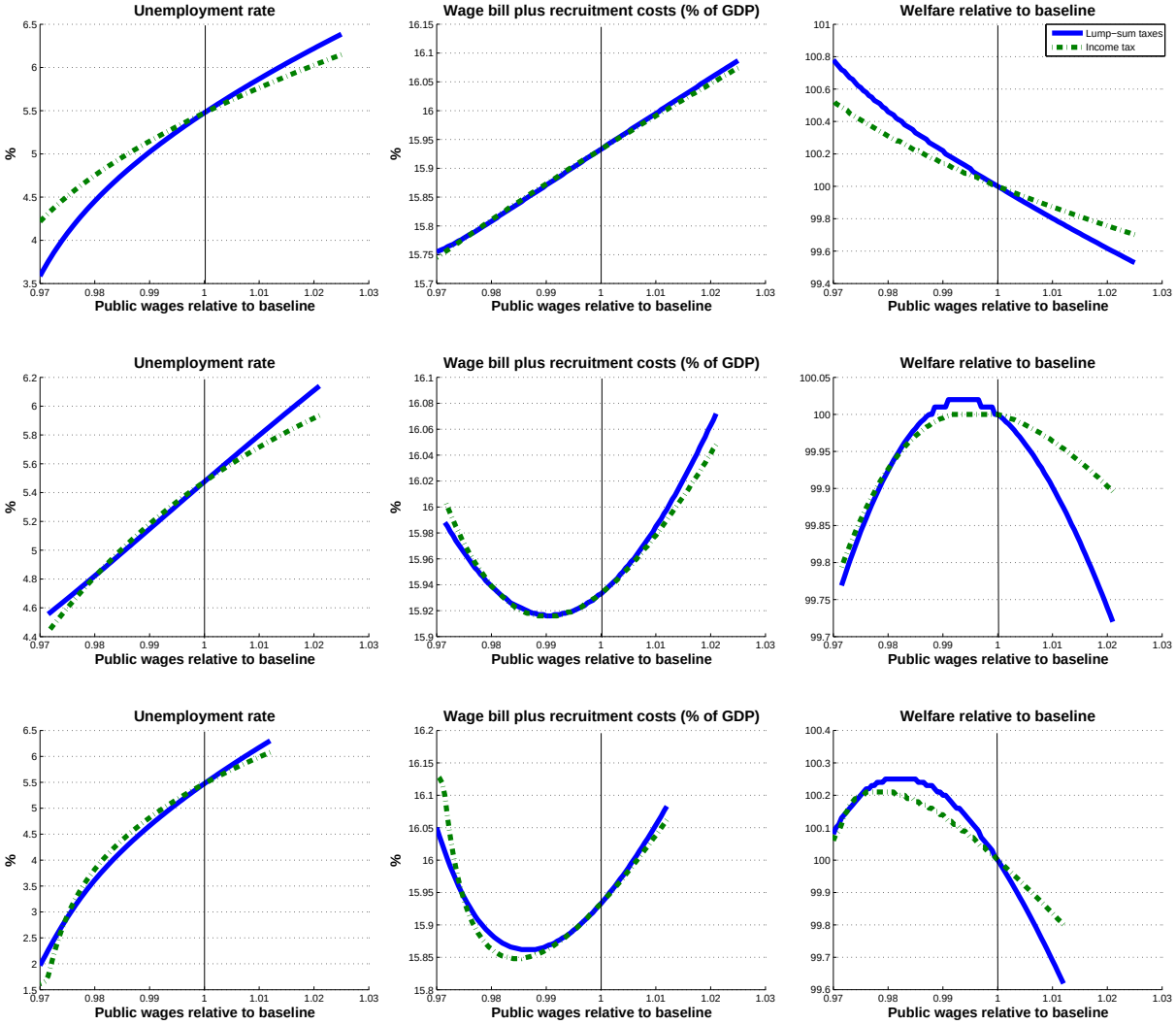


Figure A3: Effects of public wages with distortionary taxes



Notes: The first row is the change of unskilled wages, the second row is the changes of skilled wages and the third row is the change in all wages.

Figure A4: Aggregate rules for different countries

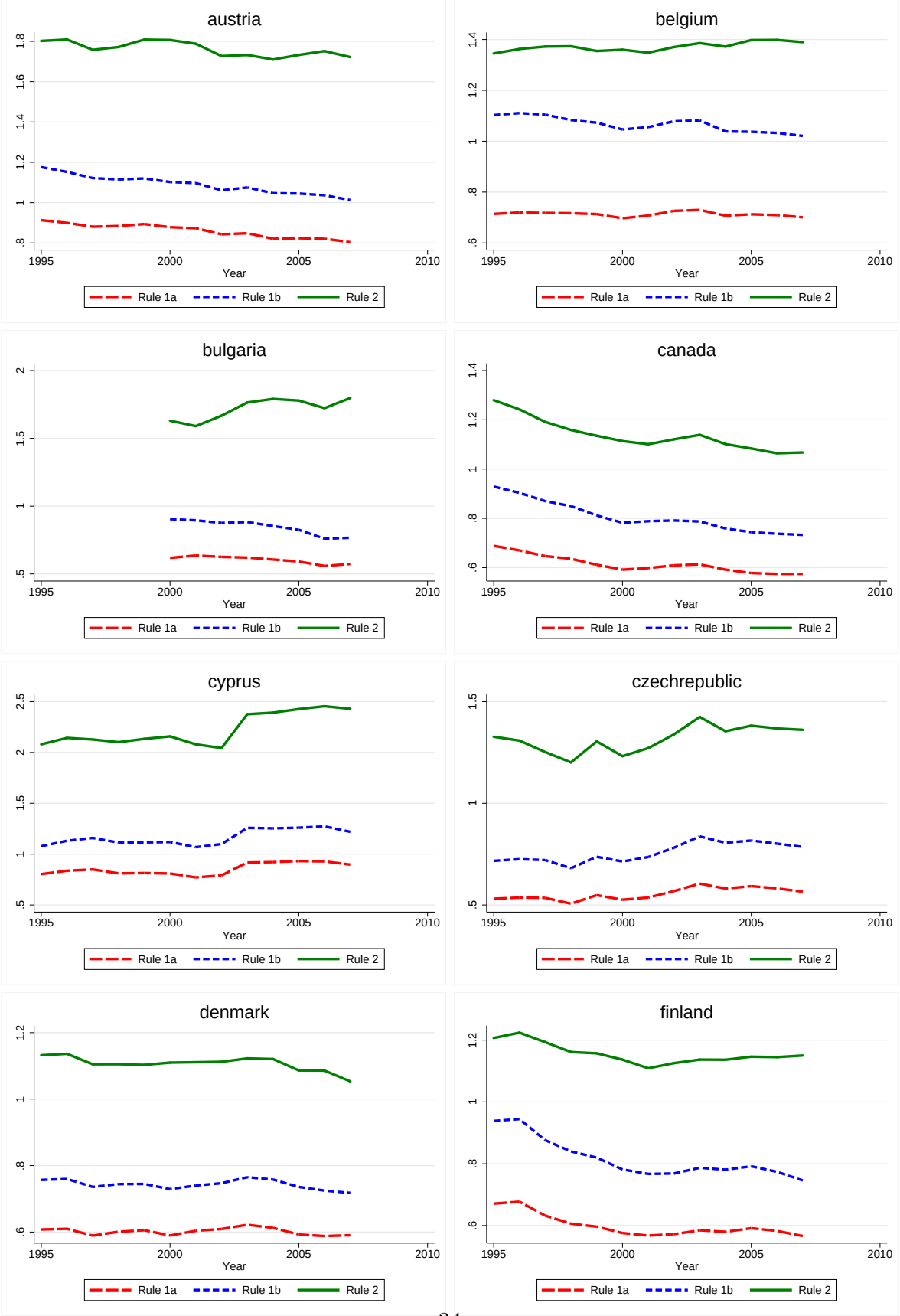


Figure A4: Aggregate rules for different countries (cont.)

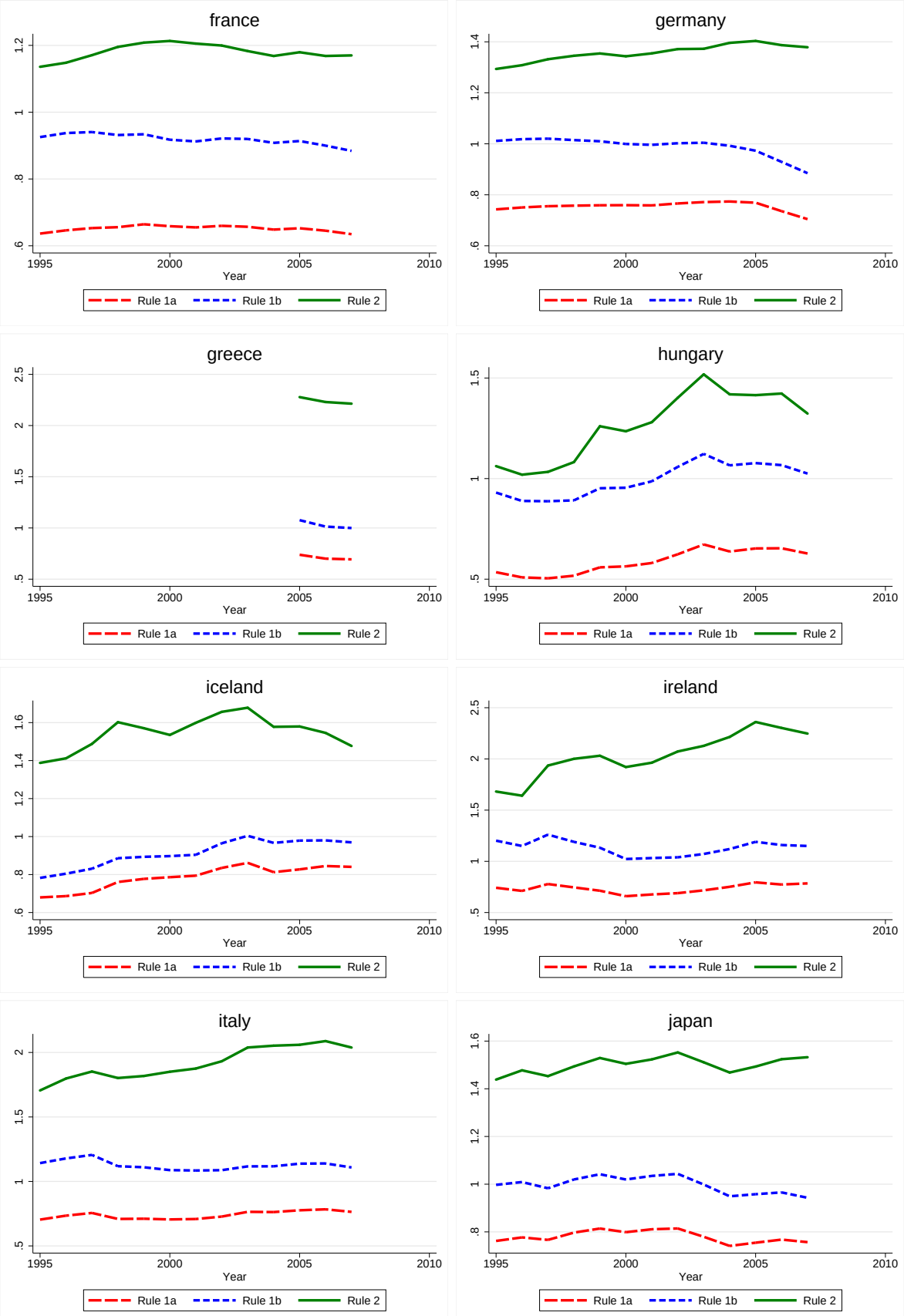


Figure A4: Aggregate rules for different countries (cont.)

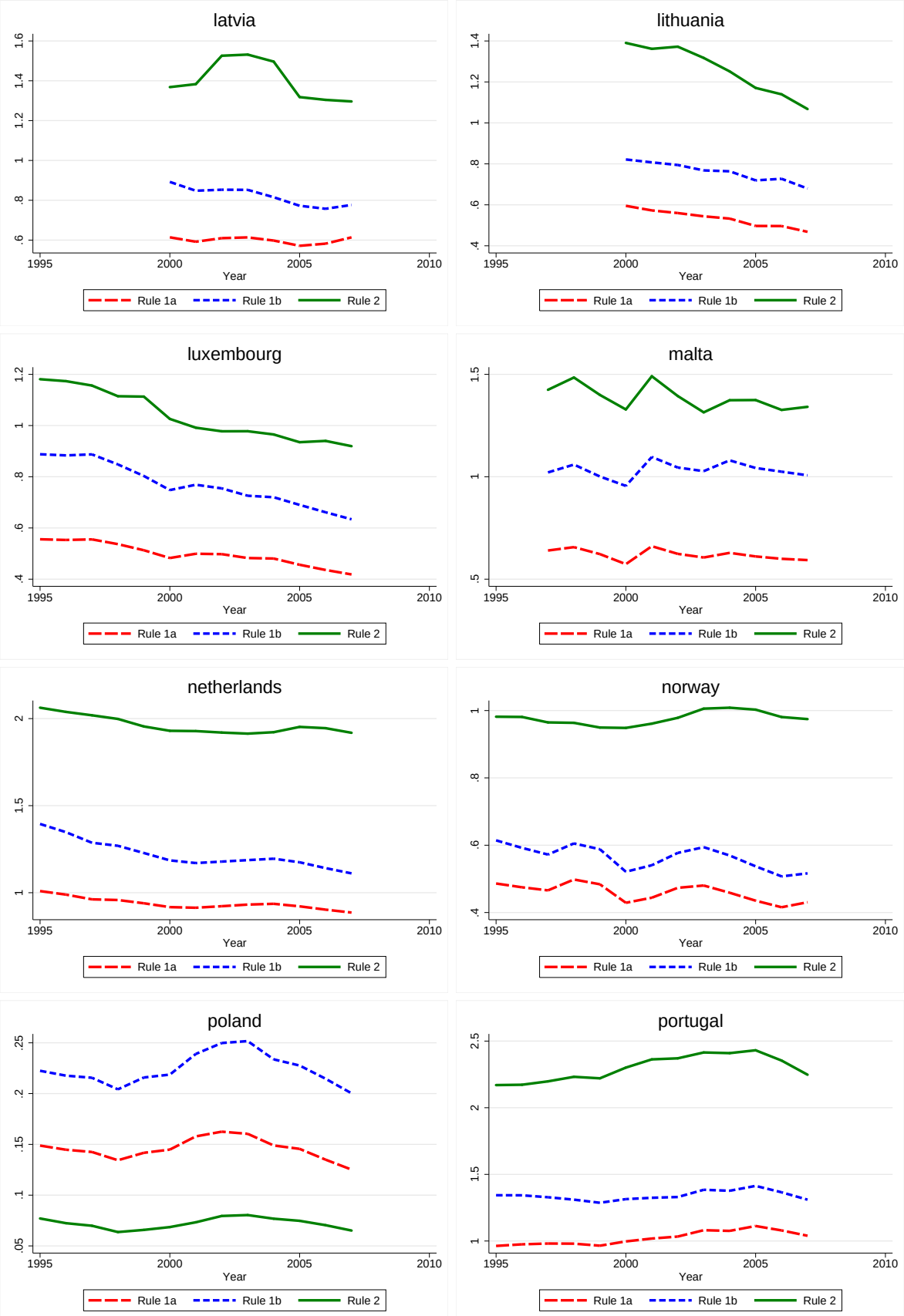
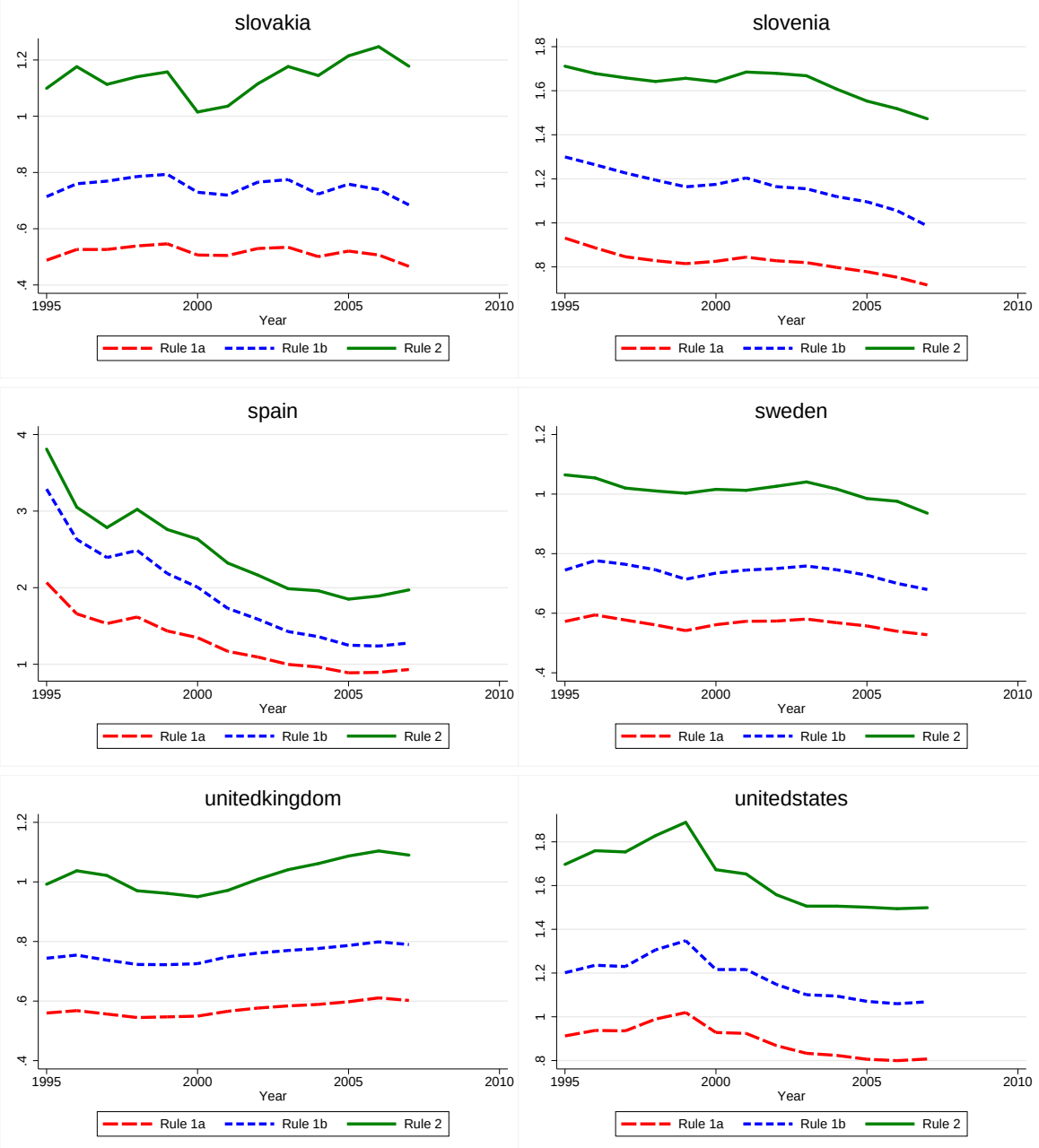


Figure A4: Aggregate rules for different countries (cont.)



This document has been prepared for the workshop "Government wage bill: determinants, interactions and effects", organised by the Directorate-General for Economic and Financial Affairs of the European Commission on 11 December 2013 in Brussels.

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