Reforming the public sector's wage policy*

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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 use a model with search and matching frictions and heterogeneous workers to evaluate this reform in the steady-state and over the business cycle. The model was calibrated to the UK economy based on Labour Force Survey data. A review of the pay received by all public sector workers to align the distribution of wages with the private sector reduces steady-state unemployment by 3 percentage points. Implementing a procyclical simple rule to determine the yearly growth rate of public sector wages reduces the volatility of unemployment by 3 to 8 percent and of private consumption by 4 to 12 percent. 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; E32; E62; J45.

Keywords: Public sector employment; public sector wages; unemployment; skilled workers; fiscal rules.

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1 Introduction

Three sets of stylized facts characterise the public sector employment and wage policy. These facts relate to their size, cyclicality, and heterogeneity across skills. First, public sector employment and wages always stand out as major components, whether one looks at the labour market or government budget. Governments of OECD countries account for 18 percent of total employment and their wage bills represent more than half of their government consumption expenditures. Regarding cyclicality, public sector wages fluctuate less than those in the private sector and are less procyclical.[1]

Perhaps less known is the policy heterogeneity across the skill dimension. The public sector predominantly hires skilled workers. In the United Kingdom, for instance, the government employs 37 percent of college graduates, but only 17 percent of workers with lower qualifications. The pay rates also vary across workers. Researchers estimate that the public sector wage premium, although positive on average, differs across education groups. Less educated individuals are paid a high premium, while more educated individuals receive a lower premium.[2] Finally, adding to the wage compression observed across education levels, a wage compression also exists within education categories, with the bottom quantile having higher premium and the top quantile having lower or even negative premium.[3]

I use a quantitative macro model with search and matching frictions that incorporates these three sets of stylized facts to evaluate a reform that strengthen the link with private sector wages, both across workers and over time. The loose relation between public and private sector pay creates distortions in the labour market. Higher public sector wages create queues for those jobs, while lower wages generate recruitment problems. It also alters the incentives of the government on which type of workers to hire. These distortions affect the unemployment rate and its volatility over the cycle. 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 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

[1]This was found using aggregate data by Quadrini and Trigari (2007) for the United States, by Lamo *et al.* (2013) and Lane (2003) for OECD countries and by Devereux and Hart (2006) using UK microdata.

[2]This was found in the United States by Katz and Krueger (1991), in the United Kingdom by Postel-Vinay and Turon (2007) or Disney and Gosling (1998) and in several European countries by Christofides and Michael (2013), Castro *et al.* (2013) and Giordano *et al.* (2011).

[3]This was found in Poterba and Rueben (1994) for the United States, Postel-Vinay and Turon (2007), or Disney and Gosling (1998) for the United Kingdom or Mueller (1998) for Canada.

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.

Given the heterogeneity across skills, it is surprising that most theoretical literature on public employment has ignored this dimension by assuming homogeneous workers. Examples include: Finn (1998), Algan *et al.* (2002), Ardagna (2007), Quadrini and Trigari (2007) or more recently Michaillat (2014), Gomes (2014) and Afonso and Gomes (2014). Two reasons motivate me to address this gap in the literature.

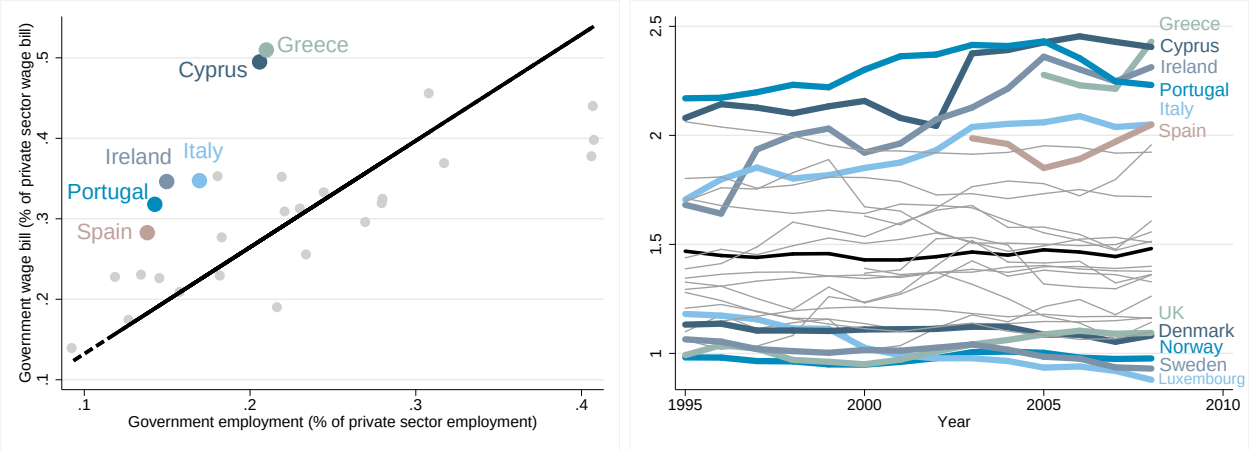
In a simple RBC model, as in Finn (1998), even if the productivity differs across sectors, identical workers receive the same wage due to arbitrage. With frictions, the labour market tolerates different wages. Gomes (2014) examines the optimal wage policy in the context of a two-sector search and matching model. 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 heterogeneous public sector wage premium suggests that we may have the two inefficiencies operating simultaneously, with long queues and high unemployment for unskilled workers and recruitment problems for high-ability skilled workers.

The second reason stems from the recent experience of European countries subject to austerity packages. Figure 1a displays the government's wage bill as a fraction of the private sector wage bill and the size of government employment relative to private sector employment, of OECD countries in 2008. Six countries stand out for having a high public sector wage bill relative to their level of public employment: Greece, Cyprus, Ireland, Portugal, Italy and Spain. These countries would end up in the centre of the Euro area crisis due their poor public finances and sclerotic labour markets. The implemented austerity measures naturally included public sector wage cuts. However, most governments opted for asymmetric cuts, centered on the highest earners, instead of reforms aligning the wage distribution with that of the private sector.[4] Although the cuts reduced spending, they did not correct inefficiencies at the bottom and probably exacerbated inefficiencies at the top.

The motivation for examining the dynamic side of the government's wage policy is shown in Figure 1b. This figure demonstrates the evolution of the ratio between the two variables, which is simply the ratio of average wages in the two sectors. How could government wages

[4]In Portugal in 2012, the wage cuts were 22 percent on the highest earners and zero percent on the lowest. In Spain in 2010, they were 10 percent on top and zero at the bottom. In Ireland in 2010, the cuts where 15 percent at the top and 5 percent at the bottom.

Figure 1: Government wage bill and employment, OECD countries



(a) Government wage bill and employment in 2008 *Source: EUROSTAT, AMECO and OECD.*

(b) Ratio of gov. wage bill (% private wage bill) over gov. employment (% of private employment)

grow by such a large factor relative to the private sector, in so many countries? To understand it, we must recognise that public sector wages are vulnerable to manipulation for electoral reasons, in the spirit of Nordhaus (1975) political cycles. Borjas (1984) finds that, in the United States, pay rises in federal agencies are two to three percent higher in election years. Matschke (2003) also finds systematic public wage increases of two to three percent prior to federal elections in Germany. In Portugal in 2009 - year of crisis and three elections - public sector workers saw their real wage increase by four percent. If such situations are to be avoided in the future, we should design institutions that limit the scope of politicians to manipulate public sector wages whilst still maintaining a certain degree of optimality.

In this paper, I extend the model of Gomes (2014) by introducing worker heterogeneity along two dimensions: education and ability. I consider heterogeneous ability for two reasons. First, the public sector wage premium also varies within education groups. Second, such inclusion acknowledges the common argument that public sector wage cuts limit the scope of governments to hire high-ability workers. Nickell and Quintini (2002) document the fall in relative pay of British public sector workers during the 1980s and find that men entering the public sector had significantly lower test score positions compared with public sector entrants in the previous decade.

The model features a government that provides an exogenous amount of services. Taking the wage schedule as given, the government decides the number and type of workers to hire to minimize the costs of providing those services. I also include capital stock and distortionary taxes. The model is calibrated for the United Kingdom. I use the Labour Force Survey from

1996 to 2006 to calibrate the parameters related to the worker heterogeneity, labour market and wages.

The objective of the model is twofold. First, it measures the steady-state effects of a pay review covering different types of public sector workers on the following variables: the equilibrium unemployment rate, the quality and composition of the public sector worker pool, total government spending and welfare. Wage cuts of skilled workers can reduce spending, but up to a limit. If the cuts are too severe, they actually increase government spending and reduce welfare. As the government lowers the pay of skilled workers too severely, it faces recruitment problems. It spends more to recruit a skilled worker and substitutes hiring towards unskilled workers. Cuts above 7 percent of skilled wages are welfare-reducing. On the other hand, wage cuts of unskilled government employees reduce both the unemployment rate and government spending. A seven percent cut reduces the unemployment rate by more than 3 percentage points. A large wage premium at the bottom, makes these workers expensive compared to their productivity. A government that minimizes costs neglects these workers in favour of more productive workers that are relatively cheaper. By decompressing the wages, the government hires more of these workers reducing their unemployment rate.

The second objective is to quantify how the volatility of unemployment, consumption and inflation depend upon the government's wage policy. Quadrini and Trigari (2007) and Gomes (2014) have shown that a procyclical policy reduces unemployment volatility in response to technology shocks. In recessions, if private sector wage drops are not accompanied by similar falls in the public sector, the unemployed turn for jobs there, which further reduces job creation, thus amplifying the business cycle. However, in policy circles there is the view that procyclical public sector wages amplify the fluctuations of aggregate demand, leading to wage spirals and higher volatility. This was argued by Holm-Hadulla *et al.* (2010) and restated in Lamo *et al.* (2013). To acknowledge this point, I introduce nominal rigidities and consider technology, government employment and cost-push shocks. I propose a simple rule to determine public sector wage growth that aims to stabilize a ratio of average aggregate wages as in Figure 1b. This procyclical fiscal rule reduces the volatility relative to the benchmark policy estimated for the United Kingdom, suggesting that the labour market channel dominates the demand channel. If taxes are lump-sum, unemployment and consumption volatilities are reduced by three and four percent. If taxes are distortionary, the volatilities are reduced by eight and twelve percent. This highlights one important dimension of procyclical wages: it allows for some tax smoothing in the absence of government debt. In recessions when the tax revenues fall, with an acyclical or counter-cyclical policy, the government requires higher tax rates and higher distortions when they are most detrimental.

The proposed policy resembles the one followed by Nordic countries. Across the 1970's and 1980's, these countries reformed the public sector, simultaneously reducing the wage premium and employing more unskilled workers; see Domeij and Ljungqvist (2006) for Sweden and Pederson *et al.* (1990) for Denmark. The policy allowed these countries to have large public sectors without asphyxiating the private sector and maintain low levels of unemployment. These countries also seem to implicitly follow the simple rule, as we can see from Figure 1b. They are also the countries in the sample with lower volatility of unemployment.

Using data from the European Commission and OECD, I compute the evolution of the ratio of average public to private wages of 29 countries for the pre-crisis period of 1995-2007. Nordic countries and France implicitly follow such simple rule. I show that countries showing greater deviation from this rule had larger increases in unemployment rates and higher volatility of unemployment relative to GDP.

In the final section, I draft a roadmap for a reform of public sector wages. The key idea, which follows from the discussion, is to use private sector wages as a benchmark when deciding the pay in the public sector, both across workers and over time. The first pillar consists of a review of the wage of all public sector workers. The second pillar is to establish a rule to guide their annual increase. The rule rests on the idea that the average public sector wage should track the average private wage. This reform offers several advantages: i) it guarantees parity between the two sectors for all workers that can be maintained over the business cycle; ii) it avoids politicians using public sector wages as an electoral tool; iii) it requires a low tax burden in recessions and iv) it offers simplicity and more predictability in one of the most important decisions governments take yearly.

2 Model and calibration

2.1 Main features of the model

The model used to evaluate the policy reform is shown in Appendix A. Here I explain the main features and their implications.

- **Search and matching frictions**, as in Pissarides (2000). The search and matching frictions give a non-trivial role to public sector wages. With frictionless labour markets, the wages in the two sector have to equate because of arbitrage.
- **Two sectors**: public and private.

- **Heterogeneous workers**. I introduce two dimensions of heterogeneity: in education and ability. Workers can be skilled (college degree) or unskilled (no college degree) and high-ability or low-ability. Overall there are four types of workers. This feature is crucial to evaluate the public sector wage policy.

- **Segmented markets**. There is a segment for each type of worker that cannot apply in another market. This assumption allows us to abstract from any issue of asymmetric information and adverse selection.

- **Directed search** in the labour market. Each unemployed decides whether to search for a public or a private sector job. This gives a role for public sector wages to induce more or fewer unemployed searching in the public sector.

- **Idiosyncratic preference for public sector**. This is introduced for quantitative purposes. Without it, small changes in wages in the two sectors generate large fluctuations in the fraction of unemployed searching in the public sector.

- **Capital stock** owned by households and rented to firms.

- **Intermediate good producers** that hire workers of a particular type and provide them with capital stock rented from households. The technology features capital-skilled complementarities.

- **Wholesale producer** that buys all four types of intermediate inputs and produce a final good.

- **Government produces services** using all four types of workers.

- **The government objective** is to, given a wage structure, choose the number of vacancies of each type of workers to minimize the cost of providing an exogenous level of government services.

These are the key features for the steady-state analysis. For the business cycle analysis, the model has some added features.

- **DSGE structure**, that relies on the big family assumption [Merz (1995)]: household members pool their income so private consumption is equalised across members.

- **Retail sector** that buys a final good from wholesales and produce a differentiated good. They face monopolistic competition and Calvo price setting. The New-Keynesian structure does not matter for steady-state but it is important to consider demand effects over the business cycle.

- **Three types of shocks**: technology, cost-push and government services shocks.
- **A central bank** that follows a Taylor rule.

2.2 Main features of the calibration

The model is calibrated to match the UK economy on a quarterly frequency, drawing largely on the Labour Force Survey (LFS) microdata for the period 1996-2010. Details are shown in Appendix B. With the LFS data we can calculate the share of the skilled and unskilled in the economy, the unemployment rate and public sector employment of the two types, as well as the separation rates by sector and education.

The LFS also has data on wages. I run quantile regression to estimate the public sector wage premium for different quantiles and educations. I also run mince regression and retrieve a measure of wage dispersion to calibrate the productivity differences between high and low ability. Finally I can also estimate the college premium.

The Chartered Institute of Personal Development conducts a recruitment practice survey covering 800 organizations in the UK, ranging from manufacturing to private and public sectors services (CIPD (2009)). It provides estimates of the costs of recruitment and vacancy duration for private and public sector and skilled and unskilled workers. This allows me to calibrate several labour market friction parameters. Other parameters related to technology and value of unemployment are taken from the literature.

Regarding the business cycles, I use aggregate quarterly data from AMECO to estimate the cyclicality of public sector wages, and the shock process for technology, cost-push and government services. Finally, I use data on *Google trends* to create a index of search in the public sector and calibrate the distribution of the idiosyncratic preference for the public sector, to match its mean and standard deviation.

3 Reforming the public sector's wage policy

3.1 The effects of heterogeneous pay in steady-state

I start by examining the effects of progressive and regressive wage cuts. The progressive wage cuts target skilled workers. I assume that, for each one percent cut of high-ability wages, the wages of the low-ability are cut by 0.5 percent. Unskilled wages remain constant. The regressive wage cuts target only unskilled workers. For each one percent cut of low-ability wages, the wages of the high-ability are cut by 0.5 percent. The income tax adjusts to balance the budget. Figure 2 shows the outcomes.

As the government reduces the unskilled workers' wages (top panel), the composition of public employment shifts from skilled to unskilled workers. Lowering wages has two opposite effects: wage bill effect and recruitment effect. As workers become cheaper, the government wants to employ more to save on the wage bill. However, offering lower wages makes the public sector less attractive, implying that fewer unemployed search for jobs there, making the recruitment more costly. When the government reduces unskilled workers' wages, the first effect dominates because unemployed workers are still queuing for jobs in the public sector. To maintain the same level of services, the government hires more workers, but reduces spending on the total wage bill plus recruitment costs.

The government faces a constraint when reducing wages: they have to guarantee that some unemployed search for public sector jobs. For the baseline calibration, the government cannot cut the low-ability unskilled wages by more than seven percent (3.5 percent for the high-ability) or the public sector vacancies do not receive any applicants.

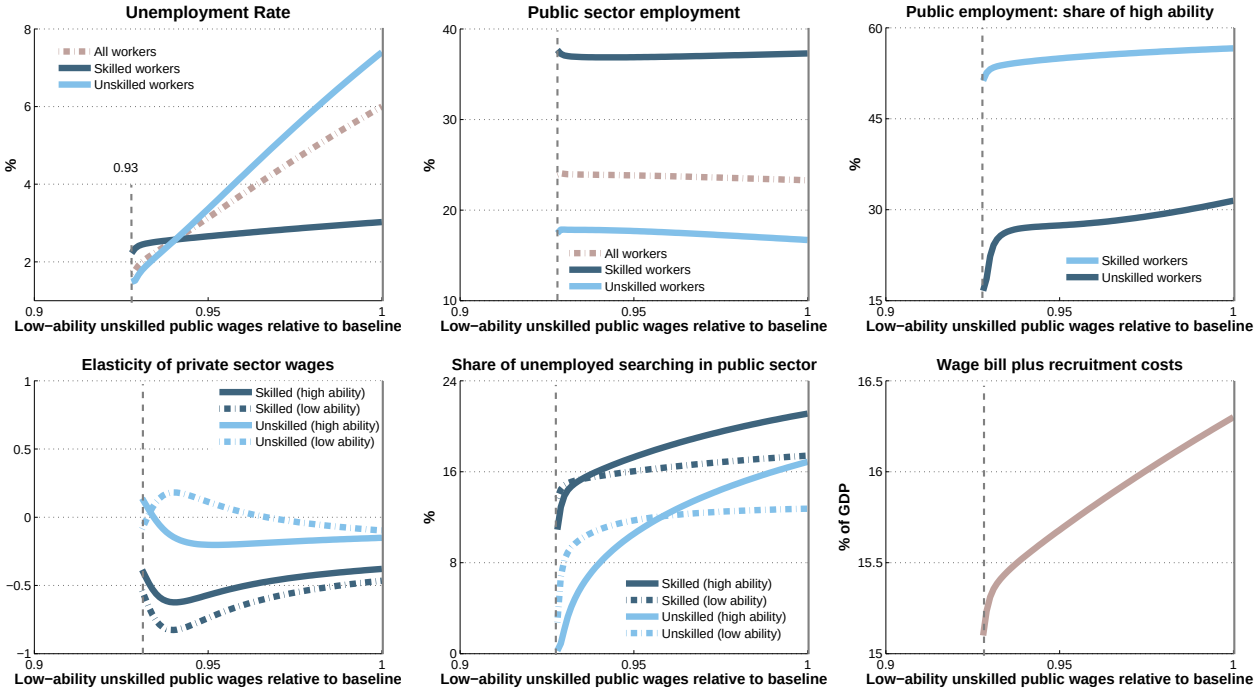
Still, the consequences in the labour market are dramatic. With a seven percent wage cut, the unemployment rate of unskilled workers falls from 7.3 percent to bellow 2 percent. Lowering wages shifts the job searches to the private sector and firms post more vacancies. But the improvement in the labour market cannot explain the magnitude of the unemployment reduction. The key reason is that the unskilled wage cuts encourages the government to hire more unskilled workers, particularly with low ability. In the baseline case, the government hires 23 percent of these workers, but when paying lower wages it hires as much as 26 percent. This is the group with the highest unemployment rate, that is reduced massively with the increase in hiring. A large wage premium at the bottom, makes these workers expensive compared to their productivity. A government that minimizes costs neglects these workers in favour of more productive workers that are relatively cheaper.

The elasticities of private sector wages with respect to the average public sector wage are heterogeneous. Wage cuts in the public sector initially raise all wages in the private sector, particularly skilled wages. Two effects explain this negative elasticity. First, by lowering unemployment and raising total production and private consumption, they entail a wealth effect. As marginal utility decreases, the utility value of unemployment increases, putting pressure on wage bargaining. Second, as the government saves on the wage bill, it cuts income taxes and hence the distortions on wage bargaining and capital accumulation. Only when cuts are too severe, the elasticity of unskilled wages become positive.

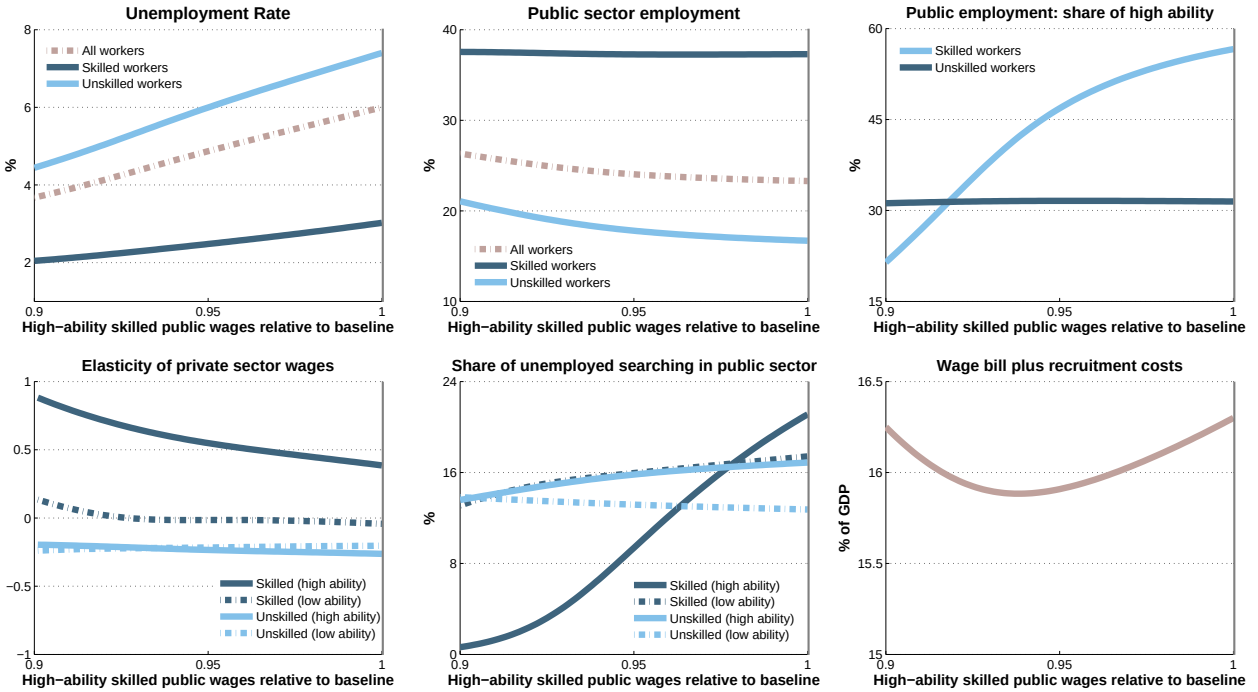
The bottom panel of Figure 2 shows the consequences of reducing skilled workers' wages. First, it shifts the composition of public employment to unskilled workers. In the case of skilled worker wage cuts, the recruitment effect dominates the wage bill effect. By offering

Figure 2: Steady-state effects of public sector wages adjustments

Regressive public sector wage cuts: unskilled wages only

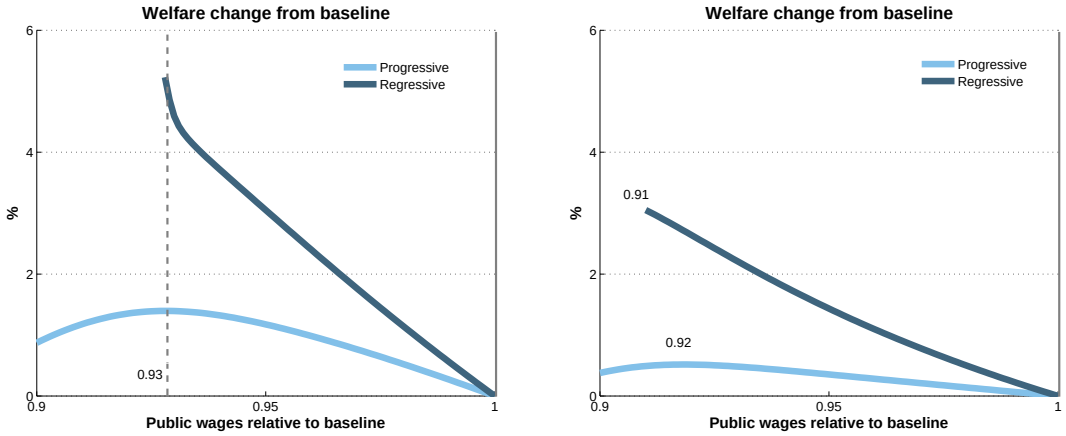


Progressive public sector wage cuts: skilled wages only



Note: model simulations under the baseline calibration. Regressive public sector wage cuts: for each 1 percent cut in low-ability unskilled wages, the wages of the high-ability unskilled are cut by 0.5 percent. Skilled wages are constant. Progressive public sector wage cuts: for each 1 percent cut in high-ability skilled wages, the wages of the low-ability skilled are cut by 0.5 percent. Unskilled wages are constant. The vertical line in the top panel indicates the maximum cuts that guarantee positive search in the public sector of all types.

Figure 3: Welfare effects of public sector wages adjustments



(a) Distortionary taxes

(b) Lump-sum taxes

too low wages, only a few devoted skilled unemployed will look for public sector jobs. The government faces recruitment problems, making it costly to hire a skilled worker. To maintain its services, the government hires more unskilled workers, increasing the size of the public sector. This is a case where lowering wages have perverse effects. With wage cuts of more than 7 percent on top earners, the total wage bill plus recruitment costs increase (bottom right graph). They do, however, reduce the unemployment for unskilled workers.

The demonstration effect of the public sector as a wage leader depends on how tight the market is. The elasticity of private wages with respect to the average public sector wage is higher for skilled workers with high ability. It is also higher, the stronger the wage cuts and the lower the unemployment. The government can only significantly affect wages in the private sector when unemployment is low.

Figure 3 shows the welfare effects of public sector wage cuts in terms of steady-state consumption-equivalent variations. On the top, high-ability skilled wage cuts above 7 percent are shown to be welfare reducing.

3.2 Equal pay in the public sector

Let us now consider a policy reform, consisting of a review of public sector wages to have a clearer parity with those in the private sector across workers in the steady-state. I consider two scenarios with a common public sector premium: one where all wages are equal to those in the private sector and second with the lowest possible premium that guarantees a positive search in the public sector. The results are shown in Table 1.

This reform significantly lowers the unemployment rate. If the government equates wages

Table 1: Steady-state effects of a reform of public sector wages

		Distortionary Taxes		*Lump-Sum Taxes*	
Public-private wage premium	Baseline	0%	$-0.5\%^*$	0%	$-0.5\%^*$
Variables					
Unemployment rate	0.060	0.022	0.018	0.027	0.023
Skilled	0.030	0.024	0.023	0.025	0.024
Unskilled	0.074	0.020	0.016	0.028	0.023
Public employment	0.233	0.238	0.238	0.239	0.240
Skilled	0.373	0.365	0.366	0.364	0.364
Unskilled	0.167	0.178	0.178	0.181	0.182
Consumption	0.615	0.644	0.647	0.634	0.637
Wage bill + recruitment costs**	0.163	0.155	0.154	0.156	0.155
Welfare Gains relative to baseline	-	3.93%	4.36%	2.47%	2.85%
Income taxes	0.2	0.181	0.179	0.200	0.200
Implied public sector wage change					
Skilled (high ability)	-	0.9%	0.6%	-0.9%	-1.4%
Skilled (low ability)	-	-2.1%	-2.3%	-3.7%	-4.1%
Unskilled (high ability)	-	-2.9%	-3.3%	-3.9%	-4.5%
Unskilled (low ability)	-	-6.9%	-7.4%	-7.5%	-8.1%

Note: model simulations under the baseline calibration. * *minimum common public sector wage premium that guarantees a positive search in the public sector of all types of workers.* ** *given in percent of GDP.*

to those in the private sector, the aggregate unemployment rate falls by 3.8 percentage points, driven by the 5 percentage points decrease in the unemployment rate for unskilled workers. This reform generates sufficient savings to cut the income tax by two percentage points. Consumption increases by 4.7 percent and the welfare gains amount to 4 percent of steady-state consumption. A further reduction in public sector wages would further reduce unemployment and raise welfare.

If lump-sum taxes adjust instead of the income tax, the unemployment rate falls by 3.3 percentage points and welfare increase by only 2.5 percent of steady-state consumption. A large fraction of the gains from the reform comes from the labour market effect rather than the consequent tax reduction.

In Gomes (2014) I discussed the optimal public sector wage policy in a simple setting. I showed that wages should be lower than in the private sector, to compensate for job security and the differences in the labour market frictions. The optimal policy problem in this setting is complicated, with tax distortions and externalities across different workers and sectors adding to the congestion and thick market externalities. Hence, I evaluate the welfare gains of this simple reform that can be realistically implemented. I could have examined the welfare gains from other policies with distinct premia for different types of workers, but type-contingent reforms are difficult to justify without computing the optimal policy.

3.3 Business cycle policies

Quadrini and Trigari (2007) find that more procyclical public sector wages reduce unemployment fluctuations following technology shocks. Gomes (2014) explains it by computing the optimal policy and finding it to be procyclical. In recessions, if private sector wage drops are not accompanied by similar falls in public sector wages, unemployed turn to the public sector for jobs, which in turn further reduces job creation, thus amplifying the business cycle.

I measure these effects in a more realistic setting with three sources of fluctuations: technology, government services and cost-push shocks. I quantify how different wage policies affect the volatility of: private consumption, unemployment and inflation. I assume that the current business cycle public sector wage policy follows the following rule

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

where w_t^p and w_t^g represent the average nominal wage in the private and public sectors and the variables with bar represent their steady-state levels. The parameter ι measures the cyclicality of wages. If $\iota = 0$ public sector wages are acyclical. If $\iota > 0$ they are procyclical. If $\iota < 0$, they are countercyclical. φ_t^w is an autocorrelated public sector wage shock. In the estimated benchmark wage policy $\iota = 0.58$. I compare it to an acyclical policy $\iota = 0$, a countercyclical policy $\iota = -0.4$ and a procyclical policy $\iota = 1$. My contribution is to propose and evaluate an alternative simple rule that generates procyclical public sector wages. The government sets the growth rate of public sector wages for the subsequent period Ξ_{t+1}, such that an aggregate target for the average wage is met:

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

Motivated by the Figure 1b in the introduction, the government aims to maintain the average nominal public sector wages relative to average nominal private sector wages as in the steady-state, given by $\Upsilon \equiv \frac{\bar{w}^g}{\bar{w}^p}$. This rule is equivalent to Equation (41), when $\iota = 1$, but without wage shocks. In other words, by explicitly assuming this rule, the government purges the political involvement and eliminates the uncertainty around public sector wages.

Table 2 shows the results. Although not a target, the volatility of the unemployment rate is 0.021, slightly above the 0.019 observed in the United Kingdom since 1990. Shimer (2005) argues that the basic search and matching model cannot match fluctuations in unemployment. The model performs well in this dimension for the same reason as in Hagedorn and Manovskii (2008). In the baseline calibration, wage heterogeneity implies that the flow

Table 2: Volatility of key variables relative to baseline wage policy

Variable	Volatility	**Percentage change of volatility relative to baseline**			
	Baseline	Acyclical	Countercyclical	Procyclical	Simple rule
Lump-Sum Taxes					
Unemployment	0.021	4.79%	10.39%	-1.58%	-2.83%
Consumption	0.017	6.30%	11.36%	-4.14%	-4.32%
Inflation	0.005	0.50%	0.94%	-0.30%	-0.32%
Distortionary taxes					
Unemployment	0.028	10.19%	19.16%	-5.62%	-8.11%
Consumption	0.023	15.65%	28.06%	-10.14%	-11.95%
Inflation	0.006	5.87%	10.21%	-4.17%	-4.90%

Note: model simulations under baseline calibration. Baseline case ($\iota = 0.58$), acyclical policy ($\iota = 0$), countercyclical policy ($\iota = -0.4$), procyclical policy ($\iota = 1$) and the simple rule given by equation (43).

value of low-ability unemployed workers is close to 95 percent of its net wage. Given that most unemployment is concentrated in this group, the overall unemployment rate becomes more sensitive to shocks.[5]

Both the acyclical and countercyclical policies raise the volatility of the three variables. Under the countercyclical rule, the volatility of unemployment and private consumption increase by more than 10 percent. If the income tax adjusts to balance the budget, volatility increases by 20 and 28 percent, respectively. Even with nominal frictions, attempting to stabilize demand by using counter-cyclical wages has the opposite effects.

The procyclical rule, on the other hand, reduces the volatility of all variables: the unemployment rate by 1.6 percent, consumption by 4 percent and inflation by 0.3 percent. With distortionary taxes, the reduction of volatility is even stronger: 6, 10 and 4 percent. This shows one important dimension of the procyclical policy. By lowering its wages in recessions, the government requires a low tax burden. If taxes are distortionary, such a policy allows some tax smoothing in the absence of debt. Notice that the simple rule reduces volatility even more because it eliminates uncertainty regarding public sector wages.[6]

[5]The good performance of the model in terms of volatility is the reason why I disregarded wage rigidity. Wage rigidity has been proposed as another solution to the Shimer Puzzle but its relevance is still under discussion. For the main mechanism of the model, only the wages of new-hires are relevant in the decisions. As been argued by Pissarides (2009), microeconometric evidence suggests that wages in new matches are more procyclical and volatile than average wages; see the discussion in Gomes (2014).

[6]The quantitative results are robust to different calibrations. I considered scenarios with different levels and volatilities of search of public sector jobs, different magnitudes of heterogeneity in ability and different shares of college graduates. I also considered a scenario with a logistic distribution of preferences for the public sector instead of a uniform distribution. The steady-state reform that equates the public sector wages to their private sector counterparts, reduces unemployment rate between 3.2 and 4.7 percentage points if taxes are distortionary and about 3 percentage points if taxes are lump-sum. The welfare gain are, in all cases, above 2 percent of steady-state consumption and can be as high as 4.6 percent. Implementing the simple rule over the business cycle reduces the volatility of all variables in all scenarios. As in the benchmark case, the effects are stronger if taxes are distortionary. Volatility of unemployment rate and consumption fall by 8 and 12 percent. With lump-sum taxes the reduction is only of three and four percent.

4 Are countries following the simple rule?

This section evaluates whether advanced economies implicitly follow the simple rule. I collected data from AMECO on compensation to government employees, compensation to employees in the overall economy and GDP, all in nominal terms. Eurostat provides data on government employment, total employment and unemployment rate. When data on government employment is absent, I supplement it from OECD data. The sample contains 29 countries. I normalise the government wage bill as a fraction of the private sector wage bill by the ratio of public to private sectors employment.

- Rule: $\frac{Government\ wage\ bill}{Private\ sector\ wage\ bill} / \frac{Government\ Employment}{Private\ sector\ Employment}$,

In essence, this is a measure of the aggregate wage premium. In the Appendix, I show the behaviour of the rule in different countries. Several countries implicitly follow this rule, notably the Nordic countries and France.

With this data, I conduct two exercises. First, I compute the change in the unemployment rate during the pre-crisis period from 1995 and 2007 for each country and regress it on the trend of the rule. The coefficient is positive and statistically significant at the 10 percent level. Consistent with the results in Section 3.2, countries having relatively higher public sector wage increases also had larger increases in unemployment.

I then compute the volatility of the unemployment rate both in absolute levels or relative to the volatility of real GDP growth. I then regress them on standard deviations of the rule. I interpret it as a measure of the extent to which governments deviate from the rule. The coefficients are positive and statistically significant. Consistent with the results from Section 3.3, countries showing greater deviations from the rule have higher unemployment volatility, even relative to volatility in real GDP growth.

Table 3: Rules and macroeconomic performance

Variable	Regressor	Coefficient	t-statistic	R-squared
$\Delta(Unemployment\ rate)^{1995-2007}$	$Trend^{1995-2007}$	0.373*	(1.94)	[0.12]
$St.dev.\ (Unemployment\ rate)$	$St.dev.$	4.53**	(2.19)	[0.15]
$\frac{St.dev.\ (Unemployment\ rate)}{St.dev.\ (Real\ GDP\ growth)}$	St.dev.	6.224***	(3.54)	[0.32]

Note: The first line shows the regression of the change in the unemployment rate between 1995 and 2007 on the same period trend of the respective rule. Statistical significance at 1 percent (***), 5 percent (**) and 10 percent (*). 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.

5 A roadmap for a reform of public sector wages

In contrast with a central bank, which mainly uses the interest rate as a means of economic influence, the government controls several instruments. On the expenditure side, it decides on investments, purchases of goods and services, employment levels, wages and transfers. Are all these variables suitable to being determined by a rule? Investment, purchases of goods and services and employment involve a political choice reflecting society's preferences regarding the supply of public goods. Hence, it is difficult to define a rule that covers all. Transfers also reflect the extent to which society wants to protect its weakest members. On the other hand, public sector wages have different characteristics. They do not directly affect the supply of government services and they are both a payment to a factor of production and transfer from society to a specific group of citizens.

Because public wages are viewed as a transfer, they are vulnerable to manipulation for electoral reasons, the possibility of which can partly explain the heterogeneity of wage policies in OECD countries. Any reform must instead view public wages only as a payment to a factor of production. In keeping with this spirit, governments should use private sector wages as their benchmark when deciding public sector pay, both across workers and over time.

The first step of wage policy reform is to review the pay schedule and progression structure of public sector workers by occupation and education. Many European governments have obsolete pay structures. For each occupation and level of education, the offered wage should have the private sector wage as a benchmark, with a similar tenure profile. An evaluation scheme should be in place to reward unobservable skills and avoid wage compression. Wages can be adjusted downwards to compensate for job security or 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 those involving national security or prone to be targets of corruption. Occupations with low private sector employment (for instance, judges) should be comparable to occupations in the private sector with similar career trajectories and education. Such occupations offer some scope for political choices.

Once a review of the pay schedule is complete, the government should set the growth rate of public sector wages to maintain the target ratio of average wages. To avoid changes in composition of public employment from driving aggregate ratios, the pay structure of public sector workers can be re-evaluated every 10 years to adjust targets for composition.

6 Conclusion and discussion

I construct a model of public sector employment with search and matching frictions and heterogeneous workers to evaluate a reform of public sector wages that links them to the behaviour of the private sector, both across workers and over time. In the model calibrated to the United Kingdom, setting the wage of all workers equal to those offered in the private sector reduces the unemployment rate by three percentage points. Implementing a simple rule that aims to stabilize the ratio of average wages in the two sectors in turn reduces the volatility of unemployment by three to eight percent.

Such a wage reform has several advantages. It guarantees parity between the two sectors and its maintenance over the business cycle. It reduces the government's scope to use wages for electoral purposes. It enables a low tax burden in recessions. It is simple and easy for economic agents to understand, and introduces some predictability in one of the most important decisions that the government takes annually.

The paper was motivated by the experience of several countries before and during the Eurozone crisis. The fiscal rule proposed to guide the wage growth would have avoided the sharp increase in public sector wages in the decade prior to the crisis. On the other hand, the principle of equating the distribution to the private sector could guide governments facing budgetary pressures regarding how to proceed with wage cuts. Instead of progressive cuts along the distribution, a review of pay by occupation and education is preferable to make the whole distribution of wages closer to those in the private sector.

Alesina *et al.* (2000) argue that politicians use public employment for redistributive policies, directing income towards disadvantaged groups. This might also justify why the distribution of wages in the public sector are so compressed and the wage premium at the bottom so high. This policy is self-defeating. On the one hand, I show that the wage compression increase the unemployment of workers with lowest skills. On the other hand, Wilson (1982) shows that, from a redistributive point of view, it is optimal for the government to increase the wage difference between skilled and unskilled worker in order to induce more individuals to obtain education. The wage compression does precisely the oppositive. Mitigation of inequality is a valid policy objective. But if governments want to reduce inequality, they should use suitable instruments such as income tax or minimum wage. Trying to deal with the problem of inequality by only protecting an arbitrary group of workers, governments do not solve this problem and further distort the labour market.

The idea that the public sector wages should closely follow private wages is simple and intuitive, but it is not acknowledged by policy makers who view government wages as a

stabilization tool. Holm-Hadulla *et al.* (2010) argue that the government should avoid mild procyclicality of wages, as increasing wages in expansions may boost aggregate demand, amplify the business cycle and create an inflationary spiral. However, I have demonstrated that such a policy has the opposite effect because it heavily distorts the labour market. If a government would commit to the proposed rule, it would lose one instrument, but for the purpose of stabilizing demand, it could use alternatives such as employment, purchases of intermediate goods, investments or transfers, which are arguably more effective.

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Appendix A: Model

General setting

The economy has two sectors $j \in \{p, g\}$. Public sector variables are denoted by the superscript g and private sector variables by p. Time is discrete and denoted by t. The economy is populated by a measure one of workers. Workers differ ex-ante from each other, with all workers falling into one of four categories $i \in \{\bar{h}, \underline{h}, \bar{\mu}, \underline{\mu}\}$, with two dimensions of heterogeneity. The first dimension is education, with skilled workers (college degree) denoted by h and unskilled (bellow college degree) workers 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), whilst the remaining are working either in the public $(l_t^{g,i})$ or private $(l_t^{p,i})$ sector.

$$1 = l_t^{p,i} + l_t^{g,i} + u_t^i, \quad \forall i. \tag{3}$$

Total unemployment is denoted by $u_t = \sum_i \omega^i u_t^i$. The evolution of employment of type i in sector j depends on the number of new matches $m_t^{j,i}$ and on job separations. In each period, jobs are destroyed at rate $\lambda^{j,i}$, which potentially differs across sectors and types.

$$l_{t+1}^{j,i} = (1 - \lambda^{j,i}) l_t^{j,i} + m_t^{j,i}, \quad \forall ji. \tag{4}$$

I assume that the markets are segmented and independent across types to abstract from the complications arising from asymmetric information. I rely on previous papers on adverse selection with labour market frictions, such as Guerrieri *et al.* (2010) or Fernández-Blanco (2013) that argue that firms can design mechanisms such that workers self-select into the correct segment I further assume that the unemployed can direct their search to the private or public sectors. This assumption finds support in micro-econometric evidence and was discussed in length in Gomes (2014). Together with the assumption of segmented markets, it allows new matches to be expressed with the following matching functions:

$$m_t^{j,i} = m^j(u_t^{j,i}, v_t^{j,i}), \quad \forall ji. \tag{5}$$

where $u_t^{j,i}$ represents the number of unemployed of type i searching in sector j. Vacancies in each segment are denoted by $v_t^{j,i}$. I define the fraction of unemployment searching for public sector jobs as: $s_t^i \equiv \frac{u_t^{g,i}}{u_t^i}$. We also define $q_t^{j,i}$ as the probability of filling a vacancy of type i is sector j and $f_t^{j,i}$ as the job-finding rate of an unemployed of type i conditional on searching in sector j:

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

Households

Following Merz (1995), I assume that household members pool their income so private consumption is equalised across members. The household is infinitely lived and has the following

preferences:

$$E_0 \sum_{t=0}^{\infty} \beta^t [u(c_t) + \nu(u_t)], \tag{6}$$

where

$$c_t \equiv \left(\int_0^1 c_{n,t}^{\frac{\xi-1}{\xi}} dn \right)^{\frac{\xi}{\xi-1}} \tag{7}$$

is the Dixit-Stiglitz basket of consumption goods produced by the final goods retail sector. The household also derives utility from members who 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 real terms by

$$c_t + \frac{B_{t+1}}{p_t} + K_{t+1} = \frac{(1+i_{t-1})B_t}{p_t} + (1-\delta)K_t + (1-\tau_t)\left(\frac{r_t}{p_t} K_t + \sum_j \sum_i \omega^i \frac{w_t^{j,i}}{p_t} l_t^{j,i} \right) + \chi^g u_t + \Pi_t, \tag{8}$$

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. 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, with $w_t^{j,i}$ being the nominal wage rate from the members of type i working in sector j. Unemployed members collect unemployment benefits χ^g. The household pays a tax τ_t on both its labour and capital income. Finally, Π_t encompasses the lump-sum taxes or transfers from the government and possible net profits from the private sector firms. The aggregate price level, p_t, is given by

$$p_t \equiv \left(\int_0^1 (p_t^n)^{1-\xi} dn \right)^{\frac{1}{1-\xi}}. \tag{9}$$

The household chooses the sequence of $\{c_t, K_{t+1}, B_{t+1}\}_{t=0}^{\infty}$ to maximise 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:

$$u_c(c_t) = \beta(1+i_t) E_t \left[\frac{p_t}{p_{t+1}} u_c(c_{t+1}) \right], \tag{10}$$

$$1 + i_t = E_t \left[\frac{p_{t+1}}{p_t} (1 - \delta + \tilde{r}_{t+1}(1-\tau_{t+1})) \right], \tag{11}$$

where $\tilde{r}_t = \frac{r_t}{p_t}$ is the real rental rate of capital.

Workers

The unweighted value of each member of type i being employed, to the household depends on their current state:

$$W_t^{j,i} = (1-\tau_t)\tilde{w}_t^{j,i} + E_t \beta_{t,t+1} [(1-\lambda^{j,i}) W_{t+1}^{j,i} + \lambda^{j,i} U_{t+1}^i], \quad \forall i, j, \tag{12}$$

where $\beta_{t,t+k} = \beta^k \frac{u_c(c_{t+k})}{u_c(c_t)}$ 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, those unemployed are searching for a job in either the private or public sectors, with value functions given by

$$U_t^{j,i} = \frac{\nu_u(u_t)}{u_c(c_t)} + \chi^b + E_t\beta_{t,t+1}[f_t^{j,i}W_{t+1}^{j,i} + (1 - f_t^{j,i})U_{t+1}^i], \quad \forall i, j. \tag{13}$$

As in Hall and Milgrom (2008), the unemployed collect unemployment benefits χ^b and contribute to home production (marginal utility from unemployment relative to the marginal utility of consumption). The continuation 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. I assume that each unemployed member decides on which sector to search according to the following condition:

$$U_t^{p,i} = U_t^{g,i} + \gamma_t^i, \quad \forall i. \tag{14}$$

Optimality implies that movement between the two segments guarantees no additional gain for searching in one sector *vis-à-vis* the other. To this condition, I add, γ_t^i, a random variable with cumulative distribution Γ, which stands for an idiosyncratic preference for the public sector. Γ puts discipline on the fluctuations on s_t^i, that are given in equilibrium by

$$s_t^i = 1 - \Gamma(\gamma_t^{i,*}), \quad \forall i, \tag{15}$$

where $\gamma_t^{i,*}$ is the cut-off point of the distribution for type i at time t. All unemployed household members with preferences above the cut-off will search for jobs in the public sector, while the ones below search in the private sector. This threshold is given by

$$\gamma_t^{i,*} = f_t^{p,i}E_t\beta_{t,t+1}[W_{t+1}^{p,i} - U_{t+1}^i] - f_t^{g,i}E_t\beta_{t,t+1}[W_{t+1}^{g,i} - U_{t+1}^i], \quad \forall i. \tag{16}$$

An increase in the value of employment in the public sector, driven by either wage increase or decrease in the separation rate, raises s_t until no extra gain exists for searching in that sector. However, the marginal searcher has a lower preference for the public sector. The ex-ante value of being unemployed is given by:

$$U_t^i = (1 - s_t^i)U_t^{p,i} + s_t^iU_t^{g,i}, \quad \forall i. \tag{17}$$

Intermediate goods producers

There is a continuum of firms that produce one of four types of intermediate goods x_t^i, which 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 produces $f(a_t, z^i, k_t^i)$, where a_t is an aggregate productivity that is stochastic and k_t^i is the capital used in the match. 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

$$J_t^i = \max_{k_t^i}[\tilde{p}_t^{x,i}f^i(a_t, z^i, k_t^i) - \tilde{w}_t^{p,i} - \tilde{r}_t^{p,i}k_t^i + E_t\beta_{t,t+1}[(1 - \lambda^{p,i})J_{t+1}^i], \quad \forall i. \tag{18}$$

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} solves the first-order condition:

$$\tilde{p}_t^{x,i} f_k^i(a_t, z^i, k_t^{*i}) = \tilde{r}_t, \quad \forall i. \tag{19}$$

Therefore, we can write the value of a job as

$$J_t^i = [\tilde{p}_t^{x,i} f^i(a_t, z^i, k_t^{*i}) - \tilde{w}_t^{p,i} - \tilde{r}_t^{p,i} k_t^{*i} + E_t \beta_{t,t+1}[(1-\lambda^{p,i}) J_{t+1}^i], \quad \forall i. \tag{20}$$

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

$$V_t^i = -\kappa^{p,i} + E_t \beta_{t,t+1}[q_t^{p,i} J_{t+1}^i + (1-q_t^{p,i}) V_{t+1}^i], \quad \forall i, \tag{21}$$

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

$$V_t^i = 0, \quad \forall i. \tag{22}$$

The surplus from the match is shared by the firm and workers as wages are the outcome of Nash bargaining:

$$\tilde{w}_t^{p,i} = \arg\max_{\tilde{w}_t^{p,i}} (W_t^{p,i} - U^i{}_t)^b (J_t^i)^{1-b}, \quad \forall i. \tag{23}$$

where b denote the worker's bargaining power. The solution is given by

$$(W_t^{p,i} - U_t^i) = \frac{b(1-\tau_t)}{1-b\tau_t} (W_t^{p,i} - U_t^i + J_t^i), \quad \forall i. \tag{24}$$

With distortionary taxes, the share of the surplus going to workers is lower than their bargaining power. For every unit that the firm gives up in favour of the worker, the pair lose a fraction τ_t to the government. Therefore, they economise on their tax payments by agreeing to a lower wage.

Wholesale firms

The representative wholesale firm buys intermediate inputs in a competitive market, produces a final good and sells it at price $\tilde{p}_t^y$. The objective is to choose inputs to maximise profits given by

$$\max_{\mathbf{x}_t} [\tilde{p}_t^y F(\mathbf{x}_t) - \sum_i \tilde{p}_t^{x,i} x_t^i], \tag{25}$$

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

$$\tilde{p}_t^y F'_{x^i} = \tilde{p}_t^{x,i}, \quad \forall i. \tag{26}$$

Retails firms

There is a continuum of retailers facing monopolistic competition. Each firm n buys a intermediate good $y_{n,t}$ and sells it as a differentiated good, facing a sequence of downward

slopping demand curves:

$$y_{n,t+s} = \left(\frac{p^n_{t+s}}{p_{t+s}}\right)^{-\xi} Y_{t+s}, s = 0, 1, ... \tag{27}$$

where Y_t is the aggregate demand of differentiated final goods and ξ is the elasticity of substitution between them. The real marginal cost is

$$mc_t = \tilde{p}^y_t + \varphi^c_t, \tag{28}$$

where φ^c_t is a cost-push shock. I follow the Calvo price setting model. In each quarter, a share θ of firms do not reset their price. All firms re-optimising at date t solve an identical problem given by

$$\max_{p^{n,*}_t} E_t \left\{ \sum_{s=0}^{\infty} \theta^s \beta_{t,t+s} \left[\frac{p^{n,*}_t}{p_{t+s}} - mc_{t+s} \right] y_{n,t+s|t} \right\}$$

$$s.t.$$

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

The optimal pricing decision and law of motion for the price level are given by

$$E_t \sum_{s=0}^{\infty} (\theta)^s \beta_{t,t+s} Y_{t+s} p^{\xi}_{t+s} \left(\frac{p^*_t}{p_{t+s}} - \frac{\xi}{\xi - 1} mc_{t+s}\right) = 0. \tag{29}$$

$$p^{1-\xi}_t = \theta p^{1-\xi}_{t-1} + (1-\theta) p^{*1-\xi}_t. \tag{30}$$

Government

The government needs to produce a minimum number of services, g_t, that is stochastic. To produce these services, the government has to hire different types of workers. I consider public sector wages to be exogenous policy variables determined a period in advance when vacancies are posted. Given a wage schedule, the government chooses the number of vacancies for each type of worker to minimise the total cost of providing the government services. The total costs, in real terms, encompass the wage bill and recruitment costs.

$$\min_{v^{g,i}_t} \sum_i \omega^i \kappa^{g,i} v^{g,i}_t + E_t \beta_{t,t+1} \left[\sum_i \omega^i \frac{w^{g,i}_{t+1}}{p_{t+1}} l^{g,i}_{t+1} \right]$$

$$s.t.$$

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

$$l^{g,i}_{t+1} = (1 - \lambda^{j,i}) l^{g,i}_t + q^{g,i}_t v^{g,i}_t, \quad \forall i,$$

where $g(\mathbf{l}^g_t)$ is the production function of government services that use the four types of workers, $\mathbf{l}^g_t$. Given the level of public wages and market tightness, the government has to guarantee that it posts sufficient vacancies to maintain an employment level capable of

providing its services. The first-order conditions are

$$\frac{\omega^i \kappa^{g,i}}{q_t^{g,i}} + E_t \beta_{t,t+1} [\omega^i \frac{w_{t+1}^{g,i}}{p_{t+1}}] = \zeta_t E_t g'_{i,t+1}, \quad \forall i, \tag{31}$$

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's employment of type i workers.

The government budget constraint in real terms is given by

$$\tau_t \left(\sum_j \sum_i \omega^i l_t^{j,i} \tilde{w}_t^{j,i} + \tilde{r}_t K_t \right) = \sum_i \omega^i l_t^{g,i} \tilde{w}_t^{g,i} + \sum_i \omega^i v_t^{g,i} \kappa^{g,i} + \chi^b u_t + T_t + \bar{g}^{int}, \tag{32}$$

where T_t are lump-sum transfers and $\bar{g}^{int}$ are exogenous purchases of intermediate goods. The costs of recruiting are external, meaning they come out of the budget constraint. I consider two cases: one where any adjustment of the government budget is guaranteed by changes in lump-sum transfers and the other where distortionary income tax rate adjusts to balance the budget.

Central bank
Finally, the central bank sets the following nominal interest rate i_t

$$1 + i_t = \rho^m (1 + i_{t-1}) + (1 - \rho^m)(\frac{1}{\beta} + \phi(\pi_t - 1)), \tag{33}$$

where $\pi_t = \frac{p_t}{p_{t-1}}$ is the inflation rate, ϕ is the response of the target interest rate to changes in inflation and ρ^m is the degree of persistence of the interest rate. **Market clearing** The market clearing conditions in the intermediate and final goods' markets are

$$x_t^i = \omega^i l_t^{p,i} f^i(a_t, z^i, k_t^i), \quad \forall i, \tag{34}$$

$$Y_t = F(\mathbf{x}_t) = c_t + \bar{g}^{int} + K_{t+1} - (1 - \delta) K_t + \sum_i \sum_j \omega^i v_t^{j,i} \kappa^{j,i}. \tag{35}$$

In this economy, the measure of GDP 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 intermediate goods producers:

$$K_t = \sum_i \omega^i k_t^i l_t^{p,i}. \tag{36}$$

As bonds have zero-net supply, the market clearing is

$$B_t = 0. \tag{37}$$

Business cycle
I assume three main sources of fluctuations: technology, cost-push and government employ-

ment shocks.

$$a_t = (1-\rho^a)\bar{a} + \rho^a a_{t-1} + \varepsilon_t^a, \tag{38}$$

$$\varphi_t^c = \rho^c \varphi_{t-1}^c + \varepsilon_t^c, \tag{39}$$

$$g_{t+1} = (1-\rho^g)\bar{g} + \rho^g g_t + \varepsilon_t^g, \tag{40}$$

where ε_t^a, ε_t^c and ε_t^g are iid innovations with standard deviations σ^a, σ^c and σ^g. $\bar{a}$ and $\bar{g}$ are the steady-state levels of technology and government services, respectively. I assume that, over the business cycle, the government proportionally adjusts the wages of all types of workers as:

$$\log(\frac{w_{t+1}^{g,i}}{p_t}) \;=\; \log(\bar{w}^g) + \iota[\log(\frac{w_t^p}{p_t}) - \log(\bar{w}^p)] + \varphi_t^w, \tag{41}$$

where $w_t^p \equiv \frac{\mathbf{w}_t^p \mathbf{l}_t^p}{l_t^p}$ and $w_t^g \equiv \frac{\mathbf{w}_t^g \mathbf{l}_t^g}{l_t^g}$ represent the average nominal wage in the private and public sectors. The parameter ι measures the cyclicality of wages. If $\iota = 0$ public sector wages are acyclical. If $\iota > 0$ they are procyclical. If $\iota < 0$, they are countercyclical. φ_t^w is an autocorrelated public sector wage shock given by

$$\varphi_t^w = \rho^w \varphi_{t-1}^w + \varepsilon_t^w. \tag{42}$$

I propose and evaluate an alternative simple rule that generates procyclical public sector wages. The government sets the growth rate of public sector wages for the subsequent period Ξ_{t+1}, such that an aggregate target for the average wage is met:

$$Rule: \quad \Xi_{t+1}\frac{\mathbf{w}_t^g \mathbf{l}_t^g}{l_t^g} \;=\; \Upsilon \times \frac{\mathbf{w}_t^p \mathbf{l}_t^p}{l_t^p}. \tag{43}$$

Appendix B: Calibration

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

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

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

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

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

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

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

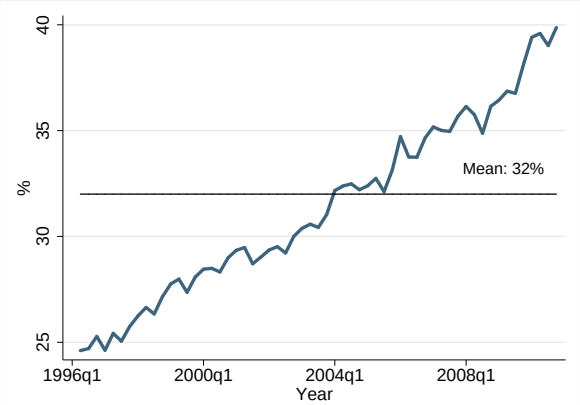
The model is calibrated to match the UK economy on a quarterly frequency. Table A1 summarizes the value of all the parameters and their source. Figures A1-A4 and Tables

A2-A4 show the data and some auxiliary regressions from the Labour Force Survey, used to calibrate the most relevant parameters.

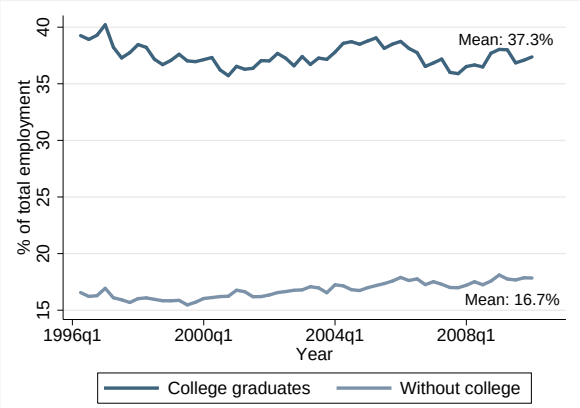
Table A1: Summary of baseline calibration

Fixed parameters fixed	**Source**	**Values**
Public-private wage ratio	LFS	$\frac{\bar{w}^{g,\bar{h}}}{\bar{w}^{p,\bar{h}}} = 1.016$, $\frac{\bar{w}^{g,\underline{h}}}{\bar{w}^{p,\underline{h}}} = 1.039$, $\frac{\bar{w}^{g,\bar{\mu}}}{\bar{w}^{p,\bar{\mu}}} = 1.037$, $\frac{\bar{w}^{g,\underline{\mu}}}{\bar{w}^{p,\underline{\mu}}} = 1.071$.
Job-separation rates	LFS	$\lambda^{g,h} = 0.004$, $\lambda^{p,h} = 0.012$, $\lambda^{g,\mu} = 0.006$, $\lambda^{p,\mu} = 0.018$.
Weights of skilled	LFS	$\omega^{\underline{h}} = 0.16$, $\omega^{\bar{h}} = 0.16$, $\omega^{\underline{\mu}} = 0.34$, $\omega^{\bar{\mu}} = 0.34$.
Matching elasticities w.r.t. unemployment	Gomes (2014)	$\eta^g = 0.15$, $\eta^p = 0.40$.
Substitution between skilled and unskilled	Krussel *et al.* (2000)	$\varsigma = 0.40$
Substitution between high and low ability		$\rho = 0.95$
Depreciation rate	Merz (1995)	$\delta = 0.02$
Discount factor	Galí (2008)	$\beta = 0.99$
Substitution between consumption goods	Galí (2008)	$\epsilon = 6$
Calvo parameter	Galí (2008)	$\gamma = 0.67$
Response of interest rate to inflation	Galí (2008)	$\phi = 1.5$
Inertia of interest rate		$\rho^m = 0.8$
Coefficient of relative risk aversion		$\sigma = 2$
Steady-state income tax		$\bar{\tau} = 0.2$
Productivity	Normalization	$z^{\underline{h}} = z^{\bar{\mu}} = \bar{a} = 1$
Ciclicality of public sector wages	OECD	$\iota = 0.58$
Process of public sector wage shock	OECD	$\rho^w = 0.83$, $\sigma^w = 0.025$
Process of public services shock	OECD	$\rho^g = 0.96$, $\sigma^g = 0.001$
Process of technology shock	OECD	$\rho^a = 0.74$, $\sigma^a = 0.010$
Other parameters	**Target (Source)**	**Values**
Matching efficiency	Vacancy duration (CIPD)	$\zeta^{g,h} = 0.70$, $\zeta^{p,h} = 0.57$, $\zeta^{g,u} = 0.99$, $\zeta^{p,u} = 0.98$
Cost of posting vacancies	Cost per hire (CIPD)	$\kappa^{g,h} = 0.90$, $\kappa^{p,h} = 1.35$, $\kappa^{g,u} = 0.13$, $\kappa^{p,u} = 0.14$
Unemployment benefits	Replacement rate (EC)	$\chi^g = 0.21$
Unemployment utility	Unemployment rate of unskilled (LFS)	$\chi^u = 0.33$
Bargaining power of workers	Unemployment rate (LFS)	$b = 0.28$
Weight of skilled in gov. production	Public employment of skilled (LFS)	$\Phi = 0.74$
Government services	Public employment of unskilled (LFS)	$\bar{g} = 0.13$
Weight of skilled in production	College premium (LFS)	$\Psi = 0.407$
Market ability	Residual wage dispersion (LFS)	$z^{\underline{\mu}} = 0.80$, $z^{\bar{h}} = 1.24$
Elasticity w.r.t private capital	Labour share (AMECO)	$\alpha = 0.35$
Gov. purchases	Gov. consumption (AMECO)	$\bar{g}^{int} = 0.033$
Distribution of preferences	Average search and volatility (*Google*)	$v_1 = -3.41$, $v_2 = 0.35$
Process of cost-push shock	Inflation (OECD)	$\rho^a = 0.7$, $\sigma^a = 0.072$

Figure A1: Share of skills in labour force and in the public sector



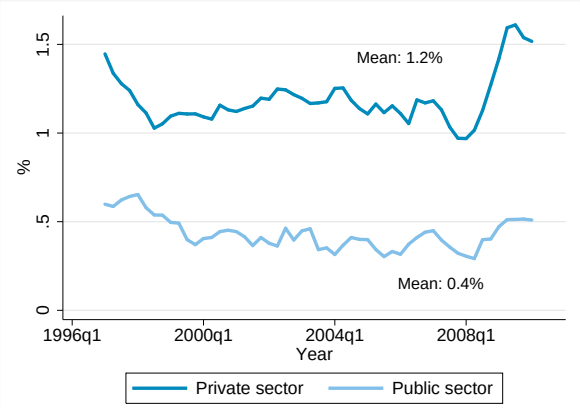
(a) Share of college graduates in labour force



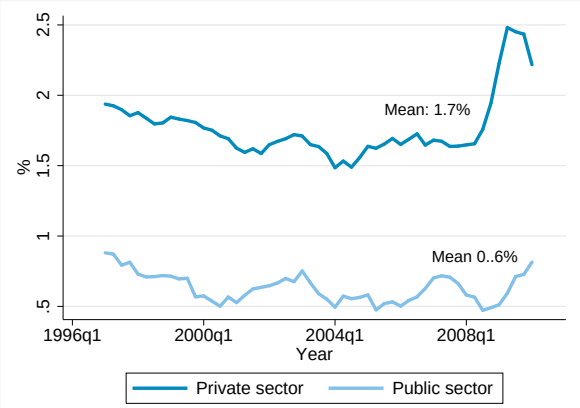
(b) Public sector employment by skill

Source: Labour Force Survey.

Figure A2: Job separation rates



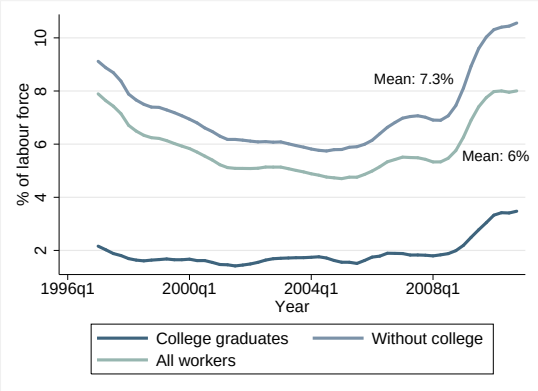
(a) College degree



(b) Without college

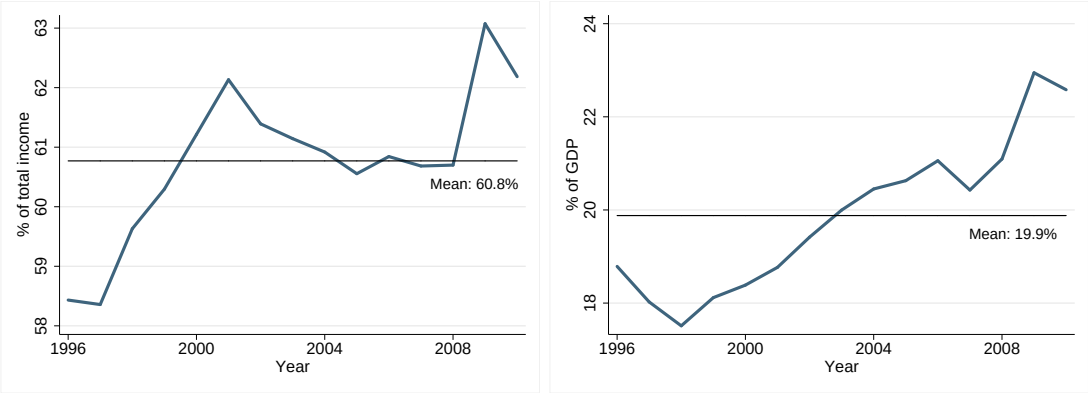
Source: Labour Force Survey.

Figure A3: Unemployment rate



Source: Labour Force Survey.

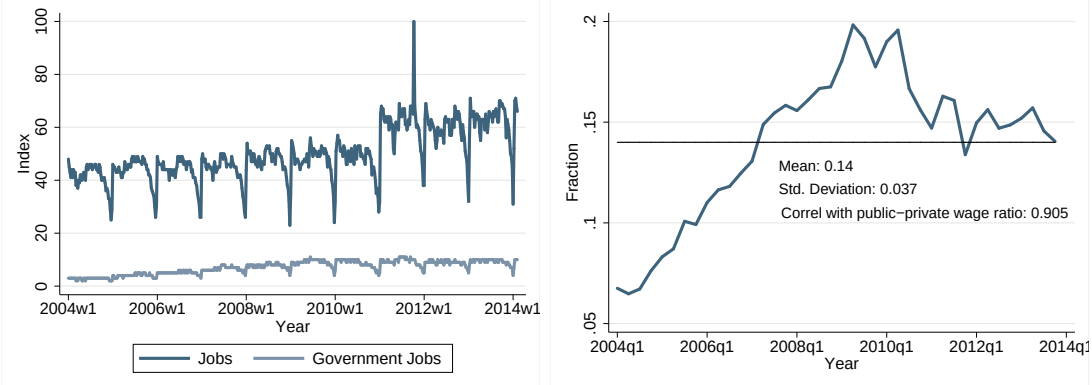
Figure A4: Labour share and government consumption



(a) Labour share (b) Government consumption

Source: AMECO.

Figure A5: Google indexes



(a) Original indexes (b) Search in public sector

Source: Google. The index of search in the public sector includes the following keywords with their relative importance in brackets: 'nhs jobs' (46%), 'council jobs' (32%), 'jobs in nhs' (5%), 'gov jobs' (4%), 'public jobs' (4%), 'direct gov jobs' (2%), 'government jobs' (2%), 'army jobs' (2%), 'local government jobs' (1%), 'raf jobs' (1%).

Table A2: Estimation of public sector wage premium

Education	Percentile	R-squared	Estimated Premium
College educated	75	0.375	0.016
Obs: 84236	25	0.456	0.039
Without college degree	75	0.488	0.037
Obs: 209740	25	0.595	0.071

Note: quantile regression of log net wages on several control variables and a dummy for public sector. Controls include: sex, industry and occupation dummies, status in previous quarter, tenure, age and its square, marital status, time and region dummies, average hours worked and its square. Labour Force Survey: sample from 1996 to 2006.

Table A3: Cost per hire and vacancy duration by sector and worker type

	Cost per hire (£)			Vacancy duration (weeks)		
Type of worker	Manufacturing	Services	Public	Manufacturing	Services	Public
Senior Managers - Directors	13396	18963	10451	16.8	16.5	18
Managers and professionals	8049	12392	6066	12.1	11.8	14.3
Administrative, Secretarial and Technical	3680	5628	1934	6	5.2	9.1
Services (costumer, personal and sales)	4564	1398	2326	6.7	5.6	9.9
Manual, craft workers	2498	2978	1898	5.2	4.5	8.3

Source: Chartered Institute of Personal Development*, "Recruitment, retention and turnover survey", 2008 (Survey of 800 organizations: Manufacturing, Services and Public sector). Vacancy duration in weeks.*

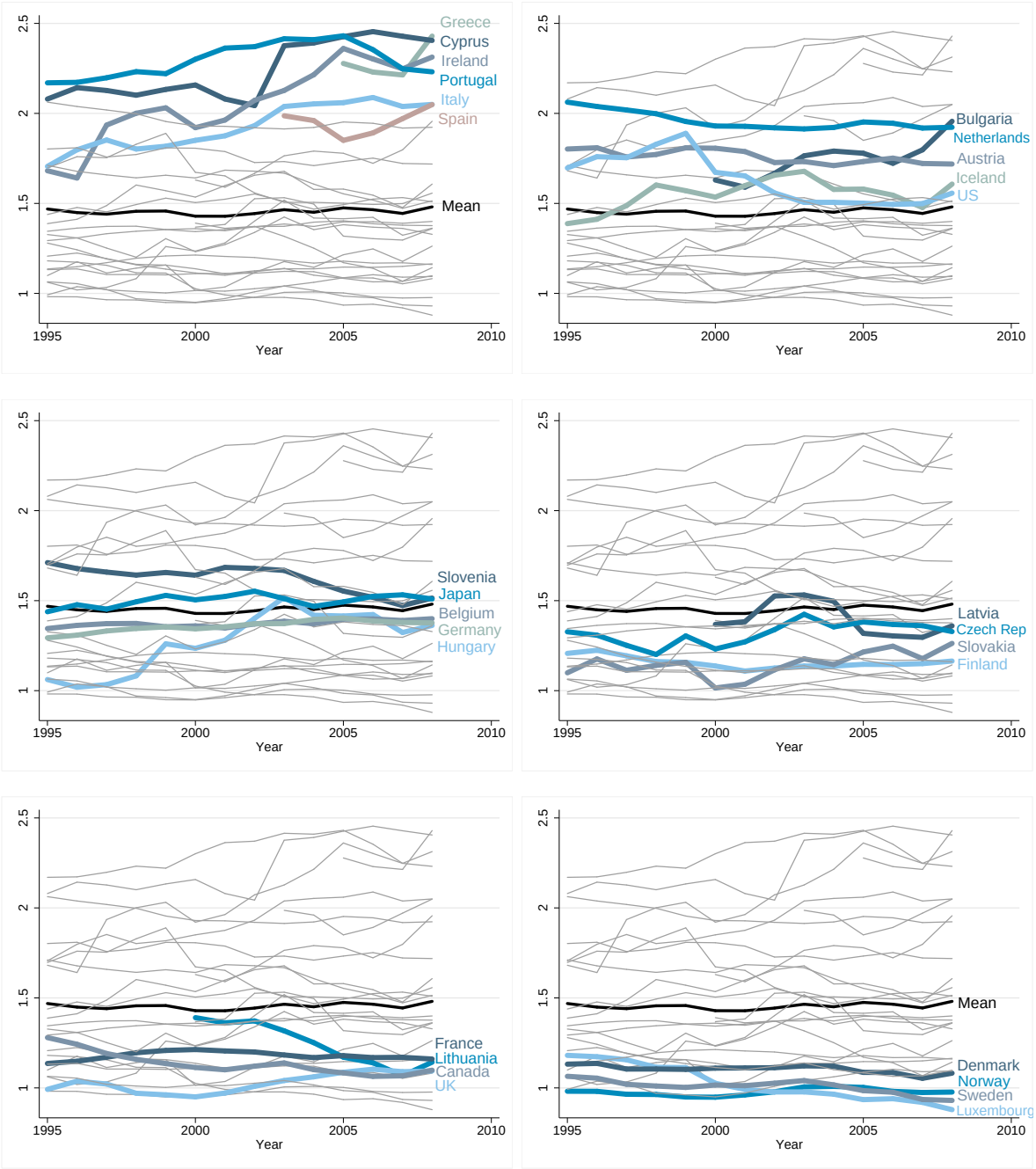
Table A4: Estimation of inter-quantile wage residual

Education	R-squared	Obs.	25-75 percentile residual difference		
			Total (100%)	Adjusted (80%)	Adjusted (20%)
College educated	0.600	44133	0.461	0.368	0.092
Without college degree	0.595	209740	0.416	0.332	0.083

Note: regression of the log of net wages on several control variables: sex, industry and occupation dummies, status in previous quarter, tenure, age and its square, marital status, time and region dummies, average hours worked and its square. Labour fource survey: sample from 1996 to 2006. The fourth column reports the 25-75 percentile difference of wage residuals.

Appendix C: Evidence for OECD countries

Figure A6: Evolution of average aggregate public-private wage ratio for different countries



Sources: compensation to government employees and compensation to employees in the overall economy (AMECO); government employment and total employment (Eurostat); employment data from Austria, Sweden, UK and Iceland (OECD). The average aggregate public-private wage ratio is calculated as $\frac{Government\ wage\ bill}{Private\ sector\ wage\ bill} / \frac{Government\ Employment}{Private\ sector\ Employment}$.